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SUSTAINABLE STORMWATER MANAGEMENT IN JOHANNESBURG'S INFORMAL SETTLEMENTS

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A Research Report submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in fulfillment of the requirements for the degree of Master of the Built Environment in Housing.

Johannesburg, 2013

DECLARATION

I declare that this Research Report is my own unaided work. It is being submitted to the Degree of Master of the Built Environment in Housing to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.

_____

Signature

_____ day of _____, _____

ABSTRACT

Stormwater management is one of the key components of basic infrastructure in the urban environment. It is important in achieving quality living environments in urban informal settlements. This study considers the social and institutional domains of sustainability in relation to stormwater management interventions in the context of Johannesburg's informal settlements. The study follows a qualitative approach, with two informal settlements in Johannesburg serving as case studies. The two settlements are Slovo Park and Elias Motsoaledi. A total of eighteen interviews were conducted with residents in both settlements, during several field visits, and with officials dealing with informal settlements and stormwater in the city. The study shows the specific challenges facing stormwater management in the settlements; the stormwater management and drainage practices adopted by the residents and the potentials of community-led, NGO-assisted initiatives on stormwater management as part of thrusts intended to catalyse *in-situ* upgrading. It also shows that specific stormwater management interventions by the City of Johannesburg are embedded in the context of formalisation of informal settlements, in other words, township establishment. Interim services provided in almost all settlements rarely touch on stormwater management. This study affirms the importance of meaningful participation in stormwater management interventions and approaches that sustain 'socio-human' capacity for resilience in relation to impacts of runoff in informal settlements. The conclusion shows the benefits of catchment-scale model for stormwater management, the potential of green infrastructure and the necessity for policy transition to sustainable drainage systems.

DEDICATION

This Research Report is dedicated to the ONE "*Who giveth rain upon the earth, and sendeth waters* [runoff] *upon the fields"*. Job 5:10.

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This study would have been impossible or at best tortuous without the support of a number of people.

I acknowledge the attention, corrections and direction from my supervisor, Professor Marie Huchzermeyer. I acknowledge financial support received through the DST/NRF programme on Resilience Assessment for Sustainable Urban Development at the University of the Witwatersrand. Views expressed in this report are mine and do not represent those of my funders.

Many thanks to Jhono Bennett and other members of what I call the 'University of Pretoria Slovo Park crew'. Jhono provided useful contacts which helped in negotiating a smooth entry into Slovo Park informal settlement. Carin Combrink's wealth of experience and involvement were sources of valuable information. Colleagues in DST/NRF Programme, Gauteng City-Region Observatory and the School of Architecture and Planning assisted with literature and other useful information. I cannot but remember my parents, siblings, friends and 'my dear', who though were far away still provided the much needed moral support and encouragement.

Aspects of this report have formed part of presentations at various academic fora. The research proposal was presented as a poster titled "Climate Change, Stormwater Management and Informal settlements in Johannesburg: Research Overview" at the Doclinks/Commonwealth Africa European Residential School held at the University of Botswana, Gaborone from 9-12 July, 2012. The case study presented in chapter four formed part of the MBE Housing Seminar Course on Informal Settlement Upgrading, and was earlier presented to stimulate discussion in the Infrastructure thematic group at the Conference on Kenya Slum Upgrading and Prevention Policy. The conference was co-hosted in September 2012 by the University of Nairobi and Pamoja Trust in Nairobi, Kenya. The presentation titled "Sustainable Stormwater management: What is happening in Johannesburg's Informal settlements?" made at the 4th Cross-faculty postgraduate symposium, University of the Witwatersrand on 19 October, 2012 contains some of the findings made from this study. I also explored some of the ideas from this study in the paper titled- "To Upgrade In situ? Pros for Stormwater Management and Drainage in a Johannesburg Informal Settlement". The paper

appeared in Proceeding of the 6th International Conference on Built Environment in Developing Countries, 4-5 December 2012 at the University of South Australia. Adelaide.

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TABLE OF CONTENT

CONTENT	**Page**
DECLARATION	ii
ABSTRACT	iii
DEDICATION	iv
ACKNOWLEDGEMENT	v
TABLE OF CONTENT	vii
LIST OF FIGURES	xi
LIST OF TABLES	xiii
LIST OF ACRONYMS	xiv
CHAPTER ONE	
1 Introduction	1
1.1 Background	1
1.2 Problem Statement/Rationale	2
1.3 Aim of the Study	3
1.4 Research Question	4
1.5 Expected findings and Outcome	4
1.6 Research Methods/Design	5
1.7 Ethical Considerations	8
1.8 Scope/Limitation of the research	8
1.9 Organization of the Research report	9
CHAPTER TWO	
2 UNDERSTANDING STORMWATER MANAGEMENT AND RELATED ISSUES IN URBAN INFORMAL SETTLEMENTS	
2.1 Introduction	11
2.2 Definition of Key Concepts	11
2.3 Stormwater Management Technologies	12
2.3.1 Structural Stormwater Management Measures	13
2.3.2 Non-Structural Stormwater Management Measures	13
2.4 Urbanization and the Stormwater Challenge	15
2.5 Climate Change and the Urban Stormwater Management	15
2.5.1 Precipitation/Rainfall	16

2.5.2 Temperature 16
2.5.3 Adapting Stormwater Management to Climate Change 17
2.6 Challenge of Stormwater Management in Informal Settlements 18
2.7 Flooding in Urban informal settlements 21
2.7.1 Studies on flooding in South Africa's Informal settlements 23
2.8 Conclusion 23

CHAPTER THREE
3 SUSTAINABILITY IN URBAN STORMWATER MANAGEMENT
3.1 Introduction 25
3.2 Understanding Sustainability 25
3.3 Sustainability Indicators in Urban Stormwater Management 26
3.4 Social and Institutional Issues on Stormwater Management 27
3.4.1 Understanding Social and Institutional issues 27
3.4.2 Ostrom's framework for the management and governance of ecosystem resources 28
3.4.3 'Socio-Institutional' factors in Stormwater Management 32
3.5 Socio-institutional factors on SWM in Informal settlements. 33
3.6 Stormwater Management Institutions 34
3.7 Institutional arrangement on Stormwater management: International examples 36
3.7.1 Malaysia 36
3.7.2 Brazil 37
3.8 Research Conceptual Framework 38
3.9 Conclusion 39

CHAPTER FOUR
4 INTERNATIONAL CASE STUDIES OF STORMWATER AND DRAINAGE IMPROVEMENTS IN INFORMAL SETTLEMENTS
4.1 Introduction 40
4.2 Hanna Nassif Settlement Upgrading, Dar es Salaam. Tanzania 40
4.3 Guarapiranga Slum Upgrading Project, Sao Paulo. Brazil 43
4.4 Nhieu Loc-Thi Ngbe Basin Upgrading Improvement Project,

Ho Chi Minh City. Vietnam 46
4.5 NkonIdongo Slum Upgrading Project, Yaounde. Cameroon 47
4.6 Vientiane Area Infrastructure Improvement Project, Vientiane. Lao Republic 48
4.7 Emerging Lessons for Stormwater Management in South Africa 49
4.8 Conclusion 50

CHAPTER FIVE
5 INSTITUTIONAL ISSUES AND INTERVENTION IN JOHANNESBURG'S INFORMAL SETTLEMENTS: PERSPECTIVE ON STORMWATER MANAGEMENT
5.1 Introduction 51
5.2 National Legislative and Policy Framework(s) for SWM 51
5.3 Stormwater Management in the City of Johannesburg (CoJ) 52
5.3.1 Sustainability in Johannesburg's Stormwater Management Policy 54
5.4 CoJ's Interventions in Informal Settlements: Perspective on Stormwater Management 55
5.5 Elias Motsoaledi Settlement Formalisation: Case Study 59
5.5.1 Background Information on the Settlement 60
5.5.2 The State's Intervention in Elias Motsoaledi Settlement 63
5.5.3 Stormwater Management in the Elias Motsoaledi Township and Housing Development 65
5.6 Conclusion 71

CHAPTER SIX
6 STORMWATER MANAGEMENT AND DRAINAGE IN INFORMAL SETTLEMENTS: CASE STUDY OF SLOVO PARK
6.1 Introduction 72
6.2 Background Information on Slovo Park Informal Settlement 72
6.3 Community Organization and the 'Struggle' for Development 74
6.4 Flooding in Slovo Park Settlement 76
6.4.1 Responses to flooding in Slovo Park 77
6.4.2 Are the residents 'inured' to flooding? 77

6.5 Perception on Prevailing Challenges: Climate Change and Dolomitic Condition 78
6.6 Stormwater Management Practices in Slovo Park 79
6.6.1 Building-related Stormwater Management Activities 79
6.6.2 Water Channels 81
6.6.3 Rainwater Harvesting 82
6.6.4 Vegetation (Green Infrastructure) 82
6.6.5 Interventions in the Klipspruit River 84
6.7 Slovo Park Community's Development Efforts 86
6.7.1 Focus on Stormwater Management and Drainage 87
6.8 Conclusion 91

CHAPTER SEVEN
7 STORMWATER MANGEMENT IN INFORMAL SETTLEMENTS: ANALYSIS OF SOCIAL AND INSTITUTIONAL ISSUES
7.1 Introduction 93
7.2 Institutional Mismatch(es) 93
7.3 Counter-intuitions in Institutional Provisions 95
7.4 Catchment Management 96
7.5 Green Infrastructure and Sustainable Drainage System 97
7.6 State intervention versus community-led, self-help initiative 99
7.7 Participation in Stormwater Management in Informal Settlements 100
7.8 Implications for Resilience 101
7.9 Conclusion 103

CHAPTER EIGHT
8.0 CONCLUSION
8.1 Introduction 105
8.2 Summary of Key findings 105
8.3 Area for further Research 107
8.4 Recommendations 107
8.5 Conclusion 108
References 109

LIST OF FIGURES

3.1 Conceptual Framework for the Research 39

4.1 Residents (Women and Men) involvement in the community labour for drainage construction in Hanna Nassif 42

4.2 One of the completed drains in the Hanna Nassif Settlement 43

4.3 A Stromwater drain and walkway constructed through the slope in Guarapiranga settlement 45

5.1 Process leading to intervention in Stormwater Management in Informal Johannesburg's settlements by the Municipality 59

5.2 Location of Elias Motsoaledi settlement 61

5.3 Satellite Image showing location and perimeter of Elias Motsoaledi 61

5.4 Diepkloofspruit river running through the land of the settlement 62

5.5 Flood Hazard Zone around Elias Motsoaledi Settlement 62

5.6 One of the roads opened in the settlement with the gullies that convey water 64

5.7 Ongoing construction activities on the Elias Motsoaledi Housing Project 65

5.8 Proposal for the Elias Motsoaledi wetland/riparian corridor rehabilitation 68

5.9 Proposal for Stormwater Management in the Elias Motsoaledi Housing Project 69

5.10 Stormwater/Greywater drainage strategies of Elias Motsoaledi residents 70

5.11 Stormwater Management strategies in Elias Motsoaledi 70

5.12 Other kinds of Stormwater Management strategies in Elias Motsoaledi 71

6.1 Satellite Image showing Slovo Park and surrounding 74

6.2 Flood Hazard around Slovo Park Settlement 76

6.3 Heaping sand to the wall base for increased stability and barrier against runoff 80

6.4 Walkway paving within stands 81

6.5 An open ditch serving as channel for greywater as well as runoff 82

6.6 A garden irrigated through harvested stormwater in Slovo Park 83

6.7 Cultivated garden (also at foreground) in Slovo Park Settlement 84

6.8 Intervention activities in the Klipspruit river 85

6.9 Intervention activities in the Klipsruit river wetland 85

6.10 University of Pretoria Students and Community members constructing the Slovo Park Community Hall 86
6.11 Concept design for Roads and Stormwater Management in Slovo Park 90
6.12 Drainage System in the Community Hall precinct under construction 91
6.13 Taps and Trees, with the failed drainage system in the public space 91

LIST OF TABLES

2.1 Aspects of Climate Change relevant to Stormwater Design/Planning

5.1 Participation Index on Stormwater Management in Elias Motsoaledi Housing Project

LIST OF ACRONYMS

ADB	Asian Development Bank
AFVP	The Association of French Volunteers (Cameroon)
AT	Alternative Technologies (France)
BMP	Best Management Practices (USA)
BNG	Breaking New Ground
CBD	Central Business District
CoJ	City of Johannesburg
DST	Department of Science and Technology
EMS	Emergency Management Services
FF	French Franc (Cameroon)
GCRO	Gauteng City-Region Observatory
GI	Green Infrastructure
GIS	Geographic Information System
GRET	Groupe De Recherches et d' Echanges Technologigues (Cameroon)
IUSM	Integrated Urban Stormwater Management
ILO	International Labour Organisation
JRA	Johannesburg Road Agency
LID	Low Impact Development (USA)
LIUDD	Low Impact Urban Design/Development (New Zealand)
MEC	Member of Executive Council
MFMA	Municipal Finance Management Act
NGO	Non-governmental Organisation
NIGP	National Income Generating Programme (Tanzania)
NLTH	Nhieu Loc-Thi Ngbe (Vietnam)
NRF	National Research Foundation
HCMC	Ho Chi Minh City (Vietnam)
LEFTA	Less Formal Township Establishment Act
LWU	Lao Womens' Union (Lao Peoples Democratic Republic)
RDP	Reconstruction and Development Programme
SABESP	Sao Paulo Water Supply and Sanitation Coy (Brazil)
SERI	Socio-Economic Rights Institute

SI	Sustainability Institute
SPCDF	Slovo Park Community Development Forum (UK)
SUDS	Sustainability Urban Drainage Systems
UCLAS	University College of Land and Architectural Sciences (Tanzania)
UISP	Upgrading Informal Settlement Programme
UN-HABITAT	United Nations Human Settlement Programme
UNDP	United Nations Development Programme
UP	University of Pretoria
VIP	Ventilated Improved Pit Latrine
WCED	World Commission on Environment and Development
WSUD	Water Sensitive Urban Design (Australia)

CHAPTER ONE

1 INTRODUCTION

1.1 Background

Stormwater management and drainage are some of the indispensable, basic infrastructural systems in the urban environment. Every drop of water brought into the city's terrestrial coverage must be disposed safely. Failure in proper removal results in a plethora of negative consequences, especially where settlements are not formally planned or have not gone through planning approval.

Rapid urbanization in developing countries has resulted in cities that are home to low-income informal settlements. For example, over 60 percent of the urban population in Africa is estimated to live in slums and informal settlements (UN-HABITAT, 2010). These settlements develop with little consideration for drainage, which has meant poor stormwater management and drainage systems in such areas (Parkinson, 2003). The locational characteristics of these settlements also aggravate the problem. Many informal settlements are located on steep slopes, hillsides, low-lying land, river banks, wetlands; which predisposes such areas to runoff related hazards and disasters. A wide range of problems related to flooding and environmental health are prevalent as a result of this situation (Parkinson *et al*, 2007).

Informal settlements have gained the attention of municipal and national authorities in developing countries in the post-millennial period. This has resulted in efforts to provide informal settlements with basic services and infrastructure (including stormwater drainage) as enjoyed in the formal areas of the city. Residents and community groups in informal settlements also take local initiatives aimed at supplying the lack in services and infrastructure, especially stormwater management and drainage. Cairncross and Ouano (1990) show that many informal settlement communities consider stormwater management and drainage as their most urgent need as far as urban infrastructure is concerned.

The concept of sustainability comes into relevance with respect to interventions aimed at improving urban stormwater management in informal settlements. As defined by the Brundtland Report, a development is sustainable when it meets the needs and aspiration of the present generation without compromising the future generations' ability to meet theirs, in the broad social, economic and

environmental aspects (WCED, 1987). This applied to the stormwater management realm implies that a stormwater management intervention is only sustainable when it is socially just and acceptable, institutionally fair, economically sound and seeks to conserve environmental and ecological resources rather than destroy them.

This study considers social and institutional aspects of sustainability in relation to stormwater management and drainage in urban informal settlements. It explores this in the context of the city of Johannesburg in South Africa.

1.2 Problem Statement/Rationale

Informal settlements are one of the consequences of urbanization in developing countries. In South Africa, many people in search for new opportunities in the cities settled illegally on vacant lands which have become informal settlements. The Gauteng City-Region Observatory's (GCRO) presentation on the 2011 national census figure shows that 19.3% of the households in the Gauteng province of South Africa live in informal or traditional dwellings (GCRO, 2012). For Johannesburg, Huchzermeyer *et al*'s (forthcoming) analysis, based on the Upgrading Informal Settlements Programme (UISP)'s definition of informal settlements, found that there are 146 informal settlements in the city with probably less than 7.5% of households living there. This percentage nevertheless shows the notable place informal settlements have in the city.

These settlements by their precarious location and characteristics are highly vulnerable to runoff-related impacts including disasters. Some of the settlements in Johannesburg are located on dolomitic land. The inundation of rainwater or percolating ground water can gradually dissolve the content of dolomitic soil which may lead to ground movements on the surface such as sinkholes or dolines (Department of Public Affairs, 2003). A number of settlements in the city also fall within the flood hazard zone as delineated by the GCRO using data from the Johannesburg Road Agency (JRA). Ponding of water and increased peak volume of runoff as a result of increased rainfall intensity attributable to climate change and variability (WSP Environment and Energy, 2009), means a rising situation of vulnerability in these inadequately 'infrastructured' settlements. These conditions underscore the importance of sustainable stormwater management and drainage systems.

Another problem is the limited body of knowledge dealing specifically with sustainable stormwater management in the context of urban informal settlements. Although there are generic principles on stormwater management in the literature, the dominant 'models' of stormwater management and drainage originate from developed countries like United States, Australia, United Kingdom. These origins are of different economic and climatic context to a developing country like South Africa. These models also do not automatically fit into the context of urban informal settlements in developing countries.

In the literature I was able to access for this study, the focus on stormwater management and drainage interventions in informal settlements is primarily in the area of technical solutions, neglecting the social and institutional context within which these interventions are embedded (Ameyibor et al, 2003; Reich and Sherman, 2008; Kastoryanco, 2010). There are few studies acknowledging the debilitating impact of weak social and institutional structures in stormwater management in informal settlements (Armitage et al, 2010; Armitage 2011). Literature on general urban stormwater management shows that major impediments to sustainable interventions are not the technical issues but the social and institutional considerations (Maksimovic and Tejada-Guibert, 2001; Brown, 2008).

It is therefore relevant to undertake a study that investigates social and institutional domains of sustainability with respect to stormwater management interventions in informal settlements. The conditions of vulnerability, as a result of dolomitic land, and flood risk in its informal settlements position Johannesburg as a relevant context where these issues can be explored.

1.3 Aim of the Study

This study sets out to investigate the social and institutional domains of sustainability, with respect to stormwater management, in informal settlements. By bringing in the reality in two of Johannesburg's informal settlements, it intends to point towards means by which stormwater management and drainage interventions can be socially and institutionally sustainable. To achieve this, it provides a review of relevant literature that relates to urban stormwater management and drainage in informal settlements. This review homes in on the context of Johannesburg in order to provide contextual understanding and

background. The study's overall aim through the literature review and reality in the two settlements is to enhance knowledge, and improve understanding of stormwater management and drainage in urban informal settlements, in order to enhance sustainability in this sector.

1.4 Research Questions

This study is guided by the following research questions.

Main Question

What is the interplay between social and institutional issues with respect to sustainable stormwater management in Johannesburg's informal settlements?

Sub-Questions

- What are the specific challenges for stormwater management in the context of Johannesburg's informal settlements?
- What are the institutional issues in relation to sustainable stormwater management interventions in Johannesburg's informal settlements?
- What are the social issues within informal settlements around improvements in stormwater management and drainage?
- In what ways do these social and institutional considerations limit or advance sustainability on stormwater management interventions?

1.5 Expected Findings and Outcome

This study hopes to find out factors that confound social and institutional sustainability around stormwater management interventions in the context of Johannesburg's informal settlements. Such factors would relate to, but not limited to, uncoordinated approaches, institutional mismatches, and contradictions in policies. It expects to find out the contribution that policy regimes, regulations and guidelines, legislative framework(s) and processes make towards sustainability in stormwater management intervention by the municipality in informal settlements. Within the informal settlements, it expects to gain insight into stormwater management practices, participation and community mobilization in stormwater management, attitudes and perceptions as they also limit or advance sustainability. It expects to find out a certain level of disjuncture between the municipality's efforts and the beneficiary communities in informal settlements.

1.6 Research Methods/Design

The study followed a qualitative research design. This was chosen based on the fact that it affords an array of approaches that facilitates identification of intangible factors which may not be readily apparent (Mack *et al*, 2005). Furthermore, it involves unique steps in data analysis and draws on varying strategies of inquiry (Creswell, 2009). The design also utilised a case study approach. Case study allows an "empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident", relying on multiple sources of evidence (Yin, 1991:23). As Yin (2003:13) states, "you would use the case study method because you deliberately wanted to cover conditions-believing that they might be highly pertinent to your phenomenon of study".

As part of the research methods, I undertook a desktop study which involved in-depth literature review and document analysis of relevant published and unpublished sources which laid relevant theoretical foundation. This included a series of international case studies. Building on this, I conducted interviews in Johannesburg. Those interviewed fall into two categories. The first category of interviewees is officials based in formal institutions, as well as municipal departments/entities that are involved with intervention in, and managing of informal settlements. The second category includes residents as well as community leaders in two informal settlements.

The interviewees in both contexts were selected through purposive sampling. Tongco (2007) justified the use of purposive sampling because it is a form of non-probability sampling that is most effective when studying a domain with knowledgeable experts within. An interview guide was initially crafted for each of the two categories. However, it was not strictly followed in the interviews as issues not captured in the guide emerged while engaging the interviewees. In the course of interviewing officials as well as residents in informal settlements, and where consent was given, I recorded the interviews with the aid of an audio recording device. I subsequently transcribed the interviews. In cases where consent to record was not given, I took notes of all the points raised by the interviewee in a shorthand notebook.

I held eight semi-structured interviews with officials and people affiliated with municipal entities within the City of Johannesburg, private organisations, training institutions and NGOs. All those interviewed are involved with interventions in informal settlements in Johannesburg especially Slovo Park. The interviewees are affiliated with the Housing Department in the City of Johannesburg, Johannesburg Road Agency, Johannesburg Water, University of Pretoria, One-to-One engagement (non-governmental group) and GFC Consulting Enterprises (a private engineering firm).

Two informal settlements within the Johannesburg municipality served as local case studies for this research. They are Slovo Park and Elias Motsoaledi informal settlements, both located south of Johannesburg's Central Business District (CDB). I choose the two settlements because they provide different intervention approaches in terms of improving stormwater management and drainage in a situation of vulnerability to flooding. Elias Motsoaledi is located between Chris Hani Baragwanath Academic Hospital and the Devland Industrial Area in Diepkloof, Soweto. It falls within Region D of the City of Johannesburg's administrative structure and is presently undergoing 'formalization' (so called by the municipality). There is a flood hazard zone, as delineated by the GCRO, within the Elias Motsoaledi settlement which makes stormwater management and drainage a critical issue.

I made three visits between August and December 2012 to the Elias Motsoaledi informal settlement and the construction site of the housing project adjacent to it. I took a transect walk across the settlement and also conducted interviews with four residents. Those interviewed were purposively selected from available residents whose shacks are located close to the river. At the construction site, the site manager who is also a civil engineer guided me round the site and gave explanations on the on-going and proposed phases of work (including the proposal for stormwater management), as well as information about the informal settlement.

Slovo Park settlement is located next to the Nancefield Industrial Area, and lies between Nancefield, Eldorado Park and Bushkoppies in the City of Johannesburg's Region G, sub-area three. The settlement is presently undergoing NGO-assisted, community-initiated, self-help developmental efforts intended to catalyze *in-situ* upgrading. The settlement is located on dolomitic

land. There is also a flood hazard zone to the north-eastern side of the settlement as delineated by the GCRO. There was a flooding event in the settlement in 2008. Both conditions of dolomitic land and flood risk make stormwater management and drainage deserve serious consideration. The vibrant community organisational strides within the settlement are noteworthy.

I was introduced to the Community Development Forum leadership of Slovo Park by a member of One-on-One Engagement (an NGO working in the settlement). The leaders had to give their consent for the research work before I made a schedule of research activities in the settlement. My field visits took place in September and October 2012. During one of the field visits, I had the opportunity to participate in a Community Development Forum leaders' meeting held in preparation for a scheduled meeting with the Gauteng provincial officials. This served as a short informal focus group discussion where some of the research issues were discussed with the leaders.

I also took a transect walk across Slovo Park during one of my field visits. This provided a first-hand observation of the existing stormwater management and drainage systems in the settlement. During the walk, I made a visual analysis of traceable runoff and surface-water flow pattern in the settlement. The field visit days fell within the period marking the end of South Africa's dry winter and the onset of rainy Spring. Due to the first rains, I had an opportunity to observe first-hand the drainage challenges and stormwater management activities put in place by the residents.

I interviewed a total of six residents in the settlement. The six people were purposively selected from two groups identified. The first group are those whose shacks are still located in the area where flooding happened in 2008 and those living close to the wetland adjoining the settlement. The second group are those whose stands were seen to have striking vegetation or greenery. The cases of striking greenery were chosen because of vegetation and green infrastructure's potential in managing stormwater. A resident, who is also an active member in the community development forum acted as field guide and an interpreter in the course of interviews.

My analysis on the information elicited began during the interviews and field work in the settlement. It continued with transcription of interviews, editing and review

of my field journal, pattern-building (comparison between the empirical and hypothetical patterns) and explanation building (contrasting data collected with propositions made at the outset). This follows the positions that analysis in a case study strategy starts during data collection (Creswell, 2009) and runs through multiple stages in the research process (Creswell et al, 2007).

1.7 Ethical Considerations

Obtaining informed consent of participants in this research was vital. I divulged my identity as a university student and the purpose of the study to the participants before engaging them in interviews. They were given the choice to give or withhold their consent, or withdraw at any time during the interview, if they so wished. The residents had no problem welcoming me because they were not new to researchers visiting the settlement. Only two out of the residents approached in Slovo Park settlement declined to participate. They stated that they were busy and could not participate and would not want me to call back. In the course of interviewing, sensitive, personal questions were avoided. Anything that attempted to raise hopes of the interviewees on the outcome of the research, especially in connection with the situation in each informal settlement was also avoided.

1.8 Scope and Limitation of the Research

This study focuses on the social and institutional aspects of stormwater management. It however does not neglect the fundamental and relevant understanding on technical and environmental issues in the drainage and management of urban runoff, in the context of informal settlements. Since the research is part of a one year taught masters programme, the scope of the study is limited to what was possible to achieve within six months of study. The study was financially supported by the DST/NRF funded programme on ‘Resilience Assessment for Sustainable Urban Development’. This research programme involves a strong collaboration between the Gauteng City-Region Observatory (GCRO) and the University of the Witwatersrand, Johannesburg. The broader research programme focuses on the Gauteng ‘city-region’ which naturally dictates the geographical scope for my study.

1.9 Organisation of the Research Report

This research report comprises eight chapters. After the introductory chapter, Chapter Two and Three present an in-depth literature review, which provides the theoretical underpinning and conceptual background for the study. The second chapter deals with explanations of key concepts used throughout the study. It considers the relationship between urbanization and stormwater, stormwater management, and climate change with reference to the context in Johannesburg. It also reviews issues that potentially confound stormwater management and drainage in informal settlements. The chapter is closed with a discussion on flooding in urban informal settlements.

Chapter Three delves into the concept of sustainability in relation to stormwater management. Through a review of sustainability indicators applicable to urban stormwater management, it identifies the social and institutional domains of sustainability, and explains what this implies in the context of informal settlements. It examines how Elinor Ostrom's seminal framework for management and governance of ecosystem resources applies to the urban stormwater management sector. It also discusses models, characteristics and international examples (from Brazil and Malaysia) on stormwater management institutions. The chapter ends with a presentation of the conceptual framework for the study based on literature reviewed in the chapter and the preceding one.

The fourth chapter extends the literature review on social and institutional issues by homing in on five informal settlement upgrading projects from developing countries (Cameroon, Tanzania, Brazil, Lao Republic and Vietnam). The upgrading projects were driven or dominated by improvements in stormwater management and drainage systems. The cases illustrate social and institutional sustainability scenarios for stormwater management interventions in informal settlements. Chapter Five examines legislative frameworks, policies, processes and institutional arrangements around the City of Johannesburg's interventions in stormwater management and drainage in informal settlements. It describes my first case study in Elias Motsoaledi informal settlement, which is currently being 'formalised' by the City of Johannesburg. This case helps to illustrate the municipality's dominant approach for stormwater management and drainage interventions in informal settlements.

Chapter Six focuses on the second and more in-depth case study - Slovo Park informal settlement. It describes the practices, attitudes and perceptions, participation, community mobilisation and thrusts with respect to stormwater management and drainage in the settlement. The chapter also presents the informal institutional context; NGO-assisted, community-initiated, self-help development strides that seek to catalyze *in situ* upgrading with a perspective on stormwater management and drainage.

The seventh chapter presents an analysis of the social and institutional issues earlier raised in Chapter Five and Six as they relate to the two cases. It links the findings back to the conceptual lens and research framework that earlier emanated from the literature review. It argues for a sustainable intervention paradigm which can emanate from a change in the municipality's present top-down approach to participatory bottom-up ways of engaging with stormwater management challenges in informal settlements. Lastly, Chapter Eight provides a summary and conclusion on issues emanating from the study.

CHAPTER TWO

2 UNDERSTANDING STORMWATER MANAGEMENT IN URBAN INFORMAL SETTLEMENTS

2.1 Introduction

Stormwater management in urban low-income informal settlements is a critical but potentially complex realm of knowledge. This chapter presents a literature review, which attempts to provide background understanding with respect to the management and drainage of stormwater in the context of informal settlements. It defines key concepts in the realm of stormwater management. It reviews the relationship between urbanization and stormwater, and also examines the impact climate change has on stormwater management, homing in on Johannesburg. The chapter discusses inherent challenges in informal settlements that tend to confound stormwater management and drainage. It discusses flooding in informal settlements (which comes as a consequence of inadequacy in urban stormwater management) and closes with a reflection on the South African context in this regard.

2.2 Definition of Key Concepts

Water that originates from precipitation events such as rainfall, snowmelt and hail-fall is referred to as stormwater. The stormwater that is not absorbed by the ground becomes runoff. Stormwater is however different from wastewater and greywater. Greywater is generated from household activities such as dish-washing, bathing and laundry, but does not include human excrement (Madungwe and Sakungwa, 2007), while wastewater encompasses all household generated water including water with human excrement (Commonwealth of Australia, 2011). The trio of greywater, wastewater and storm runoff are potentially detrimental to the environment at its source and to the receiving water bodies; hence the necessity for serious consideration towards their proper drainage and management.

Authors tend to define stormwater management from different angles due to its wide scope. The definition given in the New York State's Stormwater Management Design Manual (NYDEP, 2010) is quite explicit. The Manual defines stormwater management as

> "any structural or non-structural strategy, practice, technology, process, program, or other method intended to control or reduce stormwater runoff and associated pollutants, or to induce or control the infiltration or groundwater recharge of stormwater or to eliminate illicit or illegal non-stormwater discharges into stormwater conveyances" (NJDEP, 2010:7).

The two main strands in the objectives of stormwater management are pollution prevention (water quality) and runoff volume control (water quantity).

The concept of Integrated Urban Stormwater Management (IUSM) borders on a holistic approach to managing stormwater. It is targeted at multiple environmental benefits which include, but are not limited to, improving runoff quality, reducing the risk and impact of flooding, delivering additional water resource to augment water supply (British Colombia MLA&P, 2002). IUSM recognises the relationship between the natural and built environment, and manages them as integrated components of the same watershed (*ibid*), although 'its function[s] depend on climatic conditions' (Backstrom and Viklander, 2000:1238).

An integrated management approach for stormwater is often the goal of the dominant sustainable stormwater management 'models'. These 'models' are identified below. In Australia, the integration of 'stormwater best management practices into urban planning and design to achieve multiple objectives' is known as 'Water Sensitive Urban Design' (WSUD) (Lyod et al, 2002:1). This is analogous to what is referred to as 'Low Impact Urban Design and Development' (LIUDD) in New Zealand, 'Alternative Technologies' (AT) in France, 'Low-Impact development' (LID) or 'Best Management Practises' (BMP) in the United States and 'Sustainable Urban Drainage' (SUDS) in the United Kingdom.

2.3 Stormwater Management Technologies

Strategies for stormwater management utilize structural measures, non-structural measures or a combination of the two. A balanced combination of the two measures according to Parkinson (2003:119) is an aspect of comprehensive and integrated urban stormwater management.

2.3.1 Structural Stormwater Management Measures

Parkinson (2003) describes structural stormwater management strategies as physical interventions and devices, engineered infrastructure intended to improve drainage systems. They can be the conventional 'brick and mortar' devices or those based on natural systems. Structures based on natural systems utilize vegetation or soil mechanisms as part of their functioning and in that sense they are known as 'green structures' or 'green infrastructures' (Pennsylvania, 2005:198). Ponds (dry and wet), infiltration trenches, oil and grit separators, underground storage systems (e.g. sedimentation tank), natural or constructed wetlands are examples of structural measures. They are designed and constructed to trap pollutants from runoff and purify it, reduce runoff velocities, collect stormwater and slowly release it to appropriate destination(s). Different types of structural measures can be used on the same site.

2.3.2 Non-Structural Stormwater Management Measures

The social, institutional and pollution prevention practices designed to prevent pollutants from entering runoff or to manage the volume of stormwater can be referred to as non-structural stormwater management measures (US, EPA 1999; DE/Swan River Trust, 2005: v). They are directed towards mitigation of flood impacts and rely predominantly on behavioural changes (Parkinson, 2003:120); through government regulation, persuasion or economic instruments (Taylor and Wong 2002). They do not involve fixed, permanent facilities. Taylor (2002: unpaginated) describes them as the use of "tactics other than capital works to minimize stormwater pollution and the subsequent harm to waterways" while Scholes *et al* (2007: unpaginated) call them "good housekeeping practices".

Classification of non-structural stormwater management measures found in the literature shows the five core categories described below.

i.) Town planning controls: These are statutory planning instruments addressing stormwater quality and quantity in new/existing developments, at both site-based and city-wide scale. A good example is the 'Red Book' (CSIR, 2000) which provides guidelines for stormwater management strategies among other things in the South African built and natural environment. These controls aim at site design and development with reduced impervious surface areas.

ii.) Strategic planning and Institutional controls: These include city-wide stormwater quality management plans, securing funding mechanisms to support the implementation of such plans (Taylor and Wong, 2002). It also includes the administrative and human capacity framework.

iii.) Pollution prevention procedures: These are practices undertaken by stormwater management authorities which involve maintenance activities (*ibid.*). Examples of such include street sweeping, waste/litter collection, graffiti removal, integrated pest management, road de-icing in cold climates, maintenance of drains/road/bridges. It also includes elements of environmental management.

iv.) Education and participation programs: These involve information dissemination, persuasion and involvement by target audience. Examples include media campaigns, anti-littering signage, educational programs, public participation through clubs and associations targeted at behavioural change in aspects that impact on stormwater quality, quantity and waterway health.

v.) Regulatory controls: These are legislation and local laws passed and enforced to address specific forms of pollution or control for high risk activities. They are to enhance connections and channels, improve erosion and sediment control on building/construction sites, waste disposal and handling. Example of such as pointed out by Lehner et al (1999) is a rebate system offered to encourage the conversion of existing turfed areas to resource sensitive alternatives, and xeriscaping on new developments. The use of water-conserving (or drought-resistant) plants, therefore reducing or totally eliminating the need for irrigation is known as xeriscaping.

Non-structural stormwater management measures have advantages over structural measures, although they cannot happen without at least a minimal form of structural intervention. Non-structural measures are relatively inexpensive and cover broader areas in comparison with structural measures. They also fit into the context of already developed areas where it might be impossible or difficult to implement structural measures. Non-structural approaches also factor in the concept of community participation.

2.4 Urbanization and the Stormwater Challenge

Urban growth impacts on drainage and stormwater management systems. As the population in cities grows, more buildings and houses are built. More areas are covered with roofs and impermeable road paving. These developments lead to an increase in the amount of water to be removed by drainage during rainfall. In the course of construction, removal of vegetation and change in soil condition, mostly through compaction, takes place; which reduces the soil's capacity to retain water and resist erosion (Cairncross and Ouano, 1990). Replacement of previously pervious surfaces with impervious ones and modifications in drainage channel (natural or constructed), alters the characteristics of runoff hydrograph (Goonetilleke et al, 2005). Land use/land cover modifications associated with urbanization result in hydrological consequences (Booth 2006), which negatively affects urban catchment (Booth and Jackson, 1997; Goonetilleke et al, 2005). The hydrological consequences in quantitative terms include, increased runoff peak and peak volume, reduced time to runoff peak (Mein and Goyen, 1988), and in qualitative terms means the degradation of natural habitat and water courses (Walsh et al, 2005:691).

Stormwater management challenges are pronounced in the cities of developing countries. Most large cities in developing countries (with the exception of Johannesburg and some others), are located on the coasts or estuaries of rivers which serve as seaports or commercial arteries for transportation of goods. These areas have high average rainfall, but the usually flat estuarine terrain and soft alluvial soil make draining water difficult (Cairncross and Ouano, 1990). Improper urban planning and management, inadequate and poorly enforced development control mechanisms and the emergence of low-income settlements with little or no consideration for drainage aggravates the problem of stormwater management (Parkinson, 2003; Armitage, 2011).

2.5 Climate Change and the Urban Stormwater Challenge

The challenge of managing stormwater in cities is exacerbated by the potential indicators of change and variability in the global climate systems. Elements such as precipitation and temperature in the context of climate change directly and indirectly impact the way stormwater would be managed.

2.5.1 Precipitation/Rainfall

It is very 'likely' that heavy precipitation would increase in many regions of the world in the 21st century (IPCC, 2012:9). For Johannesburg, rainfall is expected to increase moderately and then significantly into the future. Projections reported by WSP Environment and Energy (2009) for the City of Johannesburg shows that this would involve lengthening of the rainy season; particularly into early autumn, potentially starting earlier in spring and an increase in both the frequency and intensity of the rains. However, Archer et al (2010) only indicated changes in total rainfall and increase in amount per event for Johannesburg. They express the need for further and detailed investigation for a firmer position. Notwithstanding the inconclusiveness, the expectation of precipitation increase is valid. This would mean the magnitude of storm events and runoff are going to rise.

Due to higher humidity and rainfall, potentially attributable to climate change, WSP Environment and Energy (2009:17) predicts increased blockages associated with plant roots in stormwater infrastructure as a result of a more active and longer plant growth season. At present in the City of Johannesburg, stormwater management is under-resourced with respect to expenditure on upgrading and routine maintenance (*ibid*). Blockages would therefore increase the risk of urban flooding as the stormwater infrastructure which at present is not optimally efficient might be overwhelmed with the increased pressure. Poorly drained, low-income informal settlements also would become more vulnerable as a result of this.

These ideas follow Randall's (1981) earlier warning. Much before the global awareness of climate change and variability, he showed that varying rainfall pattern and increasing population in cities lead to limited opportunities for future water impoundment, rising impoundment costs and increased interdependence among water users in the cities. This means that population growth and increased rainfall attributable to climate change in Johannesburg has serious implication for water management, especially stormwater management.

2.5.2 Temperature

At a global level, there are strong indications from climatic projections for general and significant increase in temperature which would impact average seasonal temperatures. The average of the seven climate model projections of the Climate

Systems Action Group for Johannesburg indicates an “annualised temperature increase in the order of 2.4℃ by the “near future” and 4.5℃ by the “far future”, meaning an increase in average maximum day-time temperature and average minimum night-time temperature (WSP Environment and Energy, 2009). This predicted increase is likely to result in faster evaporation from organic surfaces and water bodies, causing increased losses from large water dams and other storage facilities supplying water to Johannesburg as well as Gauteng Province (GDARD, 2011:38). More water would be consumed by humans and animals due to warmer summer time temperature (Booth, 2006), which has negative implications for a water-stressed region such as South Africa. Stormwater management therefore, especially in the under-serviced informal settlements needs to adapt to these climate change and variability induced stresses.

2.5.3 Adapting Stormwater Management to Climate Change

Exploiting the resource potential of rainwater or stormwater is a notable response in areas where climate change results in water shortage. Harvesting, storage, quality recovery of urban runoff and reuse are useful at buffering seasonal shortages and providing a partial remedy for inter-drought water stresses. This is being applied for instance in Australia (Ward et al, 2008). This approach reduces the quantity of water going into the drainage system (Gerolin et al, 2010); hence a lowered amount of runoff to be controlled. Stormwater runoff, which used to be regarded as a waste product of urban metabolism will have to be recognized as a valuable resource that can no longer be discarded.

Adapting stormwater management to climate change also involves design and planning considerations for new drainage infrastructure and performance enhancement on existing ones. Such consideration is necessary at a catchment scale (Burke and Mayer, 2009:50), since it touches on informal settlements related to such catchment. Design and management of stormwater systems are usually based on data from historical climate/rainfall and flooding events such as 1 in 50, 1 in 100 year storm events. However, with climate change, these historical events are a poor predictor of future events (Environmental Commission of Ontario, 2007) and therefore might become useless in design and planning. Table 2.1 below shows aspects of climate change that should inform stormwater infrastructure design and planning.

Table 2.1 Aspects of Climate Change relevant to Stormwater Design/Planning

Type of Change	Relevance for Stormwater Design/Planning
Increase in heavy rainfall	Increase in total rainfall depth for design on storm events for durations of up to 72 hours
Change in mean rainfall	Change in antecedent soil moisture saturation
Increase in mean temperature	Change in evaporation from soils and ponds, which changes antecedent soil moisture saturation
Increase in wind	Changes in rainfall over complex topography- increase upwind of hills and ranges

Source: Shaw et al (2005).

My literature search indicates an emergent sustainable approach to urban stormwater management in the light of changing climate. The general agreement, based on a growing amount of evidence is that trees, grasses, rain garden, shrubs, parks and so on in a network of natural ecosystem resources (referred to as green infrastructure) can manage storm runoff. Their (vegetation) water retention and purification functions help to manage the quality and quantity of runoff (Mentens et al, 2006; Wise, 2008; Herrera Environmental Consultants, 2008). Green Infrastructure is a significant component of sustainable stormwater management system earlier identified. Button et al (2010) adapted one of these 'models' to the setting of Monwanbisi, an informal settlement in Cape Town. It was however a micro-scale intervention that led to the development of a guidebook applied to that particular settlement.

The implication of this sustainable approach is that planning for stormwater management infrastructure would have to be conceptualised as natural systems. Ruhke (2011) made an illustration of this with the mushroom plant which has a self-organizing network of mycelia fungi and cellular slime molds. Slater (2010) sees designing with nature (engineering/hydrological systems mimicking natural systems) as one of the essentials of climate change adaptation. Benedict and McMahon's (2002) study show that such an approach is more cost-effective compared to the conventional public works projects.

2.6 The Challenge of Stormwater Management and Drainage in Urban Informal Settlements

Low-income, informal settlements account for a notable population in cities of developing countries. They have become part and parcel of South African cities since the demise of apartheid. The 2011 South African National Census report

shows that 13.6% of households live in informal dwelling /shacks (Stats SA, 2012:50). As earlier mentioned, the Gauteng City-Region Observatory's presentation on the census figure shows that 19.3% of the households in the Gauteng province of South Africa live in informal or traditional dwellings. Of these, 7.8% are in backyard shacks, 11.1% in informal settlements and 0.4% in traditional dwellings (GCRO, 2012). The City of Johannesburg's (a municipality in the Gauteng province) list shows that there are 189 'informal settlements' in the entire city (CoJ, 2011a:8). However, Huchzermeyer *et al* (forthcoming) challenge the figure as inaccurate. Huchzermeyer et al's (forthcoming) analysis, based on the Upgrading Informal Settlement Programme's (UISP) definition, found out that there are about 146 informal settlements in the city. If the municipality's figure is not regarded and the latter position by Huchzermeyer et al (forthcoming) accepted, it is still clear that informal settlements have a notable place in Johannesburg.

Informal settlements emerge as spontaneous, opportunistic shelter developments, taking advantage of publicly or privately owned but vacant land. Such lands are often alienated or normally unsuitable for residential development. Locations where such are found as identified from literature include; near streams, wetlands, floodplains and low-lying ground (high water table, flooding problems), former waste-disposal sites, volcanic slopes (toxic gases), land close to airports (with noise problems) or railway lines and steep slopes/hillsides (difficult to build on, access and drain properly). In Johannesburg, some settlements are located on dolomitic land (Murray, 2008). These locations are vulnerable to erosion and flooding, which makes stormwater management and drainage deserve serious attention.

Usually, formal provision for stormwater and greywater drainage does not exist in informal settlements (Winter et al, 2008). Stormwater is therefore usually contaminated by greywater, which might contain elevated faecal bacterial loads (Carden et al, 2007; Winter et al, 2010). In settlements where some form of drainage facilities is provided, such facilities are inadequate, dysfunctional or abused. The transect walk I made in the course of this research showed that vandalism and improper waste disposal are two main sources of abuse in relation to drainage facilities in informal settlements. For example, in its 2010/2011 report, *Pikitup*, the municipal entity in charge of waste management in Johannesburg

shows that only 119 settlements were covered by waste collection services and this was merely at Level 2 cleanliness (Pitikup Johannesburg Pty Ltd., 2011). The City of Johannesburg rates cleanliness on a scale of one to five. An area with a level 5 rating means 100% clean, that is there is no litter 24 hours/7days and an area with level 1 is on the other way round. The excess and uncollected wastes in the settlements are disposed into what serves as stormwater/greywater drainage system. This situation disallows proper conveyance of runoff through those channels.

Informal settlements are generally unplanned and irregular in their spatial configuration. They are often characterized by narrow access routes and lack of precise definition of public and private spaces (Imperato and Ruster, 2003). The disorderly layout and high-density contributes to increased imperviousness which results in high volume of peak runoff. However, many of Johannesburg's informal settlements show overwhelming orderliness and relatively low densities. Huchzermeyer *et al* (forthcoming) explain that such settlements 'have expanded in a pattern of parallel roads, mirroring closely the layout dimensions of formal settlements'. This spatial pattern presents good prospects for in-situ upgrading with easy intervention on drainage and stormwater management in the process.

Dwellings in informal settlements are built without conformity to prevailing planning regulations or building construction standards (Parkinson, 2003). They are self-constructed from cheap, readily available, scrap materials. As a result of this, it is common to have the buildings set into the ground so that the soil can provide some lateral support for the walls (Armitage, 2011:139). I observed that old vehicle tyres were used as support for the wall base in the settlements in Johannesburg that I have had the opportunity to visit. A lowered floor level is a common problem of this kind of construction. As soon as it rains, stormwater finds its way into the building. The roofs are also poorly constructed. The floor becomes moist whenever it rains, due to the poorly installed and leaking roof material. The roof overhang is usually small, if any at all. This allows rainwater to splash on the wall during rainfall. Backyard shacks and other unauthorized extensions in low-income neighbourhoods also increase imperviousness which impact runoff volume.

2.7 Flooding in Urban Informal Settlements

Floods occur when stormwater drainage systems (natural or man-made) are overwhelmed by the quantity of runoff or when runoff overflows the banks of a river or creek. Flooding has gained much attention from scholars. A wide range of literature deals with this topic; ranging from the quantitative approach of mathematical/spatial modelling (Schmitt et al, 2004; Mascarenhas and Mignez, 2002; Apirumanekul and Mark, 2001), through risk and vulnerability (Tran et al, 2009; Awuor et al, 2008), coping strategies (Chaterjee, 2010; Olorunfemi, 2009) to disaster management (Chan, 1995; Kreimier *et al*, 2003). A fair amount of these scholarly works reviewed focus on cities in developing countries. A shift from engineered devices and physical interventions, to non-structural approaches and reduction in human vulnerability, is a notable international flood management strategy trend emanating from these studies.

The usual reason for flooding in informal settlements is their precarious locations and inadequate stormwater management strategies. Global climate change aggravates the risk of urban flooding in these vulnerable areas (ActionAid International, 2006; Douglas et al, 2008) and the devastating impacts of such occurrences are felt most by poor residents of urban low-income communities (Chaterjee, 2010, Parkinson, 2003).

Literature shows that informal settlement residents are usually inured to flooding events. Stephen et al's (1994) study in Indore, India shows that the slum dwellers expect floods and see them (flooding events) as part of their lives. This is also the position expressed by Parkinson (2003) and Armitage (2011). Literature shows that the residents see living nearer sources of job opportunities and existing social support (which comprise neighbours, churches, welfare agencies, NGOs and so on) as more beneficial than avoiding the disadvantages associated with flooding. They generally perceive flooding as a natural and seasonal event. The story however is different from what Santosa (2003) found in East Java informal settlements, Indonesia. The East Java residents worry about the risk floods pose to their livelihood and health. The attitude of being inured to flooding or otherwise can affect stormwater management interventions, both positively and negatively in the informal settlements.

Residents in such informal settlements however engage in practices that seek to manage stormwater in order to prevent flooding while they also devise coping strategies to flooding events. These coping strategies are the means of resilience. Lamond and Proverbs' (2008:64) international comparison shows that resilience to floods can be built through structural measures and non-structural measures. Structural measures refer to those physical devises and systems put in place while non-structural are those measures that do not involve physical intervention and devices.

Chatterjee's (2010) and Sakigele et al's (2012) studied two Mumbai slums and Keko Machungwa settlement in Dar es Salaam respectively. Their studies confirm the fact that residents employ a combination of structural as well as non-structural means to cope with floods. In Mumbai, Chatterjee (2010) identified raised foundations, constructing a second floor or an elevated platform as structural means. However, these structural strategies are practically inefficient because of the residents' poor financial resources and crude construction skills. Non-structural measures for resilience shown by Chatterjee (2010:344) include layers of support network, assistance associations and 'loss redistribution networks'. These measures are attributes of informal settlement which provide means of quick recovery from disasters like flood especially in marginalized communities.

In Dar es Salaam, Sakigele et al (2012) identified structural means to include the use of sandbags and tree logs, raised doorsteps, construction of protective walls and elevated foundations as well as provision of pipe outlets. Community-based, non-structural measures identified include; control of housing development by the municipal council in collaboration with a settlement-based local committee, protests, requesting compensation for those affected and waste management practices (Sakigele et al, 2012).

It must be pointed out that informal settlements do not enjoy adequate formal structural stormwater management interventions that would prevent or make it resilient to flooding. The reliable and efficient means of resilience to flooding at hand therefore are the non-structural measures. These non-structural means are woven into the socio-cultural fabric of each settlement or community.

2.7.1 Studies on flooding in South Africa's informal settlements

There are some studies dealing with flooding (some with an interface on stormwater management) in informal settlements in South African cities. Of all the literature I managed to access in the available time, only one deals with an informal settlement in Port Elizabeth in the Eastern Cape (Solomon and Viljoen, 2003). The majority of literature comes from settlements in Western Cape's Municipalities. Authors like Bouchard et al (2007), Olorunfemi (2009), Button et al (2010), Musungu et al (2012) express the high flood risk in informal settlements in the Western Cape. These studies however bring to fore the possibility of managing flood through appropriate non-structural stormwater management strategies, as they seek to reduce human vulnerability and enhance resilience. Van zyl et al (2009) even put forward the notion that information technology infrastructure can help towards flood risk preparedness.

The risk of flooding is high in many of Johannesburg's informal settlements, although I did not come across literature on flooding or stormwater management in this context except for Ngie's (2012) study on Diepsloot. Ngie (2012) utilised a combination of the conventional GIS approach and social survey to identify and map flood vulnerability in the settlement. She found that dwellings on hill-sides and beside storm drains are vulnerable to flooding. The study also shows the residents' knowledge on flood coping strategies, but such is difficult to implement due to inadequate technical skills and resources (Ngie, 2012:73). These findings are clearly in line with CoJ's (2009:17) observation that its informal settlements either do not have at all or have inadequate formal stormwater attenuation infrastructure which makes them subjected to the worst of the city's flooding events.

2.8 Conclusion

This chapter through a literature review attempted to provide background understanding with respect to stormwater management in informal settlements, also linking this to the context in Johannesburg throughout. Local urban change and global climate change make the challenge of stormwater management huge. Conditions in the informal settlements with respect to location, spatial configuration, being inured to flooding, dwelling construction and so on perpetuates vulnerability to negative runoff related impacts. From literature, it

became clear that residents in informal settlements employ a combination of structural (albeit inadequate) as well as non-structural measures to cope with and enhance their resilience to floods. Since informal settlements are highly vulnerable to surface-runoff related hazards, but bereft of adequate structural stormwater management systems, the development of appropriate infrastructural systems is therefore more than necessary. This is however not the comprehensive solution. The social and institutional contexts into which these physical devices and structural systems are embedded are important. For structural interventions to be sustainable and enhance communities' resilience to the impact of surface water and runoff, they have to be responsive to the social context.

CHAPTER THREE

3 SOCIAL AND INSTITUTIONAL SUSTAINABILITY IN URBAN STORMWATER MANAGEMENT

3.1 Introduction

The concept of sustainability has gained prominence in the last two decades. The concept has huge relevance to the urban stormwater management sector. This chapter, through a review of relevant literature, explores issues in the social and institutional domains of sustainability, in relation to stormwater management in urban informal settlements. It begins with a review of sustainability indicators applicable to urban stormwater management in order to highlight the domains of sustainability in this sector. It explains what social and institutional issues in stormwater management mean and how they relate to the context in informal settlements. The chapter also explores Elinor Ostrom's seminal concept of 'common pool resource' in relation to the management of stormwater as a common ecosystem resource. The chapter discusses the 'models' of stormwater management institutions and considers the cases in Malaysia and Brazil to exemplify these. Distilling the ideas that emanated from literature reviewed in this chapter and the previous one led to the conceptual framework for this research. The framework is shown in the concluding part of the chapter.

3.2 Understanding Sustainability

In the last two decades, sustainability has become the buzzword, principle and goal in development. There are varying positions as to its definition. It is however more generally agreed that attention should be paid to resource utilisation such that it meets the present and future generations' needs, in the broad interconnections of environmental, economic and social realms (WCED, 1987).

Within the last two decades, indicators have been devised to measure the sustainability levels of various systems. 'Sustainability Indicators' (SI), as they are called are very useful towards comparisons (across time and space or with targets), performance reviews, improvement of scientific understandings, informed decision-making or policy change (Milman and Short, 2008:759). It should be leading indicators that account for resilience of a system, based on the understanding that they show the system's ability to provide early warning of

problems as well as adapt to change and continue to function over a long time span (Alberti, 1996; Morrison *et al*, 2001; Milman and Short, 2008). These indicators are applicable to the urban stormwater sector.

3.3 Sustainability Indicators in Urban Stormwater Management

Sustainability in the urban water sector has gained significant attention of scholars within the last two decades. My literature search revealed studies from an ecological perspective (Lundin and Morison, 2002:145; Richter et al, 2003:206), as well as social and economic perspectives (Icke et al, 1999; Hellstrom et al, 2000). The studies considered fresh water, greywater, waste water and stormwater. A major argument emanating from research is that a system cannot be judged as sustainable without due consideration of its surrounding (Kain, 2000), or the interaction between subsystems, parallel systems and superior systems (Sunberg et al, 2004:122). Notwithstanding how fundamental these are, Hirji and Molapo (2002) observed poor understanding on sustainability by certain stakeholders in the Southern African region.

From a sustainability perspective, Sunberg et al (2004:122) explain that stormwater systems are comprised of not only the technical infrastructure that collects precipitation on impervious surfaces and disposes it off. It includes the social dimension representing the organization and individuals that develop, use and maintain the facilities as well as the economy. A number of indicators applicable to the urban stormwater sector have emerged.

Revitt et al (2003) developed sustainability criteria/indicator set within the context of stormwater management, which Ziller and Erthl (2010) refer to as ‘most detailed’. The set of indicators is grouped into social, environmental and economic criteria. The indicators were utilized by Ziller and Erthl (2010) in an assessment of Tehran urban district in Iran. Bardin et al (2002) shows another sustainability Indicator that utilizes a multi-indicator approach. This was related to a stormwater infiltration tank. It allows the comparison between several alternatives at the design stage or during the working phase. Seventeen performances were defined, while other complimentary indicators were proposed in accordance to different levels of data availability (Alfakih and Miramond, 2003).

In the Swedish project Mistra, the Indicator used was developed into five categories of hygienic and public health, social and cultural, environmental,

economic as well as functional and technical (Malmquist, 1999). For each category, one or more indicators were used. The Sustainable Water Industry Asset Resource Decision (SWARD) project in the UK developed its Indicator in primary criteria (social, technical, economic and environmental), secondary criteria and then the actual indicators. Ashely et al (2006) utilised this in a case study which explored sustainable urban drainage system (SUDS) versus conventional drainage.

Sunberg *et al* (2004) present a framework to assess sustainability of stormwater systems. Theirs was based on systems theory with a focus on general system characteristics rather than a case-specific target. The indicator (which was formulated with Swedish conditions in mind) comes under six criteria, namely: Existence, Effectiveness, Freedom of action, Security, Adaptability and Co-existence. In Sunberg et al's (2004) indicator, it is necessary to de-couple the system complexities that are often inherent in the vision and drive towards overall sustainable development, not just towards stormwater management alone.

All these indicators are very useful in evaluating sustainability from a multi-dimensional perspective. The result of such assessment provides useful input towards the emergence of sustainable urban stormwater, and by extension entire water systems. As observed above, the indicators' main domains/dimensions are economic, environmental/ecological, social and institutional with various sub-criteria. This is similar to the four domains arranged at the Wupptertahl Institute where sustainability is described as a prism with economic, environmental, social and institutional dimensions as the corners (Valentin and Spangenberg, 2000). Of specific concern in this study are the social and institutional domains of sustainability in stormwater management. This is considered in the context of urban informal settlements.

3.4 Social and Institutional Issues on Stormwater Management

3.4.1 Understanding Social and Institutional issues

The concept of institutions has been extensively explored, sociologically as well as philosophically, and applied to almost every realm of endeavour. An institution has been defined as conventions that govern decision making process; the people that make and execute these decisions, and edifices created to carry out the results (Gunderson et al, 1995:497). North (1990) and Knight (1992) see it as

set of rules that structure social interaction by shaping or constraining 'actor' behaviour. Cortner (1998) explains that the product of formal and informal rules as well as norms that shape human interactions with each other and the environment also refers to institutions. Linking these definitions to the context of stormwater management in informal settlements shows the relationship between stakeholders and decision-makers at both formal and informal institutional levels.

Institutional arrangements comprise formal and informal aspects. From the perspective of natural resource management, Eggertsson (2010: 711) sees institutions as the formal and informal 'technologies' that guide social life. In the context of stormwater management, Parkinson (2003:124) explains institutions as the way stakeholders routinely think and respond to problems and issues. Formal institutions refer to those administrative, organizational structures or governance apparatuses (programmatic, inter-governmental or intra-governmental), promulgated laws and stated regulations (Pahl-Wostl et al, 2007:5). Informal institutions include customs and practices, management behaviour and those socially shared rules, usually unwritten, created, communicated, and enforced outside of officially sanctioned channels (Helmke and Levitsky, 2004).

There is interaction between formal and informal institutions with a notable overlap. This overlap is the kernel of what I call 'socio-institutional' interplay which in the context of this study is related to stormwater management. Social values and institutions are linked together because values of the past create institutions of the present, while changing values in the present will determine the institutions of the future (Cortner, 1998; Dovers, 2001). Interdependence and synergies between formal and informal institutions could aid collaborative governance styles and enhance transition towards more adaptive (sustainable) water management regimes (Pahl-Wostl et al, 2002).

3.4.2 Ostrom's framework for management and governance of ecosystem resources

Elinor Ostrom (co-winner 2009 Nobel Prize) explored human's interaction with ecosystems in order to show how long-term sustainable resource yields can be maintained. It is important to discuss Ostrom's framework not only for its relevance to the management of an ecosystem resource such as stormwater, but because it is embedded in the social and institutional context of sustainability. Of

note herewith is her concept of ‘common-pool resources’, also known as common property resources. The concept of common-pool resources refers to ‘natural or human-made facilities [or stocks] that generate flow of usable resource units over time’ (Ostrom, 1994:2). She identified two main characteristics of common pool resources. The first is that they (common pool resources) are costly to develop, due to their size and it is impossible to exclude potential beneficiaries from them. The second characteristic is that ‘the resource units harvested by one individual are not available to others’ (Ostrom et al 1994:2); that is, resource use is ‘subtractable’.

As indicated in the definition, common-pool resources consist of both ‘stock’ (can be man-made or natural) and ‘flow’ aspects. This applies to rural settings as well as formal and informal areas of urban centres. For example, a rock outcrop is a natural resource system (the stock). Stone cutting is the flow of resource units from such natural systems. Water is also an example of a common-pool resource. This is so because substantial component of available water resources in both rural or urban settings confers mutually shared, environmental benefits to owners of extractive rights. It is costly to exclude beneficiaries and it is also ‘subject to rival or subtractable consumption’ (Ward et al, 2008:4). For instance, an irrigation system or stormwater system is a man-made or natural (where applicable) resource stock while water for the plants, storm runoff is the flow of resource unit from the system/stock respectively.

Over-use or total destruction is a common consequence/characteristic of common-pool resources, since they are usually open-access. By open-access it is meant anyone interested can gain access and appropriate resource units (Ostrom, 1994:3). Experiments where participants do not know the other individuals involved and also when they cannot communicate with each other have supported this fact (*ibid.*). An over-use/misuse by one user leads to exclusion by some other potential beneficiaries from successful use of resources. In this case, I consider the hypothetical case of a stormwater infrastructure system serving an urban catchment. User A in a particular location (maybe from an informal settlement) might misuse it by allowing waste to spill into or deliberately depositing materials that can impede the stormwater system. He does not know that this act deprives user B in another location (maybe in another informal settlement) from benefiting from the flood prevention/mitigation service

of this stormwater infrastructure. User A's house would therefore become flooded when it rains. If the runoff is to be harvested, stored and reused, such water would have its content already polluted as a result of the first user's action.

Ostrom also studied the structure of long-standing 'common pool resource' institutions in various contexts. This study, combined with her passion for institutional arrangements to manage resources and avoid ecosystem collapse (even if it cannot avert resource depletion) led to the identification of eight design principles for adaptive governance (shown in the Box 3.1). The eight principles are relevant to fairly simple localized biophysical and social systems, local governing bodies as well as complex systems or higher governing bodies (Ostorm 1990; Ostrom 2005). They are capable of facilitating local, robust institutions for effective governance and management of such resources.

Another important point from Ostrom's analysis relates to rules. Sets of rules are often established by users or by government. When these do not cohere with local conditions, sustainability in the long-term may not be achieved as Janseen (2002) and Norberg and Cumming (2008) indicated. Studies have shown that rules must match attributes of the resource system, resource units and the users. Also, the long term sustainability of rules devised at a local level, for example at the informal settlement setting, would depend on monitoring, enforcement and the rules not been overruled or confused by larger government policies (Ostrom, 2009). This is applicable to the context of sustainability in urban stormwater management. The idea underscores the place of congruence between rules and provisions emanating from the formal institutional setting and conditions at the local level of informal settlements.

1. *Clearly defined boundaries:*
   The boundaries of the resource system, and the entities (individuals or households) with rights to use or harvest resource units are clearly defined.

2. *Congruence between rules for appropriation/provision and local conditions:*
   Rules regarding the appropriation of common resources and provision are adapted to local conditions.

3. *Collective choice arrangements:*
   Many individuals affected by harvesting and protection rules are included in the group who can modify these rules and they participate in decision-making.

4. *Monitoring:*
   Effective monitoring by those who may also be part of resource appropriators. They actively audit biophysical conditions/user behavior and are accountable to the users or appropriators.

5. *Graduated sanctions:*
   Users who violate or disrespect community rules receive graduated sanctions from other users, from officials accountable to these users, or from both.

6. *Conflict resolution mechanisms:*
   Users and their officials have easy access to low-cost, local arenas to resolve conflict that arises among users or between users and officials

7. *Minimal recognition of rights:*
   The rights of users to devise their own institutions (to self-organize) are not challenged by external or higher authorities (e.g. by the government).

8. *Nested enterprises:*
   Activities like appropriation, monitoring, enforcement, conflict resolution and governance are organized in multiple layers of nested enterprises and at times with small local common pool resources at the lower/base level.

Box 3.1 Ostrom's design principles for adaptive governance
Source: Ostrom (1990, 2005)

3.4.3 'Socio-Institutional' factors in Sustainable Stormwater Management

Stormwater management is a technical endeavour, has an institutional component and is embedded in a social context. Major impediments to sustainable stormwater management are not the technological issues but the social and institutional ones (Maksimovic &Tejada-Guibert, 2001). A number of authors attest to this. Grigg's (2006:152) institutional analysis shows that 'unless institutional problems are addressed, progress is not possible on the technical issues'. Progress in applying new concepts towards stormwater management, Brown (2008) observes, is slow and suggestive of a range of institutional barriers impeding implementation. With respect to stormwater management, Ellis (1995) notes that institutional inertia may be much more significant than technical issues in pushing forward sustainable urban drainage targets, while Mitchel (2004) explains that institutional structures at times 'constrain integration and innovation'.

Literature from a range of international sources identifies in detail examples of such social and institutional problems in relation to urban stormwater management. Such literature are based on studies from Australia (Brown *et al*, 2006; Lee et al 2010; Brown and Farelly, 2008), United Kingdom (Ellis et al, 2009), United States of America (Roy *et al*, 2008), Korea (Mun, 2012), Brazil (Nascimento et al, 1999) and Malaysia (Sidek et al, 2006). Some of these problems are specifically identified below.

Roy et al' s (2008) comparative study of Australia and the United States shows fragmented responsibilities, lack of institutional capacity, lack of legislative mandate and resistance to change. Mun (2012) identifies inflexibility of development process manuals and ordinances, communication gap between stakeholders and poor knowledge on design, construction and maintenance with the attending benefits of stormwater interventions in Korea. Nascimento et al (1999:304) found out weak municipal institutions, dependence on political support, inadequate budget and inadequate legal tools to regulate waste disposal (illegal dumping) in their study of Belo Horizonte, Brazil. Brown and Farelly's (2008: 839) study indicates insufficient skills and knowledge, organizational resistance to change, lack of political will and limited regulatory incentives in Australia.

These ‘socio-institutional’ problems apply to the context of informal settlements. In urban centres, interventions in informal settlements happen through various municipal institutional structures put in place. Institutional problems affecting such formal structures impact negatively on interventions in informal settlements, especially intervention on stormwater management. Social issues in the informal setting would have the same impact. The following section expands on this aspect.

3.5 Socio-institutional factors in relation to stormwater management in Informal Settlements

My review of literature so far shows the critical role social systems and informal institutional structures play in sustainable stormwater management in informal settlements. Elements of such social and informal institutional issues I could identify from a broad perspective include rules, attitude/behavior, perception, information dissemination and communication, participation, beliefs/customs and so on. As earlier indicated by Armitage et al (2010) and Armitage (2011), many intervention projects in informal settlements have not sufficiently put this into consideration.

Armitage *et al*’ s (2009) study in four Western Cape informal settlements shows that the management of greywater (including stormwater) has a low priority amongst the residents. They found that frequent breakdown in communication and mistrust between residents, ward councillors and local authority hindered progress in physical development of the settlements. This concurs with Carden et al’ s (2007) earlier position from a two-year study in 39 low-income, non-sewered settlements. They found out that social dynamics, attitudes and behavioural patterns significantly impact the way communities deal with water management issues. Winter et al (2008) also points out such shortcoming in their study of three Cape Town informal settlements. They observed that the local authority in charge of these settlements lacks understanding of local-level social dynamics necessary at tackling the problem of greywater (including stormwater) management. Education and training of residents is important if they are to take responsibility after stormwater management interventions are made (Carden et al, 2007).

Owusu-Asante (2009:625) developed an intervention and management decision support tool towards the improvement of runoff quality in the context of informal settlements. After applying the tool in the informal township of Alexandra, Johannesburg, he proposed settlement-based educational programmes among other non-structural/operational measures to enhance stormwater quality in the settlement. Button et al's (2010) work in Monwabisi settlement in the city of Cape Town attempts to integrate the social condition underlying flooding problems with sustainable urban drainage systems (SUDS) adapted to informal settlements. Their work led to a guidebook on stormwater management which they believe can work for informal settlements with similar physical and social conditions to Monwabisi (*ibid.*). All these studies point to the importance of social dynamics in settlements with respect to sustainable drainage systems.

Participation as a social component is important in stormwater management and drainage improvements in low-income informal settlement. The role of an organized, appropriately mobilised community is central. The community's consent, contribution, consensus and collaboration is possible and essential at the design/planning, implementation/construction, operation and maintenance stages (Cairncross and Ouano, 1990; Parkinson 2003). The case of Urban Environmental rehabilitation in one of the slums in Santo Domingo, Dominican Republic illustrates possibilities in this regard (Parkinson et al, 2007). Tasks such as clearing of garbage heaps, digging trenches, building sewers and stormwater drains were done by volunteer and hired members of the well-organized community *(ibid)*. The next chapter presents case studies that illustrate various forms of participation in the context of stormwater management and drainage in informal settlements. Participation is essential to the success of non-structural stormwater management and flood mitigation strategies. Women have a central role to play in this aspect (Parkinson and Mark, 2005). However, utilizing meaningful participatory approaches takes considerable time and might be derailed through conflicting interests of a wide and incoherent diversity of stakeholders in informal settlements (Parkinson, 2003).

3.6 Stormwater Management Institutions

Various institutional apparatuses have evolved towards stormwater management in both formal and informal areas of urban centres. These have largely been government-controlled. Such structures are often formal, conventional,

departmental and bureaucratic (Connor and Dovers, 2004). These institutions are involved in planning, budgeting and expenditure on stormwater management related funds and resources. They host and train relevant human capacity as well as handle regulations, guidelines, standards, legal, maintenance and monitoring in relation to stormwater management. They are also involved in non-structural stormwater management activities such as mobilizing public involvement and public education. Guidance towards 'riparian corridor preservation and restoration' is also provided by stormwater management institutions (Jones et al, 2000:15). For example, a manual towards the restoration of urban streams in Midwest, United States was produced through a partnership between federal, state and local government stormwater management units (Newbury et al, 1998).

Jones et al (2000:1) identifies four stormwater management institutions. They include watershed-based committees; local government agencies; stormwater utilities and privatized institutions. The watershed-based stormwater management approach integrates the management of all resources (land, biological, water, infrastructure, human, economic) within a catchment or watershed (Horner et al, 1994). This model is relevant to the context of informal settlements, since these settlements are often located at different points on the bank of an urban river. Managing stormwater at the watershed scale would touch on all settlements. This is advantageous due to the economy of scale, as it avoids a piece-meal approach to stormwater management. Coordinating, establishing and determining authority as well as raising funds can be challenging because a watershed most times crosses different administrative boundaries thereby involving a variety of parties and entities.

Stormwater Utilities function like municipal water utilities. This involves raising taxes and rates through stormwater management facilities which is in turn used to develop other facilities and programmes for stormwater management. Raising taxes and rates in informal settlements is however contestable, since the residents are generally poor.

Local agencies include government institutions such as public works departments and urban drainage/flood districts. They rely on the local government's authority and funding to address stormwater issues. Privatization on the other hand involves full or partial involvement of the private sector in stormwater management. Privatization has been proven feasible in other water management

sectors (for example water treatment and distribution) and is also possible in the stormwater sector, since stormwater has economic value. It would only require a market-driven approach (Rendall, 1996), but this would be difficult in the context of informal settlements.

3.7 Institutional Arrangements for Stormwater Management: International examples

This section considers institutional arrangement for stormwater management in Malaysia and Brazil. The intention is to gain knowledge on the institutional structures obtainable from international examples and probably draw lessons for the context of informal settlements in Johannesburg, South Africa.

3.7.1 Malaysia

The *Urban Stormwater Management Manual for Malaysia* shows the institutional structure for stormwater management in Malaysia (Drainage and Irrigation Department of Malaysia, 2001). The responsibility for urban stormwater management is shared between the federal, state and local agencies. The Federal Drainage and Irrigation department sees to flood mitigation, while the Department of Environment (DOE) is in charge of stormwater point source pollution. The federal government is also responsible for national policy, strategy and planning. The state shares the responsibilities of stormwater management and drainage with local authorities (*ibid.*).

The state government has the role of state level policy, planning and strategy formulation. Regulatory responsibilities such as establishing legislative framework/support, coordination, public awareness and education, financing, approval and licensing, are shared between the state and local authorities. Emergency management activities such as advance warning, rescue operation, temporary relocation or any other assistance when negative runoff-related events (flash flooding, erosion problems, slope failures, stormwater pollution) happens or are about to happen takes place at the state/local level.

The Urban Stormwater Management Manual shows the fragmented and overlapping environment around stormwater management in the country (Drainage and Irrigation Department of Malaysia, 2001). IDRA's (2011:8) review of Malaysia's stormwater management institutions shows lack of an entity

designated to manage drainage and stormwater in an integrated manner and poor understanding of nationally prescribed guidelines. The Malaysian case once again enunciates the role of institutional structures in stormwater management. Although my brief review could not draw out a direct link on the impact in informal settlements, I believe that institutional arrangement would determine sustainability of stormwater management interventions in informal settlement.

3.7.2 Brazil

In Brazil, federal responsibilities for stormwater management are fulfilled in concert with state and municipal structures. For example, the Environment and Water Resources Law indicates charges from the provision of stormwater management services. This is based on impermeable area and consideration on the possible use of source control measures by the owner. Also, responsibility on flood emergency planning/preparation, response, recovery falls to the Brazilian Civil Defence Organization. The Brazilian Civil Defence is organized according to the diverse territorial scales in a system called the National System of Civil Defence (SINDEC) (Ellis et al, 2007a:48).

With the provision of appropriate policy direction and enabling legislation at the federal level, the local municipalities have the responsibility of service provision and delivery related to surface runoff control and stormwater management. For instance, city councils would state the laws and criteria that control land use. They stipulate design guidelines and building standards with respect to implementation of urban stormwater management systems (Ellis et al, 2007a:43). Gomes (2005) observes that many small towns (with a population under 100,000) do not have organizational and legislative frameworks to manage stormwater. They often reproduce standards adopted in bigger cities and subsequently face huge constraints while trying to enforce them. Ellis *et al* (2007b) recommend political willingness and administrative commitment at the municipal level towards effective intra- and inter-institutional municipal structures for integrative approaches, as a necessity.

Ellis *et al* in the SWITCH research report (Ellis et al, 2007), and conference paper (Ellis et al, 2007b) report on stormwater management in Belo Horizonte - the planned capital city of Minas Gerais state, Brazil. Their study explores regulatory regimes and institutional structures that support integrated stormwater

management in the city. The study shows that a sustainable infrastructural system is only possible with supportive 'national strategic policy and enabling legislation nested in appropriate municipal level organizational delivery structures' (Ellis et al, 2007b). In relation to my study, this means that sustainable stormwater management in urban informal settlements would depend on existing institutional arrangements.

3.8 Research Conceptual Framework

Drawing on the key literature reviewed in this chapter and the previous one, I developed a conceptual framework for this study. A conceptual framework is 'an alignment of key concepts of a study which helps to position it in the bigger research enterprise' (Henning, 2004:26). It is a form of 'intermediate theory' that helps to appropriately and logically connect all aspects of inquiry in the research. Figure 3.1 below presents the conceptual framework for this research. The framework shows elements involved in the relationship between formal institutions, informal institutions and settlements as it relates to the social and institutional domains of sustainability in stormwater management.

As earlier indicated, informal institutions generally refer to socially shared values and rules, usually unwritten and that are created, communicated and enforced outside officially sanctioned channels (Helmke and Levistsky, 2004). On the other hand, formal institutions include promulgated laws, stated regulations, documented processes and other key constituents of administrative and organisational structures (programmatic, inter-governmental or intra-governmental) (Pahl-Wostl et al, 2007:5). In the context of this study, elements of informal institutions to be considered include; practices, participation, perception/attitude and community organization within informal settlements as they relate to stormwater management and drainage. Elements of formal institutions that relate to stormwater management to be considered include; guidelines and regulations, legislative frameworks, policy documents and processes. The two areas of focus are indicated in the shaded portion of figure 3.1 below.

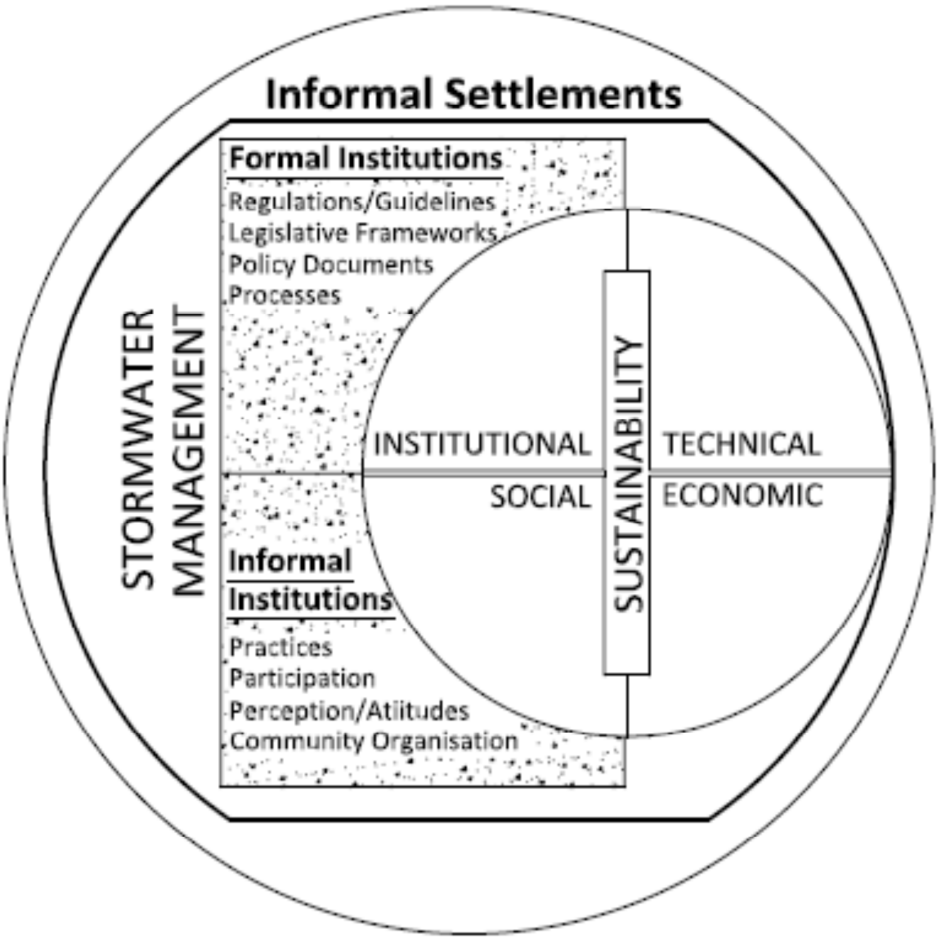


Figure 3.1 Conceptual Framework for the Research, drawn from literature review in this chapter.

3.9 Conclusion

This chapter has shown what social and institutional aspects of sustainability mean, and the role they play in relation to urban stormwater management in informal settlements. Following the conceptual framework described and shown above, this study would explore elements involved in the relationship between formal institution, informal institutions and settlements with respect to stormwater management.

CHAPTER FOUR

4 INTERNATIONAL CASE STUDIES OF STORMWATER/DRAINAGE IMPROVEMENTS IN INFORMAL SETTLEMENTS

4.1 Introduction

Improvements in Stormwater management and drainage are often a partial or dominant aspect in the package of upgrading intervention in urban informal settlements. This chapter extends the literature review on social and institutional issues to case studies of informal settlement upgrading projects dominated or driven by improvements in stormwater management and drainage. I selected five cases from many upgrading projects found in literature, that have taken place in developing countries. The fact that authors and various actors from whom the information presented were sourced adjudged the projects as generally successful informed my choice.

The schemes are Hanna Nassif Upgrading Project in Dar es Salaam, Tanzania; Guarapiranga Slum Upgrading Project in Sao Paulo, Brazil; Nhieu Loc-Thi Ngbe Basin Upgrading/Environmental Improvement Project, Vietnam; Nkonldongo Settlement Upgrading Project in Yaounde, Cameroon and the Vientiane Urban Village Improvement Project in Ho Chi Minh City of Lao Peoples' Democratic Republic. The projects took place over different periods. The schemes illustrate social and institutional sustainability scenarios in stormwater management and drainage interventions in informal settlements. The cases show possibilities for community participation; women's involvement and empowerment; local and international institutional collaboration as well as youth empowerment, among other social and institutional dimensions. The cases provide lessons for future interventions touching on stormwater management and drainage in informal settlements. The objectives, actors, impacts and other aspects of each project are shown below.

4.2 Hanna Nassif Settlement Upgrading Project, Dar es Salaam, Tanzania.

Hanna Nassif informal settlement is located in the city of Dar es Salaam, capital of Tanzania. Lack of drainage infrastructure in this low-income community was leading to flooding in the area (Lupala et al, 1997:4). The residents sought for solutions to this problem, and their aspiration towards upgrading of the settlement

drew the attention of the International Labour Organization (ILO). This eventually led to formulation of the Hanna Nassif Community-Based Upgrading Project in 1992 (IT Transport, 2005:4). Phase I and II of the project was from 1993 till year 2000. The project's main goal was improvement in stormwater management and drainage (Gulyani et al, 2002b). While aiming at this improvement, the project intends to show the possibility of a community-based, employment-intensive approach to slum upgrading through community management and contracting (Lupala, 1997:4). Figure 4.1 shows the community's (men and women) involvement for drainage construction.

Technical support for the project was provided by the University College of Land and Architectural Sciences (UCLAS), now Ardhi University, while the City Council played the role of facilitator/promoter. The ILO and UNCHS (now UN-HABITAT) were associate agencies. Funding came from United Nations development Programme (UNDP), Ford Foundation, European Development Fund (EDF) and local community contributions (Lupala et al, 1997; Clifton and van Esch, 2000). The funds were managed by the National Income Generating Programme (NIGP). The Community Development Committee provided informal institutional platform for community participation and wider residents' involvement in the project (Kyessi, 1997). Design of the stormwater drainage infrastructure evolved out of collaboration/negotiation between the engineers/planners and the community. Labour-based, employment-intense approach and community contracting was used in executing civil works which delivered socio-economic benefits to the local community (Lupala et al, 1997; Clifton and van Esch, 2000).



Figure 4.1 Residents (Women and Men) involvement in the community labour for drainage construction in Hanna Nassif.
Source: From Alphonce Kyessi, 2001 (with permission).

The impact of this project in the community was palpable. Improvements in the stormwater management and drainage infrastructure prevented further occurrence of flooding in the settlement. Water-borne diseases reduced from 4,137 cases before 1996 to less than 2,000 cases in year 2000. Water prices also decreased from 0.06 US$ per 20 litre in 1998 to about US$0.025 per 20 litre bucket in year 2000 (Ministry of Lands and Human Settlement, Tanzania, 2001). The project created about 55,000 employment days between 1994 and 2000. 24,430 days were recorded in the first phase, while phase II had 29,646 days. More than 35% of these were women worker days (Lupala et al 1997:5). Skills on community-based project management, accounting, artisanal works were transferred to residents in course of the project. Training on maintenance of the drains also took place (Gulyani et al, 2002b). Kinondoni Moscow Womens' Development (KIMWODA), a women's group to undertake clearing of the drains was established (Clifton and van Esch, 2000:40).

The Hanna Nassif case addresses aspects of social and institutional sustainability as shown in the research's conceptual framework, though not

limited to them. The social and institutional context into which the stormwater management and drainage interventions are embedded is ideal. With respect to the conceptual framework derived in the previous chapter, the Hanna Nassif case specifically speaks to participation and community organisation. Health improvement, employment creation, skill acquisition, women empowerment as sustainable and enviable consequences of the project is commendable. The case suggest that stormwater management and drainage intervention in Johannesburg's informal settlements could evolve out of meaningful participation and community organisation, while also delivering a plethora of benefits.



Figure 4.2. One of the completed drains in the Hanna Nassif settlement. Photograph by M. Huchzermeyer, 2007 (with permission).

4.3 Guarapiranga Slum Upgrading Project, Sao Paulo, Brazil

Guarapiranga is a large water reservoir in the extreme south of Sao Paulo providing more than 20% of the city's drinking water to some 3 million people in the city's southern region (Sao Paulo City, 1997). People who relocated from other *favelas* in central Sao Paulo settled informally around the Guarapiranga basin. This gained momentum in the 1970s and 1980s (Imperato and Ruster, 2003). In 1999, about 100,000 people were estimated to be living in this area of

which 180 clusters of the slums belong to the municipality of Sao Paulo (Abiko et al, 2007). A huge amount of runoff, sewage and effluent flowed from these areas to pollute this highly resourceful river and degrade the environment (Aulicino et al, 2011). For an environmental recovery of the water catchment area, and resolution of the problem caused by water contamination and sewage disposal from the slum, construction of adequate drainage infrastructure for the slum areas around the reservoir was done (Abiko et al, 2007; Imperato and Ruster, 2003).

The State of Sao Paulo Water Supply and Sanitation Company (SABESP), with World Bank financing executed the project from 1993 to 2000 (Imperato and Ruster, 2003). The residents were to contribute on an ongoing basis the minimal amount they can afford. This was not effective as the chunk of the funding eventually came from the donor and Brazilian government's purse (Abiko et al, 2007). The project involved comprehensive infrastructural provision and adaptation which include drainage (channelling), retaining wall, pavement, extensive sewage collection networks. It also included landscaping along the riparian corridor; creating multiple function parks that serves as open spaces and recreational areas (World Bank, 2001a). See figure 4.3 below capture some of these. Integrated provision of water supply, slope stabilization and solid waste collection in un-served areas also took place while households in risk prone and geologically unstable areas were resettled. Imperato and Ruster (2003) observe that participation to an extent influenced urban design decisions. Huchzermeyer (2004:57) mentions that the contractor drew a quota of labour from resident population. This eased entry for construction works into less accessible areas of the settlement.



Figure 4.3 Stormwater drain and walkway constructed through the slope in Guarapiranga settlement
Photograph by M. Huchzermeyer, 1997 (with permission).

These infrastructural investments led to improvement in the environment and water quality of the Guarapiranga River. After these environmental improvements took place, residents were able to improve their houses themselves. Common areas were maintained (sweeping/picking of trash) by one of the resident who was also hired as a groundskeeper. Property prices in the area rose after the exercise (Smith 2008). The Guarapiranga case shows the possibility of recovering a degraded environment through infrastructural investment in informal settlements. Therefore, rather than indiscriminately evict slum dwellers and clear slums in response to environmental problems, improvement in infrastructure such as drainage and stormwater management can be of help. Notwithstanding the impacts these improvements can make, ‘the engine of change is the community’ (Imperator and Ruster, 2003:364), which is a critical factor in the social and institutional domain.

4.4 Nhieu Loc-Thi Ngbe Basin Upgrading/Environmental Improvement Project, Vietnam

The Nhieu Loc-Thi river basin is a drainage catchment in the urban area of Ho Chi Minh City (HCMC) in Vietnam. The basin covers an area of about 33 square kilometre, incorporating the HCMC centre and other seven districts partially or totally (ADB, 2006). According to the World Bank's report, the Nhieu Loc-Thi Ngbe (NLTH) basin contains a predominantly poor population of about 12,600 to 55,000 persons per square kilometre (World Bank, 2001c). The NLTH canal which runs the length of the basin serves as the main drain and collector for untreated wastewater into which some 280km length of the city sewer discharges. The hydraulic capacity of the canal diminished while the city's sewers draining into it have insufficient capacity for runoff from new developments (ADB, 2006). Flooding along the canal is a regular occurrence during the rainy season as raw sewage overflows into public areas, roads, sidewalks around floor of homes and other structures within the basin (Le, 2008).

The project was funded by the World Bank and HCMC people's committee. The basin's upgrading programme started in mid 1990s with a first phase of 500 metre long canal improvement and construction of houses for relocated residents. This phase tended towards urban beautification. It aimed at reducing flooding, improving environmental quality, health and well-being, promoting economic development and strengthening institutional capacity towards urban drainage system management. This involved separating wastewater from storm drainage during the dry season and dilution of sewage overflows during wet weather (Le, 2008: 81).

Components of the second phase include wastewater, drainage and technical assistance. The wastewater components include the construction of wastewater interceptors, combined storm overflow and canal flushing chambers and wastewater pumping station (World Bank, 2001c). Drainage works include replacement and extension of sewers (primary and secondary) and storm drains to accommodate predicted increase in runoff; dredging sludge and strengthening of canal embankments and extension of tertiary sewers to the homes in the basin not yet connected to the system (ADB, 2006). Technical aspects involve contracts for design, construction management and institutional strengthening *(ibid.)*.

The project led to reduced flooding and improvement of water quality in the canal. Bad odours in the environment reduced, as well as the cost incurred on waste management. Access to public open space and better services improved *(ibid)*. Vietnamese Style (2005) reports a household survey which showed that most residents (87%) believed their living environment became far better. The value of properties in the area increased (ADB 2006:390). Public involvement/engagement and consultation engendered better understanding of the project and its potential benefits. It also led to strengthening of HCMC's human/institutional capacity to design, construct and maintain stormwater and wastewater management systems (ADB, 2006:391).

4.5 Nkonldongo Slum Upgrading Project, Yaounde. Cameroon

Nkonldongo is one of the informal neigbourhoods in city of Yaounde IV in Cameroon. The Nkonldongo settlement Upgrading Project in the municipality started in the early 1990s. It was funded by the French Development Agency at a cost of 1.5 million French franc (FF) and was executed in partnership with two Cameroon-based NGOs – GRET (Groupe de Recherches et d' Echanges Technologigues), and AFVP (the association of French volunteers) (Gulyani et al, 2002a:6). About 25% of the total project cost was borne by the residents (Mabou, 2003:15). The project aimed at improving the living conditions and environment in the settlement through the execution of drainage and water-related infrastructure.

The settlement was bedevilled by the problem of inadequate services, especially drainage, water supply and sanitation. When it rains, the runoff level reaches buildings' floor level, leading to floods in the area (Mabou, 2003). Also, Valley 8 in Nkolndongo was a big swamp where the absence of good roads and stormwater management infrastructure sometimes made access to the nearby neighbourhood impossible or very difficult. Community associations in the area met and reached a consensus to designate these water-related problems as the main challenge and priority in upgrading intervention *(ibid)*.

Youth groups in the area, under the Forum of Associations of Yaoundé IV worked towards the development of the swampy area. They were supported by AFVP and GRET on these interventions which included the construction of a road, small bridge linking two quarters, stand pipes for water supply and drainage infrastructure (culverts, drains). It also involved clearing and deepening of the

river-bed downstream to allow proper draining of the area. The upgrading process led to the comprehensive program of development for the marshy lowlands in order to utilise its unused/vacant spaces in the context of high pressure on land. A sports field was developed from a portion of the land in the formerly swampy area *(ibid)*.

Records show that construction of the new bridge allowed easy passage of about 3000 residents in a day (*ibid*). Development of the vacant swampy lowland prevented invasion by new squatters. Engagements and exchanges on the project led to improvements in the people's know-how on stormwater management and drainage technology. The scheme triggered a new set of initiatives potentially useful for intervention in Cameroon's informal settlements. Lessons drawn from the project was utilized by GRET (the executors) in packaging of subsequent upgrading programs for other parts of Yaounde, for example FOURMI I and II in 1995 and 1996 respectively (Gulyani et al, 2002a:6).

One outstanding and noteworthy aspect of the Nkonldongo scheme is the level of interest shown by the youth in the upgrading process. Informal settlements in South Africa are usually places with a vibrant youth population. The pent energy in these young people can be positively harnessed towards improvements in stormwater management and drainage.

4.6 Vientiane Area Infrastructure Improvement Project, Lao Republic

Vientiane is the capital and major city in Lao Peoples Democratic Republic. The urban area of Vientiane which is located between the Mekong River and hinterland of swamps and ponds is divided into 189 villages and has a total area of approximately 30 square kilometres (ADB, 2001). Flooding was a serious challenge in the dense urban villages of Vietiane. For instance, after primary drainage infrastructure was completed through an earlier project, flooding continued to occur away from the main drainage network (ADB, 2006:200). This was due to absence of parallel interventions at the secondary/tertiary or village level to complement the primary/city wide improvements. The Village area improvement sought to address this challenge.

The Vientiane Urban Infrastructure and Services Project (VUISP) was designed in 2000 as part of Asian Development Bank's Project Preparation Technical Assistance (PPTA) and was funded by the Bank (ADB, 2006:200). The

intervention focused on a range of improvements on roads, surface drainage and waste collection. An earlier Poverty Participatory Assessment showed environmental improvements (especially drainage) as the poor people's priority (*ibid*). The village area improvement component of the larger project sought a demand-led, village-by-village approach to this tertiary level infrastructural improvement.

Rigorous selection of villages to participate in various phases of the project first took place. This selection was based on environmental and health conditions, incidence and severity of flooding experience, conditions of the existing infrastructure, proximity to trunk infrastructure and willingness to participate. Involvement of the Lao Women's Union (LWU) in monitoring, village meetings later facilitated maintenance activities. Design and implementation decisions were participatory through collaboration between engineering and social development professionals, community advisors and village representatives (ADB, 2006:204-205). These infrastructural development projects led to significant improvement in the physical environment.

Participatory approach utilized for design and project implementation as well as the involvement of Lao women, as aspects of social and institutional sustainability, in the Vientiane project is commendable. Attempt to improve infrastructure in South Africa's informal settlements would benefit immensely from participatory design approaches and appropriately mobilised community-based womens' groups. One can learn that women have a positive role to play all through a stormwater management and drainage intervention cycle.

4.7 Emerging Lessons for Stormwater Management Research in South Africa

This section presents a summary of key lessons that emerge from or run through the initiatives briefly reviewed above. The first lesson is that of community participation. Interventions in stormwater management in informal settlements must involve meaningful participation of the beneficiary groups or community. These bring benefits which include but are not limited to empowerment and enhancement of livelihood through job creation, skills acquisition and transfer, smooth running of the project, cost-reduction. For example, recruiting unskilled and skilled labour from residents in the concerned settlement(s) can enhance the

effectiveness of human resources. These benefits make such intervention socially, institutionally and even economically sustainable.

Improvement in stormwater management and drainage convey health benefits on residents. Improved health leads to a plethora of worthwhile benefits. Such is in line with the adage - 'health is wealth'. Improvement in infrastructure (especially drainage) can in the long run lead to house improvements by the residents and an eventual rise in property values in such informal areas.

Mention must be made that women are disproportionately affected by lack of drainage; hence they benefit more from its improvements. They also have critical roles to play in the entire course of stormwater management intervention, especially on non-structural stormwater management measures. The youth too are not left out as an important stakeholder to socially sustainable stormwater management interventions.

Institutional collaboration and partnership is necessary for institutional sustainability. Governmental, international, training, educational, research, community and other non-governmental organisations need to work together for success on infrastructural improvement projects in informal settlements. While improvements in drainage and stormwater management systems would generally rely on funding support from the government or other international sources, local community financial contributions from the beneficiaries can be explored. This enhances their value for such projects.

Stormwater management and drainage improvement within an informal settlement alone is insufficient. It must be complemented by improvements in relevant primary and secondary infrastructure or trunk infrastructure in the entire city.

4.8 Conclusion

The projects considered above have shown possibilities on social and institutional sustainability in intervention in informal settlements, especially when dominated by improvements in stormwater management and drainage systems. The lessons drawn can be brought on board in the attempt to improve stormwater management as part of intervention in informal settlements in Johannesburg and South Africa at large.

CHAPTER FIVE

5 AN INSTITUTIONAL PERSPECTIVE ON STORMWATER MANAGEMENT IN JOHANNESBURG'S INFORMAL SETTLEMENTS

5.1 Introduction

Interventions to improve stormwater management and drainage in informal settlements are embedded in certain institutional contexts. These contexts involve arrangements that are guided by a range of regulations and guidelines, legislative frameworks, policy regimes as available in published and unpublished documents. The state intervenes from the 'top' in informal settlement communities at the 'bottom', based on these institutional provisions. Against this background, this chapter discusses the City of Johannesburg's intervention with respect to stormwater management and drainage in informal settlements, reflecting on this 'top to bottom' relationship. The chapter begins with an examination of national legislative and policy documents that touch on stormwater management and drainage. It extends this to the municipal context in the City of Johannesburg, examining how stormwater management and drainage interventions are handled in informal settlements. The chapter also presents a case study of ongoing state's intervention through 'formalizing' Elias Motsoaledi informal settlement in Johannesburg, with a focus on provisions for stormwater management.

5.2 National Legislative and Policy Framework on Stormwater Management

The primary legal document in South Africa is the national Constitution of 1996. Schedule 4, Part B of the Constitution, under local government matters, touches on the management of stormwater in built-up areas. It places the responsibility of stormwater management with the local government and municipal institutions (Republic of South Africa, 1996). The *National Water Act No. 36 of 1998* is the key legislative document with respect to water resources management in the country. Section 19 (1) of the Act stipulates the responsibility of land owners or occupiers towards the prevention of pollution in natural water resources through runoff. Section 144 shows the requirement for the consideration of 1 in 100 year flood lines before the establishment of township and residential developments (Republic of South Africa, 1998). The *National Water Resource Strategy* of 2004 builds on the legal foundation in the National Water Act to provide a national

framework for integrated water resource management in the country. Recognising rainfall and runoff as critical phases in the hydrological cycle, the framework proposes catchment management strategies for the management of water quality and quantity in urban territories (DWAF, 2004).

Another notable national document that deals with stormwater management is the 'Red Book'. The Red Book was published in 2000. It succeeds the 'Blue Book' earlier published in 1984. The Red Book in its sixth chapter deals with design and planning guidelines on stormwater management and drainage (CSIR, 2000). The guidelines' purpose is to achieve a very low impact of physical development on the South African natural environment. The *National Environmental Management Act No. 107 of 1998* also stipulates individuals and institutional stakeholders' responsibilities toward minimal disturbance and degradation through runoff in the ecosystem and environment (Republic of South Africa, 1998b:11). The Disaster Management Act No. 57 of 2002 prescribes the state's prompt response to the situation and to victims of runoff related disasters like flooding (Republic of South Africa, 2002).

These legislative and regulatory documents recognise that the responsibility for the management of stormwater, in both formal and informal urban areas is domiciled with the local government or municipal authorities. Some of the responsibility also rests with the land owners, developers and occupiers as explained above. These national documents serve as basis and reference point for all other regulations, guidelines or legislation utilised by provinces, municipalities or local government across the country with respect to stormwater management. This means that no provincial or local government can promulgate legislation, establish regulations or evolve arrangements that negate the provisions made at the national level.

5.3 Stormwater Management in the City of Johannesburg

Tackling the challenge of stormwater in Johannesburg, the densest urban conurbation in South Africa, deserves careful institutional considerations. In line with these considerations, institutional apparatuses, legislative and regulatory frameworks recognizing the need, stipulating the provisions, stating the rules and expounding the processes with respect to stormwater management in the city have evolved over time.

Catchment management dimension is a notable and recent institutional attempt in the municipality's approach to stormwater management. The 2010/2011 *Spatial Development Framework* for the City of Johannesburg recognizes the need to address stormwater at a catchment scale. This approach is not only resulting from the increasing inadequate capacity of the existing stormwater management infrastructure, but is influenced by the fact that 'urban development patterns and the stormwater runoff are significant contributors to the degradation of riverine environment' (CoJ, 2010b) in the city. Such degradation to some extent is as a result of runoff from poorly serviced and 'infrastructured' informal settlements located along the riparian corridor of the rivers. In order to tackle the degradation and as part of the development framework, the City formulated a Catchment Management Policy which primarily seeks to enhance the health, biodiversity, ecological and morphological state of rivers and wetlands in the city (CoJ, 2008a). Before the emergence of the catchment policy, CoJ had undertaken a 'Wetland Audit'. The Audit led to a 'Wetland and Riparian Protection and Management Plan' in 2009 (CoJ, 2010b). The plan informs development decisions, spatial planning and management strategies for the promotion of wetlands in the city. The findings of the Audit and contents of the Plan are also captured in the Catchment Management Policy. A notable aspect of the policy is the rehabilitation and conservation of wetlands upstream through intervention in informal settlements and townships (CoJ, 2009:9).

Another document in relation to stormwater management in Johannesburg is the *Guideline Document on Environmental Impact Assessment (EIA) Regulations.* Published in 2010, the document is based on the *National Environmental Management Act* and prescribes regulations for the development (planning, construction and operation) of stormwater infrastructure. The essence of this regulation is that the development of drainage and stormwater management infrastructure itself does not impact negatively on the environment (CoJ, 2010a:15). Also, the *City of Johannesburg Metropolitan Municipality Water Services Bye-laws* amended in 2008 touches on stormwater management. In Section 92, it prohibits the ingress of runoff into sewerage drainage installations while Section 62(2) stipulates the prohibition of foreign substances in stormwater drains, river, stream or natural water courses (CoJ, 2008c:57). This particular law is based on the subsisting principle of conveying stormwater and sewerage through separate channels in Johannesburg.

Responsibility for the implementation and management of stormwater infrastructure in Johannesburg officially lies with the Johannesburg Road Agency (JRA) (JRA, 2004:41). This municipal-based institutional entity ensures that developers, contractors and property owners comply with provisions in the city's stormwater management bye-laws and policy. A key feature in JRA's stormwater management policy statement is the attenuation of stormwater on or off site 'such that the pre-development flows for the 1:5 as well as 1:25 – year storm events are not exceeded' (JRA, 2005). This feature has been enforced since 2002 and is primarily based on the requirements of the National Water Act that the flow in a watercourse should not to be altered in any way (Republic of South Africa, 1998). However, this policy only seeks to regulate stormwater discharge in terms of peak volume and rates (quantity) without proper guidelines on the quality of runoff (Buys and Aldous, 2009:24). JRA also fulfils its stormwater management responsibility as part of the City's intervention to formalize or provide interim services in informal settlements as I will show in relation to Elias Motsoaledi informal settlement later in this chapter.

5.3.1 Sustainability in Johannesburg's Stormwater Management Policy

Sustainable stormwater management and drainage systems are gaining currency as an approach in handling the 'stubborn' problem of urban runoff. With this 'stubbornness' been aggravated by the potential indicators of global climate change, it is important that stormwater management policy in urban territories incorporate a sustainable approach. In the City of Johannesburg, this approach is however not yet part of the stormwater management policy. The knowledge of such approach and benefits it conveys are however not lacking. In fact, two of my interviewees from the City of Johannesburg explained that they have attended a workshop on sustainable stormwater drainage systems (Official 2, personal communication, 27 August 2012; Official 3, personal communication, 6 September 2012). The knowledge acquired by these officials has not yet translated into policy initiatives in the municipality.

Through my interview with Official 3, I identified budgetary constraint as a hindrance to the incorporation of sustainability in stormwater management policy. The municipality, at one instance proposed the implementation of a sustainable drainage system, as a stormwater management strategy in one of its informal settlement formalisation projects. According to the official, who is also in charge

of infrastructure in the Housing Department, this did not materialise due to inadequate funds (Official 3; personal communication, September 06 2012).

My interaction with relevant stakeholders in the urban stormwater management sector in Johannesburg shows a 'stickiness' to traditional drainage systems, expressed through a reluctance for policy transition into sustainable systems. One can link this reluctance to speculations that consultants would earn less professional fees on sustainable stormwater drainage projects. Sustainable drainage systems are often based on green infrastructure and less 'bricks and mortar'. They often cost less to install compared to the traditional 'brick and mortar' projects (Benedict and McMahon, 2002). This means that consultants handling the installation of sustainable stormwater management projects would earn less professional fees, since these are usually based on a percentage of total installation cost. This discourages additional push for policy transition to sustainable drainage systems, that would have come from the concerned professionals.

5.4 CoJ's Intervention in Informal Settlements: A Focus on Stormwater Management

As discussed earlier in this chapter, the various national legal frameworks place the responsibility of stormwater management with the municipality or local government. The City of Johannesburg (CoJ) is the concerned municipal government in the context of this study. Interventions by the City of Johannesburg in relation to stormwater management infrastructure in informal settlements are embedded in the context of what the municipality refer to as 'formalization'. Formalising an informal settlement in Johannesburg involves certain procedures, which are discussed below.

The first step towards formalisation (which includes stormwater management intervention) is the application for formal township establishment for an informal settlement. The application process requires professional expertise (town planner, attorney, land surveyor and so on), feasibility studies and environmental assessment. It also requires input from relevant departments within the City of Johannesburg and municipal-owned entities like JRA (roads and stormwater management), Pikitup (waste management), City Parks (open spaces), City Power (energy) and Johannesburg Water (sewerage and pipe-borne water). Other governmental agencies outside the municipal authority of the City of

Johannesburg (for example Eskom, Telkom, Rand Water) and neighouring municipalities are also brought into the process for their inputs. The application is brought to the notice of the public through print advertisements or any media for comments (Tissington, 2011:17). Approval for the new township should normally be granted or an objection made based on views and comments from these municipal, non-municipal institutions and public forum. However, the processes explained above are often long, tedious, complex and subject to political manipulations.

As Official 3 pointed out to me (personal communication, 12 October 2012), approval for formal township establishment for an informal settlement located in Johannesburg can happen via two legal frameworks. The first framework is the *Town-Planning and Township Ordinance Act 15 of 1986* which is employed by the City of Johannesburg to formalize informal settlements. The other is the *Less Formal Township Establishment Act (LFTEA) Act No. 113 of 1991*. It is the Gauteng Provincial government that utilises LFTEA to establish townships. The Gauteng Provincial Members of Executive Committee (MEC) grant approval for the establishment of a township in any of the municipalities within the Gauteng Province, of which the City of Johannesburg is one. This approval is however not granted independent of the concerned municipality authority. Their input and consent in the process is essential (Official 3; personal communication, 12 October 2012).

Provisions in these two legal frameworks on intervention in informal settlements are not exactly the same especially in relation to the provision for stormwater management. For example, LFTEA allows beneficiaries to move into newly established townships before all the services are installed. In as much as the site is laid out into stands and serviced with at least water and sewerage, beneficiaries would build top structures or occupy RDP houses, if they are built as part of the process. At this instance, they can also receive the relevant title document(s) (Official 3; personal communication, 12 October 2012). Services like roads and stormwater management systems are not a precursor to occupation. They can come later (ibid).

However in the Town-planning and Township Ordinance Act, all services (including stormwater management infrastructure) must have been installed and the houses completed before the beneficiaries occupy such houses and receive

the relevant title document (Provincial Council of Transvaal, 1986). Applicant(s) for the establishment of a township through the Township Ordinance Act may be required to make financial contributions to the installation of stormwater management, roads and other engineering services in the new area. This contribution is determined in accordance with 'administrator guidelines' (CoJ, 2008d). Figure 5.1 captures the difference between the two legal frameworks discussed above.

For a case of intervention in an informal settlement through the Township Ordinance Act by the CoJ, it is only when approval for a new township is already granted or an affirmative assurance is in sight that a detailed design and layout for such township is done with the help of relevant professionals. It is at this stage that detailed considerations on stormwater management are made in line with JRA stormwater management policy. For Johannesburg, the key feature in the stormwater management policy is what I call 'pond and pipe'. I mean conduit 'pipes' convey runoff from source to the attenuation 'pond' located on or off-site. The engineering design for roads in the newly proclaimed or about-to-be-proclaimed township considers stormwater drainage and management. This consideration deals with the way runoff will be collected from the stands, drained through the pipes and transferred by gravity into the attenuation pond(s). The attenuation pond serves as temporary storage to allow for evaporation and absorption by the ground or transfer to the receiving water body.

Engineering design for roads and stormwater management facilities in the course of formalizing informal settlements are commissioned by the CoJ Housing Department. The design however must be approved by the JRA. Construction of the roads and installation of stormwater management facilities in such township must also receive JRA's approval. When construction is completed, inspection is made by relevant stakeholders (clients, consultants, contractors) for final approval before the facilities are handed over to the JRA for operation and maintenance.

The City of Johannesburg does not make any intervention targeted at stormwater management or drainage improvement in informal settlements that has not been proclaimed a township. I learnt that the municipality will not spend on a piece of land that is not designated for formalisation (Official 1; personal communication, 24 August 2012). The municipal officials claim that the Municipal Finance

Management Act No. 56 of 2003 (MFMA) does not allow budgeting and expenditure of state funds on land not legally recognized or that does not belong to the government (Republic of South Africa, 2004). Many informal settlements are not designated for formalisation or have not received affirmative response on township establishment for various reasons which include but are not limited to location on privately owned land, acute geological risk or political manoeuvring. Interventions in such settlements are usually limited to the provision of interim services (Official 6; personal communication, 4 September 2012). Such services include grading of roads only, provision of communal stand pipes for water supply, interval waste collection and Ventilated Improved Pit (VIP) toilets. The roads are graded to enhance pedestrian and vehicular access around the shacks, especially for ambulance in case of emergency. The grading is not done with consideration for the drainage of runoff, although it at times includes shaping gullies through which runoff flows off on the streets.

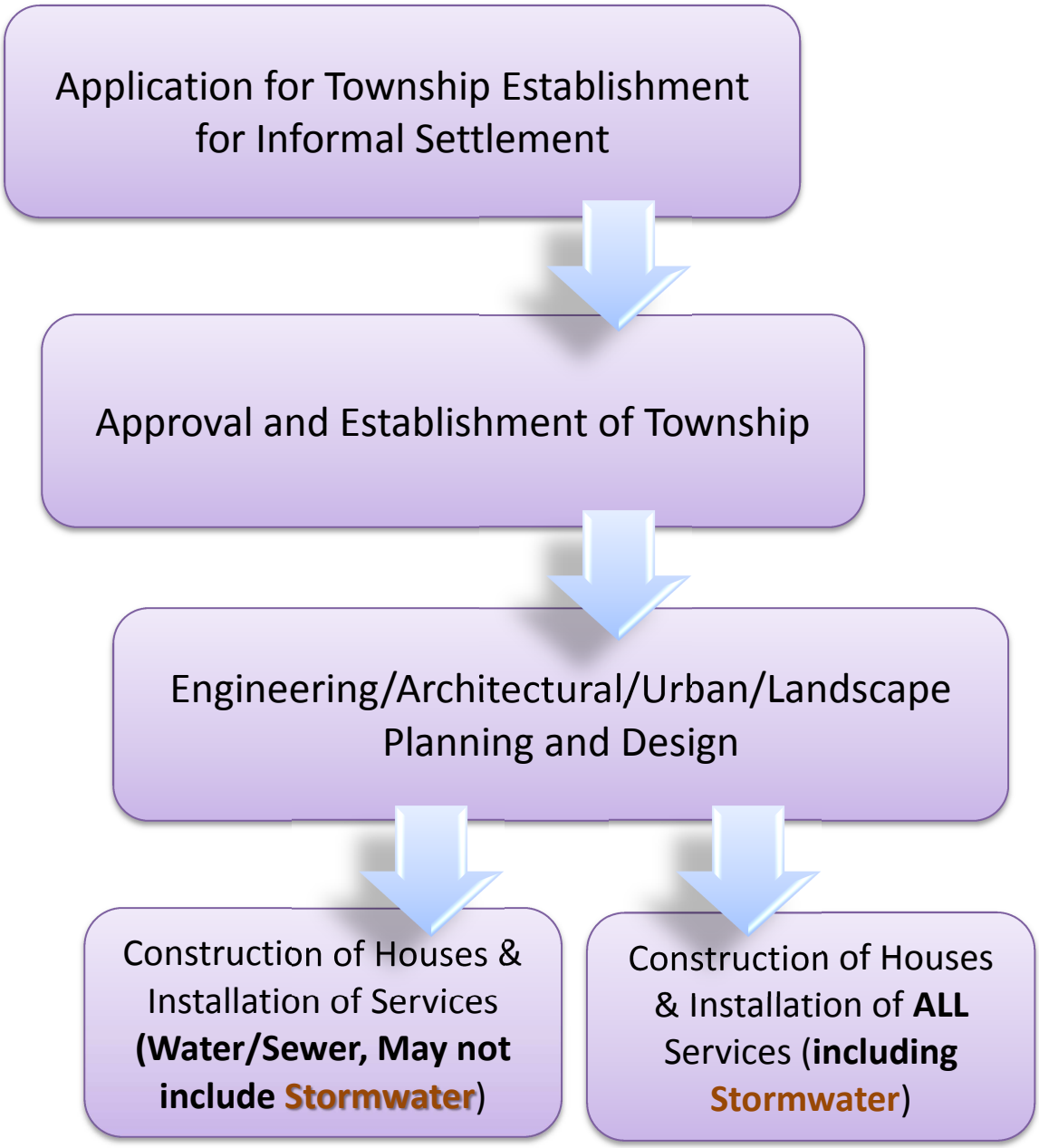


Figure 5.1 Process leading to Stormwater Management Intervention in Informal Settlements by the City of Johannesburg. Author's own construction based on findings.

5.5 Case Study of Elias Motsoaledi Settlement 'Formalisation'

In response to the growth, increasing vulnerability, contentions around service delivery and the political significance of informal settlements, the CoJ adopted an "Informal Settlement Formalisation and Upgrading programme". This programme proposes to formalise all informal settlements in the city by 2014 (Masondo,

2009). Formalisation includes a legal process whereby a township is established, top structures (RDP houses) are developed, residents obtain secure tenure (formal title) and formal services, including stormwater management infrastructure are installed (Urban Landmark, 2009). Elias Motsoaledi is one of the settlements in Johannesburg presently benefiting from an implementation of this programme. The case of Elias Motsoaledi provides a context to study CoJ's intervention, in terms of 'formalising' informal settlements and thereby improving stormwater management systems.

5.5.1 Background on the Settlement

Elias Motsoaledi is an informal settlement located on the portion of land between Devland Industrial Estate and Chris Hani Baragwanath Hospital in Dieplkloof, Soweto. The area highlighted in Figure 5.2 and 5.3 below shows the portion of land where the settlement is presently located. This location falls within Region D of City of Johannesburg's administrative division. The settlement was formed in 1993, but was only named after Elias Motsoaledi, a notable activist and leader in the African National Congress (ANC), after he died in May 1995. The settlement contains 3,368 households according to the 2008 community survey (Tau, 2012). On the western side of the settlement are overhead high-tension pylons. The Diepkloofspruit river runs on the north-western side across the settlement into the Orlando Dam. During heavy rainfall, the roof of most shacks leak which results in the internal spaces being filed with water. The area close to the river is generally prone to flooding (Harsh, 2011), although no external flooding that seriously affected the shacks has been recorded in 19 years of the settlement's existence. The river (shown in figure 5.4) however poses a flooding threat to the area as delineated by the GCRO (2012) and shown in figure 5.5 below.

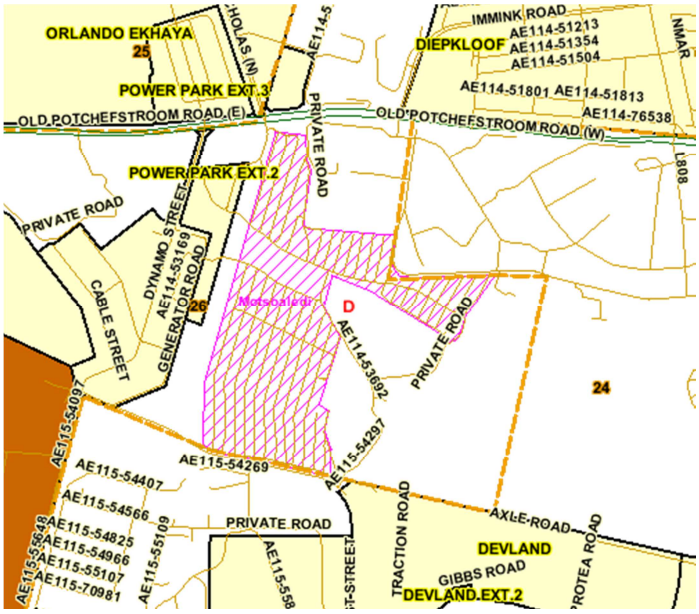


Figure 5.2 Location of Elias Motsoaledi Settlement.
Source: City of Johannesburg, 2010c. Region D Informal Settlements. Powerpoint Presentation of Informal Settlement Data-base. May. City of Johannesburg, Johannesburg.



Figure 5.3 Satellite Image of Elias Motsoaledi Settlement.
Source: City of Johannesburg, 2010c. Region D Informal Settlements. Powerpoint Presentation of Informal Settlement Data-base. May. City of Johannesburg, Johannesburg.



Figure 5.4 The Diepkloofspruit river running through land of the settlement/proposed township. The existing settlement is at the background.
Source: Author's Photograph, September 2012

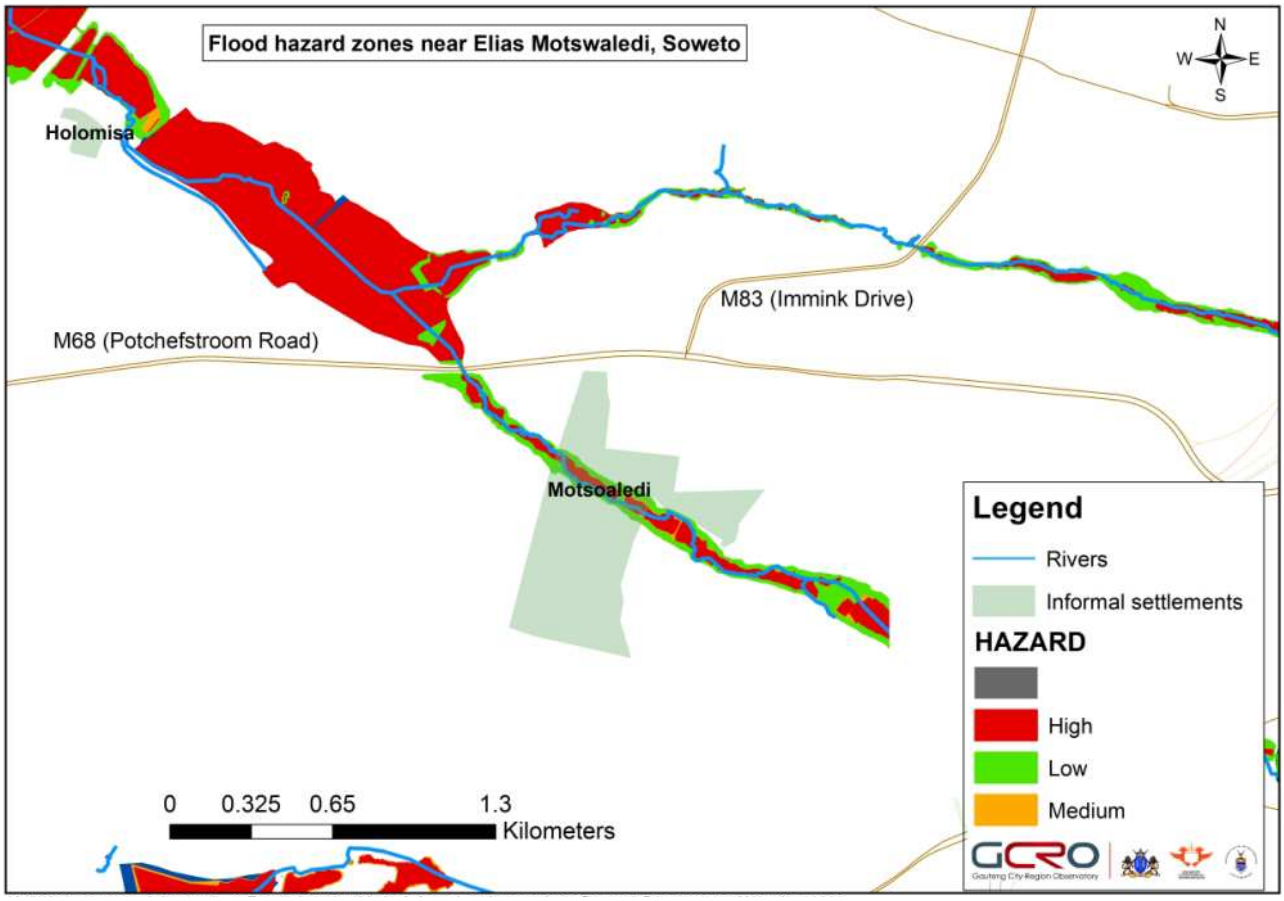


Figure 5.5 Flood Hazard Zone around Elias Motsoaledi Settlement.
Source: GCRO, 2012 using data from Johannesburg Road Agency.

5.5.2 The State's Intervention in Elias Motsoaledi Settlement

The settlement has benefited from the municipality's interim and permanent (in the recent time) intervention intended to improve lives of residents and environment in the area. In 1998, about 48 concrete stands, pipes and taps providing clean water for the residents were installed by the municipal authorities (Harsh, 2011). Some of the residents later extended these pipe connections to their stands. The municipal authority through the JRA also opened up the roads in the settlement and graded them (Resident 1; personal communication, 27 September 2012). This move did not only improve pedestrian and vehicular accessibility, allow ambulance access in emergency situations, but also in a minimal way enhanced stormwater management in the settlement. Grading of the roads slightly improved the flow of runoff. Gullies that emerged on the graded roads as shown in Figure 5.5 provided channels for runoff flow by gravity to the river. It reduced the instances of ponding of water on such roads.

On waste management, the residents' committee organizes waste collection within the settlement. *Pikitup* later comes to convey it from the various designated points within the settlement to the final destination outside the settlement. Despite this waste collection arrangement, some of the residents still dump refuse close to the river and other inappropriate locations away from the river. One might also trace this negative attitude to failure on the part of *Pikitup*. Nevertheless, such action pollutes the river and may block the free passage of runoff.



Figure 5.6 One of the roads opened up in the settlement showing the gullies that convey runoff.
Source: Author's Photograph, September 2012.

More than explained above, Elias Motsoaledi has received the municipality's attention in the recent times for permanent intervention. This permanent intervention was however preceded by a violent service provision protest by the residents in 2009 (Nkosi, 2009). In line with the national government's policy to 'formalise' informal settlements, Elias Motsoaledi residents are in the process of receiving 40 m^2 RDP/BNG houses in a township newly established out of the present settlement. The new township is located on a portion of land which includes the adjacent as well as the one that they presently occupy. The Elias Motsoaledi Housing Project (caption for the new township project) emerged from collaboration between the City of Johannesburg and the Gauteng Department of Housing and Local Government. It is meant to lead to the delivery of 2,756 dwelling units. 1,456 of these are fully subsidized units and 1300 are rental units (Tau, 2012). The housing project is located on the parcel of land between the Chris Baragwanath Hospital and the Devland Industrial area, a part of which is presently occupied by the settlement. The project would involve the construction of roads, stormwater infrastructure and the formal provision of service such as water, sanitation, electricity, waste collection and so on.

The township establishment process for Elias Motsoaledi settlement was finalized in 2011 and construction work on the site is ongoing. As of September 2012, during my field visits to the site, the laying of underground pipes for sewerage

and water was in progress as shown in figure 5.6 below. The entire development is to be in phases. The current residents in the settlement will be moved to RDP houses completed in the first phase. Their shacks will then be cleared and another set of houses built on the cleared land in a later phase.



Figure 5.7 Ongoing construction activities on the Elias Motsoaledi Housing Project, with the settlement at the background.
Source: Author's Photograph, September 2012.

5.5.3 Stormwater Management in the Elias Motsoaledi Housing Development

The stormwater management system proposed for the Elias Motsoaledi settlement formalisation project follows JRA's formal and conventional 'pipe and pond' system. Runoff from each stand would be conveyed by gravity through underground concrete pipes to attenuation ponds scattered around the riparian corridor of the Diepkloofspruit river. The entire housing project is designed to have a total of eleven attenuation ponds as shown in figure 5.8 and 5.9 below. The attenuation pond system is in line with CoJ's stormwater management policy. A proposal for eleven ponds was developed after consideration of runoff that spills from the adjoining Chris Baragwath Hospital into the present informal settlement. Figure 5.11b shows pipes in the wall through which the spill occurs. The eleven ponds will accommodate such spills in the new township.

The township layout recognises the riparian corridor and wetland area around the Diepkloofspruit River with respect to stormwater management and flooding. No

building would be erected in the area within the delineated 1:100 year flood line in accordance with the provisions of the National Water Act. The entire riparian corridor and the area within the 1:100 year flood line, are reserved as a buffer towards wetland rehabilitation and ecosystem conservation as shown in figure 5.8 below. The area within the riparian corridor but outside the 1:100 year flood line will be developed as public open spaces, with children's play parks and community parks. The attenuation ponds are designed to be shallow and bevelled such that they also serve as children's playgrounds when dry. It is important to note that the proposed development along the riparian corridor is clearly nuanced as a landscape enhancement and socio-economic feature as well as a stormwater management facility.

My field work in the Elias Motsoaledi settlement and housing project shows the absence of residents' meaningful participation on the ongoing housing development. This also extends to the development for stormwater management. Table 5.1 below shows my construction on this, based on interviews and interaction with stakeholders on the stormwater management intervention in the project. There is no evidence of 'meaningful participation' so far. One of the residents I interviewed explained that the Ward Councillor through the settlements residents' association only informed them of the proposed RDP houses. According to him, the councillor said the residents would have a choice of the units and be allocated the houses when they are ready (Resident 1, personal communication, 27 September 2012). Another resident said "we don't know much" and that the municipality is not truthful on the project (Resident 5, personal communication, 14 December 2012).

I must acknowledge that during my field visit, I found that some of the residents in the present settlement are employed in the ongoing phase of work. However, they are largely participating as unskilled labourers, whose impact on the project is insignificant. In my opinion, the motivation for this involvement stems from exploiting proximity to source of labour rather than an intention for meaningful participation. Residents' participation in some of the stages cannot be ascertained for now. The place of participation as a social component in stormwater management is important (Cairncross and Ouano, 1990:164; Parkinson, 2003:124; Parkinson et al, 2007:142). In fact, the cases of informal settlement upgrading earlier reviewed in chapter four illustrates the place of

meaningful participation at various stages for successful and sustainable stormwater management intervention in low-income urban settlements.

Table 5.1 Participation Index on Stormwater Management in Elias Motsoaledi Housing Project

	Active Participation	Passive Participation	No Participation	Cannot be ascertained
Conception				
Design/ Planning				
Installation/ Construction				
Operation/ Maintenance				
Non-structural Stormwater Management Strategy				

Table 5.1 Author's own construction, based on field visit in 2012.

Mention must be made of the stormwater management and drainage strategies presently utilized by residents in the informal settlement. They can be classified into physical/engineering interventions (known as structural stormwater management strategies), and measures that do not involve physical interventions, known as non-structural stormwater management measures. Baring from mind their efficacy and sustainability, these strategies show the residents' sense of responsibility at draining and managing surface water and runoff. The pictures in Figure 5.10, 5.11 and 5.12 below shows some of the measures utilised as captured during the field work in the settlement. My discussion on these self-help stormwater management strategies is accentuated in the case study of Slovo park as considered in the next chapter.

Figure 5.8 Proposal for Elias Township's Wetland and Riparian Corridor. Source: In-site Landscape Architects & Environmental Consultants, 2012, (permission pending).

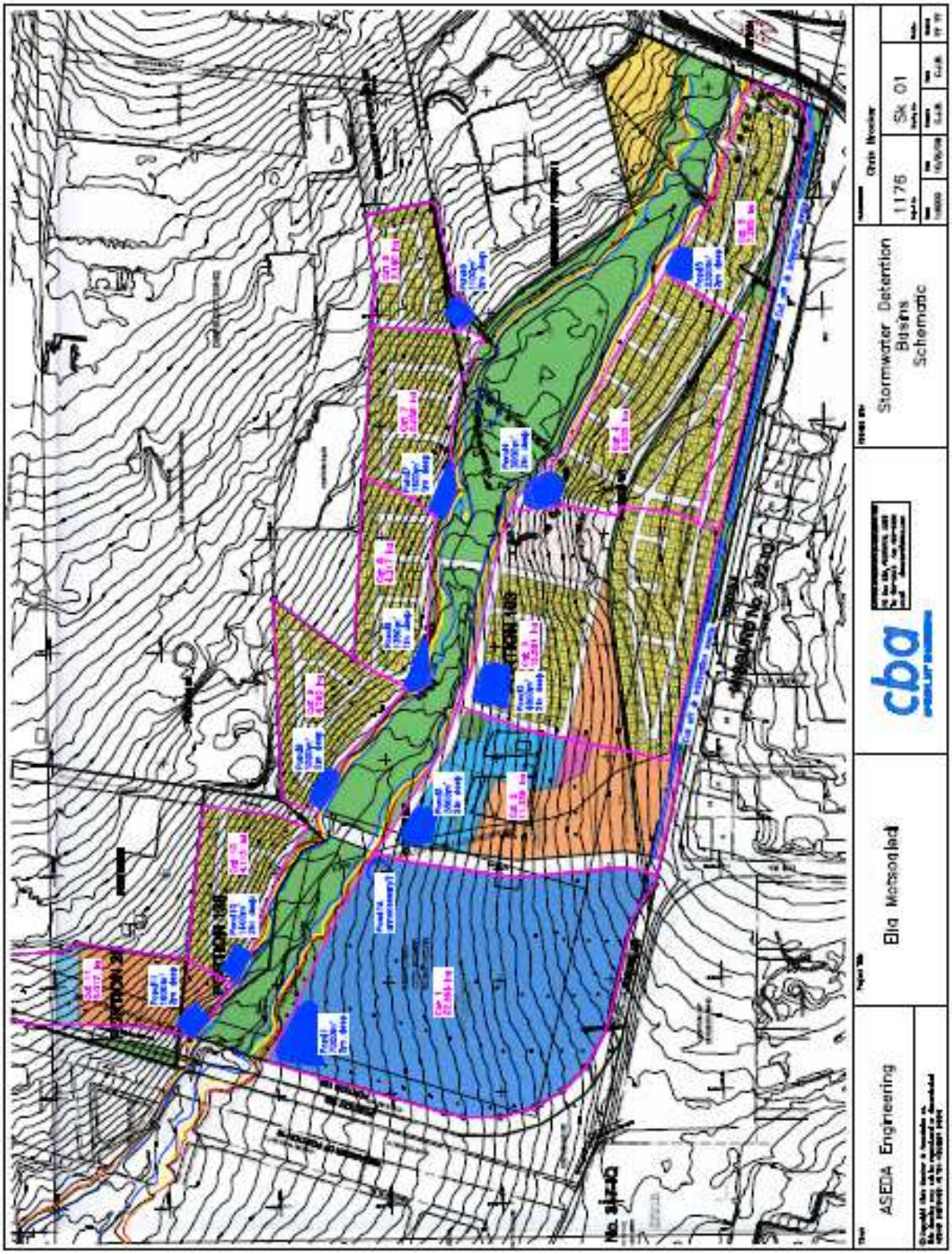


Figure 5.9 Proposal for Stormwater Management in the Elias Motsoaledi Housing Project
With permission from Chris Brooker & Associates, 2012.



Figure 5.10 Stormwater/Greywater drainage strategies of Elias Motsoaledi residents. Pipe from a old bath tub used for laundry activities (left) and tap stand (right) conveys surface water to gullies on the road.
Source: Author's Photograph, September 2012.



Figure 5.11 Stormwater Management strategies in Elias Motsoaledi. Waste trap to keep runoff and the gullies free of rubbish (left). Wall notice warns against refuse dumping (right). Outlets on the perimeter wall discharge runoff from the adjoining Chris Baragwanath Hospital.
Source: Author's Photograph, September 2012.



Figure 5.12. Other kinds of Stormwater Management strategies in Elias Motsoaledi. Paving made from perforated brick to aid permeation of runoff (left). Vegetation/Green Infrastructure in one of the stands (right). Not so widespread. Only prominent in stands close to the river.
Source: Author's Photograph, December, 2012.

5.6 Conclusion

So far, I have discussed the legal apparatuses, guidelines, processes, policy documents which form the basis for formal institutional interventions in relation to stormwater management and other developments by the municipality in informal settlements. I can infer that the state is *de jure* concerned for the urban environment, from these institutional provisions. Also the state's central role with respect to stormwater management in these settlements comes to the fore. If any significant improvement in the lives of residents and the environment in informal settlements would happen, as it is, this depends on the state.

It can be seen that stormwater management and drainage interventions in Johannesburg's informal settlement are embedded in the municipality's "formalisation" process. Interim services usually provided in informal settlements rarely or only marginally contribute to stormwater management and drainage. This situation implies that the hope of an adequately drained informal settlement neighbourhood is hinged on formalisation. This 'top-down' approach, as seen in the case study of Elias Motsoaledi raises questions on the way by which stormwater management interventions can be more sustainable socially and institutionally in the context of informal settlements.

CHAPTER SIX

6 COMMUNITY-BASED STORMWATER MANAGEMENT AND DRAINAGE IN INFORMAL SETTLEMENTS: CASE STUDY OF SLOVO PARK

6.1 Introduction

The impacts of inadequate drainage and stormwater management infrastructure in informal settlements are directly felt by the residents. Although they are generally poor, they have strong aspiration and motivation for physical development of their neighbourhood. The residents individually and together as a community make efforts to temporarily or permanently tackle the challenge of stormwater. Slovo Park informal settlement, south of Johannesburg's CBD is an interesting 'laboratory' where such efforts are happening. This chapter presents a case study of Slovo Park with respect to community-based, bottom-up improvement in stormwater management. The chapter begins with a brief background on the settlement which is followed by discussion on the community's "struggle" for development over time. The chapter presents the stormwater management and drainage practices identified in the settlement. In order to identify what influences these practices, the chapter describes the 2008 flooding incidence, responses to it and the residents' perception on the dolomitic condition and climate change (through precipitation patterns). The chapter closes with a focus on stormwater management in the community's involvements, thrusts and plans for development of the settlement.

6.2 Background to Slovo Park Informal Settlement

Slovo Park was established in the late 1980s by James Mthembu and some people who were searching for a dwelling place close to where they work. They found a vacant piece of land and settled there, but moved from that initial site to the current Slovo Park location. The settlers relocated from the initial site because of flooding (Tissington, 2011:23). The current site is located next to the Nancefield Industrial Area, and lies between Nancefield, Eldorado Park and Bushkoppies in the City of Johannesburg's Region G, sub-Area Three. The settlement was initially known as Nancefield Township, although not formally established as a township. The name came because the settlement is next to the Nancefield Industrial Area. However, after the death of Joe Slovo, the first post-apartheid Minister of Housing, the settlement was named 'Slovo Park' to honour

and probably immortalize him (Resident 6; personal communication, 8 September 2012).

According to the community forum leaders, in Tissington (2011:23), the early settlers received informal consent from the then Transvaal Provincial Administration (TPA) officials to occupy the current site. Some of the community members were even informally appointed as ‘surveyors’ to assist in laying out and organizing the new site into streets and stands. Mr Mapara, one of the early settlers made out lines for the stands (Pretoria Picture Company, 2012). The site layout imitated that of the neighboring Eldorado Park Extension 7. In 1994, the residents voluntarily rearranged their shacks to follow the new layout. The layout was made with the understanding that the municipality would only have to build and install necessary infrastructure and services.

Slovo Park is bounded on the north by the N12 Moroka Bypass. Cavendish Street/Concorde Road is to its east and East Road to its west, while Stockwell Avenue lies to its south. The settlement covers a land area of approximately 47.46 hectares, the greater portion of which the residents believe is publicly-owned. An informal survey conducted by the community in 2011 showed that there are over 1,600 households and more than 5,000 people living in the settlement (Tissington, 2012:51). However, the City of Johannesburg’s Regional Spatial Development Framework 2010/2011 (RSDF) puts the number of households at 1,052. There are 1,050 Ventilated Improved Pit (VIP) latrines, installed in 2005, one in each yard in the settlement, while each street has approximately four communal standpipes (Tissington, 2011:23). More than ten different languages are spoken in the settlement which illustrates the inherent socio-cultural diversity.



Figure 6.1 Satellite Image of Slovo Park Settlement, with adjoining streets. Source: City of Johannesburg, 2010d. Region G Informal Settlements. Powerpoint Presentation of Informal Settlement Data-base. May. City of Johannesburg, Johannesburg.

6.3 Community Organization and the 'Struggle' for Development at Slovo Park

The structure for settlement-wide organization and leadership in Slovo Park is the Slovo Park Community Development Forum (SPCDF). The SPCDF emerged in 2007 out of the erstwhile Community development Forum (CDF) which dates back to 2001, when the residents elected leaders for the community (Tissington, 2011:23). Presently under the leadership of Mohau Melani, the SPCDF consist of thirty-six representatives in charge of various portfolios such as heading the business forum, the religious forum and so on (*ibid*.). SPCDF leads the 'struggle' to attract, promote and sustain development in the settlement. The forum proactively engages the government and relevant stakeholders in its thrusts towards the settlement's development. For example, it engaged a legal NGO while trying to gain access to municipality-installed interim services. Through collaboration with a university's department, social movements and civil society groups, a proposal and plan for the settlement's *in-situ* upgrading was made. The Socio-Economic Rights Institute (SERI) was approached and helped with

investigation on non-implementation of the housing project promised by the government since 1994, (See Tissington, 2011).

The ‘struggle’ for development is as old as the settlement. One of the early struggles was on access to water between 1991 and 1994. This resulted in a temporary but inadequate solution, and the promise of permanent intervention by the municipal authorities. In 1994, the residents were promised 950 houses on the land they are presently occupying. These promises have not been fulfilled to date (*ibid.*). In fact, allegations of misappropriation on allocated funds and corruption trail the promised housing project. The recommendation to formalize and subsequently upgrade *in-situ* was made in a 2005 feasibility report by iNtatakusa Africa Consulting (iNtatakusa Africa, 2005) but was not taken into consideration. Application for the establishment of Slovo Park as Nancefield Township Extension 4 in terms of *Town-Planning and Townships Ordinance Act 15 of 1986* was made to the City of Johannesburg in December 2008 (Tissington, 2011:47). The process involved had taken off, but my interaction with the SPCDF in September/October 2012 shows that the application is presently locked in ambiguity and controversy. There are fears in the community that the application process may not lead to anything meaningful as the report which formed basis for the application would no longer be valid after five years of lodging an application (Resident 6; personal communication, September 8, 2012).

The more controversial issue around the settlement’s development is the suitability of its geological and environmental condition for formal housing development. Slovo Park is underlain by dolomite (CoJ, 2010d). This condition has technical implications for formal housing development. There is a flood hazard zone on a small portion on its north-eastern side as delineated by the GCRO and shown in Figure 6.2 below. There is a perception within civil society and the residents that the dolomitic condition and flood risk is used as a smokescreen by the municipality. This conceals the political manoeuvrings inherent towards the settlement’s formalisation and eventual development, which would include improvement in stormwater management. The municipality wants to evict and relocate the residents (ibid). The residents are opposed to this. They want to stay. From my interaction with the residents, I discovered that they believe formal housing development can take place with the low level of geological and flood risk obtainable in the settlement.

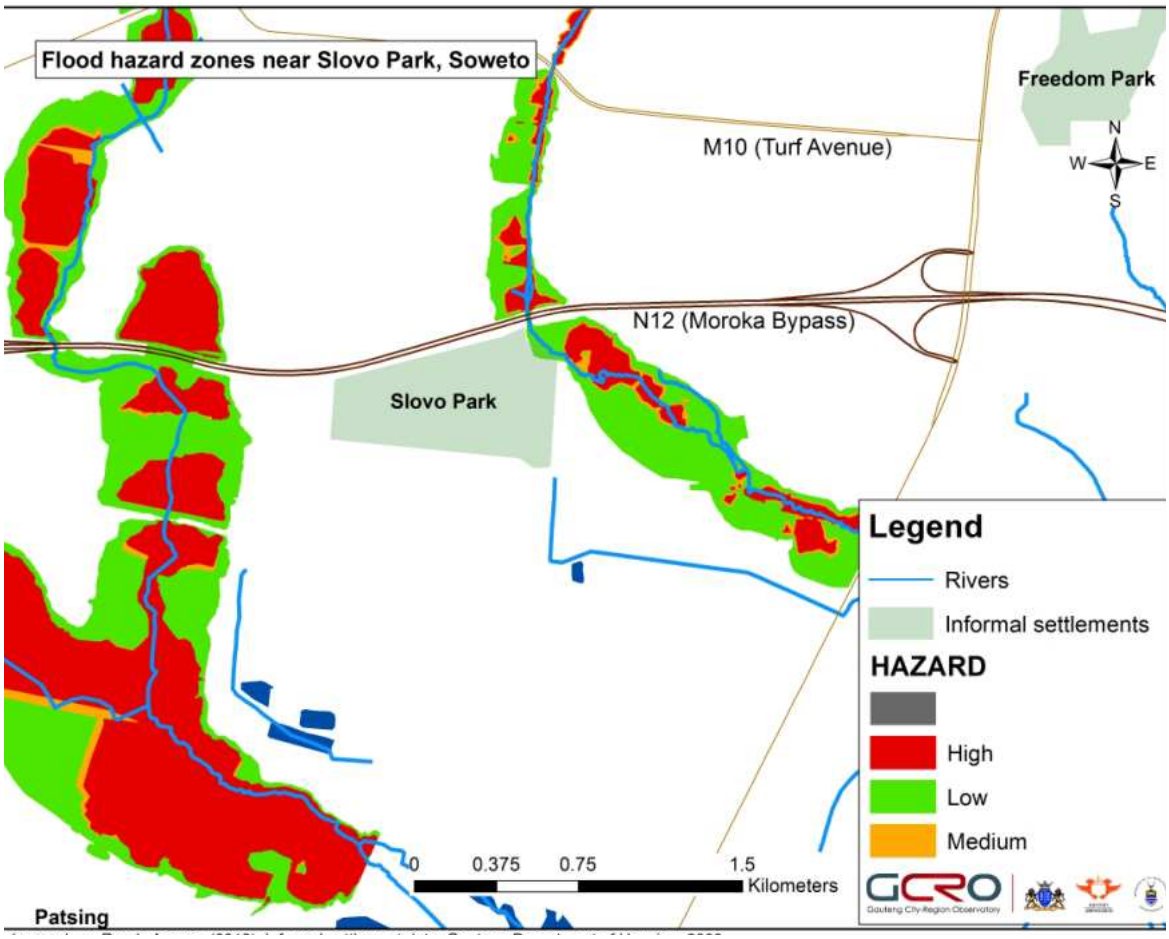


Figure 6.2 Flood Hazard around Slovo Park.
Source: GCRO, 2012 using data from Johannesburg Road Agency.

6.4 Flooding in Slovo Park Settlement

Flooding is one of the main threats to Slovo Park residents. Nana Radebe, CoJ's Emergency Management Services (EMS) spokesperson, reflecting on the settlement's vulnerability, indicates that 'flooding impacts greatly on Slovo Park due to its adjacent position to the Klipspruit valley stream' (CoJ, 2012a). The settlement's vulnerability to flooding increases as the river and wetland's water level rise. This rise can be attributed to detrimental activities from upstream in the Klipspruit River catchment as well as the already evident increase in rainfall potentially attributable to climate variability and change.

In 2008, Slovo Park was flooded. This happened because the wetland along the Klipspruit River, and adjacent to the settlement overflowed. Some shacks were swept away as a result of the overflowing waters. Salphia Khubeka, a victim of the flooding incidence, is reported to have said, initially runoff was only entering

their shacks after heavy downpour on a Saturday. By Sunday, the water had reached waist level and swept away anything along its course (CoJ, 2008b). The experience was a bad one for the entire community, especially residents whose shacks was affected.

6.4.1 Responses to flooding in Slovo Park

The municipality responded to the 2008 flood incidence in Slovo Park, notably by providing material assistance to the victims. Thamsanya Radebe, the then acting regional director for CoJ's Region G, led a team to deliver relief materials to the victims as part of the city's disaster management program and as prescribed by the Disaster Management Act of 2002 (CoJ, 2008b). Residents whose shacks were flooded had to relocate from the flooded area to an open space within the settlement, which before the floods served as the Community's Sports Ground. Region G's acting director even joined at rebuilding the relocated shacks (*ibid.*). However, not all whose shacks were affected by the floods relocated. Some remained in the flooded area. After the 2008 flooding, the municipality promised measures such as early warning systems, monitoring of weather, flood lines and low-lying bridges and so on as means to better forestall and manage runoff related disasters especially in informal settlements (*ibid.*).

As part of the fulfilment on the promise for better disaster management measures, early in 2012, the Emergency Management Service (EMS) in Johannesburg organized a training session for Slovo Park residents. The training equipped the residents with tips and skills to aid their safety in the incidence of flooding. The emergency management agency promised that such 'program will be offered as long as the settlement exists' (CoJ, 2012a), because the threat of flooding does not only remain but is increasing.

6.4.2 Are the residents 'inured' to flooding?

In the course of my field work in Slovo Park, I visited some of the shacks still located in the area that was flooded in 2008. I interviewed household heads in the area. I investigated the reasons why they did not relocate from that part of the settlement, despite the community forum's directive and provision for that after the disastrous event of 2008. My questions also touched on their experience with flooding during and after the 2008 incidence.

The concerned residents did not relocate because the new location, which was formerly the community's sports field, earmarked as a new site to them was not spacious enough (Resident 7 and 9; personal communication, 8 September 2012). While remaining in the flood risk area, they continuously engage in various stormwater management activities, some of which are discussed later in this chapter. However, these measures are not making any significant impact at preventing runoff from entering the shacks. They are not in any way averting the menace of flooding and a marshy environment within their stands after rainfall. All the interviewees' responses showed what I call 'innurance' to flooding. They prefer to endure and seem already used to the negative aftermath of heavy precipitation events. Stephen et al's (1994) study in Indore slums, India, Parkinson (2003) and Armitage's (2011) position as shown in chapter two have earlier pointed out this phenomenon of been inured to flooding.

6.5 Perception on Prevailing Challenges: Climate Change and Dolomite Condition

Slovo Park residents may not fully understand the jargon used by professionals on various geological, hydrological and environmental issues. They however can tell through signs and manifestations what is happening in their environment. Consideration of perceptions on two conditions in the settlement – climate change and dolomitic risk - is necessary because these affect the kind of strategy employed at draining runoff and managing stormwater. I found that the residents' perception of climate change is divergent. Some of the residents, by their observation believe there has not been any significant change in rainfall to confirm the increase that climate change models have predicted. Such people however observe that rainfall pattern is unlike before, it has become unstable. On the other hand, some of the residents believe that rainfall has increased. One of such respondents said, "the rains have increased so much from last year" (Resident 9; personal communication, 8 September, 2012).

Perception of the dolomitic risk in the settlement by one of the SPCDF members interviewed shows a different opinion to what is being touted. This makes such touting resemble propaganda by the municipality and concerned institutional entities. A member of one of the NGOs working in the community also shares the same view with this resident. They do not see the dolomitic risk as really serious. They feel the risk has been or is being over flogged and that the residents can

remain in the location (Official 4; personal communication, 1 September, 2012 and Resident 6; personal communication. 8 September, 2012). Their position is that development of formal houses with the appropriate infrastructure and services can take place in the current location with the level of dolomitic risk. This positions follows the EIA Report by Moore Spence Jones titled "*Report to Arcus Gibb PRT and Gauteng Department of Housing on Dolomite Stability Assessment for the Remainder of Portion 33 of the Farm Olifantsvlei 316 IQ (Proposed Slovo Park)".* The report classified Slovo Park site as Dolomite Risk Class 4. The Council for Geosciences classified dolomite risk on a class of 1 to 8 (Council for Geosciences, 2007:16). Class 4 is area reflecting a medium inherent risk of large size sinkhole and doline formation with respect to ingress of water. With this class 4 status, the report recommends formal housing development, although with minimal size of 350m^2 for each stand (Tissington, 2011:36).

6.6 Stormwater Management Practices in Slovo Park

This section describes measures through which Slovo Park residents drain runoff and manage stormwater on their stands. Such measures involve activities intentionally directed at stormwater management in order to avert the menace of flooding. However, some of the measures are not primarily directed to manage stormwater but they have positive influence on stormwater and runoff. All the measures are made at the shack or stand level. The identified stormwater management measures function in four main ways. They either create a barrier against stormwater, provide channel/path for runoff, provide temporary storage for runoff or aid the permeation of stormwater into the ground.

6.6.1 Building-related Stormwater Management Activities

Most of the residents, on a continual basis, enhance the wall base of their shack in order to prevent runoff penetration into the shack from underneath the walls. This enhancement also increases the shack's stability in the case of wind-storm during precipitation. Such enhancements are usually made when the rainy season is about to or has just commenced. The shack enhancement process involves heaping laterite or sand against the base of the wall (see Figure 6.4 below), adding concrete to places that seem exposed at the wall base or packing stones and hard materials for support to the base of the wall.

Another building-related activity identified to be useful during runoff or surface water inundation is the paving of walkways within the stand. The walkway defines the circulation area in the stand and access into the shack. It contributes some aesthetic and landscape value to the stand. However, its main purpose is the provision of a stable ground to tread when everywhere else in the stand is marshy, muddy or flooded after rainfall. The paving materials are not cemented but are usually arranged in a pattern that allows permeation of runoff on the pathway.



Figure 6.3 Heaping sand to the wall base for increased stability and barrier against runoff
Source: Author's Photograph, September 2012.



Figure 6.4 Walkway paving within stands.
Source: Author's Photograph, September 2012.

6.6.2 Water Channels

In this context, water channels refer to the media which conveys runoff. Open ditches are the main surface water and runoff channel in Slovo Park. I did not observe a single case of open drain, conduit or surface runoff pipe throughout the settlement. Stormwater is managed through surface measures not underground. The open ditches are usually widened and deepened at the commencement of the rainy season. They collect greywater as well as runoff from stands and empty this into open ditches along the road or straight into the street. However, this emptying leads to ponding of water on the roads. I also noticed open but shallow pit into which runoff/greywater flows in a few stands. Such open pits however have implications as potential breeding ground for mosquitoes and other disease carrying organisms. It is also not safe for small children because it is uncovered. The dolomitic condition in the settlement also does not support such measure. According to the Department of Public Works (2003:1), with ponding of water in such pits, sinkholes can easily form leading to catastrophic ground movements in such location.



Figure 6.5 A open ditch serving as channel for greywater as well as runoff.
Source: Author's Photograph, September 2012.

6.6.3 Rainwater Harvesting

Rainwater harvesting is a means to reduce peak volume of runoff and exploit the resource potential of stormwater (rainwater). I found that Slovo Park residents rarely harvest rainwater. They do not see any use for it since there is a ceaseless and free supply of potable water through pipes in almost every stand in the settlement. The length of the roof overhang in many of the shacks is also so short that it would not easily support a gutter to harvest rainwater. It is only one of the interviewees in the settlement that engages in rainwater harvesting. He harvests rainwater from the rear side of his shack with a gutter to irrigate the beautiful garden of flowers, grasses, climbers and trees in his stand. A picture of such a garden is presented in Figure 6.6 below.

6.6.4 Vegetation/Green Infrastructure

The presence of green infrastructural resources in Slovo Park settlement is significant. The majority of stands in the settlement have at least one form of cultivated vegetation. On a typical street, at least sixty percent of the stands have one form of garden or cultivated vegetation. This includes grasses, climbers, shrubs, trees and flowers. These vegetative materials provide food (e.g. vegetables like spinach, onions, and pitches) and landscape enhancement or aesthetics. Some plants are cultivated to provide herbal medicines. The residents bring indigenous crops with medicinal potentials from their respective rural origin to plant them in their stands (Official 7; personal communication, 12 October

2012). The indigenous crops provide plant materials for curative/preventive concoctions, herbs and food supplements to the residents.

One additional and relevant purpose these green infrastructural resources fulfil is to manage runoff in the stand where they are cultivated, although from my interaction with residents it was evident that this is never a primary reason for their cultivation. Vegetative materials aid the absorption of runoff by the ground, which in turn reduces impermeability. With increased permeability, the volume and velocity of runoff during precipitation in each stand is reduced. Stands that do not have such vegetative materials (especially grasses) become marshy and are at times flooded whenever it rains.

Communal areas in the settlement such as open spaces and road setbacks do not have tangible vegetation or greenery. The possibility and prospect of developing the communal areas in the settlement with appropriate vegetation as a stormwater management strategy must be acknowledged. It supports the idea of an *in situ* upgrading (Adegun, 2012). This supported by the fact that dolomitic soil as obtainable in the settlement is very fertile for agricultural cultivation. Scientific evidence shows that naturally occurring lime in dolomite can help to raise soil PH. Therefore, agricultural practices that require limited irrigation or public open spaces, excluding flood irrigation or storage of water are possible on dolomitic land (Buttrick et al, 2011:15).



Figure 6.6 A garden irrigated through harvested rainwater in Slovo Park.
Source: Author's Photograph, September 2012.



Figure 6.7 Cultivated garden (also at the background) in Slovo Park Settlement. Author's Photograph, September 2012.

6.6.5 Interventions in the Klipspruit River

The Klip River runs through the north-eastern side of Slovo Park. The river moves through the western areas of Soweto and Lenasia, forming a number of wetland in the various townships along its course, merging with the Klipspruit just beyond Lenasia before the final flow into the Vaal river (CoJ, 2012b). One of the river's wetlands falls within Slovo Park's territorial coverage. This waterbody is what actually gives a flood risk to the settlement. However, the residents make effort to keep the river's flow as smooth as possible in order to prevent flooding in the area. The main effort made is that of clearing blockages under the bridge across the river on Concorde street as shown in Figure 6.9 below. The channel provided by the low-lying bridge is usually filled with refuse materials flowing from upstream, thereby blocking the smooth flow of runoff. The residents' aspiration is the construction of a new and much higher bridge with the capacity to allow free flow even with the presence of waste from upstream (Resident 6; personal communication, 8 September 2012).

Also, agricultural activities used to take place in the wetland area in which old vehicle tyres were arranged to form a base for the cultivated plants. Tyres were also used to form a retaining wall in the footpath through the wetland area from Concorde street into the settlement as shown in figure 6.10 below. The footpath

serves as a dam/barrier to river runoff, so that the cultivated area is not over-filled with water. These measures have however been overwhelmed by the high volume of water that is usually retained in the wetland after rainfall. This has happened in the last few years. Moreover, the resident who championed the move and cultivated the area has passed away (Official 4; personal communication, 1 September 2012).



Figure 6.8 Intervention activities in the Klipspruit river. Junk materials trapped under the bridge (left) and residents removing the junk materials after rainfall (right).
Source: Author's Photograph, September 2012.



Figure 6.9 Intervention activities in the Klipsruit river wetland. Footpath made across the wetland for access and water retention (left) and formerly cultivated area in the wetland (right). Source: Author's Photograph, September 2012.

6.7 Slovo Park Community's Development Efforts

The desire for Slovo Park's transformation into a serviced, livable, formal township has resulted in various community-led developmental thrusts, intended to catalyse *in-situ* upgrading. Such efforts have to some extent yielded fruits in the last few years owing to the community's self motivation, deep aspiration and organisation under the SPCDF. In 2008, when a portion of the settlement was flooded, the forum organized relocation of the people. In 2010, through a project executed in collaboration with Informal Settlement Network (ISN) and other grassroot/non-governmental organizations, the SPCDF installed yard taps in the settlement. Residents who have the appropriate skill (for example plumbers) contributed their 'sweat' to get this done (Tissington, 2011). Design and construction of the community hall involved the combination of skilled and unskilled labour from both the community members and University of Pretoria architecture students. The hall is presently under the SPCDF's management. As earlier discussed, the community members perform what I can classify as maintenance activities on the bridge to the Klipspruit River on Concorde street. The efforts and achievements shown above are a testimonial to the strong self-motivation and drive for development existing in the Slovo Park community.



Figure 6.10a University of Pretoria Students and Community members constructing the Slovo Park Community Hall.
Source: UP Slovo Park crew, 2010 (with permission).



Figure 6.10b University of Pretoria Students and Community members constructing the Slovo Park Community Hall.
Source: UP Slovo Park crew, 2010 (with permission).

The SPCDF on behalf of the community is engaging with relevant professionals to have appropriate technical designs and guidelines for community-led infrastructure and service development in the settlement. Notably, some of the professional assistance is coming as a result of the forum's relationship with the University of Pretoria's (UP) architecture students and staff.

UP architecture postgraduate students had Slovo Park as the context for their human settlement design course in 2010. Some of the master's students also located their design project in Slovo Park in 2012. They developed an urban design framework for in-situ upgrading and development of the settlement. This design framework evolved out of informal workshops and other processes of engagement with the residents and the community at large. Their engagement showed that the residents' priority is on the installation of basic infrastructure and services in the settlement (Official 7; personal communication, 12 October 2012).

6.7.1 Focus on Stormwater Management in the Community's Development Thrusts

My interaction with Carin Combrink, a senior lecturer in UP's architecture department and coordinator of the human settlement design and research module revealed aspects of the student's design proposal that interfaces with stormwater management. Such aspects dwell largely on the development of green infrastructure in the settlement. The students proposed that the space (servitude) under the electricity pylons running through the settlement be

developed as an area for commercial urban agriculture. It was proposed that a chicken farm be established on the servitude/buffer between the settlement and the N12 highway. The plan is that droppings from the birds would serve as input for a vermiculture farm to be located by the chicken farm. The proposal also included a permaculture system for the wetland area (Official 7: personal communication, 12 October 2012). It should be noted that these design proposals are largely academic exercises. However, they bring to fore realities and possibilities in the course of developing Slovo Park settlement.

Carin Combrink, is also a doctoral student in the University of Pretoria and Slovo Park is one of the case studies for her research. This I believe spurs the extended involvement which brought her husband into the picture. Her husband is a professional engineer and runs an engineering consulting firm based in Pretoria. On a pro bono basis, his firm undertook an engineering design for the installation of infrastructure and services in Slovo Park, based on the settlement's existing layout. The design was based on the notion that, movement of people or relocation from their present stands/place should be minimal in the course of developing infrastructure.

The stormwater management and drainage design evolved out of the engineering team's engagement with the community, but also leveraged on UP student's earlier work in the settlement. The team approached the community not as researchers who only want to obtain information and leave. They came into the settlement as deeply interested and professionally endowed service providers. They interacted, obtained information and gained knowledge through means that follow the action research methodology. They met with the residents and knew who they are. They followed their experiences, aspirations and dreams. The design team saw themselves as providing service for the community as opposed to the state-commissioned consultant who is in the service of the government, not the people (Official 7; personal communication, 12 October 2012).

The plans made by the engineering team (GFC Engineering Consulting) on stormwater and drainage considered a feasible and durable solution despite the dolomitic condition in the settlement. Figure 6.11 shows the concept design for roads and stormwater. Since stands in the settlement are laid back to back, stormwater drains will run across two stands backing each other. This would then

lead to pipes that run along the road. This is more cost-effective than separate pipes for each stand leading to drains along the road. The main stormwater drains follow the direction of the road. This design implies that some shacks would have to be relocated within the stands. The perimeter line of some stands will also be adjusted to straighten the roads. According to Official 7 (personal communication, 12 October 2012), the residents indicate their readiness to make these minimal adjustments and relocations in the process of the engineer's engagement with the community.

The engineers had to strike a balance between their professional knowledge and the idiosyncratic beliefs expressed by some residents. Some residents hold superstitious views concerning the adjoining Klipspruit River and the wetland. They believe it is sacred and therefore puts limitations on the kind of development to take place there. However, while cultural sensitivity is required, scientific knowledge of the professionals ought to prevail over unfounded superstitious claims that might derail sustainable plans and development for stormwater management and drainage, especially as it affects the river.

Mention must be made of UP students' drainage intervention implemented in the Slovo Park community hall's precinct. A low-cost drainage solution was developed for greywater from taps and runoff in the public meeting space in front of the community hall. The system collects water from the tap base with a perforated old vehicle wheel serving as drain sieve/trap as shown in Figure 6.12 below. Greywater from the various taps are collected at a junction (made out of old small buckets) and then transferred to irrigate the cultivated vegetation (trees, grasses, shrubs) close to the taps as shown in figure 6.13 below. This system however did not work due to its technical inadequacy. Such a drainage solution is not appropriate for a dolomitic soil. The systems conveying the runoff is not water proof. It is therefore risky because sinkholes can be formed around the damped junctions of the drainage system or around the trees if a high volume of water is retained for a long time. Moreover, children in the settlement played with and destroyed the trees and shrubs planted to aid water absorption into the ground (Official 8; personal communication, 2 October 2012).

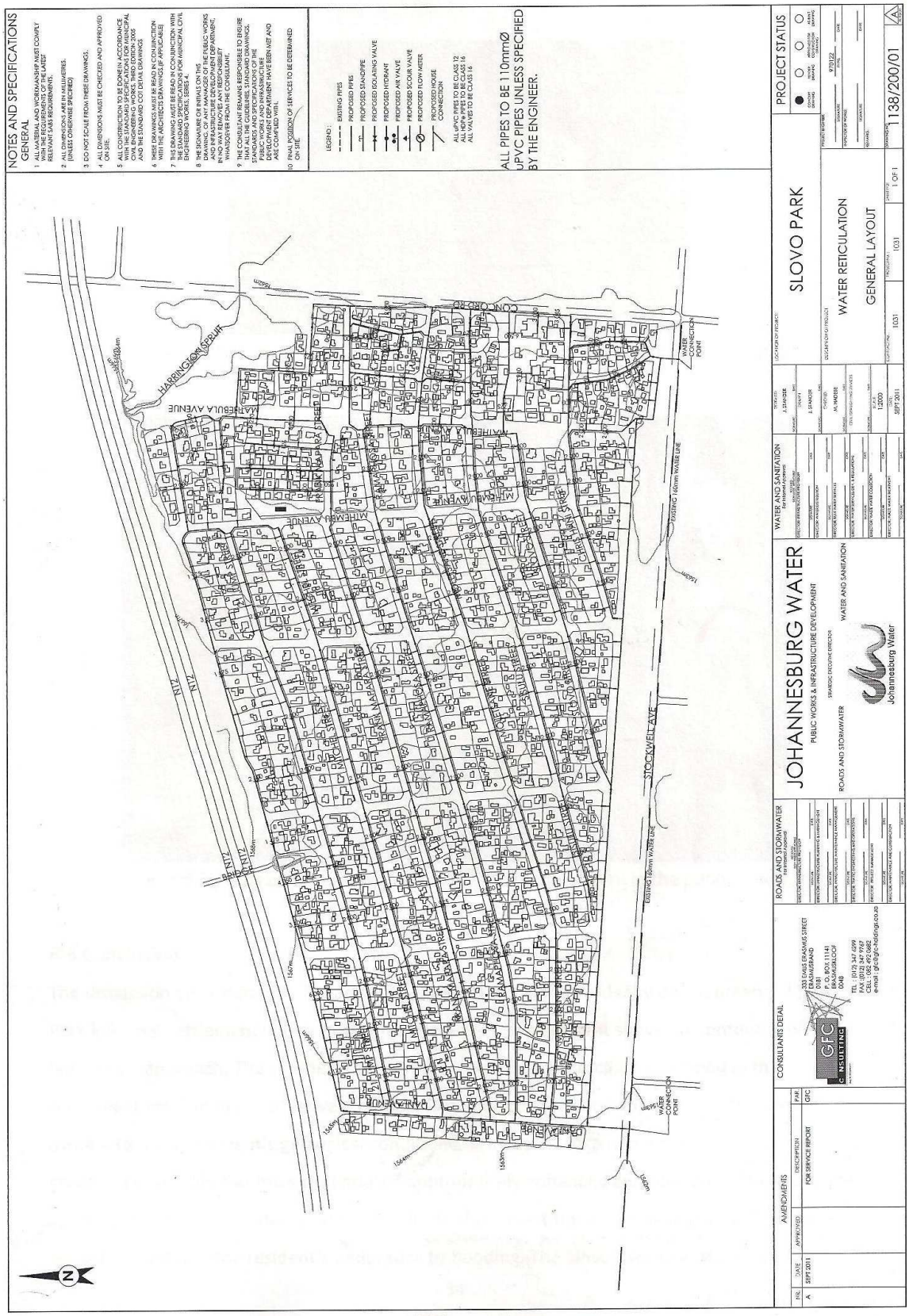


Figure 6.11 Concept Design for roads and Stormwater Management in Slovo Park by GFC.
Source: GFC Consulting, 2012 (with permission).



Figure 6.12 Drainage System in the Community Hall precinct under construction
Source: Slovo Team, 2010 (with permission).



Figure 6.13 Taps and Trees, with the failed drainage system in the public space.
Source: UP Slovo Park crew, 2010 (with permission).

6.8 Conclusion

The discussion on community-led and NGO-assisted thrusts towards the development of Slovo Park informal settlement, with a focus on stormwater management, shows the potential of a bottom-up approach. The self-help stormwater management practises identified in the settlement are minimally effective. Practices such as open shallow pits and ditches are detrimental owing to the settlement's geological condition. Measures such as rainwater harvesting

and green infrastructure have huge potentials if appropriately enhanced. The incidence and threat of flooding in the settlement point to the adjoining Klipspruit River's impact on the settlement, and the resident's endurance or what I call 'innurance' to flooding. The Slovo Park case shows that professionals' meaningful engagement with the low-income communities they serve unleashes potentials and possibilities, and can also lead to socially and institutionally sustainable interventions.

It is noteworthy that the Slovo Park case presents a 'laboratory' where the interesting and unfolding scenarios in relation to *in-situ* informal settlement upgrading are worth following. If Slovo Park pulls through with the in-situ upgrading process despite the municipality's reluctance and the prevailing geological and environmental challenges, it would provide exemplary lessons for other informal settlements in similar situations. These lessons would especially come in relation to stormwater management and drainage.

Findings in this chapter have dealt with some of the guiding research questions for this study. It attempts to answer questions on the specific challenges for and social issues around stormwater management improvements in the context of informal settlements. Examining the Slovo Park case side-by-side with the Elias Motsoaledi scenario discussed in the previous chapter raises a question. Can the City of Johannesburg desist from its formalisation approach into which stormwater management interventions are embedded, (even if it involves relocation to an adjacent site), for the sake of sustainable interventions?

CHAPTER SEVEN

7 STORMWATER MANGEMENT IN JOHANNESBURG'S INFORMAL SETTLEMENTS: ANALYSES OF INSTITUTIONAL AND SOCIAL ISSUES

7.1 Introduction

The state, through institutional apparatuses, processes and provisions, intervenes to improve stormwater management as part of infrastructure and services in informal settlements. In the process, an informal settlement is replaced by a formally laid out township. This is the situation in Elias Motsoaledi settlement. On the other hand, informal settlement residents alone or through informal institutional arrangements and non-governmental professional assistance help themselves. They make attempts to improve stormwater management as part of daily existence or the thrust to catalyse *in-situ* upgrading. This is the situation in Slovo Park settlement. By linking back to positions that emerged from the literature, this chapter analytically discusses various elements in the interplay of these two approaches. The discussion leads directly to certain reccomendations for the City of Johannesburg.

The chapter captures areas of contradiction in the pool of institutional provisions that guide stormwater management intervention in informal settlements in Johannesburg. It points out the mismatch among institutional entities dealing with stormwater management in the city. It discusses green infrastructure as part of sustainable drainage systems in informal settlements and the imperative of a catchment-scale urban stormwater management strategy. It compares the municipality's approach with the community-led, NGO-assisted approach and in that course harps on the place and possibilities of participation in stormwater management in the both settlements. The chapter closes by drawing out implications for resilience from the context in both settlements.

7.2 Institutional Mismatch(es)

As earlier indicated, stormwater management in both formal residential areas and informal settlements in Johannesburg is officially domiciled and regarded as responsibility of the Johannesburg Road Agency (JRA). Realities however show that the activities involved in sustainable stormwater management go beyond the scope of what JRA does. At JRA, stormwater drainage is seen and handled as a

complement to road infrastructure. This subsisting perception which has hitherto influenced the institutional disposition in the City of Johannesburg is straight-jacketed. For stormwater management to be sustainable, it has to be more than a mere companion to road infrastructure.

For instance, green infrastructure has the potential to manage stormwater. Green infrastructure is usually developed in communal/open spaces or around the riparian corridor in townships newly established for informal settlement communities. This would happen in the case of Elias Motsoaledi as earlier shown in figure 5.7. However, stormwater management is usually not a dominant reason for the development of these 'green matters'. City Parks, the municipal institution in charge of managing open spaces sees and manages these 'aspects' in the light of their landscape, aesthetic, economic and recreational value far above the stormwater management value.

Not that alone, waste management is an indispensable complement for stormwater management. Street sweeping and drain cleaning, as aspects of waste management, are examples of non-structural stormwater management strategies. They are most times handled by contracted companies especially in newly established townships. *Pikitup* is the municipal institutional entity in charge of waste management and only transfers already collected waste from informal settlements at intervals to the appropriate destination. However, stakeholders' responsibilities in waste management in informal settlements and even formalised townships are not clearly nuanced towards stormwater management.

Also, greywater drainage and sewerage management is intertwined with stormwater management. The general lack of drainage infrastructure in informal settlements results in a situation where greywater, stormwater and even wastewater are mixed. This was evident during the transect walk I made in both Slovo Park and Elias Motsoaledi settlements. Official 5 also confirmed this mixture as the major challenge his institution faces with sewerage management in informal settlements (personal communication, 5 September, 2012). However, the municipal entity in charge of greywater and sewerage drainage and management is Johannesburg Water, an institution that is different from the JRA.

What is important to note in all this is that sustainable stormwater management, especially in informal settlements interfaces with other environmental sectors,

and encompasses various activities handled by differentiated and mismatched institutional entities. It is not implied that a separate institutional entity other than JRA be evolved for the management of stormwater in the City of Johannesburg. I am also not inciting that JRA should take up responsibilities of these other institutions. My point is that sustainable stormwater management in informal settlements must be seen and approached as a task beyond JRA. It is the responsibility of virtually all institutional (formal and informal) entities involved in intervention for improved quality of life in informal settlements. JRA intervenes through 'pipes and ponds'. Other institutions should play appropriately-informed complementary and supplementary roles either through 'green infrastructure' or non-structural stormwater management strategies.

While Parkinson (2003) acknowledged the possibility of deficiencies in institutional arrangement and coordination, Ellis et al's (2007) report of Belo Horizonte in Brazil shows that intra- and inter-institutional municipal structures for integrative approaches aids the effectiveness of stormwater management institutions. There is need for careful coordination between relevant institutional structures whose responsibility touches one way or the other on stormwater management measures in the city's informal settlements.

7.3 Contradictions in Institutional Provisions

Earlier in chapter five, this report identified documents, guidelines, processes, legislative frameworks and policy contexts through which the municipality's intervention with respect to stormwater management in informal settlements are governed. There are areas of contradictions and counter-intuitions in the pool of these institutional provisions.

Firstly, it seems counter-intuitive that the Municipal Finance Management Act No. 56 of 2003 forbids budgeting and spending on informal settlements located on land not owned by the municipality or not yet designated for formalisation (RSA, 2004). However, the Disaster Management Act prescribes prompt intervention in such informal settlements when disaster takes place (RSA, 2002). The MFMA prohibits investment in stormwater infrastructure which would have helped to prevent flooding, but the Disaster Management Act allows the same city's resources to be spent in a reactive manner to assist flood victims. The fact that legislation precludes the expenditure of public resources on informal settlements

is not totally justifiable. Parkinson and Mark (2005:192) argue that these communities contribute to the city's economy and many urban economies depend on the low-paid workforce living in informal settlements.

Also, the Municipality discourages self-help efforts that seek to catalyse *in-situ* upgrading by residents in informal settlements (Official 1; personal communication, August 24, 2012). They are however accused of reluctance, suspected of underhand dealings and undue politicking with respect to the upgrading of informal settlements, as I can deduce from my interaction with Resident 6 (personal communication, 8 September 2012). In order to drive intervention in informal settlements, the Municipality constituted an inter-departmental, inter-entity informal settlement steering committee. In the course of interviewing one of JRA's officials who is also a member of the committee, I learnt that the committee had not convened for eight months (Official 2; personal communication, August 27, 2012). While I could not ascertain reasons for the delayed meetings, such action sends negative signals about the Municipality's pronouncement and commitment towards improving the situation in the city's informal settlements.

Stickiness to 'traditional', unsustainable approaches and reluctance towards incorporating a sustainable drainage paradigm in CoJ's stormwater management policy is a contradiction to the 'spirit' of *Johannesburg's Growth and Development Strategy 2040* (CoJ, 2011b), the *Spatial Development Framework 2010/2011* (CoJ, 2010b) and other documents emanating from the municipal authorities. These documents recognize and express the necessity for policy transition towards an environmentally sustainable developmental paradigm in the face of prevailing global as well as local climatic, environmental and socio-economic challenges. Here, it is relevant to note that the City of Cape Town has evolved strategy, supporting by-laws and policies towards sustainable stormwater management in Cape Town (Haskins, 2012).

7.4 Catchment-Scale Management

Managing stormwater from a catchment-scale or water-shed level is a relevant approach for Johannesburg. I realised that the recently approved catchment management policy for Johannesburg (CoJ, 2008a) is a document intended to address this, and its appropriateness for the context in informal settlements is

affirmed. However, the policy is nuanced to water quality management, bio-diversity preservation and the economies of water courses. This is not holistic because challenges of urban stormwater management are not only limited to the areas mentioned above. Flood control should be frontally tackled as part of the policy and accompanying action plan, especially in the informal settlements and townships located on wetlands or close to rivers. Since some of the settlements in Johannesburg share the same drainage basin, that is, the Klipspruit river, there is a basis for holistic intervention rather than single-settlement, piece-meal intervention. Hoyner et al (1994) show that such approach is even beneficial from the economy of scale.

Example of the 2008 flooding in Slovo Park, and the continual threat of floods in recent times emanates mainly from the Klipspruit River. The river flows through some residential areas upstream, runs through Slovo Park and continues its journey through other residential locations downstream. Detrimental activities such as waste dumping into the river upstream, perhaps from informal settlements, inhibit proper runoff flow and lead to excess accumulation of water in the wetland which then spills and causes flooding in the Slovo Park settlement. In the same vein, detrimental activities from Slovo Park residents (for example dumping) would also negatively affect other informal settlements downstream. This demonstrates how important it is to manage the Klipspruit River at a catchment scale. It assists in tackling runoff issues along the entire river course, especially as it affects informal settlements in it flows through Johannesburg.

It is noteworthy that improving drainage infrastructure inside Slovo Park settlement is not enough to properly manage runoff and prevent flooding. Installing stormwater management infrastructure as part of formalisation in Elias Motsoaledi Settlement is also no guarantee against flooding. Drainage improvements at a local scale would be of little impact if water still backs up because of insufficient upstream or downstream capacity (Cairncross and Ouano, 1990:164). Stormwater management at catchment level is therefore very important.

7.5 Green Infrastructure and Sustainable Drainage System

In light of the impact that local urban change and global climate change can have on stormwater; sustainable drainage systems are gaining currency as a means to

manage urban runoff. Green infrastructure is a core component of sustainable drainage system. Trees, grasses, rain gardens, shrubs, climbers and so on in a network of natural ecosystem resources, through their water retention and purification characteristics, manage the quality and quantity of runoff (Mentens et al, 2006; Wise, 2008; Herrera Environmental Consultants, 2008). This is very relevant in the context of informal settlements where greening can have a wide variety of uses and functions.

A comparison between the two settlements with respect to green infrastructure shows their position at different ends of a spectrum. In Slovo Park, vegetation is widespread at the stand and shack level. It is not prevalent in the communal areas (open spaces, road setbacks, servitude to electricity pylons and so on) in the settlement. The ongoing housing project for Elias Motsoaledi settlement includes a proposal for green infrastructure in the common areas. This is visible along the riparian corridor of the Diepkloofspruit River as earlier discussed in Chapter Five. From my field visit and interaction with stakeholders, I cannot recognise any plan for greenery (vegetation) at the scale of each stand or dwelling in the ongoing housing development. In the present Elias Motsoaledi informal settlement, vegetation is not a prominent feature in the various stands. Efforts to promote it could not be identified. Both ends of the spectrum must be utilised. Green infrastructure would optimally fulfil stormwater management functions when available not only in the common areas but also on stands.

In the interplay of social and institutional issues in relation to stormwater management, exploiting the potential of sustainable drainage systems through green infrastructure is germane. I believe this should not be dependent on the settlement's legal or planning status. Whether a settlement is formalised, about to be formalised, not to be formalised or undergoing *in-situ* upgrading, green infrastructure should be exploited at managing the 'stubborn' problem of urban stormwater and reduce the danger of flooding. In fact, Schaffler and Swilling (2012) explain that a complex sub-Saharan African city such as Johannesburg, with its under-serviced settlements interspersed with open spaces, would find sources of resilience in their 'green infrastructure'.

7.6 State intervention versus community-led, self-help initiative

Placing the municipality‘s intervention (as seen in the case of Elias Motsoaledi settlement), side by side with the community-led, NGO-assisted initiatives (as seen in the case of Slovo Park settlement), in relation to stormwater management is telling. The state’s intervention often emerges after agitation and protests by the community. It largely follows professionals and consultants’ views as well as recommendations for such settlement. These views and recommendations at times avoid extensively meaningful participatory approaches. On the other hand, the informal settlement community usually after long and unsuccessful engagement with the state may resort to helping themselves. They may engage with available professionals who lend their expertise towards stormwater management in the settlement.

In state intervention, the government officials and commissioned consultants think or plan for the poor informal settlement residents; while in the community-led thrusts, the professionals think and plan along with the poor residents and community. In the absence of close engagement between professionals and community, state interventions in relation to stormwater management and drainage can be received by the residents as a loathsome gift. Initiatives aspired to, perspired for and achieved by the community can be held with much value. The former often has no input from the residents while the latter is a product of the residents’ drive or participation. It is very likely then that the approach led by the community will be much more successful and sustainable in all ramifications than the intervention made by the state, where due consideration and consultation with communities is absent.

Chambers (1995:173) among other authors have condemned professionals’ views on development issues for the poor as universal, ‘reductionist’ and ‘standardized’. He argues that poor people not the professionals should analyse and articulate their own needs in order to enhance sustainable living and livelihoods. Elinor Ostrom’s analysis on the management of an ecosystem resource such as stormwater also touches on the interplay between formal institutions like the municipality and local contexts as obtained in informal settlements (Ostrom, 2009:422). When there is incoherence between the two, sustainability is elusive in the long run (Janseen, 2002; Norberg and Cumming, 2008).

7.7 Participation in Stormwater Management in Informal Settlements

The place of community engagement and meaningful participation in stormwater management and drainage improvements as part of housing and basic service delivery for the urban poor is very important. As earlier indicated, 'public participation is an opportunity to assess the social feasibility of stormwater management systems and flood response strategies' (Parkinson 2003:123). This position was corroborated by Cairncross and Ouano (1990) as well as Parkinson *et al* (2007).

The absence of meaningful community participation and residents' involvement in relation to stormwater management intervention by the City of Johannesburg, as applied in the case of Elias Motsoaledi settlement is not without problems. One can hope that the project would not turn out like the Kosovo settlement upgrade in Cape Town discussed in Chapter Three (Armitage et al, 2010). The stormwater drain in Kosovo, as part of the entire upgrading project, failed to curb flooding especially during heavy rains. The failure was linked to the inadequate participatory programme; with the residents' non-involvement in decision making, they were not made to commit to working with new infrastructure.

On the other hand, interventions initiated by the community (as in the case of Slovo Park), by the fact that they emerge out of participatory efforts yield important and very useful information that might not be available elsewhere. For example, GIS-generated data, contour lines and distance mapping at times yield inaccurate information, which are very useful information in making plans and implementing local stormwater management and drainage systems. People living in informal settlements know exactly where it floods, where water actually runs and so on. Professionals' meaningful engagement with them would yield such valuable information.

There are opportunities for meaningful engagement and participation of the informal settlement community in stormwater management and drainage interventions, whether these are state-led or community-led. Such opportunities can be utilised at planning, implementation (construction), operation or maintenance stages. For example, design for stormwater management and drainage for an informal settlement should be informed by the community's experiences of flooding, existing stormwater management practices, water or

runoff related beliefs and so on. Informal workshops, focus group discussions and other means of engagement with communities would elicit relevant input for design and planning.

Members of the community can also be involved in the implementation and construction process. With respect to reduction in unemployment and empowerment through remunerations received, involvement of the Elias Motsoaledi residents in the ongoing housing project is commendable. Participation at the implementation and construction stage should go beyond this. It is not too late to have meaningful participation. I concur with Imperato and Ruster's (2003:36) idea that in urban upgrading projects not built around participation from commencement, "elements of participation need to be introduced at a later stage to ensure feasibility of project implementation". Participation should seek the transfer of appropriate skills to the residents. Community-based groups that are capable with sub-contracting can also be given opportunity on such projects. The case of Hanna Nassif in Dar es Salaam, Tanzania (IT Transport, 2005; Lupala et al, 1997), discussed in Chapter Four is exemplary. It shows possibilities on improvement in stormwater management and drainage through an employment-intensive, community-based contracting and management approach in the slum upgrading process.

Participation is also possible at the operation and maintenance stages. Active members in the community can be mobilized or existing informal institutions within the settlement appropriately restructured to take charge of the maintenance of stormwater infrastructure. In fact, the success of non-structural stormwater management strategies is largely dependent on the community's involvement. Women have a notable role to play in this regard (Parkinson and Mark, 2005). The cases of Vientiane Area Infrastructure Improvement project in Lao Republic discussed as part of the cases reviewed in Chapter Four shows the role of women. The Lao Women's Union (LWU) were involved in monitoring the project and facilitated maintenance activities on the drainage infrastructure (ADB, 2006).

7.8 Implication for Resilience

Negative surface water and runoff related impacts (or disturbances) usually result from failure in stormwater management and drainage systems. It at times

reaches disastrous dimensions. Threat of such negative impacts is increasing as a potential result of global climate change and developments arising from local urban change. This phenomenon is particularly and increasingly challenging for residents in low-income informal settlements of African cities (Douglas et al, 2008). Resilience is the quality that sustains communities, should this runoff related disaster happen. What implications for resilience therefore can be drawn out from the context of the informal settlements earlier discussed in this report?

With respect to stormwater management systems, and flooding in urban informal settlements, resilience is in two dimensions. This follows Lamond and Proverbs' (2008:64) explanation, as well as Chatterjee (2010) and Sakigele et al's (2012) example of informal settlements in India and Tanzania respectively. Physical devices/engineered infrastructure for stormwater management constitute the first means for resilience, while the network of human beings is the other aspect. The social aggregation of residents in a settlement constitutes a vital fibre in the stormwater management web. Consideration of both dimensions for resilience has policy implications.

Resilience of physical infrastructure to runoff related disturbances involves technical and environmental considerations. Such considerations are beyond the scope of this research. However, Fiskel's (2006:4) position that the design and development of sustainable systems must be informed by 'understanding system resilience relative to foreseen and unforeseen stressors' comes into relevance. The other dimension of resilience relates to the residents themselves, who form human and social capital deployable in the event of disturbance or disaster (Chatterjee, 2010:340; Sakigele et al, 2012). This aspect is indispensable in resilience to runoff-related disaster in informal settlements, especially in the case of flooding. However, intervention approaches to formalise or 'upgrade' informal settlements in Johannesburg raise questions on this essential aspect of resilience.

Stormwater management intervention by the municipality in Johannesburg's informal settlements is embedded in the process of formalisation. The City of Johannesburg's approach to formalisation involves removal of residents from their shacks to green-field development of RDP/BNG houses in a newly established township. This approach as applied in the case of Elias Motsoaledi settlement potentially stands to directly or indirectly weaken or totally eradicate

the existing social network and capital in the settlement. If this approach is utilised in Slovo Park, the strong cultural cohesion, communal spirit and organisation which has formed a distinct and strong social fabric in the settlement would be lost. However, the community-led, NGO-assisted approach employed in Slovo Park, aimed at improving stormwater management and drainage as part of the overall provision of infrastructure in in-situ upgrading would sustain the existing social network and capital. It may at worst involve minimal disruptions to it. Slovo Park residents' experience of and lifestyle adjustment to flooding indicates somewhat of this social capital although their endurance or what I refer to as 'innurance' cannot be equated with resilience.

The decimation of what I call 'socio-human' capacities and capital for resilience in urban informal areas, under whatever guise, does not mean well in the incidence of flooding or any other runoff related disaster. These scenarios from Johannesburg's settlements point to the importance and benefit of *in situ* upgrading over the present approach taken by the municipal authorities to formalise these areas.

It is possible that the dolomitic condition of the land in Slovo Park can also lead to disturbing or disastrous events. However, it is envisaged that housing and infrastructural developments in the course of *in-situ* upgrading on such land would be adequately guided by requisite technical prescriptions. If after appropriate developmental precautions are taken and the unforeseen still happens, I believe the 'socio-human' capacity in the concerned community is vital to their resilience.

Although, this discussion was limited only to negative runoff related impacts and disasters, other forms of disaster/disturbance might happen in informal settlements. 'Socio-human' network and capital as described above is essential to low-income urban communities' resilience to any form of disturbance or disaster.

7.9 Conclusion

This chapter has shown the shortcomings in formal institutional provisions and present disposition of the municipality towards sustainability on stormwater management in informal settlements. The chapter demonstrates the place of catchment-scale intervention on stormwater management in informal settlements.

It also brought to fore the inherent deficiencies in the state (municipality)'s top-down approach and the potentials of community-led, NGO-assisted initiatives at sustainably managing stormwater in informal settlements. The attempt is not to remove the state in the scheme of things with respect to the development of informal settlements. Instead, this study points to the need for meaningful engagement with the informal settlement communities. Through this approach, the inherent potentials and ingredients for sustainable stormwater management in the settlement which is also necessary for development can be harnessed while these low-income communities remain resilient.

CHAPTER EIGHT

8 CONCLUSION

8.1 Introduction

This research report has discussed issues relating to stormwater management in urban informal settlements. It presented case studies of two settlements in the City of Johannesburg to contextualise the social and institutional issues raised in earlier chapters. The City's institutional approach and how this unfolds in the actual setting of Elias Motsoaledi settlement was considered in the first case study. The second case study is on Slovo Park, a settlement where the local community assisted by NGO and professionals' are working towards improvement in stormwater management. This concluding chapter recapitulates some of these earlier points, presents a summary of key findings emanating from the study and show how these provide answers to the guiding research question and sub-questions in the study. It identifies and recommends possible areas for future research. It concludes with recommendations based on the findings.

8.2 Summary of Key findings

The first sub-question guiding this study relates to the challenges for stormwater management in the context of informal settlements. The literature I reviewed and realities for the case studies show these challenges. They include poor construction of shacks, inappropriate waste disposal attitude and inadequate waste management services. The mixture of greywater and wastewater with stormwater, as well as the complexities involved for settlements to gain the municipality's developmental attention are also included. Locational characteristics of the settlements studied, that is, their proximity to rivers and location on dolomitic land make the concern for stormwater management and drainage critical.

The second sub-question dwells on institutional issues in the context of stormwater management in informal settlements. To provide an answer, this study examined the pool of documents, guidelines, processes, legislative frameworks that touch in one way or the other on the state's intervention in stormwater management. This shows aspects with contradictory positions, while the reality of comprehensive implementation indicates institutional mismatches.

The state's delay and shortcomings towards the speedy and sustainable development of informal settlements also comes to the fore. A key issue is that of reactive intervention to fallouts from poor stormwater management and drainage systems rather than proactive, preventive investments on sustainable stormwater management infrastructure in informal settlements by the municipality. Also, policy on stormwater management in Johannesburg has not incorporated sustainable drainage systems. Budgetary constraints came up as one of the reasons for the non-transition to sustainable drainage systems while 'stickiness' to traditional drainage systems is also still been manifested by some stakeholders.

The social and informal institutional issues within the informal settlements are what the third sub-question addresses. An answer to this comes through the identified perception, attitude and range of measures by which negative impacts of runoff, especially flooding, are prevented and tackled in informal settlements. In Slovo Park, the residents' perception on dolomitic risk and climate change are not influencing stormwater management practices in the settlement. Some of the residents also exhibit endurance to flooding. The strategies utilised to tackle flooding include self-help, household-based stormwater management practices, community-initiated spatial planning measures (relocation from high risk areas), training by municipal institutions on safety measures in the event of flooding and state's disaster response after flooding. The various self-help stormwater management practises within the informal settlement, which though are important to be recognised are inefficient to curb flooding and also contextually inappropriate with respect to geological condition of dolomite, especially in Slovo Park settlement.

The study also shows that approaches towards stormwater management in the two informal settlements studied do not optimise the potential of green infrastructure. The example of Slovo Park shows the significant presence of green infrastructure in the private areas (arounds shacks, within stands) but such is not prevalent in the communal areas within the settlement. Conversely, the case of Elias Motsoaledi shows plans and proposals for communal areas only, but not the private areas (within stands) in the process of 'formalising' the settlement.

The study also found that interventions specifically targeted to improve stormwater management in informal settlements by the City of Johannesburg are embedded in the context of what the City calls 'formalisation' or township establishment for the concerned settlement. Interim services that are usually provided in most informal settlements by the municipality rarely touch on improvement in stormwater management and drainage. This study, in an answer to the fourth research sub-question, shows that the approach of formalisation by the municipality as seen in the case of Elias Motsoaledi settlement does not potentially support social sustainability. On the other hand community-led, NGO-assisted initiatives towards stormwater management as part of thrusts intended to catalyse *in-situ* upgrading as seen in the case of Slovo Park settlement support social and institutional sustainability. The municipality's intervention decimates resilience capacities while the approach emanating from within the settlement which is essentially participatory sustains or might minimally disrupt resilience capacities to negative surface water and runoff impacts especially flooding.

8.3 Area for further research

The limited scope of this study can be extended through future research focus on the areas described below. The focus on institutional issues in relation to stormwater management in informal settlements can be extended to other elements such as human resource capacity, planning and budgeting as well as intra- and inter- institutional relationships. Although I am not aware of any such in Johannesburg as yet, but I believe scenarios where sustainable drainage systems have been adapted to the setting of urban informal settlement would be a worthwhile case study. It would provide a more appropriate context where not only social and institutional issues can be studied but a rounded investigation can take place. Exploring financing and cost recovery on stormwater management projects in urban low-income settlements would also contribute to their socio-economic sustainability.

8.4 Recommendations

This research speaks to the necessity of socially and institutionally sustainable approaches in the bid to achieve living environments of adequate quality in informal settlements through stormwater management and drainage improvements. With respect to social and institutional sustainability, the Slovo

Park study calls to question the present ‘formalisation’ approach by the City of Johannesburg. The formalisation approach must be reviewed. This should not just in line with the national policy, which calls for *in situ* upgrading of informal settlements wherever possible. It is important because strengthening and sustaining, rather than weakening, the social and institutional contexts into which stormwater management interventions are embedded is important.

This study also speaks to the place of green infrastructure as a component of sustainable drainage systems at managing stormwater. It is necessary to create appropriate policy context that would scale up the present self-help elemental green infrastructure initiatives in informal settlements towards the management of stormwater. The place of catchment-scale strategies at preventing runoff related hazards in informal settlements is also imperative. These approaches should not remain in the realm of academic and professional knowledge, but speedily translate into policy, programme and practice in the City of Johannesburg. Above all, there is an overarching need for positive institutional disposition towards the development of informal settlements in the city.

8.5 Conclusion

This study set out to investigate the social and institutional domains of sustainability around stormwater management in informal settlements. Literature-based findings and the reality from the two informal settlements studied have led to a number of findings which are summarised above. These findings provide answers to the guiding research question on ‘the interplay between social and institutional issues with respect to sustainable stormwater management in Johannesburg’s informal settlements’. The study points to the importance of stormwater management as a driver and key component in informal settlements and that the key to successful stormwater management interventions lies in the social and institutional contexts. It is only when the appropriate social and institutional contexts are in place that technical solutions as well as economic innovations can work well in order to make urban stormwater management interventions in informal settlements sustainable.

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