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INFORMAL SETTLEMENT INTERVENTION AND GREEN INFRASTRUCTURE: EXPLORING JUST SUSTAINABILITY IN KYA SANDS, RUIMSIG AND COSMO CITY IN JOHANNESBURG

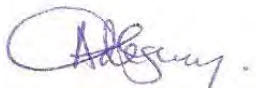
Olumuyiwa Bayode Adegun

A thesis submitted to the Faculty of Engineering and the Built Environment, University of Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Doctor of Philosophy

Johannesburg 2016

DECLARATION

I declare that this thesis is my own unaided work. It is being submitted to the Degree of Doctor of Philosophy to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.



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August 30, 2016

ABSTRACT

This thesis is concerned with the relationship between informal settlements and green infrastructure. It uses the concept of just sustainability to explore the ways green infrastructure can contribute to more just and sustainable informal settlement interventions.

The study draws on a case study design, with three low-income areas in Johannesburg serving as case studies. The first, Kya Sands, is an informal settlement that has not experienced substantive intervention. The second, Ruimsig, is an informal settlement that has experienced *in situ* intervention through reblocking. The third, Cosmo City, is a green-field housing development where households from informal settlements were relocated. The thesis utilised qualitative methods (semi-structured interviews, transect walks, focus group discussion) for data collection across the case studies. These were supplemented by a quantitative component for data collection in an individual case and in-depth interviews with purposively selected key informants.

The three cases reveal how the low-income residents in these areas derive a range of ecosystem services from natural ecosystems. A range of ecosystem disservices also came to the fore. In Ruimsig settlement, reblocking involved spatial reconfiguration that created opportunities for greening. Co-producing the *in situ* intervention involved some processes and outcomes related to equity and inclusion but also included situations that were exclusionary. Relocation from informal settlements into a new housing environment in Cosmo City formally created spatial opportunities for greening and reduced dependency on the natural ecosystem for certain basic resources. However, the course of events leading up to relocation and post-occupancy trajectory of green spaces reveal shortfalls in relation to justice and incognisance on socio-ecological and socio-economic realities at the planning stage. Juxtaposition between the cases of Ruismig and Cosmo City shows that *in situ* intervention can fulfill more principles of just sustainability in comparison with relocation.

This thesis argues that careful assessment of the relationship between poor households living in informal settlements and green infrastructure — their interaction with natural ecosystems should influence the approach to informal settlement interventions. The cases reveal that achieving just sustainability in relation to green infrastructure in informal settlement intervention is not straight-forward, but not impossible. Progress towards just sustainability in the form of improvement in quality of life and in the environment requires navigating (with foresight rather than hindsight) the intricacies and dynamics obtainable in contexts into which informal settlements are embedded.

'Thou shalt not destroy the trees … for the tree of the field is man's life'
Deuteronomy 19:5

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LIST OF ACRONYMS

ANC	African National Congress
BNG	Breaking New Ground
CoJ	City of Johannesburg
CDF	Community development Forum
CEO	Chief Excutive Officer
CORC	Community Organisation Resource Centre
COSATU	Congress of South African Trade Unions
CPUL	Continuous Productive Urban Landscape
DA	Democratic Alliance
EIA	Environmental Impact Assessment
EJNF	Environmental Justice Networking Forum
EPWP	Extended Public Works Programme
FTFA	Food and Trees for Africa
GBCSA	Green Building Council of South Africa
GDACE	Gauteng Department of Agriculture, Conservation and Environment
GI	Green Infrastructure
ISN	Informal Settlement Network
JCCA	Jukskei Crocodile Catchment Area
JCPZ	Johannesburg Parks and Zoo
NGO	Non-governmental Organization
NIMBY	Not in my Backyard
NPO	Not for Profit Organisation
NUSP	National Upgrading Support Programme
PMM	Professional Mobile Mapping
RDP	Reconstruction and Development Programme
ROD	Record of Decision
RNHOA	Ruimsig North Home Owner's Association
RSA	Republic of South Africa
SDG	Sustainable Development Goals
SDI	Shack/Slum Dwellers International
Stats SA	Statistics South Africa
SUDS	Sustainable Urban Drainage System
TPA	Transvaal Provincial Authority
UN-HABITAT	United Nations Human Settlement Program
UISP	Upgrading of Informal Settlement Programme
UJ	University of Johannesburg
VIP	Ventilated Improved Pit Latrine
WCED	World Commission on Environment and Development
WTP	Willingness to Pay

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Informal settlements provide shelter for a significant percentage of people living in cities in developing countries. Between 30 and 60 percent of the urban population in some developing countries live in illegal or informal settlements (Mitlin and Satherthwaite, 2013). In South Africa, the Housing Development Agency's efforts to estimate the national percentage showed that around 11% of households might be living in informal settlements (HDA, 2013). These settlements, within South Africa and beyond, are characterised by social, economic and environmental disadvantage and embody urban inequality (Beall *et al*., 2000; Sverdlik, 2011). For instance, lack or inadequate access to basic services, infrastructure and amenities predisposes informal settlement residents to socio-economic disadvantage while location in high-risk areas such as floodplains can be concomitant to environmental disadvantage.

Environmental aspects of informal urban settlements are important. While location of a settlement close to natural ecosystems such as rivers and wetlands might bring about environmental disadvantage, it can be construed as serving informal settlement residents through the way in which the poor households connect with ecological contexts in order to participate in urban 'socio-metabolic flows' — flow of raw materials that support human societies (Swilling, 2011). In this situation, a natural ecosystem functions as green infrastructure based on its characteristic and value, involving processes and benefits that support society's functioning (Gill *et al.,* 2007; Schaffler and Swilling, 2013). Apart from being located in natural ecosystems, the residents of such informal settlements at times undertake agricultural cultivation (Redwood, 2009; van Averbeke, 2007; Battersby and Marshak, 2013). This presents another notable environmental dimension to informal settlements.

To address the various forms of disadvantages and deprivation in informal settlements, a variety of interventions are being promoted. In South Africa, interventions in and for informal settlements, carried out by the state, non-state actors or local communities themselves, take different approaches. These range from the provision of interim basic services, regularisation, *in situ* upgrading to demolition and either replacement with or relocation to new site and services areas or subsidised

low income housing developments (Abott, 2002; Huchzermeyer, 2002; Wekesa *et al*., 2011). Depending on the approach, informal settlement intervention has greater or lesser implications for environmental sustainability and the way residents relate to the natural ecosystem. These implications may be unanticipated, hidden, and seem contradictory, as may the benefits of certain interventions.

The connection between natural ecosystems and informal settlements predisposes residents to problems while also holding the potential for sustainable solutions. Therefore, this study frames the interaction between residents of informal settlements and the natural environment or green infrastructure through ecosystem services and ecosystem disservices. It explores particularly how informal settlement interventions impact these ecological benefits (services) and problems (disservices) in the context of urban inequality.

Understanding how residents relate to natural ecosystems and how informal settlement intervention impacts this relationship in the context of inequality can further be considered through the conceptual lens of 'just sustainability'. Coined by Agyeman *et al.* (2003), 'just sustainability' builds on the definition of sustainable development presented by the World Commission on Environment and Development's (WCED), adding and emphasising on a broad social equity dimension to it. Just sustainability involves the deliberate integration of social considerations into sustainability (Pearsall and Pierce, 2010) in order to achieve 'an ecological balance and a social balance' (Campbell, 1996:300). Broadly, it means ensuring 'better quality of life for all, now and into the future, in a just and equitable manner, whilst living within the limits of supporting ecosystem' (Agyeman *et al.*, 2003:5). This conceptual framing stems from the need to connect issues related to urban inequality and socio-spatial exclusion with responses to global environmental change in the light of informal settlement intervention in cities of developing countries. In this situation therefore, there is an interaction between human equality and equity through informal settlement intervention on the one hand and environmental quality through settlements' connection to natural ecosystem on the other. Both are central motivations of this study.

The city of Johannesburg, South Africa's largest urban centre, presents an appropriate context for this study. Informal settlements within the municipality,

which are in many cases connected to natural ecosystems, accommodate people who are historically disadvantaged, thus embodying the city's high-ranking social, economic and environmental inequality (Turok, 2012; Todes, 2014). The settlements' connection to natural ecosystems (green infrastructure) involves beneficial and detrimental outcomes which are impacted upon by varying intervention approaches. Apart from inequality and connection to natural ecosystems, which could equally apply to some South African cities, research on state-delivered green infrastructural interventions targeted at tackling inequality specifically suggests a need to match justice and sustainability in the context of low-income urban areas in Johannesburg (Schaffler and Swilling, 2013). This positions Johannesburg as a fitting setting for an investigation into informal settlement intervention and green infrastructure and a conceptual engagement with the concept of just sustainability.

1.2 DEFINITION AND EXPLANATION ON KEY TERMS

Green Infrastructure

The term 'green infrastructure' has two main meanings. On the one hand, green infrastructure relates to green goals; that is, natural and eco-friendly approaches in the delivery and operation of infrastructure and services such as energy, transport, sanitation, waste management (Foster *et al.*, 2011). Here green infrastructure means greening of infrastructure with the intention of 'minimising environmental damage while maximising environmental benefits related to the use of material and energy during the construction and operation phases' (Giordano, 2014:482). John Abbott employed this normative use of the term green infrastructure to argue for a context-sensitive ecological (green) infrastructural approach in African cities, from the position that the delivery and management of a full range of urban infrastructure and services can indeed be 'green' (Abbott, 2012).

On the other hand, the term green infrastructure refers to 'green spaces and other environmental features' (Natural England, 2009:7) as well as productive natural landscapes (Bohn and Viljoen, 2011:150) that deliver a range of benefits to human beings. In this case, the term 'green infrastructure' is used as a noun to represent a phenomenon rather than as a normative phrase related to the ideal, or the process, of 'greening'. In this thesis, green infrastructure refers to natural ecosystems and to

tangible ecological resources, with a more detailed review of the concept made in Chapter 2.

Ecosystem Services and Ecosystem Disservices

The ecological processes associated with green infrastructure involve services and disservices and therefore relates to the already mentioned concepts of ecosystem services and disservices. Ecosystem services are direct or indirect benefits, whether actively or passively utilised, that people obtain from natural ecosystems functioning as green infrastructure (Fisher *et al.,* 2009). They have been categorised differently in literature, as reviewed in Chapter 2. This thesis mainly uses the Millennium Ecosystem Assessment (2005) categorisation, which distinguishes between provisioning, regulating, socio-cultural and supporting ecosystem services.

On the other hand, ecosystem disservices are 'functions of ecosystems that are perceived as negative for human beings' (Lyytimaki and Sipila, 2009:311). As shown in more detail in Chapter 2, Dunn (2010) dinstinguished between disservices that are 'real' as opposed to those that are based on perception. Both kinds of negative experience deserve attention when considering green infrastructure.

Informal Settlements

As an international phenomenon, precarious forms of low-income urban shelter are referred to and understood as 'slums', often replacing terms such as 'informal settlements', 'squatter camps' or 'shanty towns'. The term 'slum' applies to conditions of deteriorating and rundown public or private housing or 'makeshift dwellings in unplanned settlements, all in antithesis to the modern city' (Huchzermeyer, 2014a:886). In UN-HABITAT's (2003) use of the term, any form of urban shelter where there is absence of secure tenure, inadequate access to water and sanitation, inadequate shelter and exposure to risk, is categorised as a 'slum'. This definition (and the term) has been found to be too broad, negative and at times ambiguous to be analytically useful, as aspects of it may even apply to up-market residential conditions in South Africa and some African countries (Groenewald *et al.*, 2013).

The definition of what an informal settlement is varies across municipalities and different spheres and agencies of the state in South Africa. As pointed out by the

Housing Development Agency (HDA, 2013), some of the available definitions are ambiguous. For the purposes of this thesis, I use the term 'informal settlements' as defined by the Department of Human Settlement's National Upgrading Support Programme (NUSP):

> 'Informal settlement exists where housing has been created in an urban or peri-urban location without official approval. Informal settlements may contain a few dwellings or thousands of them, and are generally characterised by inadequate infrastructure, poor access to basic services, unsuitable environments, uncontrolled and unhealthy population densities, inadequate dwellings, poor access to health and education facilities and lack of effective administration by the municipality' (NUSP, undated: unpaginated).

The term 'informal settlement' as used in this thesis includes forms of urban shelter within or outside South Africa that some authors might have called 'slums', 'squatter camp' and so on.

Just Sustainability

Highlighting the connection between justice and sustainability, three American scholars - Julian Agyeman, Bob Bullard and Bob Evans jointly coined the term 'just sustainability' in 2003 (Agyeman *et al.,* 2003). They defined 'just sustainability' as 'better quality of life for all, now and into the future, in a just and equitable manner, whilst living within the limits of supporting ecosystem' (ibid:5). The thesis uses the term to show social dimensions – equity, justice and inclusion – in relation to green infrastructure and environmental sustainability at large. As shown in Chapter 3, the term 'just sustainability' was developed to provide a conceptual framework for this research.

1.3 PROBLEM STATEMENT AND MOTIVATION

Challenges associated with urban shelter in developing countries are often linked to broader global issues around environmental sustainability. Contrary to this link, as pointed out by Quilan and McCarthy (1995) and Taylor (2011), there is an assumption at the global level among some urbanists that the consideration of bio-physical conditions is something of a luxury in relation to informal urban settlements. As a result, issues of informal dwellings and environmental sustainability have diverged within discourses on urbanism, including architecture, with sustainability discourse taking place mainly in relation to formal, middle- and

upper-income residential neighbourhoods internationally (Sullivan and Ward, 2012). As argued over the last two decades (Dalgliesh et al., 1997; Magi 1999; Groebel, 2007; Shackleton *et al.,* 2014), environmental sustainability in low-income and informal housing settlements, with reference to green infrastructure, has not been much of a concern to state and some non-state actors in South Africa. The same problem has been raised for developing countries in general (French and Lalande, 2013).

Inadequate attention to environmental sustainability, especially green infrastructure, in informal urban settlements is problematic for the following reasons. Firstly, informal housing constitutes a notable (and at times growing) proportion of the territory and population in cities. The percentages of urban population living in informal settlements in developing countries, South Africa and Johannesburg as earlier shown provide evidence to the significance. Secondly, these informal areas are usually peopled by the socially and economically disadvantaged, to which environmental disadvantage must be added. For instance, being 'victims' of urban inequalities, the residents are more vulnerable to and lack adequate resources to mitigate the impacts of global ecological change and unsustainable development (Agbor, 2013; Nenweli, 2015).

Apart from inadequate attention to environmental problems that may be related to green infrastructure in informal settlements, literature (Jabeen *et al.,* 2010; Schaffler and Swilling, 2013; Adegun, 2013) shows that there are opportunities for sustainability and resilience in and around urban informal settlements through more careful attention to green infrastructure. This motivates the need to consider the relationship between green infrastructure and people living in low-income informal housing in a manifestly unequal city such as Johannesburg.

The research problem can be described as follows: *contributions, challenges and potentials associated with green infrastructure are not well known in the context of informal settlements in Johannesburg; and in relation to 'just sustainability'*. Research is therefore needed to understand green infrastructure in relation to informal settlements in Johannesburg. In order to inform policy and programmes, this knowledge is particularly useful if related to changes that occur over time and in the spaces that the low-income urban residents inhabit. For the purposes of this

thesis, it is understood that such changes may be triggered or driven by state or NGO intervention. The study therefore explores how the residents relate with green infrastructure in settlements that are at different stages of substantive intervention, including relocation to a new housing development. As a result, three areas - Kya Sands, Ruimsig and Cosmo City in the city of Johannesburg, were chosen to serve as case studies for this research. Kya Sands is an informal settlement — a settlement where no substantive form of intervention has taken place. Ruimsig is an informal settlement that has experienced *in situ* intervention through re-blocking. Cosmo City is a township established for residents relocated from informal settlements. It embodies the relocation approach to informal settlement intervention. More information on and justification for choosing these areas are provided in Chapter 4.

1.4 THE OBJECTIVES OF THIS STUDY

As already stated, this study aims to contribute to the understanding of the role of green infrastructure in informal settlements. In particular, it seeks green infrastructure's relation with residents of such settlements, through use of the lens of just sustainability and with a view to producing knowledge that may ultimately inspire similar research elsewhere, but also to inform more effective intervention in South Africa and beyond. The study's objectives are to show how low-income residents in informal settlements as well as areas that emerged through informal settlement intervention interact with different components of green infrastructure. While exploring green infrastructure, the study set out to discover histories, perceptions, expectations and values associated with the residents' interaction with identified natural ecosystems, bringing to the fore multiple dimensions of ecosystem services and ecosystem disservices in the studied areas.

Where substantial intervention had occurred, the study set out to establish how residents had related with natural ecosystems in their former informal settlements or previous settlement condition, drawing on respondents' recollections. By analysing the previous and current situations through the lens of just sustainability, the objective was to establish how intervention approaches impact on the relationship residents have with green infrastructure within the given socio-economic conditions.

1.5 RESEARCH QUESTIONS

This study is based on the following research question:

> *In what ways do informal settlement residents relate with green infrastructure and how do interventions impact these, in the light of just sustainability?*

The above question is devolved into the following sub-questions which guided this research:

i. What are ecosystem services and ecosystem disservices that green infrastructure provides to residents of informal settlements or areas that emerged through relocation from informal settlements?
ii. How do formal interventions (either in situ or relocation) impact the relationship between residents and green infrastructure?
iii. How might informal settlement interventions better meet the requirements of just sustainability?

1.6 OVERVIEW AND STRUCTURE OF THE THESIS

Chapter 2 of the thesis reviews literature on the key themes of the research that relate to the natural environment, namely — green infrastructure, ecosystem services and ecosystem disservices. This offers definitional foundation for the empirical research and later discussion of findings from the case studies. Through the literature, it provides conceptual understanding of the multi-faceted benefits (ecosystem services) and problems (ecosystem disservices) associated with green infrastructure in light of informal settlements across developing countries.

The following chapter (3) moves on to review concepts relevant to the study on green infrastructure in the context of urban socio-spatial exclusion, manifested through informal settlements. In this chapter, the concepts of inequality, justice and sustainability, bring together questions of environment and socio-economic disadvantage generally and in the South African context. These lead to the conceptual framing around just sustainability, for an application to the unequal context of Johannesburg, South Africa.

Chapter 4 covers research design, methodology and methods used in the study. The choice of a case study design is explained and the three case study areas (Kya Sands, Ruimsig and Cosmo City) are briefly introduced. The chapter sets out the qualitative and quantitative data collection instruments used in the three case study areas and presents the methods and processes used to analyse the case study data. The chapter ends with a report on ethical challenges that were anticipated and those that emerged during the field work and how these were resolved.

The case of Kya Sands informal settlement is considered in Chapter 5. It reveals ecosystem services and disservices through different components of green infrastructure – private and collective gardens, informal parks and sports field, and the stream, wetland and riparian corridor. The case reveals a range of ecosystem services, showing many unexpected ways in which green infrastructure, though much of it degraded, is useful to the residents. The case also reveals important disservices that Kya Sands residents do experience.

The case of Ruimsig settlement in Chapter 6 shows how co-produced *in situ* improvement impacts the way residents relate to green infrastructure, and the complex implications for just sustainability. The case reveals that an *in situ* intervention of this nature may lead to improved quality of life and a more environmentally sustainable situation, but that this outcome is not necessarily linear or as might be anticipated.

The case of Cosmo City, presented in Chapter 7, gives insight into how relocation as an informal settlement intervention approach impacts the relationship between relocated low-income residents and green infrastructure. The case engages with the assumptions around residents' relationship with green infrastructure in the planned and regulated relocation site. It reveals a certain informalisation of this relationship which is given meaning through a comparison with the case in Kya Sands settlement. The case of Cosmo City also captures residents' recollection of the green infrastructure situation in the informal settlements from which they were relocated, which helps understand the current situation in the relocation area.

Chapter 8 undertakes a cross-case analysis of findings from the three areas. It discusses findings from the three case studies, linking the issues emanating with relevant positions from literature and the conceptual framework. This allows that

chapter to discuss in situ intervention versus relocation with reference to aspects of just sustainability. This leads to a discussion of co-production and co-management in the light of just sustainability, showing what might and might not lead to just and sustainable situations in informal settlement interventions in Johannesburg. The chapter acknowledges the potential of a beneficial relationship with the natural environment in just and sustainable interventions in informal settlements.

Finally, in Chapter 9, the thesis is drawn to a close through a synthesis that responds to the objectives and research questions set out in Chapter 1, a conclusion as well as recommendations for further research. The contribution to knowledge is articulated through an improved understanding of green infrastructure in the context of informal settlements through informed recommendations for intervention as well as through the application of the conceptual lens to the context in Johannesburg that this study addresses.

CHAPTER TWO

URBAN GREEN INFRASTRUCTURE AND ECOSYSTEM SERVICES IN RELATION TO INFORMAL SETTLEMENTS

2.1 INTRODUCTION

It is important to understand concepts related to the natural environment in order to research issues around justice and environmental sustainability, with key reference to green infrastructure. As a result, this chapter, through a review of literature, considers the concepts of green infrastructure, ecosystem services and ecosystem disservices in relation to informal urban settlements.

The chapter begins by defining green infrastructure, ecosystem services and ecosystem disservices. This definitional foundation allows unpacking and interrogation of the concepts in the context of informal urban settlements. Thus, the chapter identifies three ways in which informal settlements are associated with green infrastructure and discuss ecosystem services (benefits) and ecosystem disservices (problems) from these connections. It illustrates the benefits and problems with concrete examples drawn from international as well as South African literature. The examples available in literature led to an examination of the reliance/demand for and the need to secure/supply different types of ecosystem services in low-income urban communities. The latter part of the chapter considers the 'fate' of green spaces and relationship with green spaces in informal settlement intervention, which underscores relevance of the concept of green infrastructure for an exploration of just sustainability.

2.2 UNDERSTANDING GREEN INFRASTRUCTURE

Within the past three decades, Green Infrastructure (GI) emerged as a term in academic literature and is rapidly evolving in the field of urbanism. The term was first used by Charles Little in his book 'Greenways for America'. Little (1990) introduced the term to describe a networked assemblage of natural landforms and green open spaces that create alternatives to municipal or regional infrastructure in the USA. So far, 'green infrastructure', has been most frequently used in the Anglophone countries of the global north – primarily the USA and UK, but is also used by the European Union (Lennon, 2014). Its use in literature from countries in

the global south, especially Africa, is only beginning to emerge through recent works seeking to advance the potential of natural ecosystems and green spaces as part of urban infrastructure (Abbott, 2012; Schaffler and Swilling, 2013; van der Walt *et al.,* 2014; Elewa, 2014).

The concept of green infrastructure is based on the principle that natural elements and systems can serve as 'infrastructure'. Natural elements and systems include 'green spaces and other environmental features' (Natural England, 2009:7) as well as productive landscapes (Bohn and Viljoen, 2011:150). All of these occur at different spatial scales as shown in Table 2.1. As 'networks of multi-functional ecological systems within, around and between urban areas, at all spatial scales', natural elements and systems involve processes that deliver goods and services associated with the sustenance of human beings (Tzoulas *et al*., 2007:169). They conserve 'ecosystem values and functions and provide associated benefits to human populations', thereby serving as green infrastructure (Benedict and McMahon, 2002:12).

Table 2.1 Green Infrastructure at various spatial scales

Spatial Scale	**Example of Green Infrastructure Components**
Dwelling/Stand Scale	home gardens, planted hedges, creepers, bio-swales, potted plants
Neighbourhood Scale	street trees, vegetated verges, play parks, community gardens
Township Scale	parks, urban waterways (wetlands, streams etc), riparian corridor
Urban/Sub-regional scale	agricultural land, urban forest, waterway network, national parks

Source: Adapted from Parkin *et al.* (2011)

Central to the concept of green infrastructure are the themes of *multi-functionality*, *connectivity/network* and *ecological services*. Multi-functionality, as the name implies, refers to multiple purposes and functions of green space(s) (Mell, 2008). That is, a particular green space has the ability to 'perform several functions and provide several benefits on the same spatial area' (European Commission, 2012:1). For instance, the riparian corridor of an urban river might be developed with a park used for recreation and social activities. Vegetation in the corridor or park aids visual quality, micro-climate control and carbon sequestration. It might also support plant and animal biodiversity. Therefore, this singular riparian corridor performs a range

of ecological functions. In the context of informal settlements though, green infrastructure functions may be diverse – for play, socialisation and dumping, as my case studies will show.

Network and *connectivity* in green infrastructure deal with integration and interaction between the natural ecosystems and green spaces and their diverse functions within a city. Connectivity is an essential and inherent attribute of green infrastructure (Kambites and Owen, 2006). It can be *spatial*, *scalar* and/or *institutional* (Lennon and Scott, 2014). *Spatial connectivity* refers to 'linear connections' and 'continuously connected networks' (Kambites and Owen, 2006:490) between the ranges of green infrastructure's spatial scales, especially as it links town/urban areas to the wider rural hinterland (Grant, 2010). Spatial connectivity is compromised when the built environment cuts off, isolates or completely reshapes natural landforms. A situation where rivers are contained and conveyed in underground pipes is an example. Unplanned development which leaves little or no room for greenery of any kind also decimates connectivity of urban green infrastructure. *Favelas* covering Brazilian cities' steep slopes, or shacks on stilts covering coastal strips in some Nigerian cities fall into the category of these unplanned anti-connectivity developments.

Scalar and institutional connectivity is an ideal characteristic in green infrastructure planning and management across various spatial scales. It refers to the necessary connections between administrative entities, different parts and hierarchies within an organisation as well as disciplines involved in the planning and implementation of green infrastructure for a city or region. Since the linear movement of and link between plants, animals and people in physical spaces does not recognise institutional boundaries, Kambites and Owen (2006:490) argue that 'the silo mentality' is inimical to the true nature of green infrastructure planning and management.

The ecological functioning of green infrastructure involves services and disservices, called ecosystem services and ecosystem disservices respectively. This third theme of green infrastructure is intrinsically socio-ecological because it emanates from human beings' interactions with ecosystem resources and processes. The spatial dimension of green infrastructure makes ecosystem services and ecosystem

disservices relevant to urban planning (Lennon and Scott, 2014). I expand on the concepts ecosystem services and ecosystem disservices in the following sections.

2.3 ECOSYSTEM SERVICES

Broadly conceived, ecosystem services are benefits people obtain from ecosystems. They are aspects of ecosystems that are utilised actively or passively, directly or indirectly, to produce and sustain human well-being (Fisher *et al*., 2009). Urban ecosystem services refer to those benefits provided by components of urban green infrastructure, that is, natural and semi-natural 'green and blue spaces' such as gardens, parks, cemeteries, forests, wetlands and rivers (Gomez-Baggethun and Barton, 2013:236).

The Millennium Ecosystem Assessment (MA) report, published in 2005, provides the first major global assessment of the effects of human activities on the environment, thus raising the profile of ecosystem services. The report appraised the conditions and trends relating to the world's ecosystems, the services they provide, and their link to human well-being and development. The report's twenty-seventh chapter deals with 'Urban Systems', thereby touching on the phenomenon of unplanned urban development and expansion in developing countries. Based on the global appraisal of human settlement development trends, the report posits that growth of informal, inadequately serviced settlements in cities 'put pressure on the basic ecosystem services necessary for healthy life' (MA, 2005: 818).

A notable outcome in the Millennium Ecosystem Assessment's (MA) report is the categorisation of ecosystem services into the four classes, namely provisioning services, regulating services, socio-cultural services and supporting services (MA, 2005). The following section describes the different categories with some examples

- *Provisioning* ecosystem services are goods and products (material outputs) derived from natural ecosystems, for example, food, water, timber.
- *Regulatory* ecosystem services refer to processes of ecosystems that control the natural environment, for example, micro-climate moderation, air quality control, flood regulation and disease control.
- *Socio-cultural* ecosystem services: These are non-material benefits from ecosystems — cultural, psychological, social, spiritual, educational gains that support human well-being. They are manifest through spiritual enrichment,

aesthetic experience, socio-cultural expression, educational and recreational opportunities.

- *Supporting* services underpin and are necessary for the production of other services. Photosynthesis, maintenance of species' genetic diversity, soil formation and production of atmospheric oxygen are examples of supporting services.

Some scholars have criticised MA's four-fold categorisation of ecosystem services, presenting alternative categories. To Wallace (2007), MA's (2005) categories mix up route (means) to achieving services with services (ends) in the same level/standing. Demonstrating the mix-up, he referred to pollination, soil formation, water regulation (classified into regulating and supporting services by MA) which are processes (means) of delivering services such as food, fibre and water (ends, classified as provisioning services by MA). The argument here is that all types of ecosystem services should not be on the same level, as MA explained. Wallace (2007) therefore proposed a typology of ecosystem services linked to human values, shown in Table 2.2. In his classification, ecosystem services are arranged to match the human values that they maintain. Furthermore, ecosystem processes and assets are not directly and specifically linked to any service or category of values.

Table 2.2 Classification of ecosystem services based on links to human values, ecosystem process and natural assets

Category of Human Values	**Examples of Ecosystem services experienced at the individual human level**	**Examples of processes and assets to be managed to deliver ecosystem services**
Adequate resources	Food; Oxygen; Water; Energy; Dispersal aids (transport)	*Ecosystem processes* • Biological regulation • Climate regulation • Pollination • Nutrient regulation • Soil formation
Protection from predators/disease/ parasites	Protection from predation; Protection from disease and parasites	
Benign physical and chemical environment	Benign environmental regimes of temperature, moisture, light and chemical	*Biotic and abiotic elements (natural resource assets)* • Biodiversity assets • Land Assets • Water Assets • Air Assets • Energy Assets
Socio-cultural fulfilment	Access to resources for spiritual contentment, recreation/leisure, aesthetics, opportunity values - knowledge/educational resources	

Source: Wallace (2007)

A further critique of MA (2005) and Wallace's (2007) classifications was made by Fisher and Turner (2008). To Fisher and Turner (2008:1168), 'where the benefits are realized; by whom; and how their value changes across the landscape' are not clear from the categorisations made by MA (2005) and Wallace (2007). Another problem identified on the classifications is that they are not directly useful for economic valuation (Fisher and Turner, 2008). As a result, Fisher and Turner (2008) proposed a categorisation distinguishing between actual 'benefits', intermediate ecosystem services and final ecosystem services (end-products). This categorisation is primarily aimed at deriving economic value and financial implications of ecosystem services in the context of environmental accounting.

In Fisher and Turner's (2008) classification, pollination or photosynthesis is regarded as an intermediate ecosystem service that underpins the final ecosystem service of food provision. Food for consumption, for example almonds, is the benefit in this situation. In the same vein, soil formation (as an intermediate service) is a pre-requisite for water regulation (final service). The benefit here is say water for irrigation. Although this classification links ecosystem services with human welfare, its fundamental shortcoming lies in the fact that it emerged out of interest in

delineating ‘benefits that we can place an economic value on’ (Fisher and Turner, 2008:1168). It is therefore less useful for my research.

Of the three classifications discussed above, I use Millennium Ecosystem Assessment’s classification (MA, 2005) to discuss research findings in the thesis. This choice is based on the fact that MA’s classification is more commonly used and easier to understand compared with the alternatives listed above. Fisher and Turner (2008:1167) even agree that it ‘stands as a strong heuristic’, which is based on the linkage between human welfare and ecological services. Though drawing principally on MA’s classification, I use Wallace’s (2007) categorisation to discuss findings where relevant in the thesis.

2.4 ECOSYSTEM DISSERVICES

Having discussed benefits that humans derive from green infrastructure — ecosystems services, it is necessary to discuss ‘functions of ecosystems that are perceived as negative for human beings’, regarded as ‘ecosystem disservices’ (Lyytimaki and Sipila, 2009:311). Ecosystem disservices, a relatively recent term was used by Lyytimaki and Sipila (2009) to mirror the concept of ecosystem services and promote ‘comprehensive overview of the net effects of ecosystem functions for human well-being’ (Lyytimaki, 2015:136). It refers to harms and nuisances associated with the normal functioning of undisturbed ecosystems or the results of ecosystem degradation through direct or indirect human activities (*ibid.*).

According to Dunn (2010), natural ecosystems can constitute real dangers and inflict harm or result in negative experiences that are based on perceptions. Real ecosystem disservices generally occur through health problems from disease vectors such as mosquitoes breeding in wetlands and damage to properties and infrastructure from biotic elements such as tree root systems breaking up pavements (Escobedo *et al.* 2011). Disservices constituting real dangers can also result from decreased visibility because of trees or vegetation hosting pathogenic animals. Negative experiences from green infrastructure are related to perceptions are based on subjective human experiences. They include phobia of thickly vegetated areas in night-time (Jorgenseen and Anthopoulou, 2007) or idiosyncratic responses (fright, irritation or even allergies) towards the sound, smell and behaviour of certain plants and animals (Lyytimaki and Sipila, 2009).

Whether real or perception-based, ecosystem disservices generally fall under the broad categories of security and safety, health (physiological and psychological), aesthetics (sight, smell and sound), mobility and economic (financial implications of harm and nuisances) issues (Lyytimaki *et al.,* 2008). More examples of actual as well as perception-based disservices directly relevant to the context of unplanned, low-income and informal settlement in developing countries are presented later in this chapter. Examples of both kinds of disservices from the three case study areas are presented in Chapter 5, 6 and 7.

2.5 THE CONNECTIONS BETWEEN INFORMAL SETTLEMENTS AND GREEN INFRASTRUCTURE

Evidence from the review of literature, supported by personal experience from field visits across cities in developing countries, shows a notable connection between informal settlements and natural and semi-natural ecosystems functioning as green infrastructure. This connection happens in three main ways. Location in ecologically significant, environmentally sensitive and biodiversity rich places within cities is one. Agricultural cultivation within urban areas is another, while an ecological approach to infrastructural supply is the third. This section considers the three forms of connection.

Informal settlements are established through a process that takes advantage of unutilized publicly or privately owned but vacant land across cities in developing countries (Alsayyad, 1993; Van Gelder, 2010). Such land is unsuitable for residential development because it is located near streams, on low-lying river banks, in wetlands, on steep hillsides or servitudes, buffer strips and other forms of interstitial space. The locations are usually of ecological significance and biodiversity wealth or contain mineral resources. Land containing mineral resources triggers the formation of informal settlements because people are attracted to the location through extractive activities. Informal settlements are established to provide cheap accommodation for the informal miners or low-income, migrant workers in formal industries undertaking mining activities. Bryceson and MacKinnon (2012) explained that mineral discovery has effect on nature and spatial patterns of settlenents in African cities – with the informal housing being the dominant trend.

An informal settlement in Alexandra, Johannesburg is located the Jukskei River bank (see figure 2.1). Langrung informal settlement in Stellenbosch is located on a steep hillside (see figure 2.2). The Marikana case in South Africa among other is an example of the link between informal housing conditions and the exploitation of mineral resources. Providing evidence to the locational pattern in relation to riparian zones, Vollmer and Gret-Regamey (2013:1544), note that due to the presence of informal settlements in low-income Asian countries 'population density appears to increase by roughly 10% within 1 km of waterways'.

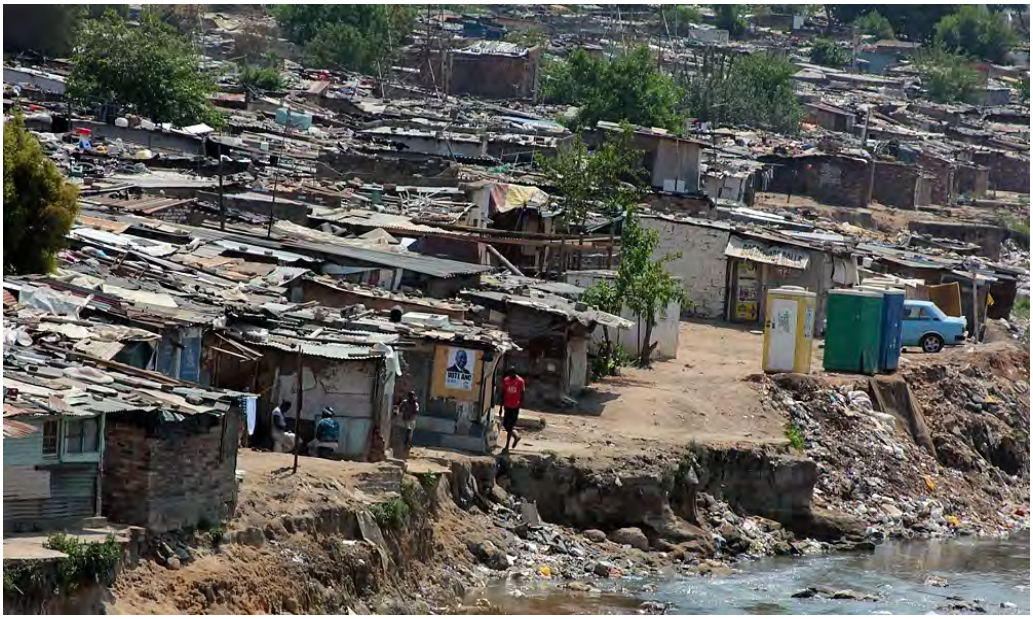


Figure 2.1 Alexandra township in Johannesburg includes an informal settlement located by bank of the Jukskei River.
Source: 2Summers, 2011 (used with permission).



Figure 2.2 Langrung informal settlement in Stellenbosch (Western Cape, South Africa) is located on a steep hillside
Source: Author's Photograph, October 2013.

A Mexican case provides empirical evidence on the locational characteristic of informal settlements. Between 295 and 300 informal settlements, about 36% of Mexico City's informal settlements, are located on ecologically significant conservation land that make up a unique cultural landscape (Wigle, 2014). Part of this informally occupied conserved land had been designated as a World Heritage Site by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and declared as a Natural Protected Area (NPA) by the Mexican government (*ibid.*). This situation confirms Guneralp *et al.*'s (2013) findings. Through an analysis of urbanisation in developing countries, Guneralp *et al.* (2013) found that urban growth through informal housing developments is taking place around and expanding into the world's biodiversity rich areas.

Interventions in and for informal settlements, whether *in situ* or otherwise, at times tend to perpetuate the locational characteristic pointed to above. This can happen as an outcome of urban planning where certain trade-offs might have taken place. Hetz and Bruns (2014:891), in their interview with urban planners in Johannesburg found that 'wetland areas and other ecologically sensitive sites are increasingly under pressure to be utilized for give-away housing' developed as part of the prevailing informal settlement intervention approach in the city. Wetlands and other

ecologically sensitive natural ecosystems are also under threat for up-market housing development in the city (Hartdegen, 2011; Bryne, 2014).

Apart from location in or close to natural ecosystems, the second form of connection between informal settlements and green infrastructure takes place through agricultural practices. To a greater or lesser extent, residents of informal settlements undertake various forms of agricultural cultivation, whether through planting in containers or beds in yards, home gardens in stands/plots and communal gardens in open spaces (see figure 2.4 and 2.5) (Redwood, 2009; Webb, 2011; Hamilton *et al.,* 2014). These agricultural spaces make up part of green infrastructure in informal settlements.

The third form of connection between informal settlements and green infrastructure occurs when infrastructural needs are met through natural or semi-natural systems, called socio-ecological infrastructure. This may be at the dwelling/household scale or through catalytic insertions at strategic points that stimulate wider-scale improvements in a settlement. A roof garden on a dwelling is an example of socio-ecological infrastructure at the household level. The garden attenuates rainwater, thus controlling runoff's quality and quantity and subsequently reducing the capacity of surface or underground drainage system needed. Vertical gardens installed by shack walls (see figure 2.3) in the course of re-blocking MtshiniWam settlement, Cape Town, offers micro-climate control through socio-ecological infrastructure at the dwelling scale (Henning et al., 2012:5).



Figure 2.3 Vertical gardens by shack walls in re-blocked MtshiniWam settlement
Source: Design Indaba 2013 (use with permission).

At the wider scale, patches of green open spaces or a wetland relate to interventions that catalyse neighbourhood-wide improvements. Shaping a multifunctional wetland; for runoff retention, water treatment and vegetable production reduces capacity of the sewage treatment facility needed at the township/municipal level. The wetland's productive nature may also generate improvements in socio-ecological relations within the settlement. Socio-ecological infrastructure through an adjoining wetland was explored as part of the Tactical Landscape Operations for Informal Settlement Upgrading project in Cantinho do Ceu, Sao Paulo (Werthmann, 2011). The positive relationship between ecological development and socio-economic improvement emerged from catalytic projects such as public use of small leftover land, developing wetlands for storm runoff treatment.

The connection between informal settlements and urban green infrastructure, as explained, also reveals prospects for climate change adaptation and mitigation in cities (Gill *et al.,* 2007). As argued by Kithiia and Lyth (2011), in the light of resource decline accompanying global climate change, an ecological infrastructure approach presents multi-functional, soft engineering alternatives to expensive grey infrastructure in low-income urban areas. The possibility of addressing climate change in urban areas through green infrastructure in informal settlements makes a study of this connection relevant.

2.6 BENEFITS OF GREEN INFRASTRUCTURE FOR INFORMAL SETTLEMENTS: ECOSYSTEM SERVICES

As earlier shown, the connections between humans and green infrastructure involve certain benefits regarded as ecosystem services. Through a range of academic papers mainly in the field of environmental sciences and (more recently) urban ecology, this section shows the kinds of ecosystem services obtainable in low-income urban settlements. The papers, though not conceptually articulated in direct relation to informal urban housing, reveals how poor households living in informal settlement generally draw benefits from natural and semi-natural ecosystems and landforms, vegetation, gardens, waterscapes, agricultural areas. I explain these benefits based on MA's (2005) classification of ecosystem services.

2.6.1 Provisioning ecosystem services

As a resource fundamental to life, water is a notable provisioning ecosystem service. Since there is usually outright absence or inadequate municipally-supplied potable water in informal settlements, the residents often depend on freshwater sources such as streams, wetlands, hand-dug shallow wells or other forms of ground/surface water appropriation. For instance, in an informal settlement in Jakarta where fewer than 30% of households have access to municipal water provision, Vollmer and Gret-Regamey (2013) report that over 80% of households obtain groundwater for washing through wells. Kimani-Murange and Ngindu (2007) reported that 89% of households depend on groundwater from wells in the Langas settlement in Nairobi while Ochieng *et al.* (2011) found that 85% of households depend on wells in three informal settlements in Ibadan. Ground/surface sources supplying water in informal settlements are generally of poor quality (Cairncross, 1990). If potable water (piped or bottled) is unaffordable or available, residents use the readily available poor quality water for cooking, laundry, sanitary purposes and irrigation.

Cultivated food, including edible medicinal plants, is another provisioning ecosystem service. At the international level, academic papers and project outcomes affirm the positive role of agricultural cultivation in food supply and food security in low-income informal urban settlements (Rau *et al*., 2011; Dubelling, 2011; Gallaher *et al.*, 2013; UAC, 2013). Scholars and project stakeholders generally agree that shortage of land/space is a problem for urban farming. The 'informal nature and resulting lack of political recognition' in sub-Saharan Africa is also another problem (Drechsel and Dongus, 2010:69). It is still unclear how food production can move to scale, such that it supplies a substantive portion of household food requirements in informal settlements.

The South African experiences in urban agriculture in low-income settlements are similar to those from other developing countries. South African-based scholars such as van Averberke (2007), Davoren (2009) and Kornienko (2013) point to food benefits derived from farming in informal settlements (see figure 2.4 for home gardens in two informal settlements in Johannesburg). According to van Averberke (2007), over half of the households in five of Pretoria's informal settlements participated in farming which took place in home gardens and communal gardens in

public open spaces. Group farming in open spaces supplied households with about 25% of annual staple food requirements. But home gardeners harvested a meagre 1.7 kilograms of fresh food monthly, which represents 6.7% of the recommended monthly vegetable intake (*ibid.*). This means that smaller amounts of food are produced from home gardens, compared to group/communal gardens.



Figure 2.4 Home garden in Slovo Park (left) and Elias Motsoaledi (right) informal settlements in Johannesburg.
Source: Photograph by Marie Huchzermeyer (left), June 2013 and Author (right), December 2012.

Another product from the natural environment which is common in informal settlements is timber/wood. Since informal settlements are not formally connected to the electricity grid, timber, usually collected from trees within or away from informal settlements, provides fuel for cooking and indoor heating, construction of dwellings, fencing yards and to make household furniture. Nissing and Von Blottnitz (2007) estimate that 142,000 tonnes of timber, sourced from nearby vegetated areas or as waste from industries is used for household thermal purposes annually in Cape Town's informal settlements. In their study of Tzaneen, BelaBela and Zeerust towns in South Africa, Kaoma and Shackleton (2014) found that at least 43% of households in informal settlements reported collecting firewood from their own home gardens/plots. These authors did not indicate long-term horizons for replenishment so that supply of this provisioning ecosystem service can be sustainable.

2.6.2 Regulatory ecosystem services

People living in informal settlements also benefit from urban green infrastructure through services that regulate the environment, called regulatory services. There are

three main forms of regulatory services. The first relates to micro-climate moderation, illustrated in Bangalore where Gopal (2011) observes most dwellings in informal settlements have plants grown in a variety of containers. The plants and trees in the neighbourhood reportedly contribute to city-wide decrease in air temperature (by 3 to 5^{O}C in summer) and air quality improvement through reduction of pollutants and suspended particulate matter (Gopal, 2011; Sudhira and Nagendra, 2013). As a result of their shade, trees in the settlements create cool space for domestic activities (e.g. cooking), livelihood activities (e.g. operation of a mechanic workshop, phone booth) and recreational activities (Gopal, 2011; Nagendra *et al*., 2013).

A further illustration of micro-climatic regulation comes from the mapping project of residential urban morphological types (UMT) in Addis Ababa (Cavan *et al.,* 2014). In what may be particular to Addis Ababa, the study observes that 'informal settlements and traditional housing areas have higher proportions and better composition of green structures than other residential areas, and are thus associated with the lowest modelled land surface temperatures' (ibid.:54). Green spaces in the settlements contribute to temperature moderation and the residents benefit from this service. Further confirming green spaces' temperature moderation functions, 'the use of roof canopies or vegetation to reduce heat exposure were identified as regular practices' in Dakar (Bangladesh) informal settlements (Jabeen *et al*., 2010: 429).

As another service involving regulation of the natural environment, the location of informal settlements in or near certain natural/semi-natural landforms and ecosystems renders drainage-related functions. As mentioned earlier, vegetation in a roof garden can regulate the quantity and quality or runoff. Wetlands may provide flood control and the treatment of greywater (Adegun, 2013). Button *et al.* (2010) experimented with a Sustainable Urban Drainage System (SUDS) that consisted of artificial swales, soakaways and infiltration trenches linked to a wetland in Monwabisi Park informal settlement, Cape Town. Vegetation covering the swales redirects runoff away from unwanted areas. The soakaways incorporate a layer of bio-filtering plants which also redirect excess water to the wetland. While this emerged as a promising drainage approach (Jiusto and Kenney, 2015), the experiment showed that 'community involvement in both planning and

implementing the adapted SUDS methods … would help determine if [green/sustainable drainage] solutions do, in fact, work in informal settings' (Button *et al.,* 2010:16).

In my review of literature, I did not come across any evidence of green infrastructure component in informal urban areas that contributes to wind moderation or erosion control as part of regulatory ecosystem services. I am mentioning this because Nenweli (2015) found that windstorms are one of the worst climatic events experienced by informal settlement residents in Johannesburg.

2.6.3 Socio-cultural ecosystem services

Benefits related to socio-cultural ecosystem services are obtained in informal settlements through green spaces that provide aesthetically pleasing environment and opportunities for recreational activities, social interaction, spiritual and inspirational enrichment or cultural expression. Regarding spiritual benefits, water-bodies connected to informal settlements at times form the object of worship and location for religious/cultural ceremonies by residents. Some of Slovo Park (Johannesburg) residents meet for religious events on the unused natural land (around the white-washed stones in Figure 2.5) adjacent the informal settlement. Ballantyne and Oelofse's (1999) study in Mizamoyethu (now known as Mandela Park) settlement in Cape Town provides another fitting example. Regarding natural ecosystems in and around the settlement, the residents remarked: 'Mizamoyethu has a nice view', 'the mountains are beautiful and the trees', 'when they do their ritual, the mountain becomes the ideal spot' (respondents quoted in Ballantyne and Oelofse, 1999:209).

Natural areas also offer opportunities for educational and cognitive development to informal settlement residents, especially children. In La Lagunita settlement, Rosario (Argentina), Dubbeling *et al.* (2009) observed that green spaces serve as an educationally productive space for children's cognitive development through a demonstration garden and an educational path. As a result of social interaction between people participating in group farming activities, communal gardens contribute to social capital in informal settlements, and this outcome often surpass food benefits from such gardens (Kornienko, 2013). The socio-cultural aspects of green infrastructure that are benign have potential to support environmental justice

and equity in the context of low-income, marginalised communities (Ferris *et al*., 2001).



Figure 2.5 A portion of open space (demarcated with white stones) adjacent Slovo Park informal settlement is used for religious events by some of the residents. Source: Author's Photograph, November 2014.

2.6.4 Supporting services

Based on the literature accessed, it is generally unclear how informal settlements specifically benefit from supporting ecosystem services since this category of ecosystem service underpins and is interwined with others. O'Farell *et al.* (2012) stands out as it is the only known study showing how informally built-up areas (among other types of urban land uses) contribute (but not how they benefit from) supporting ecosystem services. In a rapid assessment of ecosystem services in Cape Town, O'Farell *et al.* (2012) shows that natural vegetation remnants in informal areas contribute less to certain supporting services (soil retention, critical infiltration, groundwater recharge, yield and quality) when compared with formal areas.

Having shown how the urban poor located in informal settlements directly and indirectly derive a variety of benefits (ecosystem services) from green infrastructure, I need to point out a notable thread running through the discourse. Based on my reading of the literature, benefits (ecosystem services) from green infrastructure have the potential for incremental improvements in the quality of life of the residents. Although seldom harnessed at present, much can be done incrementally to build on the provisioning, regulatory and socio-cultural services potentials of green infrastructure in informal urban areas. This could be achieved through measures such

as encouraging gardening, tree planting, de-restricting residents' access to adjoining green areas.

2.7 DEMAND FOR AND SUPPLY OF ECOSYSTEM SERVICES TYPES IN INFORMAL URBAN AREAS

The benefits (ecosystem services) derived from green infrastructure, as presented, play a fundamental role in the lives and livelihood strategies of people living in informal settlements. According to Sukdhev (2009:277), ecosystem services are the primary wealth of the poor, called 'Gross Domestic Product (GDP) of the poor', because of their primary reliance on resources from natural ecosystems. This fundamental role in the context of informal urbanism highlights the need to consider demand (reliance and dependency on) and supply (availability of) ecosystem services in informal settlements.

A number of studies relate the level of demand placed on provisioning ecosystem services with other categories of services in low-income urban communities. Waters (2013) studied ecosystem services and adaptive capacity in the resilience of three Kampala informal settlements. Of the 720 survey respondents across the three settlements, 11% drew benefits related to provisioning services of some sort, while only 5.2% and 3.7% of the benefits are related to regulatory and cultural services respectively (*ibid*.). Although the range of ecosystem services available only makes meagre contributions to adaptive capacity and resilience in the areas, it became clear that 'poorer individuals tend to use provisioning services more while only relatively higher-income individuals value cultural services' (Waters, 2013:109).

Similarly, Shackleton *et al.*'s (2014) study of three South African towns involved a survey comparing informal settlements and township neighbourhoods. Both neighbourhoods are largely low-income. But township areas are formal, legally recognised, enjoy better infrastructural services and are wealthier in comparison to informal settlements. The study's comparison on use of tree products (a provisioning ecosystem service) shows that informal settlement residents made more use of trees for supply of fruits, timber, firewood and herbal medicine. Township residents were consistently the least likely to collect tree products from within and outside their area. In total 80.7% of respondents in the informal settlements collected tree products from their homestead or elsewhere while only 41.3% did so in the formal

townships (Shackleton *et al.,* 2014). The study did not explore socio-economic factors that might have influenced the lower rate of tree product collection in formal townships.

In Potchefstroom (Tlokwe municipality, South Africa), Lubbe *et al.,* (2010) analysed plant diversity patterns across six urban residential typologies – from peri-urban informal settlements to up-market formal neighbourhoods. The study found that 'a relatively strong negative relationship exists for fruit trees and socio-economic status (R^2 =0.65), suggesting that poorer households grow more fruit trees' in order to avoid dependence on market products, gain additional income and improve livelihoods (*ibid*.:2907). Findings from Kigali by Seburanga *et al.* (2014) concur with those of Lubbe *et al.* (2010). Seburanga *et al.* (2014:92) observed that non-fruit bearing aesthetic trees such as 'palms, were more frequent in [well off] quarters due to their relatively high price, while fruit-bearing ornamentals such as avocado and banana plants were ubiquitous among [poorer] non-formal settlement neighbourhoods'.

The rapid ecosystem service assessment of Cape Town by O'Farell *et al.* (2012) is revealing in relation to regulating and supporting ecosystem services in informal urban areas. Based on expert opinion, certain regulating and supporting ecosystem services were scored on a scale of 1 to 10 for various urban land use types, including formal and informal built-up residential areas (see Table 2.3). On the scale, 0 represented no service while 10 is the score for the maximum potential service. Although covering a limited scope, the study shows that green infrastructure (patches of vegetation) in informal areas contribute less to the types of regulating and supporting services assessed (and shown in Table 2.3) compared with formal areas.

Table 2.3. Comparison between certain types of ecosystem services in Cape Town's formal and informal built-up areas. 0 represented no service while 10 represented the maximum potential service.

	Formal built-up urban residential area	**Informal built-up urban residential area**
Flood mitigation	5	3
Soil Retention	9	5
Critical Infiltration	8	5
Coastal Zone Protection	3	2
Groundwater Recharge	6	4
Groundwater Yield	5	4
Groundwater Quality	7	5

Source: Taken from O'Farell *et al*. (2012).

In terms of socio-cultural ecosystem services, I did not find any literature showing its level of demand in relation to other kinds of services. I did not come across any literature comparing socio-cultural services between formal and informal urban areas. I assume that the demand for socio-cultural ecosystem services would be diverse in informal settlements because they generally embody a hybrid, social and cultural milieu. My position here is partly informed by Nijman's (2010:10) explanation from India (which is also true for most developing countries), that informal settlements represent 'a social and cultural residential mosaic in which people are very much identified in terms of where they belong', what they believe and who they hope to become. As a result of this diversity, people tend to express and actualise themselves is ways that imply high demand for socio-cultural ecosystem services.

The inference from literature reviewed so far is that residents of low-income informal urban communities in developing countries place more demand on provisioning ecosystem services compared with other categories of ecosystem services. There is not enough evidence to inform a conclusion on the different levels of demand for regulatory, supporting and socio-cultural services. The high demand on provisioning services corroborates Cilliers *et al.*'s (2013:692) position that 'people from poorer communities put a higher demand on useful plants (provisioning ecosystem services) than more affluent communities'. Higher demand for provisioning ecosystem services can be linked to the fact that 'the poor depend directly on the natural resource environment for their livelihood' (NadKarni, 2000:1184) in rural as well as urban areas (Egoh *et al.,* 2012).

Putting higher demand on provisioning ecosystem services highlights the notion of 'reliance' and 'dependency' in low-income informal settlements in developing countries, as opposed to the notion of 'enjoyment'. Literature from developed countries frames primary benefits from green infrastructure (ecosystem services) as those of 'enjoyment' (See for example, Andersson, 2006; Roy *et al*., 2012; Buchel and Frantsezkaki, 2015). The socio-economic conditions in informal urban areas make ecosystem services, especially the provisioning category something relied on (i.e., fundamental) rather than what is to be enjoyed, which is dispensable. In this situation, reliance relates to survivalism rather than well-being. This thesis acknowledges the global North-South difference in the framing while discussing findings from the three low-income areas serving as case studies.

Seeing that there is higher demand (reliance) on provisioning services in low-income informal urban communities, is there sufficient and sustainable supply of such? Here, supply of ecosystem services can be understood as the capacity of a particular area (e.g. an informal settlement) to provide or secure those ecosystem goods and services which people rely on, and to do that within a given period of time (Burkhard *et al*., 2012). It is still unclear how the supply of ecosystem services to informal areas wihin a city can be quantified. For the sake of inclusion and equity, supply of ecosystem services in cities with informal settlements must progressively respond to inequalities which according to McConnachie and Shackleton (2010) often characterises the distribution of green spaces in developing countries.

2.8 INFORMAL SETTLEMENTS AND DISADVANTAGES FROM GREEN INFRASTRUCTURE: ECOSYSTEM DISSERVICES

To holistically understand the impacts of ecosystems on human well-being, it is important to consider negative aspects (what does not constitute benefits) in the connection between people living in informal settlements and natural ecosystems/green infrastructure. This section presents ecosystem disservices and undesirable aspects of natural ecosystems related to informal settlements based on the category of being real and perception-based. Categorisation based on perception puts into perspective subjectivity and diversity of attitudes, experiences and socio-cultural contents in informal settlements, as identified by Rolfes (2010) and Muyeba and Seekings (2011). This categorisation does not preclude the fact that what is

based on perception might have emanated from certain realities. I illustrate both types of ecosystem disservices with concrete examples from the literature.

Urban ecosystem disservice related to perceptions in informal settlements is exemplified through phobia. Some people dread densely vegetated spaces because they can conceal miscreants and criminal activities. Fear of being attacked by dangerous animals such as snakes, scorpions, or fear of being hurt by branches falling off from trees is another case (Donaldson-Selby *et al*., 2007). Another disservice based on perception peculiar to South Africa relates to poor and historically marginalised people's view of spatially delineating green spaces. During South Africa's apartheid era, 'racial' groups were spatially segregated (through legislation and forced removals) by buffer strips from green belts or cultivated/park land. From my field experience in South African cities, I found that informal settlement interventions with bordering green belt/corridor are perceived by some residents as a perpetuation of apartheid era boundaries and barriers in the post-apartheid era.

Ecosystem disservices that involve actual harm are generally manifest through health and other physiological problems. According to Douglas (2012), certain aspects of the natural environment in informal settlements have been associated with negative impacts on physical and mental well-being. Douglas's (2012) position was informed by Grubner and colleagues' study in Dakar's (Bangladesh) informal settlements. Through a survey of the informal settlements, they found that combined with poor waste disposal and sanitation, patches of vegetation increased the risk for infectious diseases (especially diarrhoea) (Grubner *et al*., 2012). Though not indicated in their findings, I assume that people dumped waste, urinated or defecated in the vegetated spaces, thus increasing the possibility of diseases' spread.

Informal settlements located close to wetlands often experience invasion of mosquitoes and other insects because wet/damp spaces serve as their breeding places. In this regard, Baragatti *et al*. (2009) show that malaria risk correlates with ecological structure (proximity to hydrographic network in this case) and living in informal, unplanned informal settlements in Ouagadougou. This happens because water-logged agricultural spaces around the hydrological areas serve as a breeding ground for mosquitoes. Also, while urban agriculture and green spaces can lead to

health benefits, they may also involve health hazards. Irrigation with greywater from poorly serviced households or polluted drainage channels/streams in informal settlements can contaminate crops, which when eaten, leads to diseases. Gallaher *et al.* (2013) identified this as a challenge associated with sack gardening in Kibera settlement in Nairobi.

Ecosystem disservices based on perception can result to a disservice involving real harm. For instance, fear of being mugged or raped can lead to anxiety and depression (psychological problems) as well as hypertension (physiological problems). A negative experience related to perception has thus become a real ecosystem service. Hence, both real and perceived disservices deserve equal attention.

Ecosystem disservices, whether real or perception-based, could occur in formal urban areas. They, however, stand out in informal settlements because poor spatial configuration, lack of services and infrastructure, precarious tenure conditions among other reasons make the emanating problems difficult to mitigate. As an illustration, absence of electricity and street lighting in an informal settlement makes security measures against night-time criminal activities difficult in densely vegetated areas.

2.9 THE 'FATE' OF GREEN SPACES AND RELATIONSHIP WITH GREEN INFRASTRUCTURE IN INFORMAL SETTLEMENT INTERVENTION

Having presented benefits and problems experienced in relation to green infrastructure in informal settlements across developing countries, I move on to discuss these in the context of interventions in and for informal settlements. This is necessary because physical transformations accompanying informal settlement intervention will impact green infrastructure and how people relate to different components of green infrastructure. This idea offers a rationale for my research and indeed choice of the case studies.

Currently, across many cities in developing countries, planning policies seek to improve and transform low-income, informal unplanned settlements. This is taking place or proposed to take place through a range of approaches — from provision of interim basic services and infrastructure, in-situ upgrading, site and services to clearance and relocation to new housing development. Irrespective of approach,

urban morphological changes accompanying informal settlement intervention programmes has consequences for green infrastructure and the provision of ecosystem services. The consequences can be beneficial or detrimental. Hence, due consideration of impacts is necessary to ensure informal settlement intervention involves not only socio-economic improvements but sustainable and just outcomes, as much as possible.

Literature dealing with the fate of green spaces and residents' relationship with green spaces in the course of physical transformations through informal settlement interventions is scant. My search for literature yielded only four scenarios. In Addis Ababa, the municipality's strategy to transform mud/wood dwellings in informal settlements into condominiums implies increase in area of impervious land surfaces and reduction in green structure. This will in turn lead to reduced temperature moderation - regulating ecosystem service people derive from the green spaces (Cavan *et al*., 2014). In Kigali, Seburanga *et al*., (2014) observe that indigenous fruit-bearing trees (source of provisioning ecosystem service) widespread in informal settlements declined as modern dwelling types replace informal dwellings. Transformations in the informal Dikmen Valley and Portakal Valley settlements of Ankara included proposals for 'green area with a contemporary high urban standard without destroying the natural characteristics of the valley' (Dundar, 2001:395). Areas reserved for public green spaces were transformed into luxury dwellings after upgrading was completed. This scenario shows that well intentioned socio-ecological goals behind green space development in informal settlement intervention may easily be given up in the face of socio-economic demands and expectations.

It is difficult to generalise from the few cases presented. The cases are not diverse – none of the three is a case of *in situ* incremental upgrading. Heterogeneity in the form and constituents of informal settlements across cities in developing countries also makes generalising impossible. However, the scenarios show that socio-economic factors can affect socio-ecological goals behind green space provision through informal settlement intervention. Although all the three studies suggest that informal settlement intervention tend to reduce quantity and quality of green space, Mng'ong'o's (2004) study in Tanzania suggest that densification of informal settlements (without being transformed into formal settlements) can also lead to loss

of green space and decline in ecosystem service provision. Scanty literature in this area motivates a need for more research investigating how informal settlement intervention impacts the way residents derive ecosystem services and experience ecosystem disservices.

2.10 CONCLUSION

This chapter provides an understanding of key concepts related to the natural environment, thus offering definitional and conceptual foundation for the research and later discussion of findings from the case studies. It shows ways by which people living in informal settlements are connected with natural ecosystems, presenting the multi-faceted benefits derived (ecosystem services) as well as problems experienced (ecosystem disservices). The possibility of incremental improvement in quality of life through green infrastructure in informal settlements runs through the illustrations of ecosystem services in the chapter. The notion of 'reliance' on natural ecosystems in developing countries rather than 'enjoyment' in developed countries of the global North — survivalism versus well-being came to the fore.

Considering green infrastructure and the multiple dimensions of ecosystem services and ecosystem disservices is critical in light of the overarching need for just and environmentally sustainable informal settlement intervention. It is therefore relevant to complement the concepts covered in this chapter with concepts building up to the framing of just sustainability adopted for the empirical part of this thesis.

CHAPTER THREE

JUST SUSTAINABILITY: TOWARDS A CONCEPTUAL FRAMING FOR GREEN INFRASTRUCTURE IN INFORMAL SETTLEMENT INTERVENTION

3.1 INTRODUCTION

Much of the green infrastructure and ecosystem services literature is examined in a far less unequal context than is obtainable in Johannesburg's landscape. Responding to this challenge, this chapter considers concepts relevant to the study on green infrastructure in the context of urban socio-spatial exclusion, manifested through informal settlements. These concepts bring questions on the environment and socio-economic exclusion together and lead to a conceptual framework adopted in the thesis.

The chapter begins by reviewing the concepts of inequality, justice and sustainability in relation to cities, and their conflation into the concept of just sustainability. It then unpacks the concepts of co-production and co-management, examining how they relate to the understanding and exploration of just sustainability. From here, the chapter turns to apply these same concepts in South Africa, focusing on low-income urban settlements, especially the modes of informal settlement intervention. This application allows the chapter to identify researchable domains and relationships which constitute the research conceptual framework. Lastly, a 'just sustainability' evaluation framework against which the case studies are assessed is presented.

3.2 CONCEPTUAL ISSUES THAT UNDERPIN NOTIONS OF JUST SUSTAINABILITY

The intertwined problems of human inequality and declining environmental quality facing our urbanising world necessitate the need to discuss inequality, justice and environmental sustainability together. This section engages the concepts of inequality, justice and sustainability. The three concepts lead up to and are fundamental to an understanding of just sustainability.

3.2.1 Inequality

The present urban age is characterised by inequality – the skewed distribution of resources. The current mode of urban production and consumption globally is

'inequitable' (Swilling, 2011:78). As a result, inequality can be read on the face of buildings, in the fabric of neighbourhoods and form of cities across the world, as discussed below. UN HABITAT's (2008) analysis of 94 cities in 47 developing and developed countries reveals that inequality has increased since the 1980s, with countries in Latin America and Africa exhibiting exceptionally high levels of urban inequality. The *State of the World's Cities Report 2012/2013*, also by UN HABITAT, brings to fore the increasing trend of inequality in many transition and emerging economies in developing countries, with highest levels of inequalities found in Argentina, Brazil and South Africa (UNHABITAT, 2012a). Cities in the three countries still had a high average *gini* coefficient of over 0.56 as at 2009 (*ibid*.).

In developing countries, colonial legacies fostered urban inequalities in significant ways. Colonialism imposed models that eroded indigenous forms of territorial occupation and produced unequal societies. The colonial administrations were primarily concerned with protection and satisfaction of the minority European population in colonial territories, thus concentrating infrastructure and service provision in areas inhabited by these foreigners (Myers, 2011). Post-colonial urban patterns in the independent countries largely followed those of the deposed colonizers (Gouverneur, 2015). The emerging post-independence elites moved into better-off urban areas previously inhabited by colonisers, thus perpetuating conditions of socio-economic disadvantage and spatial exclusion in under-serviced, low-income, informal areas inhabited by marginalised groups.

Currently, urban growth and development in developing countries involve modernist urban planning 'fantasies' that reinforce spatial inequality and socio-economic exclusion (Watson, 2009). Of note is the continued pre-occupation with colonial-era style of informal settlement eradication – 'removing the poor from the city [rather] than alleviating poverty itself' (Anand and Rademacher, 2011:1768). Authorised and aggressive bulldozing, forced eviction, clearance, resettlement and military or para-military surveillance have been applied in informal settlements; places regarded as 'the radical new face of [urban] inequality' (Davis, 2006: 202). Discrediting this unjust and exclusionary approach, scholars such as Otiso (2002), Bhan (2009) and Arimah (2010) have shown that trying to get rid of the poor in the city does nothing other than mutating or even increasing urban inequality.

There is a discursive groundswell around inequalities and need for justice. Increasing awareness of everyday manifestations of inequalities and injustices is fuelling discourses aimed at redress of inherent disadvantages and justice in cities (Connolly and Steil, 2009). Renowned economist Thomas Piketty's delivery of 2015 Nelson Mandela Annual Lecture is a recent example in South Africa. Piketty proposes effective rights – right to high-quality education, right to economic and political democracy and right of access to property as solutions to South Africa's high and growing inequality (Piketty, 2015). Furthermore, concerns are increasing in the socio-spatial realm, and some efforts are being made to remedy historical (past) or imminent (future) inequalities, for example in the distribution of environmental benefits and burdens (Ikeme, 2003). Efforts towards inclusive decision-making, for example through participatory design, planning and budgetary processes are also emerging (Smit *et al*., 2011). These discourses and efforts towards justice are based on the principle that all people are equal and have equal rights (Reich, 1992).

3.2.2 Justice

Social justice and environmental justice have gained prominence in the urban discourse as a means to address very particular manifestations of inequalities. While both concepts of social justice and environmental justice are separate and distinct, they can be conflated (Agyeman, 1990; Furman and Gruenewald, 2004). This section reviews positions of some seminal scholars on social justice and environmental justice chronologically as they evolved and also in accordance with broader divisions and similarities in social thought.

The work of liberal moral philosopher John Rawls (1971) arguably served as a starting point in the discourse on social justice and its relationship with inequality. In Rawls' conception, social justice is fundamental to an ideal human society, called 'society of peoples' (Rawls, 1971:113). To show the value of freedom and equality, he posits an 'original position' — a hypothetical scenario where rational and self-motivated individuals behind a 'veil of ignorance' are to choose principles for a just society (*ibid*.). Those behind a 'veil of ignorance' do not know their or other people's status (race, height, gender and so on) and are meant to choose principles and arrangement for a just society's structure. Rawls argues that unjust principles will not emanate from this 'original position' because of the 'veil of ignorance', thus

providing a suitable standpoint to address inequality and deliberate about social justice (Rawls, 1971: 1999).

While David Harvey, a Marxist geographer, concurs with Rawls regarding the division of benefits and allocation of burdens for 'a just distribution justly arrived at', he differs from him in many ways, including Rawls' idea of the 'original position' (Harvey, 1973: 98). Harvey rebuts the 'veil of ignorance' on the *de facto* societal order which directly and indirectly affects distribution, thus leading him to dismiss Rawls' conceptualisation of justice as merely idealistic. Harvey further argues that spatial inequality can be attributed to the functioning of capitalism, which led him to explain the Rawlsian liberal perspective as unrealistically based on a neutral stand between capitalist and socialist ways of doing things (Harvey and Potter, 2009). To Harvey, alternative modes of production, consumption and distribution (that can reorganise society's asymmetric structure - inherent in capitalism), are fundamental to justice within and beyond the city (Harvey, 1973, 2008).

Another scholar, Iris Marion Young, appropriated Marxist values in her seminal work on justice. She acknowledges the imperative of eliminating 'institutionalised domination and oppression' and challenges the prevailing reduction of social justice to distributive justice (Young, 1990:15). The overarching importance of procedures through which distribution happens is central to her work. To her, 'societies view themselves fair if the procedures of allocation treat people equally, even if the substantive outcome is unbalanced' (Campbell, 1996:300). The procedures: societal structures, processes and relationships — that produce and reproduce material distribution, visible or not, play a critical role in justice.

In contrast to Harvey's and many other scholars' views, Susan Fainstein sees the possibility of social justice within the present context of inequitable capitalist mode of urbanisation. She believes in the eventual evolution of 'humane capitalism', and therefore argues that 'the system itself will change incrementally as a consequence of continued pressure for justice. Forcing decision makers to make justice a principal consideration in urban policies would be more than a marginal change' (Fainstein, 2010:6).

It is clear that the different schools of thought agree that social justice will not be achieved by itself. I posit that the processes and paradigms influencing distribution are crucial to social justice within cities and in the society at large. To me, Rawls' concept of the 'original position' (Rawls, 1971) is something desirable but nearly impossible to realise. In the same vein, Fainsten's idea of 'humane capitalism' (Fainstein, 2010) is idealistic. It has not been and might never be a reality. I believe, deliberate and relevant change in the prevailing societal paradigm and processes is crucial to achieving social justice.

Unlike social justice which originated and became popular from the mid-twentieth century, the emergence of environmental justice is more recent. The concept of environmental justice emerged in 1980s in the USA in response to tensions about the location of undesirable land uses, and disproportionate exposure of the poor and 'people of colour' (who typically might be located in informal urban areas) to environmental hazards (Bullard, 1990). Movements that initially took on environmental justice questions in developing countries emanated from conflicts between 'indigenous populations and transnational resource extraction interests' (Leichenko and Solecki, 2008:615). Examples are the Ogoni people in Nigeria's oil rich Niger-delta and the Chipko womens' movement in India.

In its extensive use in scholarship, environmental justice has taken on distributive and procedural dimensions (Ikeme, 2003). Procedural dimension relates to *processes,* and in tandem with deontological arguments means that the decision-making process is more valuable than consequences of such process (Carter, 2002). The distributive dimension relates to *products,* and in line with consequentialist arguments is based on 'consequences and effects on the target general good' (Carter 2002:196). The two different dimensions (distributive and procedural) deserve to be considered separately as well as together.

Furthermore, environmental justice has been used with 'preventive, corrective and retributive perspectives' (Ikeme, 2003:199). The preventive, forward-looking, perspective involves precautionary measures against wrongs. The corrective perspective manifests through remedial efforts on existing wrongs. The retributive perspective relates to punishment for doing what is wrong. For example, at the international level retributive justice involves sanctions and punitive measures to

deter non-compliance or entice compliance with international agreements (Eglin, 2001). Boone and Fragkias (2013) observe that environmental justice in cities across the world has unfortunately had more reactive (corrective and punitive) than proactive (preventive) thrusts.

From my engagement with literature, I found that discourse on social justice in the twentieth-century focused on socio-economic issues. It is nuanced towards the prevailing neoliberal macro-paradigm affecting distribution. However, with the emergence and prominence of ecological discourses and environmental movements towards the end of the twentieth-century, social justice was partly subsumed by environmental justice with more attention paid to spatial issues (Taylor, 2000). It therefore becomes difficult to divorce social justice and environmental justice (Agyeman, 1990). As Swyngedouw and Heyden (2003) observe, the connection between social justice and environmental justice is now most visible through the environmental justice movement. Criticising 'social justice discourse as being concerned exclusively with human beings and fail[ing] to acknowledge the interdependence of social and ecological systems', Furman and Gruenewald (2004:54) assert that 'social justice cannot be achieved without an expanded, ecological viewpoint'. The connection between both concepts does not make them equal.

Achieving social and environmental justice requires fair distributive processes as Young (1990) emphasises. Following Harvey's standpoint, it demands alternative modes of production, distribution and consumption (Harvey, 1973; 1993; 2008). Informal settlements exemplify social and environmental ramifications of urban inequality in the production of low-income housing. Informal settlement interventions are at times conceived as part of redress for the historically disadvantaged and marginalised in cities. Engaging these informal spaces with the lens of socio-ecological justice (conflation of social and environmental justice) is therefore appropriate.

Of the various schools of thoughts and dimensions of social and environmental justice, the procedural dimension of justice is most relevant in the context of this study. Considering the distribution of green infrastructure demands delving into complex scientific information on climate, geology, morphology, quantitative spatial

information on green spaces and so on. This is beyond the scope of this thesis. Moreso, available information on these aspects in informal urban areas is limited. This research therefore aligns more with the procedures of distribution than actual distribution. It touches on the paradigm influencing *distribution,* in this context the intervention approach applied in or for informal settlements. My study considers the procedure(es) leading up to production, consumption, distribution and management of green infrastructure as material benefit in relation to intervention in and for low-income informal settlements.

3.2.3 Sustainability

The term 'sustainability' emerged in environmental lexicon in the 1970s through reports associated with the International Union for the Conservation of Nature and the World Resources Institute (Brown *et al.,* 1987). Although its actual origin is traceable to ideas that some 19th century intellectuals conceptualised (Lumley and Armstrong, 2004), sustainability came to the fore in the 20th century. It (re)emerged based on realisations and responses to the fact that aggregation of human activity is altering global bio-physical systems and processes in ways that jeopardise global ecological stability and geo-political security (Rees and Wackernagel, 2012).

'Sustainable development', derived from 'sustainability' gained prominence through the World Commission on Environment and Development's (WCED) Brundtland report in 1987, but more fully after the United Nation's Rio Earth Summit in 1992 and subsequent world summits on Sustainable Development. The Brundtland Commission's report defined sustainable development as 'development which meets the needs of current generations without compromising the ability of future generations to meet their own needs' (WCED, 1987). To move beyond the reductionism of sustainability as a buzzword to a concept that could inform a practically sustainable future, the Rio+20 conference in 2012 witnessed an agreement between nations on establishment of Sustainable Development Goals (SDG). Seventeen SDG and 164 targets in the fifteen year post-2015 development agenda advance the need for sustainable forms of development, importantly in urban areas (United Nations Department of Economic and Social Affairs, 2014).

More recently, the conception of sustainability has shifted from the scientific paradigm to a complex systems dimension. This conception is based on the notion of

space (e.g. a city) as complex adaptive socio-ecological system that is shaped by spatio-temporal processes resulting in unpredictable outcomes (Du Plessis, 2011). Accordingly, sustainability is seen as 'maintaining resilience and integrity of local and global social-ecological systems through strategies that respond and adapt to, and evolve with, change and surprise' (ibid: unpaginated).

Although WCED's definition, and notions captured in the SDGs, brings together concerns for intragenerational and intergenerational justice (social, economic and environmental – see figure 3.1), they were fundamentally inspired by the need to conserve the natural environment. The more recent complex adaptive system thinking also touches on the ecological. As a result, I interpret sustainability as fundamentally dealing with 'maintenance of natural capital', also explained as environmental sustainability in this thesis (Goodland, 1995:10).

Current environmental conditions and projected trajectory in cities raise the need for sustainability, especially in developing countries (Cohen, 2006). The aggregate scale of human activities taking place in informal and inequitable ways in urban centres in developing countries calls for environmental sustainability considerations - conservation of finite natural capital - in the context of low-income informal settlements. It is only through sustainable solutions that the tensions between urban growth, poverty, climate and ecological change and access to quality housing and environmental conditions can be properly addressed (UN HABITAT, 2012b).

3.3 JUST SUSTAINABILITY: LINKING JUSTICE AND SUSTAINABILITY

To highlight and expound on the connection between concepts of justice and sustainability, the trio of Julian Agyeman, Bob Bullard and Bob Evans coined the term 'just sustainability'. Derived from Brundtland Commission's Report on Sustainable Development (WCED, 1987), they defined 'just sustainability' as 'better quality of life for all, now and into the future, in a just and equitable manner, whilst living within the limits of supporting ecosystem' (Agyeman *et al*., 2003:5). Traditionally – in WCED's definition, sustainable development involves the social, natural (environmental) and economic (See figure 3.1). Agyeman *et al*. (2003) employ just sustainability to emphasise the social equity domain of sustainable development through putting social concerns at the heart of considerations on the

environment. They advance the principle of *intra-generational* equity, that is, equitable access to resources within the same generation (Vojnovic, 1995).

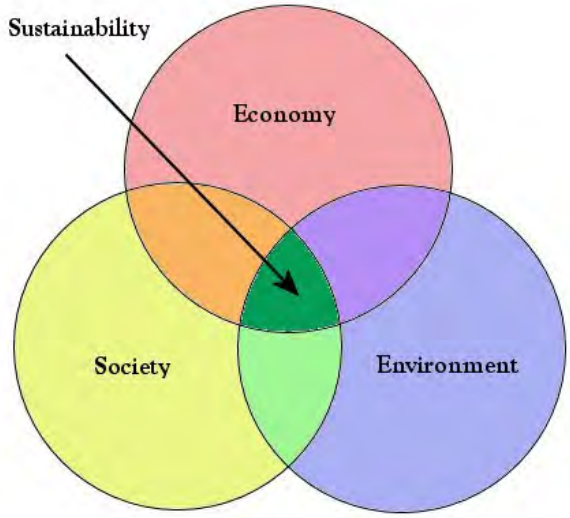


Figure 3.1 Intersecting conception of sustainable development.
Source: WCED (1987).

Just sustainability involves the deliberate incorporation of social considerations into sustainability plans and projects (Pearsall and Pierce, 2010). It seeks 'an ecological balance and a social balance' (Campbell, 1996:300) because benefits from ecological processes in cities are entangled in social processes (Ernstson, 2013). In this situation, human equality (for the present) — through justice is promoted as equally relevant and important as environmental quality (for the present and into the future) — through sustainability (Agyeman, 2008:752) (see figure 3.2). This, for instance, means redress of historical socio-economic imbalances and reversal of degradation and decline in natural environment are targeted together. It follows principles of just sustainability conveyed in keywords shown in Figure 3.2. These principles inform the just sustainability framework presented in Figure 3.4.

Though related, just sustainability is not the same environmental justice. Just sustainability effectively reframes environmental justice but does not negate real EJ struggles (Agyeman et al., 2003). The siting and development of a waste landfill will help to make an illustration on this difference. Typically, EJ will agitate against the landfill's location within or close to a low-income neighbourhood. Just sustainability concerns will advance alternative low-carbon waste management measures (e.g recycling), which apart from being eco-friendly, empowers poor or marginalised citizens in the relevant low-income neighbourhood.



Figure 3.2 Conceptualising 'Just Sustainability' (Author's diagram based on the body of literature reviewed).

Just sustainability is desirable. But there are real conceptual and practical difficulties in linking the notion of inter-generational justice, inherent in sustainability with justice for the present generations. There is usually tension between justice for the unborn and procedural/distributive justice that engages those present now. Although 'environmental sustainability and justice are integrally woven together, the tension has left it 'not always necessarily a happy marriage' (Sowman and Wynberg, 2014:1100). Studies on sustainable development acknowledge this contention (Weingaertner and Moberg, 2014; Ahmed, 2016). This is practically visible in a situation where it is 'more important to protect the ozone layer [environment for future generations] than to rectify [existing] income distribution' (Miller, 1999:154).

To illustrate incompatibility between justice and sustainability

– difficulties in achieving just sustainability, I present the hypothetical case of a manifestly unequal and diverse city. Realising various benefits (ecosystem services, as presented in the previous chapter) that present and future generation can derive from trees, the municipality (or any agency) may initiate programmes/projects aimed at increasing the city's tree coverage. Incompatibility between justice and sustainability manifests when for whatever reasons, the environmental outcomes of tree coverage supersedes an even/balance distribution as well as just and inclusive

distributive process. It doesn't matter if the process excludes and marginalises certain stakeholders (for example low-income groups) or if informal settlement communities do not enjoy a proportionate increase in tree canopy. In this situation, social considerations – equality, fairness and inclusion are not necessarily a prerequisite for or path to environmental sustainability.

The inherent difficutlies mentioned above does not mean just sustainability is outrightly impossible. Context-dependent considerations and interpretations can help keep just sustainability in view (Weingaertner and Moberg, 2014). In the hypothetical case present above, just sustainability might be acheiveable when it is possible that the processes and outcomes of tree-planting are equitable, inclusive as well as green. That is, the processes meaningfully involve and appropriately empower the diverse communities (including the disadvantaged groups) through for example participatory decision-making, planning, implementation while also evenly distributing trees and their environmental outcomes across the city.

The above illustration is not intended to imply that sustainability outcomes should not be driven in the absence of fair and inclusive procedures. Neither am I justifying exclusionary procedures in the realisation of sustainability outcomes. I am only highlighting a key outcome from the review of these concepts. The inherent incompatibility between justice and sustainability makes working towards and achieving just sustainability a process that is not clearcut or straightfoward. It is subject to 'interpretative flexibility' that cannot be fully overcome (Bostrom, 2012:12). It involves complexities and forces driving from multiple extremes, especially regarding ecosystem services and ecosystem disservices in the realm of informal urbanism as pointed out in Chapter 2. My research is aware of these inherent peculiarities while conceptually linking just sustainability with residents' relationship with green infrastructure in the context of informal settlement intervention in an unequal city such as Johannesburg.

3.4 CO-PRODUCTION, CO-MANAGEMENT AND JUST SUSTAINABILITY

The dual concepts of co-production and co-management represent forms of cooperation between multiple actors (the state, communities, and third sector) that directly influence socio-political processes leading to socio-ecological service outcomes (Brandsen and Pestoff, 2006). Although public-private partnership is a

form of cooperation whereby different parties/actors realise products, services or policy outcomes jointly (Klijn and Teisman, 2005) or partner to provide land for housing (Payne, 1999), multiple/actors in this research exclude the for-profit corporate private sector. This makes both co-production and co-management as discussed here different from the popular public-private partnerships model of procurement and service delivery. Both concepts lend themselves to an application of just sustainability, especially in relation to interventions in low-income urban communities. The earlier elaboration on inequality and justice points to the need for inclusive distributive processes and a balanced distribution. This need is pronounced by the expediency of environmental sustainability. Both situations, that is, the need to reduce inequality through justice and to improve environmental quality through sustainability considerations resonate with the concept of just sustainability. But this does not mean the the measurement of justice or just sustainability could be reduced to the question as to whether co-production and co-management are being encouraged and practiced in the concerned contexts. Both concepts' links and disjuntures with just sustainability generally and in this research in particular are examined in the following sub-sections.

3.4.1 Co-production and just sustainability

The origin of 'co-production' can be traced to political economist and Nobel Prize winner Elinor Ostrom and her husband Vincent Ostrom. The couple used the term to explain why crime rates increased when Chicago police officers came off the beat and moved into patrol cars in the 1970s. By crystallising the idea of co-production, they pointed out the negative corollary of the police's detachment from the community, explaining that the police need the community as much as the community needs the police (Ostrom and Ostrom, 1977). Ellinor Ostrom later defined co-production as a 'process through which inputs from individuals who are not in the same organisation are transformed into goods and services' (Ostrom, 1996: 1073). The notions she originally captured in the concept were subsequently developed and deepened by scholars (some of whose work I review below) to elaborate the importance of state-society relationship in service delivery.

Co-production, though popular in public management literature, appeared in urban planning literature only recently. The strand of co-production emerging in urban

studies, especially with application in developing countries are related to social-movement or grassroots-movement initiated strategies that enables citizen groups (especially the poor) to secure effective relations with state and non-state institutions in order to access basic services and resources. Examples of co-produced urban projects across some developing countries are available in Mitlin (2008), Roy (2009), McFarlane (2012), McGranahan (2013) and Ahiers *et al.* (2014).

More recently, co-production is being applied to knowledge production in urban areas (Enengel *et al*., 2012a; Munoz-Erickson, 2014; Swilling, 2014; Polk and Kain, 2015; Patel *et al.,* 2015). Co-production of knowledge means a variety of actors (e.g. local actors, civil society, decision makers, state agencies) joining researchers to generate information useful for society's transformation. It involves inclusive processes which can better capture situated understandings existing in particular contexts (Polk and Kain, 2015). Local know-how and experience is good, and knowledge co-production would be important in informing urban interventions, for example in informal settlements. But processes and relationships involved may include power dynamics and conflicting agenda setting by researcher(s) themselves or other actors that the researcher(s) cannot control or counter (Swilling, 2014).

Urban infrastructures act as the key link between cities and sustainability, between urban systems and the ecosystems into which they are embedded. As socio-technical systems, a complex relationship exists between humans, infrastructure and the environment in cities. Co-production of urban infrastructure (including low-income housing) therefore offers a domain to link sustainability with social justice, in the normative notion of just transition and just sustainability (Swilling and Annecke, 2012).

The notion of co-production in its ideal form, resonates with certain principles inherent in justice, environmental sustainability, and ultimately just sustainability. Arguments supporting co-production generally project its normative value-base in social justice, democracy and rights – quasi-moral principles that are fundamental to just sustainability (Fishkin 2010). Acknowledging that conventional economic indicators/models such as GDP can be misleading measures of progress in well-being in an era where just and sustainable improvements are needed, Agyeman (2013) argued that just sustainability lends itself to the idea of co-production as a

possible alternative economic model. Co-production here implies involving consumers in the production of goods and provision of services they consume, a model that blurs the line between producers and consumers. The developing country dimension in which the poor and marginalised seek 'outcomes specified as socio-spatial justice and more equitable and sustainable outcomes' brings co-production close to just sustainability (Watson, 2014:69).

In reality, co-production as currently practised by some NGOs and social movements differs from what Ellinor Ostrom conceptualised and illustrates shortfalls in terms of justice. Ostrom's concept of co-production depends on certain contextual preconditions - a functioning state as well as a functioning and democratic community and NGO/social movement, none of which truly or necessarily exist in present situations (Watson, 2012). Experience from some East African informal urban settlements show that the language of 'empowerment' and 'participation' in co-production are at times used as a disguise for perpetuating unequal power relations between collaborating actors (Mbaka *et al*., 2016: unpaginated). Literature has also shown that user involvement in service delivery through co-production had in some cases resulted in reduced levels of satisfaction and trust among the actors (Bendapudi and Leone, 2003; Fledderus, 2015).

To sum it up, co-production can lead to just and/or unjust outcomes – some people will gain, some will loose. Seeing the inclination and shortfalls in relation to just sustainability, this study explores the idea of co-production in informal settlement intervention, identifying its limits and contradictions. Examining a co-produced case of intervention in and for informal settlements and relationship with green infrastructure therein offers useful insights whether co-production can lead to just and sustainable situations in informal settlements.

3.4.2 Co-management and just sustainability

The idea of co-management is related to the governance of natural resources, though not without very important criticisms. To tackle diversity, differentiation and contestation in the governance of natural resources, co-management seeks to democratise decision-making, encourage stakeholder participation and foster conflict resolution (Armitage *et al*., 2007). It is gaining recognition in urbanism due to the 'social, cultural, and environmental diversity and economic differentiation' that

cities encapsulate (Graham and Ernstson, 2012:34). A synthesis of co-management definitions shows it as a community-based approach involving the decentralisation of decision-making; devolution of power, fair sharing of responsibilities, duties and accountability, entitlements and risks between primary stakeholders (World Bank, 1999; Borrini-Feyerabend *et al*., 2000; Carlsson and Berkes, 2005). The state (through government agencies) and society (local communities who are custodians or use natural resources) are generally the primary stakeholders.

Co-management of natural resources resonates with aspects of justice and empowerment. Ideally, it advances resource users' (people who are affected by natural resources management decisions) voice in decision-making (Berkes, 2009) and asserts their rights and responsibilities to protect and preserve nature for themselves and future generations (Morse, 2012). Where it works well, co-management serves as a vehicle for social justice and environmental justice (Mosepele, *et al*., 2014). Its primary concern with natural resources makes it prominent in environmental sustainability discourse, thus having relevance in just sustainability.

Notwithstanding justice-laden principles in the ideal notion of co-management, a cautionary note on the touted potentials emerged from Enengel *et al*.'s (2012b) work. Reflecting on two urban landscape co-management cases, they explain that uneven conditions that might emanate within participatory processes and an unfair distribution of costs can jeopardise the promising justice potentials of a co-management approach (*ibid*.). Cundill *et al*.'s (2013) review of four co-management cases in protected areas involving previously disenfranchised communities in South Africa concurs with Enengel *et al*.'s (2012b) caution. Notwithstanding promises of pro-poor, democratically informed management, the practical experience of co-management has seen the continuation of the status quo in terms of conservation, with very few material benefits for claimant communities and limited sharing of responsibilities and decision-making functions' (Cundill *et al*., 2013:171).

That the lofty potentials of co-management have not been not realised in certain instances underscore complexities inherent in implementation and in reality. It means co-management would not always and neccesarily lead to just outcomes. Any

attempt at collaborative means to the management of natural resources has to ensure that the inherent problems are understood and dealt with.

Co-management of green infrastructure in informal settlements can show how poor and historically disadvantaged urban communities participate or do not participate in the governance of natural resources that supports their survival and can improve their quality of life and environment. Exploring co-management on interventions in and for informal settlements might offer useful lessons around the way residents relate with green infrastructure and derive ecosystem services, some of which were pointed out Chapter 2. These lessons can show how just and sustainable intervention outcomes may be approached in the low-income and informal urban contexts.

3.5 JUSTICE AND SUSTAINABILITY: THE SCENARIO IN URBAN SETTLEMENTS IN SOUTH AFRICA

With a high average *gini* coefficient of 0.76, South Africa's metropolitan cities are sites of inequality (Turok, 2012). The level of inequality in the cities is higher than the national average and also ranks among the highest in the world (Ozler, 2007; Todes, 2014).

High urban inequality in South Africa can be explained as one of the intractable corollaries of apartheid. During the apartheid era, population groups categorised as 'Africans', 'Indians' and 'Coloured' were excluded from the formal urban economy. They were restricted to separate residential areas and circumstantially forced to more hazardous urban environments, often informal settlements, which were under-serviced and lacked basic amenities (Khan, 2002). However, urban segregation in South Africa did not begin with apartheid. It is traceable to English colonisation in the then Union of South Africa, before the 20th century (Maylam, 1995). Urban populations were markedly segregated residentially on racial lines by the Union from 1910s (Christopher, 1988); although the segregation then was less compared with what apartheid later produced (Davies, 1981).

Despite legislative and policy reforms in the post-apartheid era, the prevailing socio-economic order has not closed age-long urban inequality (Leibbrandt *et al*., 2012). Gap between the rich and poor has widened (Piketty, 2015). Neo-liberal post-apartheid policies of privatisation of resources have and are excluding the urban poor

from the environment's positive externalities and unduly exposing them to negative fallouts, which fundamentally widen existing inequality (Debbane and Keil, 2004; Cock, 2007). Despite constitutional and other legislative provisions in the democratic era, 'evidence indicates that the poor and natural environment continue to be marginalized in decision-making' (Patel, 2009:94). The enduring inequalities are manifest through emergence of informal modes of dwelling and perpetuation of informal settlements – areas which are consistently peopled by poor and disadvantaged households.

3.5.1 Towards social and environmental justice in South African cities

Socio-political changes accompanying democratic transition in South Africa in the early to mid-1990s opened up space for movements seeking social and environmental justice (Ballard *et al*., 2006). The Environmental Justice Networking Forum (EJNF), a networking organisation for civil society organisations engaging with environmental justice and sustainable development questions emerged in 1992 after the EarthLife Africa International conference in Johannesburg (Duma, 2006). The Forum, though presently dormant, was active in townships and other historically disadvantaged urban areas. Grassroots-level activities such as impoverished urban communities' protest against the Umlazi landfill for toxic industrial waste in Durban in 1995 also took place (Wiley *et al*., 2002).

In 1994, at the turn to a democratic nation, the ruling African National Congress (ANC) put forward the Reconstruction and Development Programme (RDP) – a plan seeking 'substantial resource distribution in order to reduce the profound inequalities on every score inherited from apartheid' (ANC, 1994). Regarding the environment, the RDP proposed 'better and fair control over access to our natural resources, education [and] awareness about the environment' (*ibid.*). The RDP, however, did not meaningfully influence post-1994 policy and legislation, especially on low-income urban housing (Bond and Tait, 1997; Jenkins, 1999). Its housing manifesto did not significantly influence intervention approach in informal settlements (Huchzermeyer, 2001). For example, 'people-centred development' (ANC, 1994), that is, a 'development process driven from within communities' whereby the state's role is to 'encourage and support initiatives emerging from communities or broader local social compacts' did not materialise (RSA, 1994, Section 4.4.4).

The new South African Constitution also duly considered housing and the environment as part of the Bill of Rights. Although focussed on environmental sustainability but fundamentally underpinning the ideals of environmental justice, Section 24 of the Constitution states that everyone has a right

a.) 'to an environment that is not harmful to their health or well-being; and

b.) to have the environment protected, for the benefit of present and future generations through hreasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development'(RSA,1996).

Also, Section 26 of the Constitution includes Bill of Rights stating that

i.) Everyone has the right to have access to adequate housing.

ii.) The state must take reasonable legislative and other measures, within its available resources, to achieve the progressive realisation of this right.

iii.) No one may be evicted from their home, or have their home demolished, without an order of court made after considering all the relevant circumstances (*ibid.*).

Development activities that had major impact on the receiving environment and local communities were largely unregulated in the apartheid era (Pisani and Sandham, 2006). However, to control the potential detrimental impact of development on the environment, legislation requiring the environmental impact assessment (EIA) for all kinds of development emerged in 1997 (RSA, 1997; Glazewski, 2000). EIA regulations were promulgated in 1997 in terms of the Environment Conservation Act (73 of 1989) and later modified in terms of the National Environmental Management Act of August 2003 (Sandham and Pretorius, 2008). To address the pre-1994 pattern of little or no public involvement in decision-making on environmental issues, public participation emerged as a key component of the EIA regulations. Thus, EIA became and is still a requirement for new housing projects, for instance to be developed for informal settlement residents.

3.6 INFORMAL SETTLEMENT INTERVENTION FRAMEWORK IN SOUTH AFRICA AND THE JUST SUSTAINABILITY QUESTION

Historical disadvantage, deprivation, vulnerability and inequality in South African cities are visible through the informal settlements. Recognising these problems, the state has made attempts to address challenges inherent in this form of urban housing. As will be shown later, informal settlement intervention has taken place through provision of newly developed low-income housing financed by capital subsidies from the state (Huchzemeyer, 2001, 2003). Since 2004, *in situ* intervention is meant to occur through the Upgrading of Informal Settlement Programme (UISP) (Huchzermeyer, 2011). These interventions are ideally meant to bring redress to the historically disadvantaged and improve quality of life for those living in informal settlements.

Temporary interventions by the state through respective municipalities/local governments, referred to as 'interim basic services', also takes place in almost all informal settlements. The nature of this intervention differs from region to region and often does not go beyond the provision of water (communal taps), sanitation (communal ablution/toilet facilities, for example the Ventilated Improved Pit Latrine Toilet), high mast lighting, interval waste collection and grading of gravel roads (Misselhorn, 2010; Crous, 2014). While the aim of these interventions is meeting basic and day-to-day needs in informal settlements, they are at times made in response to residents' agitation. They also take place as (at times flawed) attempts by the state to realise citizens' entitlement to free and minimum living conditions as prescribed in legal and policy documents (e.g., the Constitution, National Water Act 36 of 1998) or pronounced by court injunctions. Since 2004, there has been widespread dissatisfaction and venting of frustrations on interim service delivery across informal settlements nationally through protests and other forms of targeted disruptions (Allan and Heese, 2011; Michael and Gemma, 2013; Alexander and Pfaffe, 2014).

3.6.1 Relocation of informal settlements to subsidized housing development

Fully subsidised housing emerged as an intervention approach for informal settlements during the Urban Foundation-dominated housing policy negotiations on the eve of the post-apartheid era (Huchzermeyer, 2001). This product-driven

deterministic and individualistic approach (based on the Urban Foundation's proposals) allowed qualifying households in informal settlements to receive 'a uniform product, consisting of a standardised serviced plot with freehold tenure and a core housing structure, in a formalised township layout' (Huchzermeyer, 2003:591). Statistics South Africa shows that over 2.7 million households, mostly from informal settlements, are currently living in post-1994 state subsidised houses (StatsSA, 2013). Recent statistics from the Department of Human Settlements shows that the housing opportunities have reached 3.9 million households (Department of Human Settlements, 2015).

The state's subsidised housing approach to informal settlement intervention involves relocation – removing people from informal settlements to new but peripheral locations that are far away from existing sources of livelihoods and job opportunities (Hunter and Posel, 2012). Relocation disrupts existing social networks in informal settlements. Evictions, forced removals and litigation often characterise the lengthy process of moving people out of informal settlements into the newly established townships (Huchzermeyer, 2003b). The newly established townships should ideally be provided with physical and social infrastructure such as schools, health centres, shopping centres, parks. However, their development is often delayed, at times indefinitely (People's Environmental Planning, 2012) or inadequate in cases where they are provided (Magi, 1999; Moolla *et al.,* 2011).

Apart from the problem of forced removals, peripheral locations and inadequate infrastructure, the subsidised housing approach has been criticised for its character of perpetuating apartheid-style urban segregation (Harrison *et al*., 2003), poor quality house construction (Aigbavboa and Thwala, 2012), top-down implementation and financial un-sustainability (Huchzermeyer, 2014). Notwithstanding these shortcomings, the subsidised, individualised, stand-alone housing system is still the dominant mode of informal settlement intervention, despite the introduction of an Upgrading of Informal Settlements Programme in 2004 through a refined national housing policy initiative (Maina, 2013). The subsidised housing approach leaves much to be desired around urban inclusion and justice.

In two decades of subsidised housing as intervention approach for informal settlements, many authors observe that environmental sustainability has not been a

priority in the ensuing low-income townships (Dalgliesh *et al*., 1997; Magi, 1999; Irurah and Boshoff, 2003; Groebel, 2007; Shackleton *et al*., 2014). In relation to green spaces which provide ecosystem services, as identified in Chapter 2, Shackleton *et al*. (2014) observes broad expression of environmental and sustainability concerns in policy documents and a general absence of clear implementation guidelines. Although housing is delivered to the poor, they are being excluded from the tangible and intangible environmental sustainability benefits of green infrastructure such as trees, green spaces in the ensuing context.

Two studies attest to the problem of inadequate green spaces in townships established through the subsidized housing informal settlement intervention. In the Eastern Cape Province, McConnachie and Shackleton (2010:247) observe that 'newly built low-cost housing areas (termed RDP suburbs), occupied largely by poor black South Africans, are poorly endowed, with only 3.5sqm of public green space per capita', much lower than the national guideline stipulating 40sqm. Public open spaces in the low-density RDP suburbs are not developed as green spaces and as such do not add amenity value nor provide ecosystem services. From the City of Cape Town, Willemse and Donaldson (2012) found that townships accommodating poor and historically disadvantaged people have relatively low levels of Community Neighbourhood Park resources and accessibility. This inadequacy negatively influences the residents' pattern of recreational activities.

3.6.2 Upgrading of Informal Settlements

In 2004, housing policy in South Africa on paper shifted from delivering standardised subsidised low-income houses towards the development of 'Sustainable Human Settlements'. The policy shift was captured in Breaking New Ground (BNG) — the outcome of a ten-year review of the housing policy and programme from 1994 to 2004. BNG involves 'a new human settlement plan [which] adopts a phased *in situ* upgrading approach to informal settlements, in line with international best practice. Thus the plan supports the eradication of informal settlements through *in situ* upgrading in desired locations' (Department of Housing, 2004:12). The principles underlying this form of intervention are captured in Part 3 of the National Housing Code (Department of Human Settlements, 2009). The National Upgrading

Support Programme (NUSP) was also established by the Department of Human Settlements to support the implementation of UISP.

Reblocking, an intervention approach pioneered in World Bank's upgrading project of the late 1970s and presently adopted by the international NGO Shack Dwellers International (SDI), resonates with the new policy on *in situ* incremental settlement upgrading. It involves reconfiguring an informal settlement into a more rationalised and orderly layout through normal subdivision processes (Keare, 1987). Reblocking leads to the creation of pathways, roads (vehicular access), public and semi-public spaces that facilitate the provision of hitherto absent infrastructure and services (Bolnick, 2012). Although not equal to or a guarantee for *in situ* upgrading, re-blocking facilitates interim improvement that can make *in situ* upgrading less disruptive because the spatial layout is more amenable to the introduction of permanent services.

Incremental *in situ* upgrading, like the subsidised housing approach, should ideally serve as means of redress and path to social and environmental justice for the poor and historically disadvantaged in informal settlements. Although its implementation has not fully commenced (a delay of over 10 years being tackled by NUSP which is trying to unlock implementation), the Upgrading of Informal Settlements Programme (UISP) suggests a more just intervention approach in comparison with subsidised housing. UISP's key objective is 'structured *in situ* upgrading of informal settlements as opposed to relocation' (Department of Human Settlements, 2009:13). In line with provisions in the Constitution, relocation is to be a last resort in exceptional circumstances and should be on a voluntary and cooperative basis (*ibid*.). The Constitutional Court, in response to litigation that touched on the UISP, endorses that feasibility of *in situ* upgrading be investigated in all informal settlements before relocation is considered (Huchzemeyer, 2011). The Court's position embodies the principle of justice, but at the time of writing in late 2015, most metropolitan municipalities (with the exception of City of Cape Town) have still not begun transparently and fully implementing it.

How environmentally sustainable this intervention approach is or will be is still in the realm of speculation, since its implementation is currently underway, and unevenly so. Since sustainable human settlements in BNG refers to 'entities in which

economic growth and social development are in balance with the carrying capacity of the natural systems on which they depend for their existence' (Department of Housing, 2004:12), *de jure* concern for the environment is evident. Adegun and Ouma (2016), on the Huruma *in situ* settlement upgrade in Nairobi, suggest that *in situ* upgrading can be environmentally sustainable, especially when it incorporates densification, sourcing building materials locally and community-based construction techniques.

Of note in relation to socio-ecological justice and environmental sustainability in Johannesburg, which also touches on low-income informal urban areas, are Johannesburg City Parks and Zoo's (JCPZ) tree-planting thrusts. Over the last ten years, this municipal entity for parks and green open spaces in Johannesburg has been working to 'bridge the green divide' between the city's historically wealthy northern suburbs and the poorer southern suburbs which contain informal settlements and townships (City Parks, 2012: unpaginated). This has taken place through the planting of over 200,000 trees (*ibid.*). The trees were mainly planted in places such as Soweto, Orange Farm, and along the Klipriver catchment – areas that still significantly include informal, low-income housing. These initiatives are against an unjust backdrop of socio-economic and spatial inequality which influenced the establishment of these informal areas.

JCPZ's tree-planting and greening projects are criticised by Schaffler and Swilling (2013:250) as having 'been done hastily, where speed of roll-out to address a historical backlog has been the driving imperative rather than long-term sustainability'. This situation signifies imbalance between creating contexts that support improved environmental quality and facilitating improved quality of life for all urban residents. It also resonates with Patel's (2009) reflection, from the macro-economic perspective. She acknowledges 'the good intentions of carefully crafted policies', however observes that certain interventions promote sustainability, but lead to unjust outcomes (Patel, 2009:100). This suggests that justice and environmental sustainability have not been optimally or effectively matched in the context of green infrastructure in informal settlements in South Africa. The notion of mismatch and possibilities and prospects of combining justice and sustainability underpins what my research explores.

3.7 RESEARCH CONCEPTUAL FRAMEWORK

Drawing on the content of literature reviewed in this and the preceding chapter, I develop a conceptual framework (See figure 3.3) to show the domains and relationships of interest in this research. Miles and Huberman (1994) defined a conceptual framework as a product, in graphic or narrative form, that explains the main aspects (factors, variables, concepts, and presumed relationships among them) of concern in a research endeavour. This framework bridges the gap between conceptual paradigms explaining a research issue and the practice of investigating the domains (Leshem and Trafford, 2007). As a personally constructed intermediate/tentative theory, it helps to show a logical and contextual connection between the various aspects of inquiry in my study.

Chapter two of this thesis showed the forms of connections between informal settlements and natural ecosystems serving as urban green infrastructure. These connections are beneficial through the residents' reliance on ecosystem services but also involve detrimental aspects through ecosystem disservices experienced. Little is known on the different dimensions of the relationship between green infrastructure and residents in informal settlements in an unequal urban context like Johannesburg. There is also a knowledge gap on the 'fate' of relationship with these natural ecosystems when intervention utilising different approaches occur in informal settlements. These gaps highlight a noteworthy and researchable domain in the nexus between green infrastructure and informal settlements.

In this chapter, I delved into the concepts of inequality, justice and environmental sustainability, and their conflation in 'just sustainability'. The chapter also shows that the concepts of co-production and co-management, as forms of cooperation that influence socio-political and socio-ecological processes and outcomes, lend themselves to understanding advances and shortfalls regarding just sustainability. Relationship between green infrastructure and people who live in informal settlements and areas that emerge through informal settlement intervention are connectable to the conceptual frame of just sustainability. That is, it is possible to investigate green infrastructure in informal settlement intervention through the lens of just sustainability.

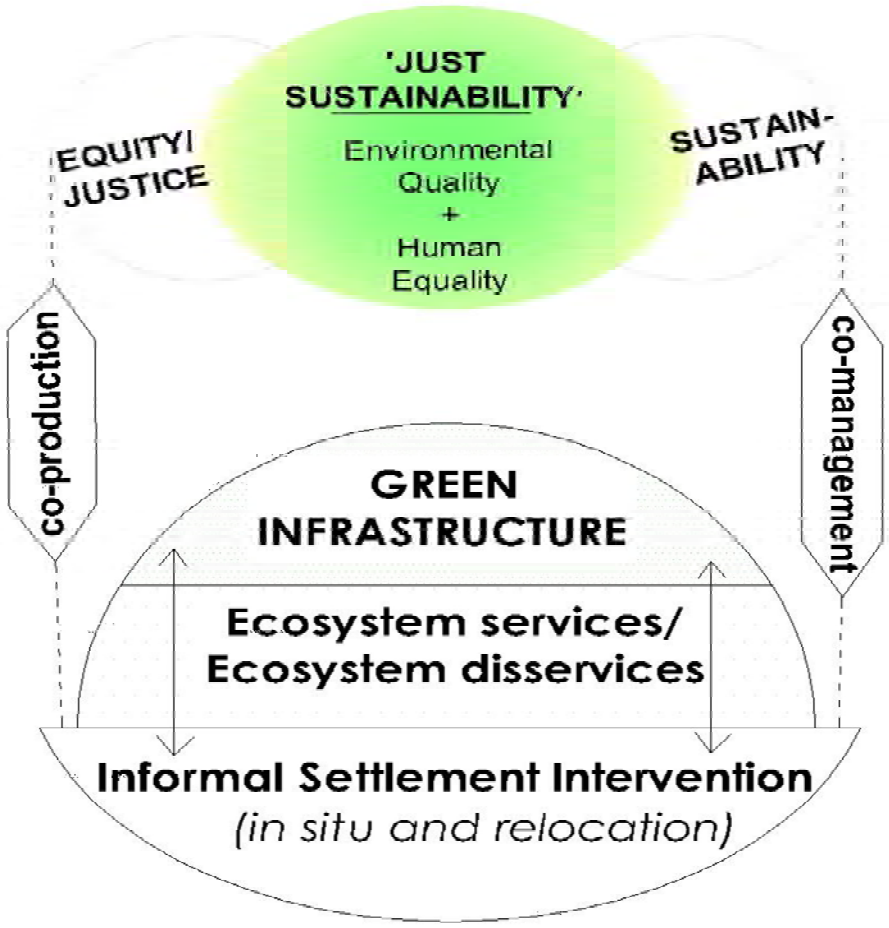


Figure 3.3 Conceptual Framework for the Research

A just sustainability framework containing key measures against which the domains and relationship of interest in the case studies are assessed and can be compared is presented in figure 3.4. Principles of just sustainability contained within the framework helps to show how just as well as environmentally sustainable informal settlement intervention approaches in Johannesburg are. Investigating the relationship between informal settlement residents and green infrasrtructure through the lens of just sustainability, aided by the evaluation framework, in Johannesburg can show how just and sustainable situations might emerge in the light of extreme urban inequalities and environmental challenges.

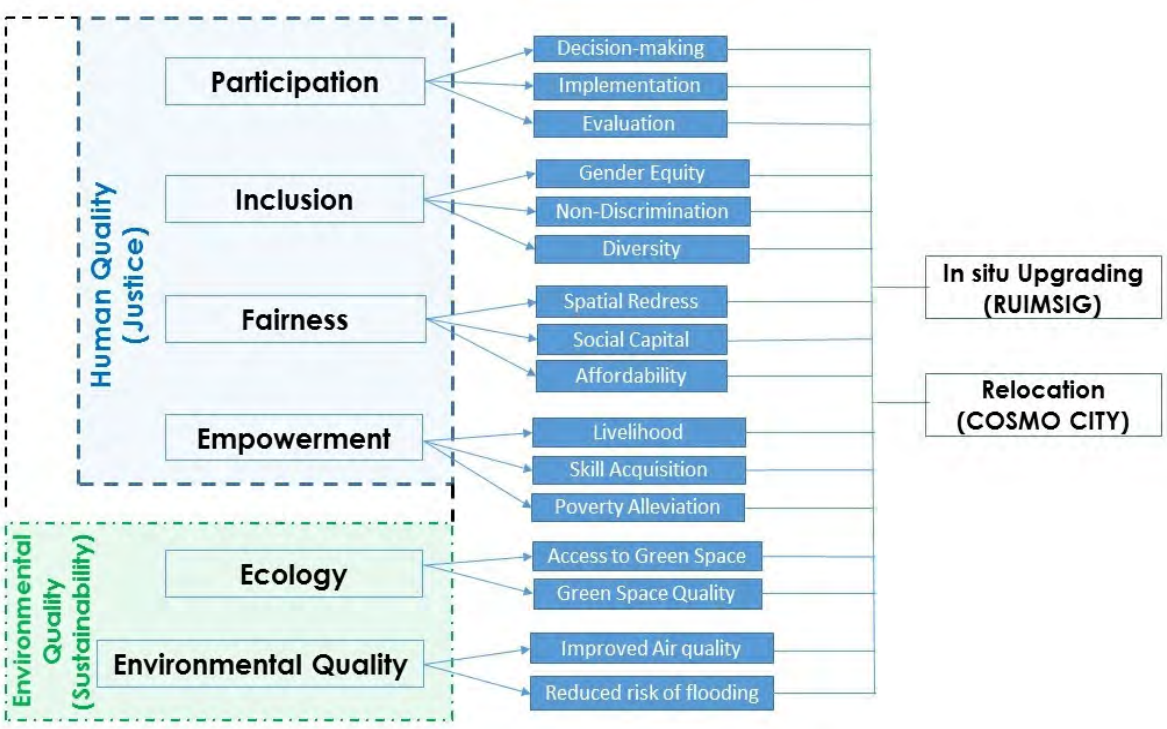


Figure 3.4. Just Sustainability Evaluation Framework for this research

Informal settlements and green infrastructure are part of a dynamic urban assemblage that involves various agents in the multiplicity of human-nonhuman relations. Understanding the relations between these agents are not only fundamental to any potential for just and sustainable interventions in and for informal settlements, it necessitates the deployment of methodological strategies that facilitate and attend to the multiple agents and relations. The methodological strategies and methods adopted for this research are presented in the next chapter.

CHAPTER FOUR
RESEARCH METHODOLOGY AND METHODS

4.1 INTRODUCTION

The literature-based discussion in the last two chapters culminated in a conceptual framework adopted for this research. By considering research methodology and methods, this chapter functions as a bridge between the conceptual/theoretical framing and empirical work in this thesis. The chapter explains the methodology for the stage where 'mixing with people and encountering moments [...] writing accounts of the encounters as some form of "data," and thinking about their meaning and theoretical import' takes place (Emerson, 2001: unpaginated).

This research is designed to employ a case study approach. After giving reasons to justify this approach, the chapter introduces the three case study areas, and specific methods deployed and the analytical strategies undertaken in the research process. To demonstrate the relevance of the chosen methods, this chapter describes the link between my research questions, the nature of information/data needed to answer them and the specific methods used. Towards the end, the chapter presents ethical considerations made and the dilemmas experienced in the research process and how these were resolved.

4.2 RESEARCH METHODOLOGICAL ISSUES AND APPROACH

As discussed in Chapters 2 and 3, this research is concerned about green infrastructure in the context of informal settlement intervention, linking these with the concept of just sustainability. The study therefore explores ecosystem services and ecosystem disservices associated with green infrastructure. Methodology (general approach and principles) and methods (specific techniques and instruments) that allows discovery and description 'from the point of view of the people who participate' in realities that are not yet apparent are necessary because of the under-explored multiple human-nonhuman relations into which this research is embedded (Flick *et al*., 2004:3).

4.2.1 Qualitative Strategy, supplemented by a quantitative method

This study draws on both qualitative and quantitative research strategies. The qualitative strategy is based on interpretevism and constructivism, that is, multiple

realities emanating from individual constructions, and mutually elicited within the situation which shapes inquiry (Sale *et al*., 2002). In contrast, quantitative research methodology is based on positivism – only one objective reality which exists independent of human perceptions and can be reduced to empirical indicators (Sale *et al*., 2002). The following quote by Yoshikawa *et al*. (2008:345) assisted me in understanding the difference and choosing between a qualitative and quantitative approach.

> 'The world is not inherently qualitative or quantitative; it is the act of human representation through numbers or non-numeric signifiers like words that make aspects of the scientific enterprise qualitative or quantitative. Behaviours or contexts relevant to human development are not inherently qualitative or quantitative, but the methods of representation through which behaviours or contexts are recorded in research are' (Yoshikawa *et al.,* 2008:345).

The qualitative strategy used involves multiple case studies. It was supplemented by a quantitative component for data collection in an individual case. This study's choice of a dominantly qualitative approach is linked to the conceptual framing on just sustainability – a framing that relates to value-based, multi-dimensional constructs. Previous city-based studies framed around the concept of just sustainability, for example in local food systems (Sherriff, 2009; Connelly et al., 2011) in parks and other kind of green open spaces (Seymour, 2012) suggest that employing a qualitative approach is better. Furthermore, anthropocentrism (related to human activities, experiences and views) associated with ecosystem services and ecosystem disservices are recommended to be studied, especially in the context of urban informality, through participatory qualitative methods (Lyytimaki *et al.,* 2008).

This study's qualitative methodology is applied in three low-income urban communities in Johannesburg, namely Kya Sands, Ruimsig and Cosmo City. The first (Kya Sands) is an informal settlement, the other (Ruimsig) an informal settlement that has experienced reblocking and the third (Cosmo City) is an area that emerged through relocation of some informal settlements. Since qualitative methodology allows various strategies of inquiry and steps in data collection and analysis (Creswell, 2009), data collection in this research methods encompassed desktop study, semi-structured interview, transect walks, pedagogic activities and a

focus group discussion. This follows Yin's (2012:4) idea that 'relevant case study data are likely to come from multiple and not singular sources of evidence'. I strived to make the methods valid and reliable. This took place through appropriate sampling approach (purposive sampling), sufficiently long engagement in the field, multiple methods of data gathering (with triangulation) and the practice of reflexivity through continuous self-review of the instruments based on the emerging contextual dynamics.

A quantitative instrument in the form of a willingness-to-pay survey was used to supplement the findings from qualitative methods in one of the case study areas, namely the Kya Sands informal settlement. The survey was carried out in order to place a numerical (economic) value on types of green infrastructure relevant to the settlement. The numerical value of green infrastructure points to the way green space interventions in the informal settlement might be approached from an economic perspective. This helped me answer research questions on ecosystem services, and their value, in relation to the Kya Sands settlement.

4.3 THE CASE STUDY APPROACH

Designing this research as a case study approach is justified by Yin's (2003) explanation that case study design should be considered when: (a) a study focuses on questions of "how" and "why"; (b) behaviour of those involved in the study cannot be manipulated; (c) the researcher wants to cover contextual conditions because of their relevance to the phenomenon being studied. The case study would allow 'empirical enquiry about [the] contemporary phenomenon (e.g., a case) set within its real world context' (Yin, 2009:18) and allow documentation and analysis of processes and outcomes in such context (Yin, 2012). Tress *et al*. (2001) assert that a case study approach in multi-functional landscape studies (as applies to green infrastructure in my enquiry) can bridge the gap between humanities, physical and natural sciences in the built-environment.

With Johannesburg as this study's context, it is expedient to focus on a few cases that allow extended empirical inquiry, and detailed and in-depth description and analysis. The exploratory nature of this research and intention to seek insights on relatively un-investigated phenomena also compels a focus on a few fitting cases —

ones that allow detailed examination, meaningful contribution and generalisation to theory.

Case studies generally include a 'unit of analysis', which 'defines what the case study is focusing on' (Berg, 2001:231) and is generally influenced by 'the unknown that the research wants to enlighten' (Grunbaum, 2008:88). Based on my research questions, the unit of analysis in this study is the process and outcomes of informal settlement intervention in terms of residents' relationship with green infrastructure therein. This calls for cases where informal settlement intervention has not taken place or has been undertaken through different approaches (relocation and *in situ* upgrading) so that appropriate analysis and contribution to knowledge can emerge.

As mentioned earlier, three low-income communities (Kya Sands and Ruimsig settlements and Cosmo City Township) in the Johannesburg metropolitan area and under municipal administration of the City of Johannesburg (CoJ) served as case studies. The three case study locations are shown in figure 4.1 and 4.2 while Table 4.1 provides reasons for choosing the three areas. Before deciding on which settlements to study, I made field visits to establish the possibility and suitability of conducting research for my thesis in these areas. I was also encouraged by the appreciable and useful amount of background information available as well as existing networks and relationships which facilitated easy access into the areas.

The first case study area, Kya Sands informal settlement, is located about 36 km north-west of Johannesburg's CBD. The Kya Sands industrial area (after which the informal settlement is named) lies to the west of the settlement while an old landfill site sits to the south. To the south-east, across Agnes Road, Kya Sands settlement borders the suburban middle-class Bloubosrand area (See figure 5.1 in Chapter 5). To the north (two and a half kilometers away) lies another informal settlement, Msawawa (see Nenweli, 2015) (see figure 5.1 in Chapter 5). Although established around 1990, available statistics show that Kya Sands settlement presently contains over 16 238 people, living in about 5 325 dwellings that accommodate at least 3 000 households (PMM, 2009; Huchzermeyer *et al*., 2014). The North Riding Stream, also known as Kya Sands Spruit, flows through the settlement. The stream's wetland, the riparian corridor as well as non-riparian green spaces (e. g., domestic gardens) make Kya Sands an informal settlement located within a natural ecosystem.

This provides an opportunity to investigate different dimensions of the residents' relationship with green infrastructure, considering ecosystem services and ecosystem disservices.

Ruimsig informal settlement started out of a now demolished residential facility for workers on a farmland located in the western periphery of Johannesburg in the late 1980s. From less than 50 shacks in the mid-1990s, the settlement has grown to over 422 shacks accommodating over 1 000 people at present (personal communication, Ruimsig Community leader, 31 July 2014). Between 2010 and 2013, the settlement underwent reblocking, an *in situ* intervention approach that resonates in part with the South Africa's Upgrading of Informal Settlement Programme (UISP). Ruimsig settlement is bordered by a small wetland which it shares with an adjoining Golf course. The rationale for choosing Ruimsig as a case study area lies in the reblocking intervention and its proximity to a wetland. These conditions provide a case where relationship with green infrastructure can be explored in aspects of *in situ* informal settlement upgrading.

The third case study area, Cosmo City, is a mixed-income housing development made up of fully subsidised (called RDP houses), finance-/credit-linked and bonded housing. Forty per cent of the dwelling units (about 5 000) are RDP houses, planned for households relocated from informal settlements (Haferburg, 2013). The greater portion (2899 of about 5 000 units) of the RDP houses were reportedly allocated to households relocated from Zevenfontein (CoJ, 2012b), a settlement which in turn made way for the exclusive up-market gated estate of Steyn City. Households were also relocated from Riverbend and Skosana informal settlements. As an example of the state's relocation approach in informal settlements, Cosmo City is of particular relevance to this study due to the ecological dimension. The relocation having been from informal settlements adjacent to natural ecosystems to a township with ecologically significant and bio-diverse natural ecosystems offers an opportunity to investigate green infrastructure in the context of relocation as informal settlement intervention.

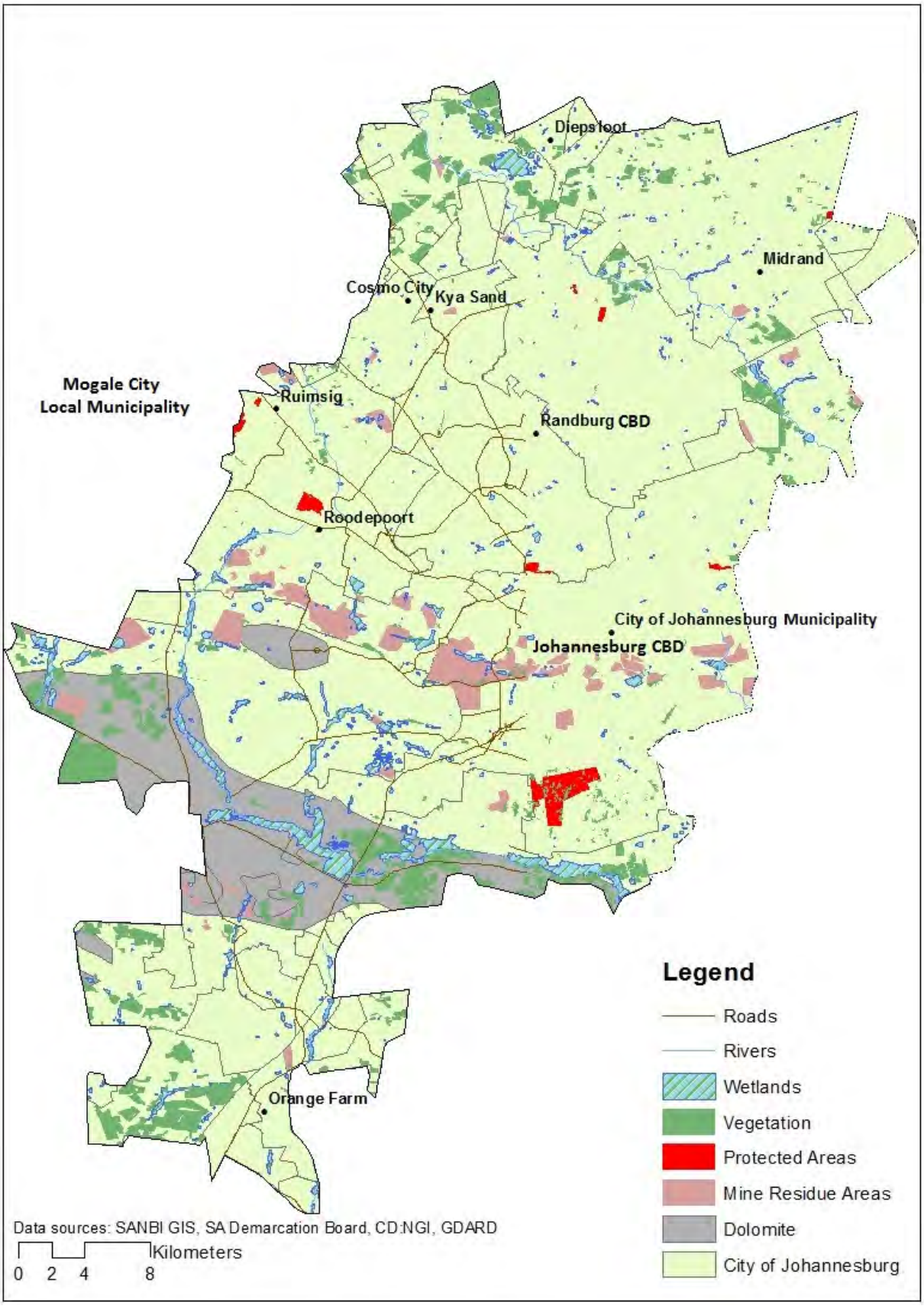


Figure 4.1 Map of the City of Johannesburg showing Kya Sands, Ruimsig and Cosmo City - the three case study areas.
Cartography: Samkelisiwe Khanyile, 2015

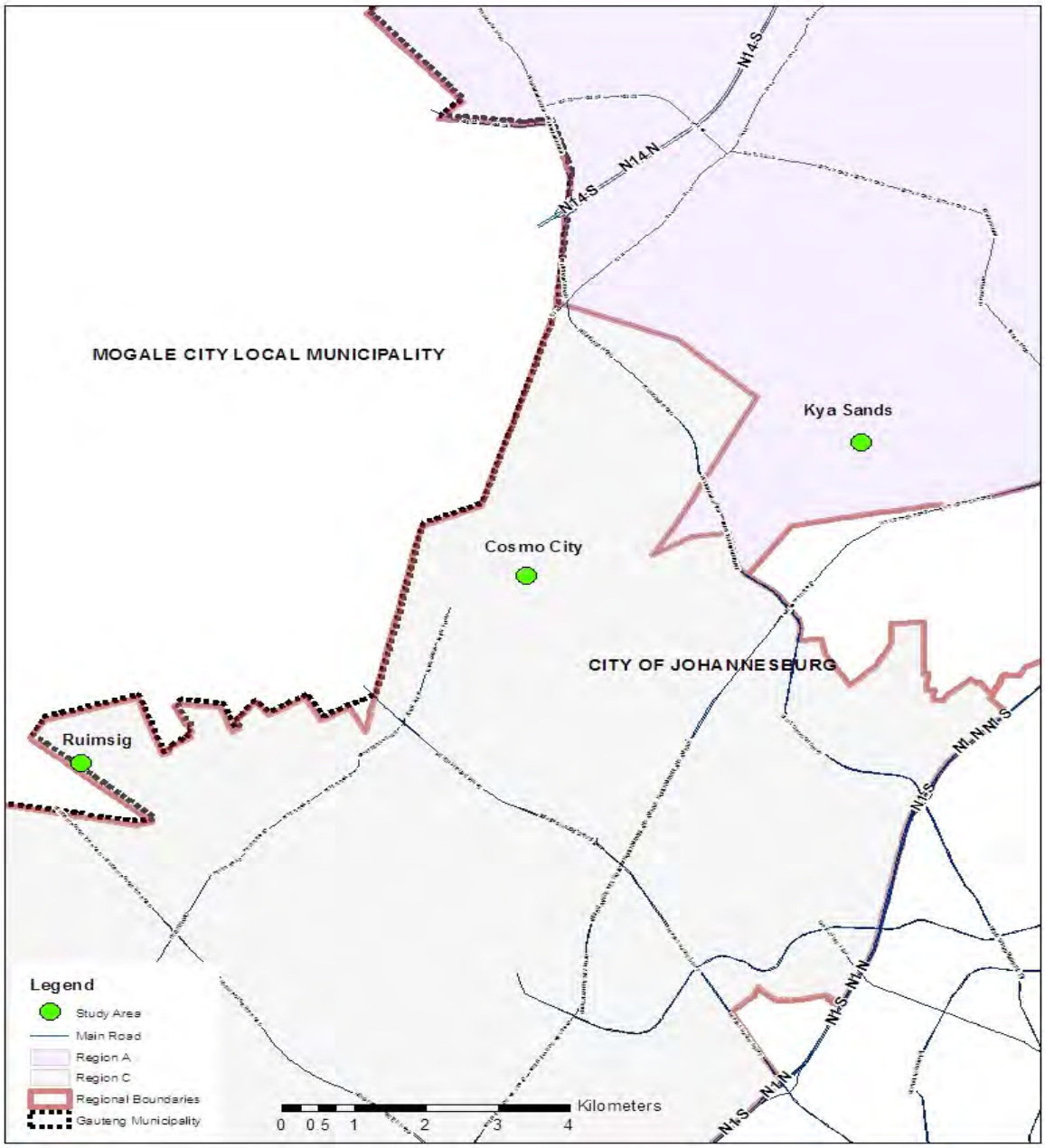


Figure 4.2. North-western part of City of Johannesburg showing location of the three case study areas
Cartography: Justice Mudau, 2016

The three case study areas are located in neighbouring administrative regions (Kya Sands and Cosmo City in Region A, Ruimsig in Region C – See figure 4.2) within Johannesburg's north-western quadrant. Region A, the northern-most region in the City of Johannesburg incorporates Midrand with the former site and service areas and informal settlements of Ivory Park. Region C incorporates the business node of Randburg with its municipal offices. The three areas are all connected to different natural ecosystems, especially hydrological ones. Figure 5.1 to 5.2, Figure 6.1 to 6.2

and Figure 7.1 to 7.4 in Chapters 5, 6 and 7 respectively provide images depicting this connection. As earlier explained, proximity to natural systems is a strong reason for choosing the three areas as case study sites (see Table 4.1). More detailed layers of analysis on the case study areas are provided in the next three chapters where findings from the case studies are presented and analysed.

Table 4.1 The Case Study Areas and Criteria for their Choice.

Case	Area	Specific/Individual Criteria	General Criteria
1	Kya Sands	Informal settlement established through gradual unplanned development on vacant land. It has not experienced substantive intervention.	• Location near natural ecosystem, especially stream or wetland, serving as green infrastructure • Availability of relevant background information on the area and existing relationships that facilitate easy access • Location within same or neighbouring regions - Johannesburg's North-Western Quadrant (geo-morphologically homogeneity)
2	Ruimsig	An area or settlement community that underwent in-situ improvement (through re-blocking) - as the substantive intervention approach.	
3	Cosmo City	A formal area that involved township establishment and relocation of households from informal settlements — as the substantive intervention approach.	

Source: Author's Construction.

4.4 METHODS USED TO COLLECT DATA IN THE CASE STUDY AREAS

4.4.1 Desktop Study

A search for and retrieval of relevant published and unpublished, academic and non-academic materials, through desktop study allowed me conduct a literature review and a document analysis. I brought together and engaged with materials on topics related to informal settlements, upgrading, green infrastructure, ecosystem services and disservices, environmental justice and sustainability in the urban environment — at local (Johannesburg), national (South African) and international scales. These materials were sourced from the key informants I interviewed as well as through online searches via sources such as government websites, academic databases (Google scholar and Scopus) and blogs. They informed theoretical foundations adopted and provided useful background information about the case study areas and municipal context.

4.4.2 Key Informant Interviews

To construct each of the case studies and grasp relevant backdrops across them, I conducted semi-structured interviews with 17 persons involved with informal settlements and those knowledgeable on environment-related issues in Johannesburg and South Africa at large. Through these interviews, which were semi-structured, I elicited specific information related to informal settlement intervention in the case study areas.

The semi-structured nature of the interviews allowed interaction in a conversational and relatively informal manner so that the participants could express themselves openly and freely and to define the issues at hand from their own perspective (Hancock and Algozzine, 2006). This semi-structured approach was useful, being 'well suited for the exploration of the perceptions and opinions of respondents regarding complex and sometimes sensitive issues and enable probing for more information and clarification of answers' (Barriball and While, 1994:330).

The interviewees, representing a variety of actors and disciplines, were drawn from people affiliated with a cross-section of state and non-state institutions (see Table 4.2). The first round of interviewees was selected through purposive sampling, which is useful and effective when researching a domain with knowledgeable experts (Tongco, 2007). The initial interviewees were identified because they are knowledgeable and/or involved with informal settlement interventions and environmental issues in Johannesburg. The initial participants then suggested and connected me with other informants they felt were relevant to the issues being researched, a form of snowballing sampling (Flick, 2007). I identified and contacted six of the informants through this process which continued till my core questions were sufficiently answered. The interviews, which took up to 95 minutes in some cases, did not only provide answers to my research questions, they helped triangulate earlier information elicited.

With each participant's consent, I audio-recorded fourteen of the semi-structured interviews and later transcribed them. I took notes during those interviews that I could not audio-tape. I promised to keep the interviewees' identity anonymous in the participation information sheet. Therefore, I did not cite them by name in this thesis.

Table 4.2. Distribution of the key informants' organisational affiliation

Affiliation type	**Organisation**	**No.**
Departments in the City of Johannesburg	Department of Housing; Department of Environment/Infrastructure	3
Municipally-owned entities	Johannesburg City Parks and Zoo	2
Private Sector	Basil Read Development	1
NGOs/Civil Society	Planact, Food and Trees for Africa	4
Professional Practice	26'10 South Architects	2
Educational Institution	University of Johannesburg	2
Community-based organisation/leadership		3
Others		1
Total		**17**

Source: Author's Construction

4.4.3 In-depth interviews with residents

Data collection within the three case study areas was effected through in-depth semi-structured interviews with residents. Although this study does not deeply make use oral testimony as such, it is worth noting that according to Furniss and Gunner (1995), black South Africans generally have a rich history of oral testimony and verbal communicative strategies. This characteristic makes interviewing an appropriate tool for data collection in the low-income and informal communities, which are evidently dominated by 'black' people.

A total of 43 residents were interviewed across the three areas; 12 in Kya Sands, 15 in Ruimsig and 16 in Cosmo City. Those interviewed were selected through multi-stage cluster sampling and purposive sampling. Multi-stage cluster sampling involves a large unit (in this case each settlement/township) with clusters (sections in the settlements/township) that are sampled to generate participants (Urban, 2002). The sectioning used in each settlement (primary unit) served as the cluster in the context. For example, Kya Sands is divided into five sections, named A to E. Ruimsig is in four quadrants named as Wetland, Church, Spaza and Shebeen. The RDP section of Cosmo City encompasses the township's Extension 2, 4 and 6.

Purposive sampling was undertaken in each section/quadrant/extension. One person, usually the household head, was approached and interviewed in each of the sections in Kya Sands and quadrants in Ruimsig. Within each extension with RDP houses in Cosmo city, I purposively sampled and interviewed residents who relocated from

Zevenfontein, Riverbend and Skosana settlements. Of the 16 residents interviewed in Cosmo City, 10 formerly resided in Zevenfontein, 1 in Riverbend and 1 in Skosanna settlement. The remaining 4 interviewees did not come from any of these three informal settlements, but were interviewed because of the information and insights they can offer on the current conditions in Cosmo City.

Interviews with residents were semi-structured. They were framed around a set of predetermined questions although other questions emerged from the dialogue (Whiting, 2008). The interview questions sought to elicit information on the residents' relationship with natural ecosystems – that is, benefits derived and problems experienced as well as perceptions and expectations on green infrastructure such as streams/rivers, wetlands, riparian corridor, gardens, parks. In Cosmo City, the questions touched on the residents' relationship with green infrastructure in their former informal settlements in order to understand the impact of relocation on ecosystem services and ecosystem disservices. In Ruimsig, the questions explored the impact of re-blocking in terms of changing relationship with green infrastructure. Information on the impact of relocation and *in situ* intervention on relationship with green infrastructure in Ruimsig and Cosmo City helped to understand shortfalls and advances in relation to just sustainability in informal settlement intervention.

Since local knowledge is at times conveyed through terminologies different from those which researchers and experts generally use or may understand, interviews with the residents were conducted with the assistance of a knowledgeable interpreter who also served as my research assistant. The interpreter used easily understood terminologies that best convey what the research intends. In a typical interview session, I posed a question in English. She interpreted it into the local language (mostly isiZulu, SeSotho and SePedi) if the participant did not understand English. She also interpreted the interviewee's response into English if it was made in a local language. The interpreter/research assistant later transcribed interviews conducted in vernacular language.

Interviewing across the three areas started in May 2014 and was formally rounded up at the end of November 2014. All the interviews, except one, were audio-recorded. One interviewee in Cosmo City withheld permission to use an audio recording device, not wanting to be captured word for word. Almost all the interviews were

conducted during weekends, so that residents who go to work outside the settlement during the weekdays were represented among the study participants. The exceptions were where interviewees preferred an appointment during a week day.

4.4.4 Walking Journey/Transect Walk

This research employed transect walks in the three areas in order to 'connect what participants say with where they [talked about]' (Jones, 2008:1). This involved walking with volunteer residents and my research assistant through identified green spaces, for example, the green belt and parks in Cosmo City, the riparian corridor in Kya Sands settlement, and the wetland in Ruimsig. There were at least two walks, which typically lasted less than an hour, in each of the areas. During each walk, I had conversations with people who accompanied me, took note of striking issues and photographs. Through the walks, I got to know more about green spaces in the areas and was exposed to a cross-section of issues on various days, for instance, weekends versus weekdays; summer's wet days versus winter's dry days. In line with Jones (2008), our physical connection with green spaces prompted conversations about histories, constructs and expectations that did not emerge through the interviews. As an example, I would not have known and seen some of the sanitary items dumped in the North Riding stream (in Kya Sands settlement) if it had not been for walks.

4.4.5 Focus Group Discussion

To enhance data collected through interviews, I conducted a focus group discussion in Cosmo City. A particular set of issues in Cosmo City necessitated a focus group discussion, but this was not deemed necessary in the other two settlements. The discussion took place with 5 residents in November 2014 at meeting room within the Cosmo City Multipurpose Centre. The discussants were identified and recruited through Mr. Phasha Magagane, leader of Cosmo City Community Development Forum, whom I had also interviewed earlier. The discussants were recruited with the aim of having representation of those relocated from Zevenfontein, Riverbend and Skosana settlements as well as those who lived elsewhere before moving to Cosmo City.

The 95-minute discussion was conducted in English and audio-taped. It triggered issues, positions and perceptions not expressed through one-on-one interaction, thus

yielding information that did not emerge through semi-structured interviews. This confirms Kaplowitz and Hoehn's (2001) position on the complementary role of focus groups alongside interviews in qualitative research. Discussion between the residents helped unlock memory of the different informal settlements they had moved from. I was able to know more about the residents' relationship with natural ecosystems in their previous informal settlements as well as presently in Cosmo City. Being the moderator, I allowed everyone to freely air his/her views and ensured no one dominated the conversation.

4.4.6 Pedagogic Involvement

During the course of fieldwork in Kya Sands, I was part of the 2014 teaching cohort for a 2nd year Bachelor of Urban and Regional Studies course entitled 'Contemporary Design and Environmental Issues in South Africa' (ARPL 2015). Again in September 2015, I served as a co-tutor during a Wits City Institute International Trans-disciplinary Workshop on 'Reshaping Socio-ecological landscapes through collaborative practices' in Kya Sands settlement. Both the students' course and international workshop sought to elaborate a community-initiated development vision for socio-ecological *in situ* upgrading, with Kya Sands settlement as the study site. Participation in the course and workshop, though not planned upfront as a research strategy, was a useful add-on for engagement with and data collection in the informal settlement.

Responsibilities during the course and workshop allowed deepened engagement with the Kya Sands community, especially on issues pertaining to the natural environment. I led two field trips and was part of three community meetings in the settlement. See Figure 4.3 for pictures of the community meetings. The meetings served as forum to receive feedback/input on the students and workshop participants' analysis of socio-ecological relations in the settlement. The students and participants benefited from my research experience and networks in the settlement, while I learnt from their analytical and design engagements, some of which dwelt on green infrastructural development within the North Riding stream and riparian corridor.



Figure 4.3 Community meeting and presentation at Kya Sands Community Centre in September 2014 (top) and at Judah Africa Church in Kya Sands settlement in September 2015 (bottom).
Source: Author's Photographs, September 2014/2015.

4.4.7 Valuing Ecosystem Services: Willingness to Pay Survey

Findings from qualitative methods (interviews and transect walks) in Kya Sands made it evident that a better understanding was needed of individual/households' value of green spaces. Literature contains different methods used to capture the value that communities give to natural assests. Landscape value methodology, hedonic

pricing, travel cost, avoided cost, replacement cost and the stated preference (also known as contingency valuation) are methods applicable to the urban setting (Raymond et al, 2009; Gomez-Bagethun and Barton, 2013). These methods are limited in various ways but the stated preference/contingency valuation method, which entails determining willingness to pay, is potentially applicable at all scales (Gomez-Bagethun and Barton, 2013). Through this method, the value of green space(s) manifests or can be captured through willingness to make a personal contribution on an ongoing basis for the use of certain green spaces in the settlement. As a result, I designed and carried out a survey of willingness to pay for green spaces in Kya Sands settlement.

This kind of survey is useful at determining non-use and non-market use value of environmental goods and services. It has been used to investigate informal settlement residents' willingness to pay for portable water supply (Raje *et al*., 2002), electricity (Mimmi, 2014), improvement in river water quality (Imandoust and Gadam, 2007), waste disposal services (Mbaye, 2008; Sarkhel and Barnerjee, 2010), sanitation services (Isunju *et al*., 2013) in developing countries. Apart from a recent study by Vollmer *et al*. (2015) in Jakarta (Indonesia), I did not come across any study considering willingness to pay for green spaces in informal settlements. Through their survey of Jakarta informal settlement residents' willingness to pay for ecological rehabilitation of the Ciliwung river corridor, Vollmer *et al*. (2015) acknowledged the importance of both qualitative and quantitative methods in green space planning for informally and densely-settled urban riverbanks.

In a willingness to pay survey, respondents are presented with information on specific hypothetical scenarios of environmental improvements, and their perception and preferences are elicited by requesting an articulation of their 'willingness to pay' (WTP) (Brouwer *et al*., 1999). For this research, I developed a questionnaire (see appendix) used to elicit Kya Sands residents' willingness to pay for certain green spaces. My supervisors and a statistician reviewed the instrument before it was finalised. For the sake of reliability and validity, the survey questions went through rounds of peer and personal reviews and a pilot exercise with a few residents. I also selected a sample size considered representative of the settlement.

The questionnaire solicited demographic and socio-economic information before requesting the amount each respondent is willing to pay for identified green space types (children's park, community park, rehabilitating the riparian corridor and allotment gardens) assuming these were developed by three kinds of developers (entrepreneurial resident, NGO or the state/municipality). With the entire informal settlement as research population, I took a sample of 200 respondents - 40 randomly selected residents across each of Kya Sands' five sections. This method ensures respondents are distributed across the entire settlement for a representative sample.

The questionnaires were administered with assistance of five 2nd year Bachelor of Urban and Regional Planning students who took the ARPL 2015 course in Kya Sands settlement. The students were already familiar with the settlement. They also understand and can speak the common languages used there. I trained the students how to administer the questionnaire before we embarked on the field work. The students were joined by five male residents who acted as field guides, meaning that five pairs of persons administered the questionnaires in the settlement's five sections. The survey exercise took place on a weekend so that residents who work outside the settlement on weekdays were represented. Completing each questionnaire at times took up to 25 minutes.

4.4.8 Linking the research questions with the data collection methods

So far, I have discussed the methods used for data collection with this research's case study design. Here, I present the relationship between these methods and research questions guiding this thesis. Table 4.2 shows how the various methods deployed resonate with the research questions based on the nature of information/data (whether quantitative or qualitative) that provide necessary answers.

Table 4.3 Links between research questions and the methods employed

Research Question	**Nature of Information needed and source**	**Research Method(s) Used**
What are ecosystem services and ecosystem disservices related to green infrastructure in Johannesburg's low-income communities – informal settlements and areas that emerged through informal settlement intervention?	Information needed to address this question is qualitative; deriving value of ecosystem services is quantitative in nature. Information was derived from residents in the three case study areas	In-depth interview with residents, focus group discussion, transect walks, community meeting (qualitative) and willingness to pay survey (quantitative)
How does informal settlement intervention (in situ and relocation) impact relationship with green infrastructure? How just and sustainable are these two informal settlement intervention approaches?	Information needed to address this question is qualitative in nature. Information was derived from residents and key informants	In-depth interviews with residents, Key informant interviews, Focus group discussion, Desktop study – all qualitative
How might more just and sustainable situations emerge in informal settlement intervention?	Information needed is from a synthesis of qualitative and quantitative data Information was derived from the literature and the entire research participants	All methods – Interviews with residents and key informant, focus group discussion, transect walks, community meetings, willingness to pay survey and document analysis

Source: Author's Construction

4.5 ANALYSIS OF RESEARCH FINDINGS

In research, the word 'analysis' refers to 'the act of unfolding' and 'searching for patterns' within information; such that what emerges can help formulate answers to certain questions (Peters and Wester, 2007:637). The 'act of unfolding' qualitative information is different from that which is quantitative. Accordingly, analytical processes and outcomes of data from qualitative and quantitative research instruments, which rely on non-numeric and numeric formats or representations respectively, are not the same (Yoshikawa *et al,* 2008). Based on the case study strategy and qualitative research methods, this process of analysis was qualitative.

The willingness to pay survey in one of the cases was analysed quantitatively, integrating the quantitative insights into the qualitative aspect of the study.

4.5.1 Analysis of Qualitative data

The process of analysing information elucidated through qualitative instruments was ongoing and iterative. In order to make proper sense of information collected, analysis is meant to be a pervasive activity throughout the life of a qualitative research project and not simply at the latter stage (Coffey and Atkinson, 1996).

Since the various data collection processes were characterized by activities such as note taking, journaling and audio recording, I was able to take stock and reflect from an early stage till the end of the fieldwork. Actual analysis started with transcription. I personally transcribed some of the interviews, while my research assistant/ interpreter during the interviews with residents transcribed those including vernacular language. In analysing the interview transcripts, I developed codes and category systems which are 'tags or labels for allocating units of meaning to the descriptive or inferential information compiled during a study' (Basit, 2003:144).

Pattern-building, that is, comparison between empirical (data from the field) and hypothetical patterns initially set out followed the steps named above. Quotations from the interviews and focus group discussion, clear examples and informative illustrations were used to communicate salient aspects of the data collected. Patterns identified and built led to arguments used to answer research questions guiding the thesis.

4.5.2 Analysis of Quantitative Data

Information collected through the willingness to pay (WTP) survey was processed and analysed quantitatively. Of the 200 questionnaires prepared and taken to the field (Kya Sands settlement), only 188 were used for analysis. The outstanding 12 questionnaires were either partially completed or not completed at all and therefore not useful for analysis. The 188 questionnaires were coded and the data entered into Microsoft Office Excel software. Demographic characteristics of the respondents (e.g, gender, educational level, household income) and categorical variables such as length of stay in the settlement were summarised using frequencies and percentages. Residents' willingness to pay for the development of green spaces by the named

types of developers and amount were analysed using simple descriptive statistical methods. The results are presented in tabular and graphical formats towards the latter part of Chapter 5.

4.6 ETHICAL CONSIDERATIONS

In order to place any research on a firm moral footing, ethical considerations are important. As explained by Oliver (2010), research processes involving human beings as participants or subjects must be concerned with the preservation of essential elements of their humanity and dignity. As a result of this, I gave due consideration to being ethical throughout my research.

Before commencing fieldwork, I familiarised myself with the University of the Witwatersrand's Code of Ethics for Research on Human Subjects. I applied for clearance with the University's non-medical human research ethics committee and was awarded a clearance certificate (see appendix). Since my case study areas are under the administrative jurisdiction of the City of Johannesburg, I informed the municipality's Innovation and Knowledge Management Unit and was granted approval for the research (see appendix for the approval letter).

Obtaining informed consent from research participants was vital. To do this, I used a consent form. In administering this, I divulged my identity as a university student/researcher. I verbally informed the participants about the purpose of this study. Where the participants could understand, I handed them a copy of the participant information sheet (see appendix). The information sheet, also translated into isiZulu language (see appendix), introduces the study, invites them to voluntarily participate and includes statements on confidentiality, non-traceability, and anonymity and so on. Generally, I was welcomed by residents in all three case study areas. I observed that they were no stranger to being participants in students' academic work and research studies. In most of the cases, I obtained the participants' consent verbally. The participants were generally unwilling or reluctant to sign the paper containing the consent form when presented.

Before starting the interviews, I made it known that they could withhold their consent or withdraw at any time during the interview, if they so wished. I also asked for permission to audio-tape the interview session. I made every effort to avoid

sensitive and personal questions and anything that may attempt to falsely raise hopes of the participants on the research outcome, especially in connection with the situation in each case study area.

Despite explanations that my project is of an academic nature, some of the interviewees attempt using my study as a means to voice their discontent with the situation in their settlement. At the end of the interview, a Kya Sand interviewee remarked:

> 'So how can you go closer to the Environmental Affairs people, to ask them or submit what you are asking here. When, or is it just a matter of school? I want to know if you will do like I do. I want to know if you are going to throw your input in the [suggestion] box or you are going to face them and meet the person involved' (Personal communication, Interview 5, Kya Sands Resident, 31 May 2014).

In response to this interviewee, I reiterated the academic nature of my work. I explained that I will not be making input in the suggestion box but writing a thesis that will be available in the public domain after completing my studies.

Another interviewee, in Ruimsig settlement, stated that 'I understand that you came here as a student to find out the kind of life that we live. But you need to indicate in your report that X [interviewee's name] said that … this place is not good at all' (Personal communication, Interview 9, Ruimsig Settlement, 12 July 2014). This interviewee, in a satirical manner, insisted that I must take the audio-taped interview to the President's office at the Union Buildings in Pretoria because she wanted her views heard.

Generally, I was cautious in responding to these expressions so that I didn't unnecessarily raise research participants' hopes. I explained and re-explained my status as a student, which involves limitations on the possibility of engagement with all relevant actors, especially in state institutions. However, I promised upon completion to disseminate my research findings widely and appropriately so that issues discussed can come to the knowledge of relevant stakeholders and authorities.

4.7 LIMITATIONS OF THE STUDY/METHODOLOGY

The case study strategy adopted in this research has an inherent limitation. 'The common complaint about case studies is that it is difficult to generalize from one case to another' (Yin, 2003:37). Since I engaged with a small unit of analysis in just

three areas in the whole of Johannesburg, the research findings cannot be generalised for the entire city. The findings can only be generalised to relevant theories and concepts.

Utilising the above described research methods in the case study areas also involved certain limitations. There are possibilities of losing rich nuances in the course of translation and interpretation from vernacular to English language and vice versa when interviewing the residents. Nuances can also be lost through transcription of vernacular responses to English. These add layers of complexity to the methodological process.

This thesis reports a cross-sectional study that is based on a case study design. A longitudinal study of the entire intervention continuum would be useful. But time and resources available for the doctoral degree would not allow a long-term study. On-going and proposed informal settlement intervention projects present opportunities for such long-term studies.

4.8 CONCLUSION

As shown in this chapter, this research's exploration of residents' relationships with green infrastructure and just sustainability in the context of informal settlement in Johannesburg used a case study approach. With the exception of one case study area where a quantitative instrument was used through a willingness to pay survey, data collection in the three case study areas used qualitative methods. Apart from making explanation on the different data collection methods used, the chapter explains processes used for analysis and some limitations of the methodology. Considerations made about ethical issues related to the process of data collection and presentation is explained. The next three chapters of this thesis present analysis of findings emerging from an utilisation of the research methods discussed in the three case study areas.

CHAPTER FIVE

GREEN INFRASTRUCTURE IN INFORMAL SETTLEMENTS: THE CASE OF KYA SANDS SETTLEMENT

5.1 INTRODUCTION

Kya Sands is arguably the largest informal settlement in Johannesburg's north-west, having survived since its formation in the late 1980s in the rapidly expanding largely gated landscape of middle and upper class residential developments. The location of Kya Sands settlement within the gated landscape is an exemplar of urban inequality in post-apartheid South Africa. As is typical of many informal settlements, Kya Sands is located within a natural ecosystem – in this case, a stream with wetlands. The settlement serves as one of the case study areas for this research, given its connection to and residents' relationship with green infrastructure as well as the overarching need for just and sustainable interventions. This chapter analyses findings from the Kya Sands case study.

The chapter begins with explanation on the emergence and growth of Kya Sands informal settlement, showing the level of basic services available and how these place pressure on or contribute to natural ecosystems. To understand the kinds of ecosystem services and ecosystem disservices and their intertwining, the chapter discusses types of green infrastructure in the settlement – gardens, 'parks', a sports field, the North Riding stream and its riparian space which includes wetlands. A survey investigating the residents' willingness to pay for green spaces in the settlement, reported towards the end of the chapter, helps to understand the value of green infrastructure and the possibility of a financial contribution from residents towards substantive intervention in informal settlements. Implications of green infrastructure for just sustainability in the settlement are highlighted throughout the chapter.

5.2 THE EMERGENCE, LOCATION AND GROWTH OF KYA SANDS SETTLEMENT

In Section 4.3 of the previous chapter, I described the location of Kya Sands settlement, alongside the other two cases, within Johannesburg (see figure 4.1 in Chapter 4) and explained why I chose it as a case study. For the purposes of this chapter, it should be noted that Kya Sands lies on both sides of the North Riding

stream, which is also known as Kya Sands Spruit (figure 5.1). This stream, 'which has been classified as non-perennial becoming perennial' is a tributary of the northerly flowing Klein Jukskei River and part of Johannesburg's Jukskei catchment (GeoZone Geoservices, 2013:4). Pedestrian thoroughfares cross the stream, connecting Sections B and C and the industrial area on the one side with Sections A, D and E and the suburban Bloubousrand area on the other (see Figure 5.1 and 5.2). The stream and riparian corridor, with its fauna and flora, form a significant part of green infrastructure in the settlement and neighbouring area.

Kya Sands informal settlement is located on both publicly and privately owned land. Part of the settlement located west of the North Riding stream is on privately owned land while the other part located east of the stream (portion 51 of Houtkoppen 193-IQ), is owned by the national government, but administered by the Gauteng Provincial Government (CoJ, 2007a). Eighteen hectares of portion 51 of Houtkoppen 193-IQ (undeveloped area next to the informal settlement) is presently leased out to Judah Africa (a non-profit organisation) (Kamp, 2015). According to Judah Africa's Chief Executive Officer (CEO), her organisation proposes using the land for agricultural activities targeted at improving the socio-economic conditions of Kya Sands residents (*ibid*.).

What is now known as Kya Sands informal settlement started around 1989 as informal shelter for people working at the now closed Randburg dumping site/landfill site (Weakley, 2013). The workers occupied vacant land (to the west of the stream - around Section B and C) close to the landfill site. Murray's (2008:102) explanations show that unlawful occupation in this area may not be unconnected with 'unscrupulous land owners [who] take advantage of the plight of the homeless poor by inviting them onto their land in exchange for a fee'. Confirming Murray's position, one of the first settlers in Kya Sand recalled that

> 'the owner of the land counted us before he gave us the land ... We would sleep close to the stream, having made make-shift reed huts, and we lived like that for a year. After that we lived in bridge pipes for another year. After that we built small shacks because we now had permission [from the owner]' (personal communication, Kya Sand Resident 6, 31 May 2014).



Figure 5.1 Image showing Kya Sands settlement's boundary, surrounding areas and the North Riding stream. Image adapted from Google Satellite Map of December 2015.



Figure 5.2. Satellite image of Kya Sands Settlement showing the sections and surrounding areas.
Adapted from Google Satellite Map of January 2016.

Kya Sands had grown to become the largest informal settlement in Johannesburg's north-west by 2009 (CoJ, 2010a). In the recollection of one of the residents, the settlement started in 1990 with about 169 people (personal communication, Kya Sand Resident 6, 31 May 2014). The City of Johannesburg's 2007 estimate shows over 7500 people living in 1 200 dwelling units in the informal settlement (CoJ, 2007a). A survey conducted by Professional Mobile Mapping (PMM) in 2009 shows 16 238 people living in about 5 325 dwellings there (PMM, 2009). More recently, the City of Johannesburg's database suggests that Kya Sands informal settlement accommodated about 3 000 households in 2011 (Huchzermeyer *et al.,* 2014). Satellite images from the City of Johannesburg, shown in figure 5.3, capture territorial expansions that occurred between 2000 and 2009, also confirming the growth of the settlement.

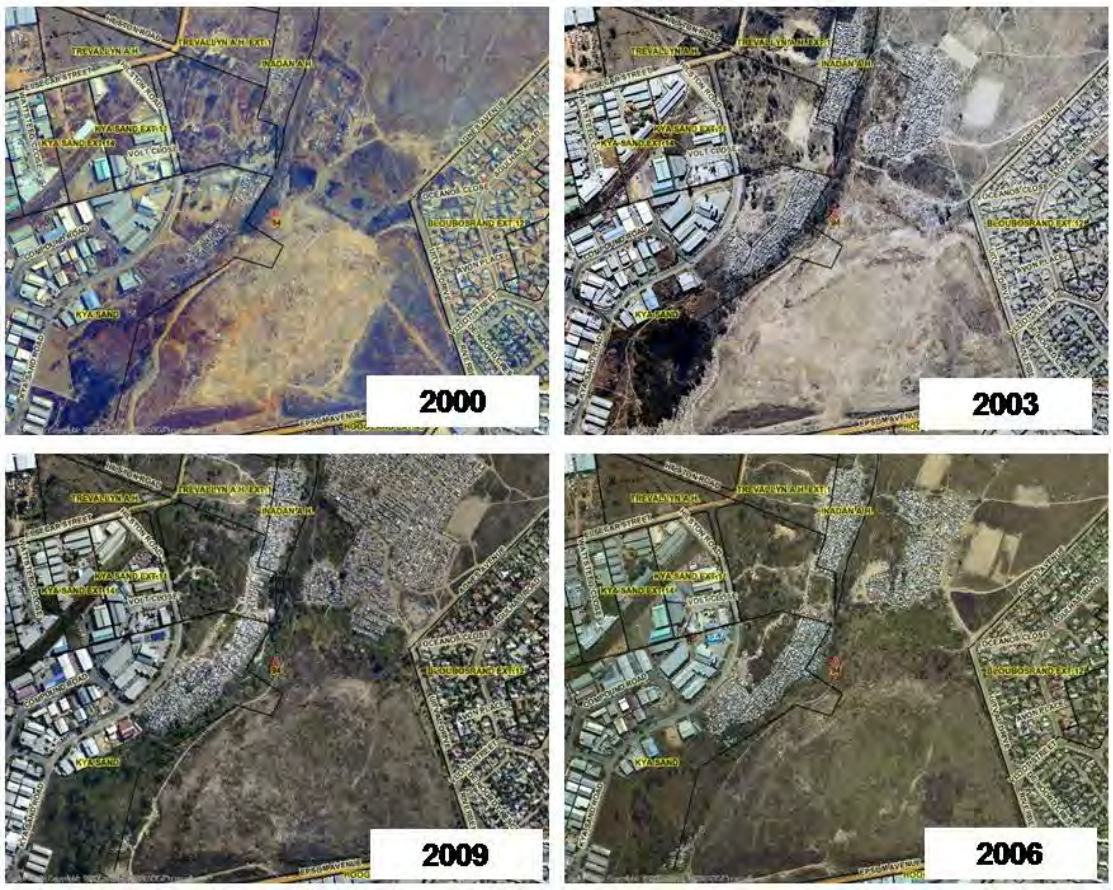


Figure 5.3. Images showing expansion in Kya Sands Informal Settlement between 2000 and 2009
Source: City of Johannesburg Database, 2010.

5.3 SERVICE DELIVERY IN KYA SANDS SETTLEMENT

As explained in Chapter 2, natural ecosystems deliver a range of services to human beings, especially where formal, municipally supplied services are absent or inadequate (Vollmer and Gret-Regamey, 2013). It is therefore critical to understand the levels of basic services in Kya Sands settlement in order to comprehend how available services lead to pressure on or contribute to natural ecosystems.

The first instance of formal service delivery in Kya Sands settlement is linked to a visit by the Mayor during the City of Johannesburg's mayoral road show in November 2006. The municipality started providing some services after the Mayor saw the absence of services and appalling living conditions in the informal settlement (CoJ, 2007a; Weakley, 2013). Jack Bloom, a Democratic Alliance (DA) parliamentarian claimed that service delivery in Kya Sands (and probably the mayoral visit) took place only after the then DA ward councillor John Mendelsohn reported the City of Johannesburg to the South African Human Rights Commission regarding the settlement's conditions (Bloom, 2013).

In early 2007, after the Mayor's visit, the municipality provided potable water and sanitation through 48 communal taps, 12 stationary water tanks and 120 toilets (CoJ, 2007a). The municipality also provided waste removal service and public space illumination from high-mast lights placed in a few locations within the settlement (see figure 5.4). Based on fieldwork conducted in 2011 and 2012, Weakley (2013) argues that the number of taps reportedly installed is fairly inaccurate. He found that 'the number of 48 is much higher than those actually installed' (Weakley, 2013:119). The municipality must have meant 8 standpipe units (each unit having 6 taps), which add up to 48 taps. Weakley (2013) also observed that stationary water tanks purportedly delivered were no longer in place in 2011. A further 18 communal standpipes were installed across the settlement in 2014 (personal communication, Kya Sands Community leader, 14 November 2014).

Chemical (plastic) toilets and Ventilated Improved Pit Latrines (VIPs) are the two types of toilets currently available in Kya Sands settlement. Households with demarcated stands normally have a VIP toilet within the stand. This is the situation in Section A and some parts of Sections D and E. When there is too little space between shacks or within stands, chemical toilets are provided in open spaces (See

figure 5.4) so that evacuating vehicles can have easy access for maintenance. This is the situation in the whole of Sections B and C, and some parts of Sections D and E. I observed that having a private VIP in a demarcated stand is one aspect that generally gives residents a stronger sense of permanence in Kya Sands, which in turn affects care of their environment e.g. establishing and tending to home gardens.



Figure 5.4. A row of chemical toilets located in an open space in Section C (left) and numbered VIP toilets in stands in Section A (right).
Source: Author's Photograph 2014/2015

Despite increases in the number of taps in the settlement, distribution of water and sanitation is uneven and still inadequate. Frustrations with the low-level of service delivery in the settlement are manifested through protests and other forms of targeted disruptions, as reported in the media (Nicolson, 2012; Lindeque, 2013). The communal provision of both water and sanitation in the settlement is subject to vandalism and scrap metal theft, a problem that is common in socio-economically deprived areas such as informal settlements in South Africa (Lagardien *et al*., 2009). While solutions may be found in community-based management of communal facilities, fault or theft reporting to the appropriate authorities seldom happens. A City official perceives that this is because 'people are very lazy at times' (personal communication, CoJ Environment and Infrastructure Department's Officer, 19 September 2014).

Waste collection and disposal services, through the municipal entity in charge of waste management in Johannesburg, Pikitup, are inadequate. A resident remarked that

> ‘we don’t have proper areas where we can dump ... We do have certain areas where you can take your plastic bags and put in. Then these Pikitup guys would come and pick it up. But then it is not for everyone. And as you can see most of the stuffs are thrown here in the river’ (personal communication, Kya Sands Resident 3, 31 May 2014).

Waste collection by Pikitup does not reach the entire settlement. I realised that households located far from garbage drop-off points end up dumping in open spaces around their dwellings or in the stream. Also, not every household in the settlement can afford plastic bags. As a result of a lack of packaging material, waste is not taken to the drop-off point, but disposed in open spaces.

The current low level of service delivery in Kya Sands settlement impinges on natural ecosystems that serve as green infrastructure. The river and riparian corridor makes up for inadequacy and poor management of water and sanitation, supplementing for the limited coverage of sanitation. This supplementary role in turn impacts the river and riparian corridor negatively. Poor drainage (for greywater – from domestic activities) can also affect food grown in gardens. Poor waste collection and disposal, an important environmental service, has a critical bearing on green open spaces in and around the settlement, as well as people’s perception and use of the spaces. The impacts of low service delivery on components of green infrastructure in the informal settlement are discussed in detail later in this chapter.

5.4 THE STATE’S INTERVENTION PLAN FOR KYA SANDS SETTLEMENT

Understanding how and when the state intends to make substantive interventions in and for Kya Sands informal settlement is crucial to the functioning of the associated natural ecosystems. Proposed interventions have the potential to either decimate or enhance ecosystem services presently benefited and address ecosystem disservices experienced by the residents. The state’s intervention plan can also show whether the residents’ constitutional right to adequate housing and redress of historical disadvantage will be achieved or not.

In January 2007, after November 2006’s mayoral road show, the municipality proposed developing and relocating the Kya Sands community to state-subsidised houses on the adjacent portion 51 of Houtkoppen 193-IQ (See figure 5.1) (CoJ, 2007a). A feasibility study for low-income housing showed that the land was

developable and that connection to bulk services was possible (*ibid*.). Later, in October 2007, this plan was revised, because the City wanted a larger scale solution that included not only Kya Sands, but other informal settlements north of Johannesburg (Weakley, 2013). The new plan is to relocate those who qualify for state's capital subsidy to Lion Park, a proposed township ten kilometres (by car), from its present location (CoJ, 2008a).

Eight years later, at the time of my fieldwork in 2014, the relocation plan had not materialised. Already in 2011, the media reported that there was no budget allocation for bulk service installation in the proposed Lion Park township (Sabela, 2011). While interviewing a City of Johannesburg Housing officer in 2014, I was told that the township establishment was delayed due to problems with electricity provision (personal communication, CoJ Housing Officer, October 3, 2014).

As reported in the media in late 2015, relocating residents to Lion Park township (one of Gauteng's Department of Human Settlement's mega projects) is still the current plan for Kya Sands settlement (Luvhengo, 2015). Despite relevant policies (UISSP in BNG – which I reviewed in Chapter 2) and a court ruling actually requiring it, *in situ* upgrading of Kya Sands settlement is not being considered by the state. Bottom-up and incremental approaches to *in situ* upgrading in Kya Sands are possible. These can be socio-ecological, that is, exploiting the residents' existing multi-faceted relationship with green infrastructure (explained in detail later) for significant improvement in quality of life and the environment.

5.5 TYPES OF GREEN INFRASTRUCTURE IN KYA SANDS SETTLEMENT

In Chapter 2, I stated that informal settlements are connected to green infrastructure through location within or around natural ecosystems and urban agriculture. People living in informal settlements derive benefits, through provisioning, regulating and socio-cultural ecosystem services, from these connections. Kya Sands informal settlement is connected to green infrastructure through its location by a stream/wetland (North Riding stream) and available gardens (urban agriculture). Honing in on this case study, this section presents components of green infrastructure in the settlement, discussing associated ecosystem services and

ecosystem disservices, while also identifying inherent intricacies as well as implications for and contributions to just sustainability.

5.5.1 Gardens in Kya Sands settlement

There are two types of garden in Kya Sands settlement – domestic/home gardens and communal gardens. Domestic/home gardens refer to vegetated private spaces, essentially, greenery within stands. Communal gardens, in the context of this case, refer to demarcated and cultivated public spaces – spaces not 'owned' or cultivated by a single person/household. Crop growing in such spaces differentiates communal gardens from another type of green open space I later refer to as 'parks'.

The contribution of domestic gardens to ecosystem services and disservices

In Kya Sands settlement I observed that domestic gardens form part of the curtilage of shacks. Their form is fairly diverse. They range from plants in containers arranged around a shack's plinth to a few square metres of vegetation on the ground (see figure 5.5). The gardens are usually irrigated with water from standpipes and rarely with water from the North Riding stream. I observed a relationship between demarcated plots and the type of gardens in the settlement. There are smaller and fewer gardens around dwellings that do not have demarcated stands. Plants grown inside containers arranged around a shack's plinth are the common type of garden in such situation. Gardening in Kya Sands is typically a leisure-time activity as no resident reports it as primary occupation.

The domestic gardens serve various purposes. They provide food, a provisioning ecosystem service. An interviewee said: 'we cook some, some are taken by people [with my permission, but] I don't sell them' (personal communication, Kya Sands Resident 9, 06 June 2014). The contribution of gardens to household food consumption in the settlement is meagre because not all households have a garden. Through the interviews, I realised that households who grow edible plants harvest small quantities, a situation that resonates with van Averberke's (2007) findings in five Pretoria informal settlements. Domestic gardeners in the informal settlements harvested 1.7 kilograms of fresh food in a month — a meagre 6.7% of a household's recommended monthly vegetable food intake (van Averberke, 2007).

The gardens also contribute aesthetics (a socio-cultural ecosystem service), thus enhancing psychological well-being. Notwithstanding the nature of shacks or size of respective stands, some of the residents I interviewed expressed their passion for trees and flowers, so they grow plants to beautify their dwellings and stands (figure 5.5). Since 'they [plants] smell nice and I just love them', a resident declared that he 'uses the [plant] leaves for indoor fragrance or … as medicine' (personal communication, Kya Sands Resident 10, 06 June 2014). I observed that some gardens are artistic. As shown in Chapter 7, Hill and Heerden (2003) also observed arty gardens in Zevenfontein settlement before the residents were relocated to Cosmo City. These gardens serve as a means of creative self-expression that fosters a sense of attachment to place, which is clearly linked to dignity in the context of disadvantage and deprivation.

Temperature and wind (micro-climate) control benefits, a regulatory ecosystem service, are also derived from the domestic gardens. Some interviewees associate trees in gardens with fresh air. One of them specifically said 'when it's hot, it [the garden] releases [cool breeze, so] we sit under the trees ... to benefit from oxygen' (personal communication, Kya Sands Resident 8, 06 June 2014). Apart from the cooling effect, this interviewee also said that trees in his stand protect the shack's roofing sheets – preventing them from flying off during strong winds.



Figure 5.5. Different kinds of domestic gardens in Kya Sands Settlement
Source: Author's Photographs, May/June 2014.

The possibility of monetary gains from garden products motivates some residents' interest in gardening. A resident with this mindset said he 'would grow these trees, chop them up, sell them for firewood or build with them' (personal communication, Kya Sands Resident 2, 30 May 2014). Another resident hopes to 'make vegetable gardens and plant vegetables to sell in order to generate income [because] people do love vegetables here' (personal communication, Kya Sands Resident 7, 6 June 2014). With secure tenure through *in situ* upgrading in Kya Sands, a resident who acknowledged that 'I have friends here, I have built a life here [said] I will grow food (maybe cabbages), and since I have gardening experience, I would grow, cut and sell them' (personal communication, Kya Sands Resident 10, 06 June 2014). Literature shows that material and monetary contribution from domestic gardens, such as the ones in Kya Sands, is modest (Van Averberke, 2007; Ruysenaar, 2013). But *in situ* interventions, if they were to be considered for Kya Sands, could deliberately explore the realisation of more substantive contribution from domestic gardens in the settlement.

Viewed dialectically, while domestic gardens are beneficial in many ways, serving as a source of ecosystem services, they are associated with certain negative experiences regarded as ecosystem disservices. Domestic gardens breed undesirable insects in summer. A resident complain that 'mosquitoes bother us, and it's only in summer…because mosquitoes love trees' (personal communication, Kya Sands Resident 10, 6 June 2014). I observed that fallen tree leaves make some of the stands I visited dirty, hence the need to commit more time and resources to cleaning. Although not articulated by my respondents, Ross' (2010) ethnographic work in The Park informal settlement (Western Cape) showed that women with stands littered by fallen leaves are generally not regarded as respectable. This means having a domestic garden can lead to low esteem which deepens the resident's sense of deprivation, although on the other hand fallen leaves in domestic gardens contribute to nutrient cycling which is a type of supporting ecosystem service.

Obstacles to home gardening

Certain factors hamper successful domestic gardening in Kya Sands and realisation of benefits therein. Insufficient or outright lack of space is an obstacle that most of the interviewees who do not have a garden and those unsatisfied with their current level of gardening activities mentioned. There is a popular notion among the residents that once you have space you will have a garden. While a resident thinks 'if I have space I would have a few plants: But when you don't have space you don't even think of things like that' (personal communication, Kya Sands Resident 3, 31 May 2014), another believes 'I would benefit from having my own garden through the provision of bigger plots' (personal communication, Kya Sands Resident 4, 31 May 2014). A resident feels that 'if everyone can be with her own space, ... though they can't build us the houses but give us space where you know this is my space, I can do everything' (personal communication, Kya Sands Resident 2, 30 May 2014).

For these interviewees, the actualisation of their gardening interest hinges on acquiring more space. The outcome of reblocking in Ruimsig informal settlement, discussed in Chapter 6, shows the positive impact of creating owned and safe space (stands) for domestic gardening. However, gardens that take up limited space in densely built up parts of Kya Sands settlement show that more space, through standardised plot sizes, is not necessarily a solution to the space problem. Perhaps

residents in Kya Sands presently lack (and need to acquire) creative gardening techniques or resources needed for gardening where little space is available.

The protection and health of plants in gardens is also of concern because, at times, plants are pilfered, harmed or destroyed. A resident reported that 'you can plant and it would be for everybody. Someone can just come and pick the food. Someone can come with rubbish and throw them there. You can't fight him because ... you don't own anything' (personal communication, Kya Sands Resident 5, 31 May 2014). Another resident said 'I am bothered by people who pour dirty water on my crops' (personal communication, Kya Sands Resident 9, 31 May 2014). Since proper drainage is absent in the settlement, grey water disposed into open spaces can fall on plants. Diseases can be transmitted when for instance vegetables from such gardens are fed with contaminated grey water (Gallaher *et al.*, 2013).

Owing to the inadequacy of solid waste removal in the settlement, I observe that rodents (especially rats) are rampant and constitute a nuisance to potential and existing domestic gardens. As reported by the interviewees, these animals eat and destroy growing plants, especially vegetables, in the settlement.

While the above-mentioned obstacles hinder the full realisation of benefits (ecosystem services), they accentuate negative experiences (ecosystem disservices) from domestic gardens. The gardens' contribution to dignity in the context of deprivation is also affected. If the problems are addressed through in situ upgrading, existing material and non-material advantages from domestic gardens will be enhanced rather than obliterated when the settlement is cleared and relocated. Prospective benefits expressed by the residents can also be realised which serve as a build up to just and sustainable situations in relation to domestic gardens in the informal settlement.

Benefits from Communal gardens

Up till late 2014, there was only one communal garden in Kya Sands settlement. At present, at the time of writing in late 2015, there are two functioning gardens. The first garden started in 2007 as a project initiated by Thandanani Support Group, a collection of vulnerable children (orphans) and adults affected by HIV/AIDS living in Kya Sands and Msawawa settlements. The group, and later the garden, was

initiated through the members' need for mutual support and transport funds to attend consultations/treatment at the Witkoppen Clinic. With funding from the Methodist Church in Bryanston, 18 Kya Sands residents (16 women and 2 men) started the communal garden in Kya Sands. The garden is located on a 180 square metres land on the settlement's western edge (see figure 5.6). The support group members generally work in the garden between 8am and 2pm.



Figure 5.6. Location of Communal Gardens, Parks and Soccer Pitch in Kya Sands Settlement.
Source: Google Satellite Image, November 2015.

A woman who was part of Thandanani garden told me the members initially planted cabbage, spinach, maize and tomatoes in the open veld. The veld was later fenced in. Products from the garden were either consumed by the members or sold in Kya Sands settlement. Selling the products did not yield significant returns, as there are days 'only two people would buy, and maybe [we'll] make R12 that day' (personal communication, Kya Sands Resident 11, 06 June 2014). After the Bryanston Methodist Church leadership changed, funding from the church ceased in December

2013. Gardening could not be sustained, as the amount realised from sales was too low and membership had dropped from 18 to 7, because some members had found employment (*ibid.*). Figure 5.7 left shows the garden at the time of my fieldwork in July 2014 (see figure 5.7 left).

Early in 2015, Build the Future, a Johannesburg-based children-focussed NPO took up space around the defunct communal garden. The NPO developed a Creche facility (situated within shipping containers) which includes toilets and playground. The organisation re-started operating the garden space, growing food which at the time of writing solely contributes to the crèche's mid-day meal (see figure 5.7 right).



Figure 5.7. The communal garden in June 2014 (left) and later in June 2015 (right)
Source: Author's photographs.

The second and newer communal garden in Kya Sands started in early 2015. It was established by Judah Africa, a NPO affiliate of Judah Africa Revival Christian Ministries, an organisation that has been operating in Kya Sands since 1998. The garden (see figures 5.6 and 5.8) is located on part of adjacent land (portion 51 of Houtkoppen 193-IQ – see figure 5.1), currently leased to Judah Africa. According to the CEO, the garden is part of Judah Africa's proposed agricultural programme intended to socio-economically uplift Kya Sands residents. Presently, food from the garden goes into the NPO's weekly community kitchen where children from Kya Sands are fed (Kamp, 2015). As at the time of writing, gardening activities are mainly undertaken by the NPO's volunteers, who come from various areas in Johannesburg. Participation is also open to interested Kya Sands residents.



Figure 5.8. The Judah Africa communal garden, with Judah Africa Church and kitchen in the background.
Source: Author's Photograph, June 2015.

The two communal gardens are productive, both materially and socially. They are a means to improvement in quality of life and environmental quality in the settlement. Food grown and harvested is a provisioning ecosystem service while social transactions associated with the green spaces contribute to socio-cultural ecosystem service. As illustrated in Thandanani garden, regular meetings, working together, peer-support and mutual aspirations potentially enhanced the vulnerable group's hopes for a better life. Volunteer participation in the gardens provides an opportunity to learn, serve and socialise, which enhances social capital and dignity among participating residents.

The contribution of communal gardens to social capital has been reported in other informal settlements locally (Kornienko, 2013). Beyond sheer social capital, communal gardens (such as the ones in Kya Sands) support socio-ecological justice and empowerment in the context of deprivation (Ferris *et al*., 2001). These influence the perception of residents on gardens as a type of green infrastructure. Realising the social benefits of communal gardens, a woman who owns a domestic food garden as at the time I conducted interviews wanted to start a gardening group. She believed the group would help 'when watering the crops, when picking the weeds, the things I can't do by myself' but acknowledges that 'people expect to get paid, but I don't have money' (personal communication, Kya Sands Resident 9, 06 June 2014).

5.5.2 'Park' initiatives in Kya Sands Settlement

Given that Kya Sands is not upgraded, regularised or formalised, and given that open spaces and parks are not considered interim basic services, it is not surprising that there is no municipal provision of parks in Kya Sands. The closest municipally provided park is at Randburg, some 13 kilometres away by car. Responding to the absence of this amenity, residents developed vegetated outdoor spaces, which I refer to as 'parks', although they are not what is obtainable in the conventional and formal sense of parks. Locations of the identified informal parks, numbered 1 to 5, are shown in figure 5.6. Their pictures are shown in figure 5.9.

An individual resident usually spearheads each park's development. S/he is assisted in the physical construction by household members, friends and interested residents. I observed that the parks are generally constructed from recycled materials - waste products such as old vehicle tyres, tree trunks and timber off-cuts. They consist of basic components such as trees, shrubs, flowers, sitting area/seats and play equipment. From the interviews, I realised that self-help attempts to develop parks have been derailed, because planting took place in winter — meaning that plants did not get enough rain water — and because of improper waste disposal — people disposing contaminated grey water and solid waste on plants and vandalism. A young man who, together with friends tried, but failed to develop a park said 'maybe we would benefit if the park successfully went on. We only tried creating it. Half-way there, things started getting destroyed, like the plants and tyres: before two months, everything was destroyed' (personal communication, Kya Sands Resident 3, 31 May 2014).

Kya Sands 'parks' are generally used for recreational purposes, contributing to socio-cultural ecosystem services in the settlement. Men gather to relax and drink in the parks on weekends, thus serving as an alternative to indoor shebeens. A resident remarked that 'a lot of people go there,... they relax, enjoy themselves and watch soccer sometimes' (personal communication, Kya Sands Resident 4, 31 May 2014). The residents desire proper parks, especially those that can support sporting activities. Capturing this desire, an interviewee 'would like to see the open spaces being developed into proper parks, with the right infrastructure where kids can play and all' (personal communication, Kya Sands Resident 4, 31 May 2014). Such

proper parks can ‘make the youth not to do bad things [... and] maybe have groups meet there’ (personal communication, Kya Sands Resident 8, 06 June 2014).

Johannesburg City Parks and Zoo (JCPZ), the municipal entity responsible for green open spaces and parks under the City of Johannesburg, does not contribute to these self-constructed green spaces. I knew about this through different interviews with officials from JCPZ and Food and Trees for Africa (a NGO) in late 2014. The leadership of Kya Sand settlement wrote to JCPZ in March 2013 seeking its assistance with the development of green spaces. A reply was received through a meeting held with the leadership and ward councillor in December 2013. I was told by one of the community leaders that JCPZ ‘said they cannot do anything here... they can only help with, for example, if there is a tree on the road. They can come to cut it’; the reason given was that Kya Sand is not a formal settlement (personal communication, Kya Sands Community Leader, 31 May 2014).

NGOs also do not support these informal parks because of the government prevailing policy which cast a cloud of precariousness and uncertainty on the situation in the informal settlement. Conditions attached to funding received by NGOs may not support working in such context. According to the Trees for Homes Manager at the environmental NGO Food and Trees for Africa, his organisation ‘do not do [work] in informal settlements ... because maybe the government can just come and tear off [clear] the settlement ... even if we get calls [from informal settlements] we won’t be able to go and plant trees’ (personal communication, F&FTA Officer, 12 November 2014).



Figure 5.9. Informal parks in Kya Sand Settlement.
Source: Author's Photographs, May/June2014.

Access to these small parks is in some cases restricted. In certain instances, access is denied to certain groups of people. For example, Limpopo mini-park does not admit women (see figure 5.10). Park 5 (below left in figure 5.9) is being developed by an entrepreneurial resident who propose to charge users. The fixtures in some of these parks do not make them child-friendly spaces. Park 4 (top right figure 5.9) is fenced with exposed barbed wires which is not safe for children.

Although they contribute to environmental sustainability, these parks clearly include exclusionary situations and tendencies which can be linked to the socio-economic setting in the settlement. For example, using parks for income generation is born out of a need to recover cost or as a livelihood strategy. Any child-friendly fixture in a park would cost something that the poor and under-resourced resident cannot afford. That there is vandalism might warrant the need for barbed wire which is not safe for children. Given the socio-economic setting therefore, one may not expect too much around inclusion and socio-ecological justice from these self-help initiatives at the local level.

That no substantive green space intervention is made or existing self-help efforts supported by the municipality or NGOs, excludes the residents from benefits (ecosystem services) associated with formal green spaces. 'Informal' labelling of the settlement in planning in terms of Johannesburg City Parks and Zoo and NGOs is not only exclusionary but problematic. It perpetuates historical disadvantage and makes existing injustices fester. Spatial and environmental justice in the city cannot be achieved with municipal and NGOs not playing appropriate intervention roles on green infrastructure in the informal settlement.

These situations highlight the place of justice considerations on green infrastructure in informal settlement interventions right from the grassroots to metropolitan level. The justice questions cut across actors from local community through NGOs to the municipality. Poverty and deprivation in local communities, funding conditions to NGOs, expenditure constraints at the municipal level, problematising informal settlements in government policies and programs are related to different forms and levels of injustices. Complexities at various levels call for conscious cross-scale justice considerations in contexts that contribute to environmental sustainability.



Figure 5.10. Signage at the Limpopo Mini-park in Kya Sands Settlement
Source: Author's Photograph, June 2014.

5.5.3 The soccer pitch as a green space

There is an open space in Section E that is used in the evenings and on weekends mainly by young men for football activities (See figure 5.11). Like most soccer pitches in informal settlements, this open space is not vegetated. Any grass seeding

there cannot grow because it is trampled on by the sportsmen and spectators. It is a notable recreational open space that contributes a socio-cultural ecosystem service. As a valuable space that facilitates community cohesion, it has not been encroached upon as the settlement expanded. Different categories of people (men and women, young and old) freely gather around the pitch to watch and take part in sporting activities, mostly on Saturdays and Sundays (see figure 5.11). The soccer field, though presently environmentally unattractive, is an inclusive space that enhances the quality of life of the residents. If vegetated, it can contribute to environmental sustainability.



Figure 5.11. Soccer game underway on the pitch in Kya Sands settlement
Source: Author's Photograph, Sunday 25 May 2014.

5.5.4 Compromised contribution of the North Riding stream and riparian space to ecosystem services

Natural ecosystems that are related to hydrological systems — wetlands, streams/rivers and riparian corridors are critical to urban green infrastructure. The North Riding stream, its wetland and riparian corridor are the hydrological components of green infrastructure in Kya Sands, serving as a source of ecosystem services and ecosystem disservices in the informal settlement.

The North Riding stream is a source of provisioning ecosystem service. The stream was a source of water in the early years of Kya Sands settlement. Speaking of the late 1980s, one of the first residents said 'the river was smaller; even though the water would be dirty, we were still able to wash our clothes and bath ourselves with water collected there, unlike now when it is polluted'(personal communication, Kya

Sands Resident 6, May 2014). Change in the size of the stream, in terms of higher flow, is likely to be the result of upstream development that led to reduced opportunities for water seepage into the soil (meaning increased run-off) in the settlement.

At the time of my field work, some residents still used the stream to complement water supply accessed via communal standpipes. I observed that water from the stream is used to prepare mortar and concrete during shack construction, although polluted water from the stream can weaken the mortar and concrete. Only one of all the residents I interviewed used water from the stream for irrigation. This occurred when there was no water from the tap. He said 'we just scoop some with a bucket to water a few of our plants' (personal communication, Kya Sands Resident 7, 06 June 2014). However, some of the residents I interviewed were wary of the quality of water from the stream, believing it is not safe for irrigating food crops. Laundry and other washing activities take place in the stream. One the days I visited the settlement, I met a group of residents washing empty paint containers in the stream (see figure 5.12). Paints washed off, which might not be biodegradable, and pollute the stream. I return to the problem of pollution below, as the stream is also polluted through sources that are extraneous to Kya Sands settlement.



Figure 5.12. Residents washing recently emptied paint containers in the North Riding stream next to a dumping area
Source: Author's Photograph, November 2014

Apart from water, the residents derive other types of provisioning ecosystem service from the stream. Early occupants harvested reeds from the wetlands to roof the traditional huts they lived in. The traditional structures were not durable so none still exists (personal communication, Kya Sands Resident 6, May 2014). Through one of the transect walks in the settlement, I found out that sand (fine aggregate) used to prepare mortar is excavated from the streambed. Sand from the streambed supports the currently high rate of brick-and-mortar building activity (shack consolidation) in the settlement. As shown later, bricks used are salvaged from construction rubble dumped in the settlement.

The stream supplements the existing sanitation system – making up for the locational disadvantages of toilets and absence of proper drainage. The riparian corridor is used as location for excretion and urination by some residents, especially those living close by. Such residents live in shacks/stands without a toilet or any nearby. Used sanitary items such as toilet paper (or its common substitute, newspaper), nappies/diapers, menstrual napkins/pads as well as human excrement are disposed directly into the stream. Grey water is also emptied into the stream. One of the residents admitted that 'we use it [the stream] like, as everything; as you can see, it is used as the dumping area, like a dust bin and as a drain' (personal communication, Kya Sands Resident 3, 31 May 2014).

Construction and gardening companies regularly dump waste materials such as sawn tree trunks and rubble in the riparian corridor and wetland (See figure 5.15). Although this is disconcerting from an ecological view, some residents have an informal arrangement with the companies to dump for free or amounts much lower than should have been paid at official dump sites because materials can be salvaged (Kamp, 2015). The police are aware of it but are not halting dumping because of the material benefits involved (personal communication, Kya Sands Community leader, September 2015). Residents salvage timber from the dump site and use it as fuel for cooking and heating. Entrepreneurial individuals salvage bricks from rubble dumps, clean these of cement and sell them for construction of shacks in the settlement. A resident involved in this business told me a stack of 1000 cleaned bricks sells for 1000 Rands (personal communication, Kya Sands resident 13, September 17, 2015). Salvaging and re-use of bricks of course is a sustainable practice, but the process in

Kya Sands has gradually encroached upon the wetland and riparian corridor, limiting their functioning as green infrastructure. Dumping destroys ecological functioning of the wetland.

The riparian corridor was and is still regarded useful for various reasons. Speaking of the time they first occupied Kya Sands, one of the initial residents said 'we would chop down the trees and use the wood to build our structures. There was wildlife. We would hear them roar, but they never bothered us' (personal communication, Kya Sands Resident 5, 31 May 2014). Although wildlife (non-domesticated animal species) has presently disappeared in the riparian corridor, their benignity in the early days is noteworthy. I was also told that a religious group (Zion Christian Church) used to congregate in an open space by the riparian corridor. The group fetched water from the stream, prayed on it and administered it, believing it brings cleansing and healing (*ibid.*).The polluted stream and dumping in the riparian corridor cannot support these activities; hence the group no longer meets there.

Kya Sands residents generally appreciate trees present in the riparian corridor. Since the trees provide shade in summer, 'people go and sit in these spaces and enjoy themselves', a young man said (personal communication, Kya Sands Resident 4, 31 May 2014). Another resident commented that 'I sometimes go there to relax and listen to birds chirp. The things I like there are the rocks on the river bank, where I normally relax: it's cool and quiet' (personal communication, Kya Sands Resident 10, 31 June 2014). The riparian space also serves as a play area for children, although it is not safe because of the stream's polluted condition and collapsed bank (see figure 5.13). To improve the recreational capacity, some of the interviewees want the stream cleaned, properly vegetated and the wetland rehabilitated. A resident said 'I would like them to clean the river, and ensure it is not polluted' (personal communication, Kya Sands Resident 4, 31 May 2014).



Figure 5.13. Children playing in the North Riding Stream while a resident collects water
Source: Author's Photograph, May 2014.



Figure 5.14. Dumping waste in the riparian corridor and wetland in Kya Sands settlement
Source: Author's Photographs, May 2014.

Various activities in and around the North Riding stream have polluted it. Pollutants enter the stream at Kya Sands settlement as well as upstream - from the adjoining Kya Sand industrial area. One of the community leaders told me factories in the industrial zone discharge noticeably coloured effluent into the stream (personal communication, Kya Sands community leader, June 2014). The residents I interviewed also made mention of burst sewers around the industrial area, which meant sewerage finds its way into the stream. Laboratory tests show that the stream's E. coli and ammonia levels and pH index are all unacceptable for human use – in terms of drinking or even contact with skin (personal communication, CoJ Environment and Infrastructure Department's Officer, 19 September 2014). This was not surprising given the conditions evident to any observer of the stream.

Pollution decimates the stream's capacity to supply ecosystem services in and beyond the settlement. For instance, environmental officers working the Jukskei Klein sub-catchment (which the North Riding stream is part of) corridor showed me an edible fish caught a few kilometres upstream around Malibongwe drive. Beneficial ecosystem goods from the stream, such as this fish, are absent in Kya Sands settlement or anywhere downstream because the waterbody is already polluted.



Figure 5.16. An edible fish caught upstream (in an unpolluted portion) by environmental workers in the North Riding watercourse -Klein Jukskei sub-catchment.
Source: Godfrey (EPWP Supervisor), June 2014.

Nuisances associated with the North Riding stream and solutions to them

As can be expected given the diverse means of interacting with the stream, the residents experience problems and associate certain negative perceptions — ecosystem disservices with the stream. The disservices are illustrated through the stream's polluted condition. The residents even acknowledge that 'one thing which brings a disadvantage is the river, according to me because there are lots of bacteria and diseases in the river' (personal communication, Kya Sands Resident 3, 31 May 2014) and 'whoever touches the water, whoever uses the water is in harm's way or is in danger of anything' (personal communication, Kya Sands Resident 1, 30 May 2014). 'When it's hot or it's at night a horrible smell comes from the stream' is a case in point presented by a man living close to the stream (personal communication, Kya Sands Resident 4, 31 May 2014).

Residents living near the stream complained about mosquitoes from the stream and wetland in summer. Although no interviewee reported any specific illness or infection through mosquitoes, their sound is a nuisance while even a benign sting can lead to disgusting feelings. Through the transect walks, I observed that house flies also breed by the stream because of domestic waste dumped there. This poses a health risk to the residents.

Many of the interviewees associate the riparian corridor with night-time fear of miscreants. It was reported that people with malicious intent (locally referred to as 'tsotsis') can hibernate in this area and from there launch attacks on residents crossing the stream, particularly on winter evenings when few people are outdoors. Because of these fears, a resident suggested 'the solution is to burn these trees, those bushes there, so people can walk' freely anytime in the day (personal communication, Kya Sands Resident 2, 30 May 2014). Some trees had already been cut down because they 'block[ed] the light from the street light' (personal communication, Kya Sands Resident 7, 06 May 2014).

During the summer season, the stream poses a threat of flooding in the settlement. According to the interviewees, flooding hinders movement between sections located east of the North Riding stream and those located west of the stream. Flooding resulted in damage to shacks in December 2010 (CoJ, 2011) and death of a drunken resident who attempted crossing the flooded stream in 2011 (Weakley, 2013). It

appears these were the last flooding incidents where serious damage and loss were recorded. Nevertheless, given the absence of a formal bridge, some residents are still scared to cross the river when the water level rises after rainfall.

In the course of desktop search, I came across documents showing that the municipality planned to build a formal bridge across the stream in Kya Sands settlement (GeoZone Geoservices, 2013; Nemai Consulting, 2014). Judah Africa's CEO, in one of the community meetings during the international workshop in September 2015, explained that the promise and plan for the bridge dates back to around 2008. The CEO alleges that funds were diverted in the municipality, leading to the delay (author's notes of community meeting, Thursday September 24, 2015). Delay in erecting a formal bridge implies perpetuation of environmental burdens borne by the residents, and is therefore a manifestation of socio-ecological injustice. As shown below, through the municipality's inaction the residents who have little if any income have to pay for a temporary solution in order to cross the stream.

Although there are a number of routes without bridges across the stream, to make up for the absence of a formal bridge a group of residents (mostly young men) built a tolled makeshift bridge across the stream (figure 5.17). Anyone crossing the stream via the bridge is charged R2, hence it is not freely accessible to all residents. During a transect walk I observed that the bridge operators are not so hard-nosed, which indicates a discretionary sense of justice — when it is fair to charge and when it is not. I also observed that the bridge operators exempt their friends and acquaintances, small children or people who need to cross in cases of emergency. That the residents are charged and pay to use the bridge was one reason why I conducted a willingness to pay survey in the settlement. The survey, as reported towards the end of this chapter, ascertained the residents' willingness to pay for green spaces that enhance ecosystem services in the settlement.



Figure 5.17. Pedestrian bridge where a toll is charged in Kya Sands settlement. The toll collector is lying under a tree-shade on the right side of the stream.
Source: Author's Photograph, May 2014.

The functioning of the North Riding stream as a source of ecosystem services is compromised due to pollution from sources within and outside the settlement. As a result, the stream is associated with various ecosystem disservices. Ecosystem services and ecosystem disservices in this situation are not clear-cut when viewed from different angles (e. g., resident's viewpoint versus ecological perspective) or when considered in terms of circumstances outside of the control of the residents. This makes straight-forward inference impossible with respect to implications for justice. Alongside situations from the other two case study areas, I discuss this complexity in chapter eight.

5.5.5 Maintaining the North Riding stream watercourse

As part of the *Expanded Public Works Programme's (EPWP) projects in the City of Johannesburg, the r*iparian corridor of the North Riding stream – from Malibongwe drive to Msawawa informal settlement – was cleaned in an eight-month project from March to October 2014. This was awarded (through a tendering process) to a contractor who, in line with the rules, hired residents of the beneficiary community(ies). In this case, the EPWP workers who cleaned the stream's catchment were drawn from Kya Sands settlement and Msawawa which is located two and a half kilometres from Kya Sands. Environmental officer in the CoJ explained that 'we've got people working from the community because what we [the

municipality] look at also in terms of EPWP is trying to alleviate poverty within the informal settlements (personal communication, CoJ Environment and Infrastructure Department's Officer, 19 September 2014). She hopes 'because people work there they [will] take responsibility more' (*ibid*.).

During one of my field work days in Kya Sands, I met the EPWP workers on duty (see figure 5.17). To the workers, keeping the stream and its riparian corridor clean is a big challenge because of improper waste disposal in Kya Sands settlement. Their leader said 'even yesterday the inspector came to inspect and found that we have cleaned that river over there and then they dumped rubbish into it again, then it was like we haven't done anything' (personal communication, EPWP Supervisor, 06 June 2014).

Given that waste disposal issues are closely associated with sustained cleanliness in the stream and the riparian edge/strip, one is left asking why the budget is spent on cleaning the stream without improved solid waste collection and holistic intervention in the concerned settlements. There is clearly lack of coordination between different actors involved in these issues. Stream cleaning, through EPWP, is primarily for job creation/poverty alleviation and driven by CoJ's Department for Environment and Infrastructure. It is also a nationally-funded project meant to take place within a limited time frame. Waste disposal and management, handled by CoJ's Pikitup, is only an interim service with limited coverage in informal settlements. Lack of coordination between funding mechanisms, organisational mandate and time frames therefore make the realisation of benefits from holistic intervention in the North Riding stream and riparian corridor impossible.



Figure 5.18. EPWP workers cleaning the Northriding stream in Kya Sands settlement.
Source: Author's Photographs, June 2014.

5.6 GREEN INFRASTRUCTURE'S CONTRIBUTION TO ECOSYSTEM SERVICES AND DISSERVICES IN KYA SANDS SETTLEMENT

Having discussed the types of green infrastructure in Kya Sands settlement, this section brings together their contribution to ecosystem services and ecosystem disservices. Table 5.1 is an attempt to summarise the interplay between ecosystem services and ecosystem disservices in this context of informality, poverty and deprivation.

As natural ecosystems, components of green infrastructure in the settlement can contribute to socio-economic development. Speaking along this line, a young unemployed male resident said 'the first thing people are looking at is the fact that they need jobs. The only way to get a job is if these places, the same ecosystem that we have — people work in there' (personal communication, Kya Sands Resident 1, 30 May 2014). Components of green infrastructure in the settlement also contribute to environmental sustainability. They provide an ecological framework for the health of the natural environment and conservation of natural resources. But not all the contexts are just. Some are exclusionary through cost measures, gender discrimination or unsafe contents, although real resource limitations within the settlement make this relatively understandable. These contexts represent self-help, small-scale initiatives by under-resourced residents at tackling existing deprivation and exclusion from the formal urban 'economy'. These initiatives are against an unjust backdrop of socio-economic and spatial inequality which led to the formation of the informal settlement in this location in the first place.

This situation implies an imbalance: contexts that support improved environmental quality only facilitate improved quality of life for some (not all) residents. The situation in Kya Sands represents an inherent mismatch between the ideals of justice and sustainability, highlighting complexities in the interplay between aspects of just sustainability.

Table 5.1 Ecosystem services and ecosystem disservices associated with components of green infrastructure in Kya Sands settlement. PS refers to Provisioning Service; RS - Regulatory Service; SS – Supporting Service and SC - Socio-cultural service

Source(s)	**Ecosystem service and Description**	**Ecosystem disservice and Description**
The North Riding stream	- Water (PS): Used for washing/laundry, garden irrigation, shack construction (preparing mortar - Sand (PS): Excavated from the streambed and used to prepare mortar for shack construction - Wetland contributes to water treatment and runoff control (RS): but this capacity is presently decimated through dumping. - Stream used as recreational space	- Foul smell: At night and in hot afternoons - Flooding: Results in damage to dwellings and properties - Fear of drowning: When stream's water level rises - Health risk from contact with polluted water in the stream
Riparian Corridor	- Micro-climate (temperature) control (RS): Trees reduce ambient air temperature - Space for religious meetings and relaxation (SC) - Timber (PS): harvested from trees within and around the settlement and used for fuel and construction	- Fear that vegetated patches serve as their hiding place for miscreants - Trees block illumination from high mast lighting
Domestic Gardens	- Food (PS): contribution to household food requirements and income - Temperature regulation (RS): Tree-shading cools the air during summer - Wind control (RS): Trees protect the roof of shacks - Aesthetics (SC): Sense of beauty and fragrance from plants	- Breeding space for mosquitoes - Falling tree leaves require regular maintenance - Plants attract rodents to stands
Communal Garden	- Food (PS): Consumed by garden members and sold to raise money - Social cohesion (SC): Communality strengthens social capital and resilience among vulnerable groups	- Plants attract rodents
'Parks'	- Recreational space and space for creative expression(SC) - Temperature regulation (RS) - Tree-shading cools the air during summer	

Source: Author's Construction based of field survey

In order to enhance ecosystem services and minimise ecosystem disservices experienced, some of the residents I interviewed wish to have properly developed green open spaces, especially parks and space for gardening and a proper bridge across the stream. They also want the river cleaned, the wetland rehabilitated and riparian corridor appropriately vegetated. While there are certainly those interested in maintaining the status quo, i.e., the informal bridge and the dumping arrangement, the residents have over the years engaged the state (through the ward councillor, ward committee meetings, protests etc.) on these aspirations. They have expressed frustrations about not being heard, answered or appropriate action taken through these fora, although I cannot explain the reasons for the state's inaction and prevarications. The reasons would definitely not be simple, given the multifarious interests tied to the current situation in the settlement.

5.7 DEVELOPING GREEN INFRASTRUCTURE IN KYA SANDS SETTLEMENT: WHO IS WILLING TO PAY AND FOR HOW MUCH?

The complex situation in Kya Sands: interests that want to maintain the status quo and that the state is not considering *in situ* upgrading – in line with UISP, cast up questions around a development route and financing for the desired green infrastructure. How can the settlement move beyond an unsafe situation whereby children play in the polluted stream, insufficient spaces such as the self-help parks or something inadequate such as the informal bridge which cannot serve the community in the context of a flood? Are the residents willing to pay if the relevant and desired green spaces are developed by non-municipal sources? The next sections report on Kya Sands residents' willingness to pay for green spaces developed through municipal as well as non-municipal routes.

5.7.1 Rationale for Willingness to Pay (WTP) survey on green infrastructure in a South African Informal Settlement

There is palpable absence of proper services and amenities in Kya Sands settlement, including green spaces. Individuals in the community have recognised livelihood opportunities in the provision of certain green infrastructure services, notably the tolled bridge (see figure 5.18 above) and user-charged small park initiatives (see figure 5.9 above). NGOs, with available external donor funding, are also providing green infrastructure through the two small communal gardens they presently drive.

Seeing the entrepreneurial inclinations and trends, it appears a user-paying model exists in the settlement. The user-pay mechanism for cost recovery by individual residents currently seems to be the only financially sustainable model in the community and thus provides a direction that might be considered for future improvements. It is therefore relevant to interrogate this model in more detail, in particular its acceptability in the community.

Since one cannot assume that a recommendation to the municipality to build a park in Kya Sands would lead to such an action, it makes sense to test the extent to which residents can themselves contribute to turning the situation around. Understanding the acceptability and responses among Kya Sands residents to the entrepreneurial user-pay model in terms of green space development will show the value of corresponding ecosystem services, which also contributes to the broader debate on informal settlement intervention. In line with Kobel and Mistro (2012), it is expedient to objectively assess a potential amenity delivery model that links equity considerations to cost recovery. That is, can sustainable financing for amenity development in the course of informal settlement intervention be achieved through users themselves, especially the poor who live in an informal settlement like Kya Sands? An answer to this question would need to be examined with regard to justice for the historically disadvantaged and in the light of constitutionally enshrined rights and responsibilities that include advancement of environmental sustainability.

5.7.2 Demographic and socio-economic characteristics of the survey respondents

Before presenting the residents' willingness to pay for green infrastructure, I provide an overview of the respondents through information on their demographic and socio-economic profile in this section (see Table 5.2). As stated earlier in the methods chapter (4), 188 completed questionnaires of the 200 equally distributed across the five sections in Kya Sands were analysed.102 (54.26%) respondents were male, while 86 (44.68%) were female. Seventy-nine (42.02%) respondents were aged between 35 and 49 years. Only 4 (2.13%) respondents were under 18 years old while none was older than 65 years. The greatest percentage of the respondents (48.40%) did not complete high school while 2.66% had undergraduate level university education. Over 67% of the respondents had a household size of between 2 and 4.

Forty-nine (26.06%) respondents had lived in Kya Sands settlement for over 10 years, fifty-seven (30.32%) for more than five years, fifty-seven (30.32%) between one and five years while only four (2.13%) had lived there for under 3 months. This means over half of the respondents had lived in Kya Sands for more than five years.

Information on monthly household income shows that 71 respondents (37.77%) received between R1500 and R3500 while 22 (11.70%) earned between R3500 and R9000 monthly. Only 2 respondents (1.27%) received more than R9000 a month (see Figure 5.19). Going by the monthly household income requirement to receive a state-subsidized RDP house in the to-be-developed Lion Park Township, at least 12.97 percent of the respondents do not qualify. The proportion of non-qualifiers would be greater if factors such as nationality and dependants in households are considered. This shows part of the proportion that will be excluded should the proposed relocation to a new township developed with fully subsidised low-income houses go ahead. If Kya Sands is to be demolished in this process, a significant portion of residents would be left homeless.

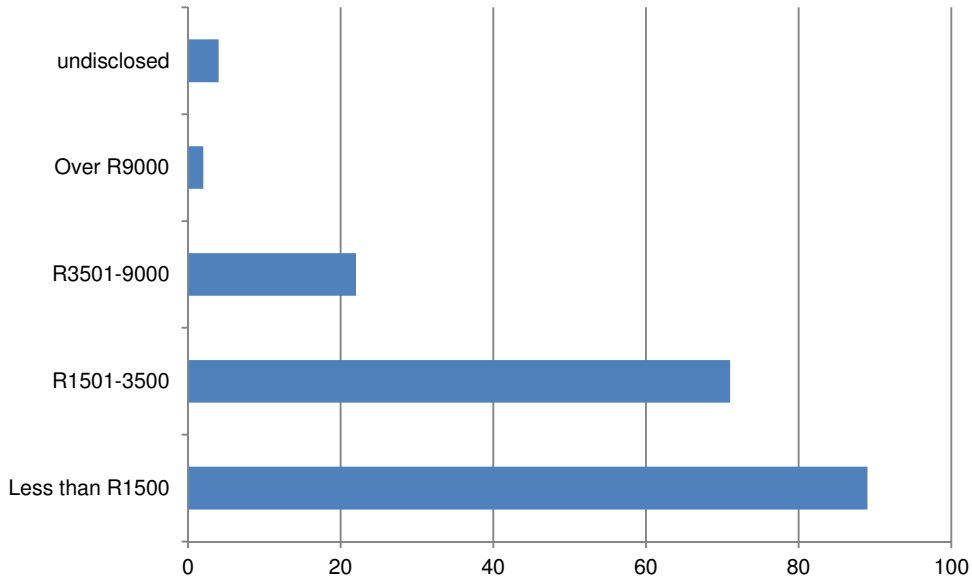


Figure 5.19. Bar chart of Respondents' monthly income

Table 5.2. Demographic and socio-economic characteristics of survey respondents

Item	Variables	N	%
Gender	Male	102	54.26
	Female	84	44.68
	Undisclosed	2	1.06
Age	Less than 18 yrs.	4	2.13
	18 - 24 yrs.	53	28.19
	25 – 34 yrs.	79	42.02
	35 – 49 yrs.	48	25.53
	50 – 65 yrs.	3	1.60
	Over 65 yrs.	0	0.00
	Undisclosed	1	0.53
Marital Status	Single	109	57.98
	Married	56	29.70
	Co-habiting	15	7.98
	Divorced	5	2.66
	Undisclosed	3	1.60
Household Size	1	32	17.02
	2-4	127	67.55
	More than 4	29	15.43
Educational level	Primary	31	16.49
	High School (didn't matriculate)	91	48.40
	High School (matriculated)	50	26.60
	College	6	3.19
	University/Technikon(undergraduate)	5	2.66
	Post-graduate	0	0
	Undisclosed	5	2.66
Length of residency in Kya Sands	Less than 3 months	4	2.13
	3 – 12 months	18	9.57
	Between 1 and 5 yrs.	57	30.32
	Between 5 and 10 yrs.	57	30.32
	Over 10 yrs.	49	26.06
	Undisclosed	3	1.60
	Total	**188**	**100**

5.7.3 Willingness to pay for green infrastructure survey results

This survey investigates the number of residents who were willing to pay for green infrastructure through a range of developers – an entrepreneurial resident, NGO or the state through the municipality (see Table 5.3 and figure 5.20). Through the survey, I found that 157 persons (83.51% of respondents) were willing to pay if

these spaces are developed by an entrepreneurial individual/resident, while 31(16.48%) were not willing to pay. 139 respondents (73.93%) were willing to pay if such spaces are developed by an NGO, while 49 (26.06%) were not willing to pay. 79 respondents (42.02%) were willing to pay if such are developed by the municipality, while 109 (57.98%) were not willing to pay.

Some respondents, in the course of stating their willingness and unwillingness to pay for green space development by the municipality, made short supporting statements which were noted to capture their reasons. Those unwilling to pay if green infrastructure was developed by the municipality said 'government has money', 'the government must provide for/help the people', 'other communities get it for free', 'they make us pay tax', 'I cannot pay for government services'. Respondents in this category also said 'I will help with labour', 'physical help only'; 'I'm not employed'. Those willing to pay if identified green spaces were developed by the municipality said 'government needs our support'; 'we need to help each other to achieve in the community'; 'It supports the community'.

Table 5.3 Residents' willingness to pay for green space development

	Entrepreneurial Resident	%	NGO	%	Government/ Municipality	%
Yes	157	83.51	139	73.93	79	42.02
No	31	16.48	49	26.06	109	57.98
Total	188	100	188	100	188	100

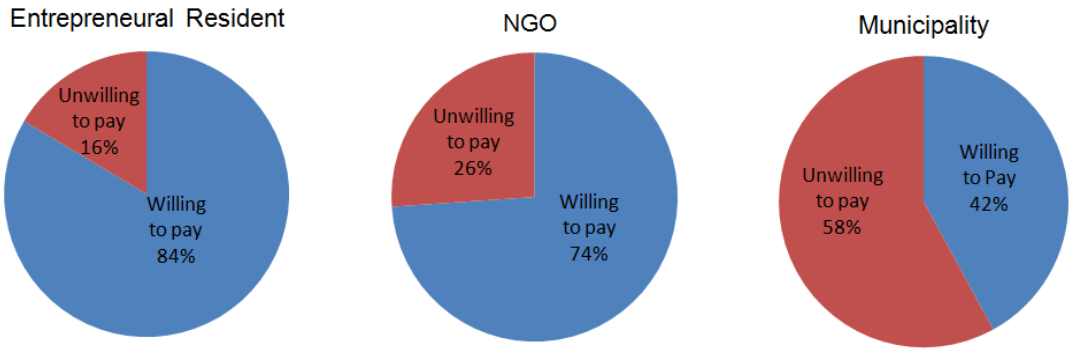


Figure 5.20. Pie chart showing residents' un/willingness to pay for green spaces

The questionnaire covered four types of green space projects, namely communal gardens (allotment), riparian corridor rehabilitation and maintenance, a community park and children's park. These spaces are relevant in terms of intervention in the

informal settlement's present condition. This survey investigated how much a resident is willing to pay per month for these spaces when developed by the developers identified earlier. Figures 5.21 to 5.24 show that the highest number and percentage of the respondents were willing to pay between R1 and R20 a month to use the green spaces (also see Table in Appendix 6). Of those willing to pay across the four green space types, it is significant to note that the highest — 94 persons (50%) were specifically willing to pay for use of the children's park (see Figure 5.24). One person is willing to pay over R500 per month for the children's park. This suggests that children's park is the green space with highest use value among residents in the settlement.

As shown in figure 5.22, a community garden with individual lots rentable to residents commands the least use value. Figure 5.21 to 5.24 shows that only 80 persons, as against 87 for the stream rehabilitation, 88 for the community park and 94 for children's park are willing to pay between R1 and R20 per month if developed by entrepreneurial resident(s) in the settlement. The same level of preference is obtainable if the garden is to be developed and operated by an NGO or the municipality. This least value placed on gardens resonates with earlier findings. From the semi-structured interviews in the settlement, I deduced that the residents prefer to garden in private and safe spaces.

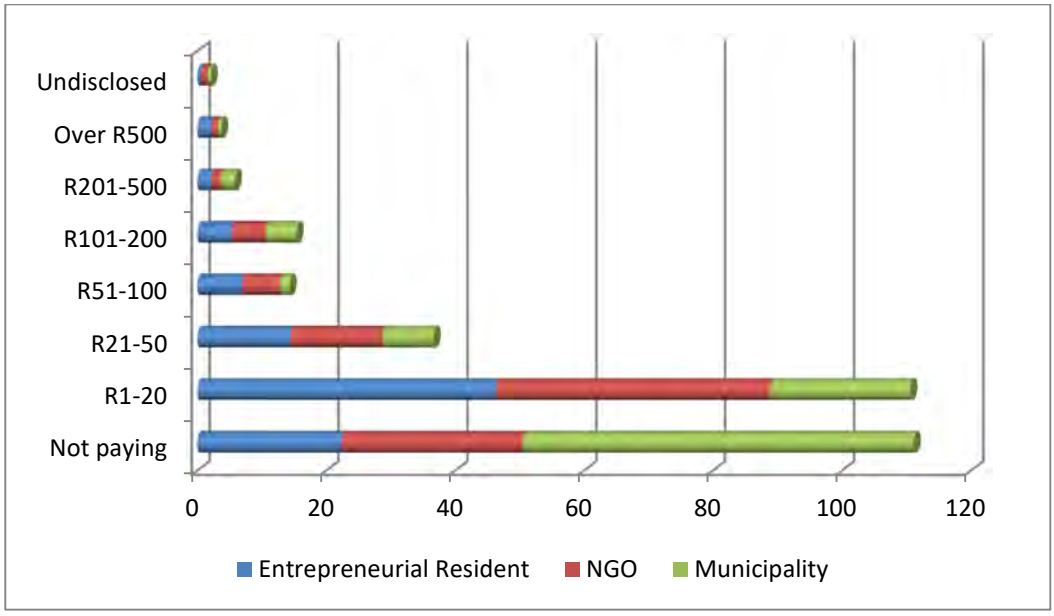


Figure 5.21 Percentage of respondents willing to pay (and amount) for Stream rehabilitation and maintenance

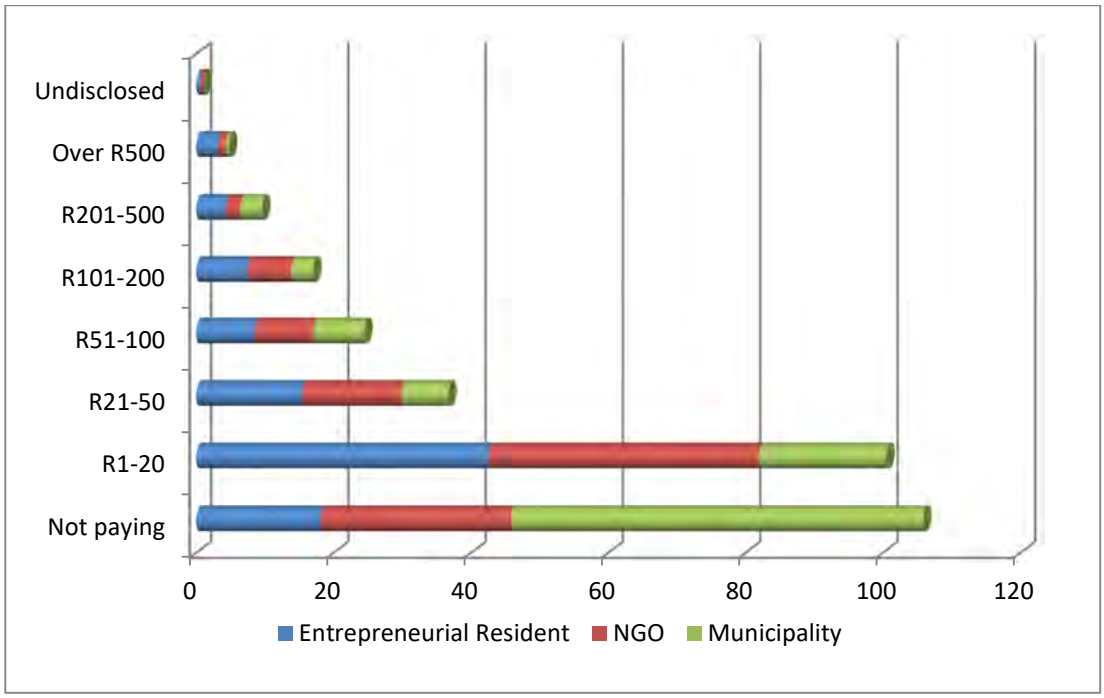


Figure 5.22 Percentage of respondents willing to pay (and amount) for communal (allotment) garden.

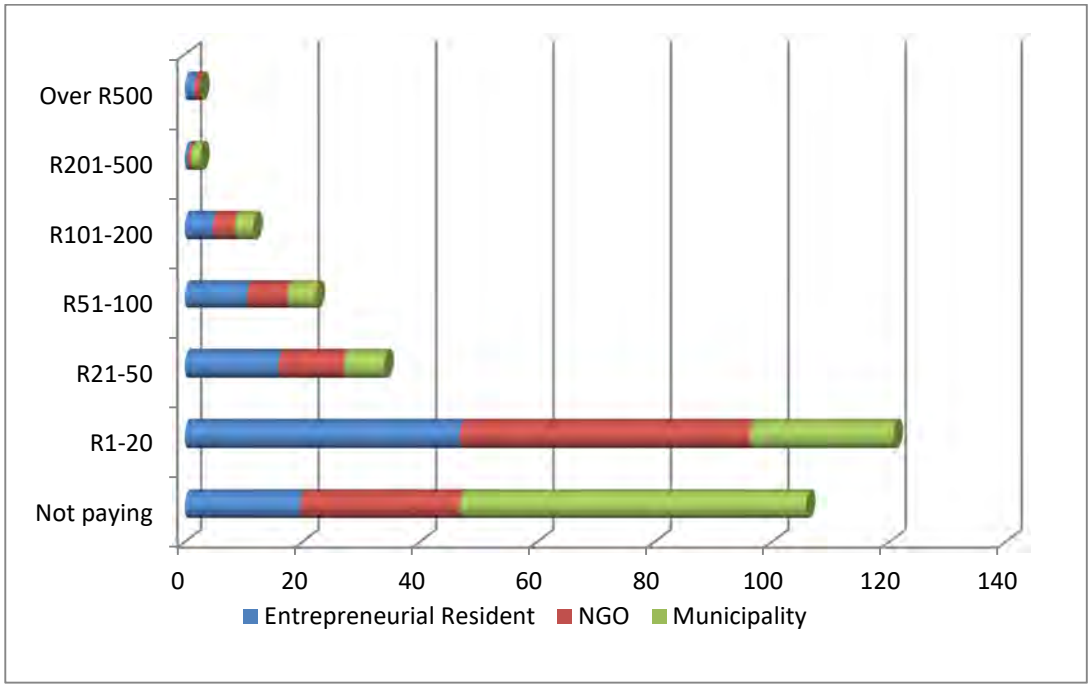


Figure 5.23 Percentage of respondents willing to pay (and amount) for a Community Park.

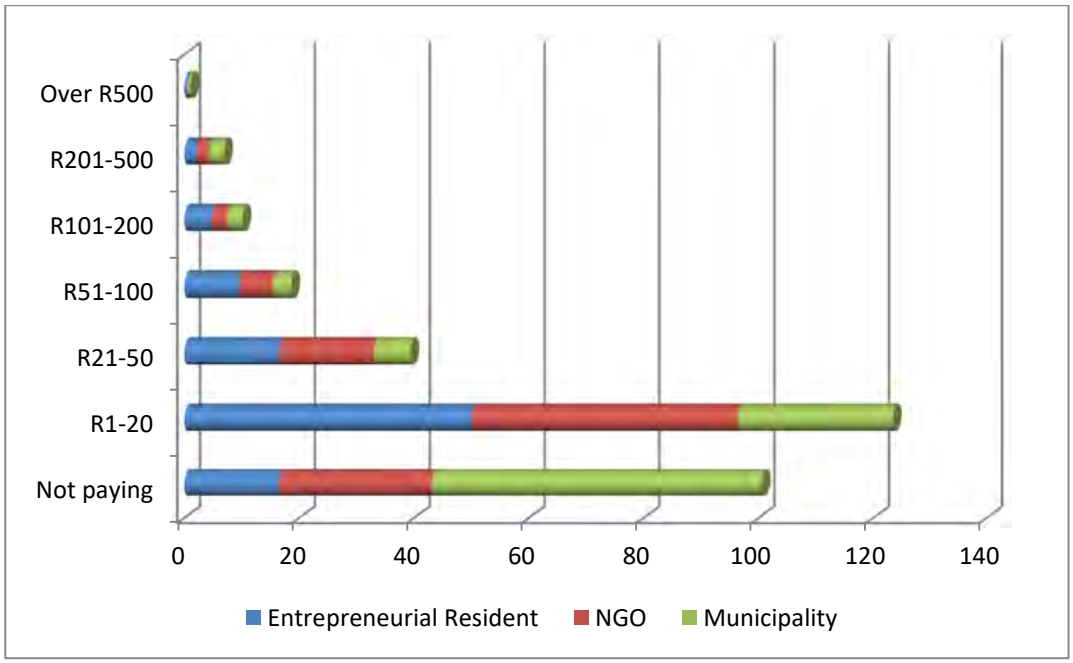


Figure 5.24 Percentage of respondents willing to pay (an amount) for a Children's Park.

The willingness to pay survey results does not provide easy answers. It suggests preference for an entrepreneurial/user-pay model within this informal and low-income context. The implications have to be placed in the context of constitutional obligations of the state, the residents' awareness of their rights in relation to these, as well as socio-ecological justice and sustainability. I return to discuss this in relation to just sustainability later in Chapter 8.

5.8 CONCLUSION

The case of Kya Sands informal settlement reveals benefits derived (ecosystem services) and problems experienced (ecosystem disservices) through different components of green infrastructure - gardens, parks, a sports field, stream, a wetland and a riparian corridor. The range of ecosystem services benefited shows that green infrastructure is useful, though presently decimated and hampered. Normal functioning of some green spaces (e.g. domestic gardens) and degradation of some natural ecosystems (e.g., the wetland) leads to ecosystem disservices.

The relationship between residents and natural ecosystem need to viewed dialletically because ecosystem services and ecosystem disservices are not that straightforward. At times, a service in one respect is a disservice in another, and at other times one ecosystem service can frustrate another. As an illustration, dumping

and salvaging bricks in the wetland results in economic benefits for a group of residents, but these destroys the wetland bringing problems that is experienced settlement-wide. A domestic garden is useful for food and/or aesthetics but the same garden provides breeding spaces for insects – a disservice that is experienced by those who own the garden and some others who are not deriving any tangible benefit from the garden. These mean that what brings benefits to one or a few persons is baneful to a few or everyone in the settlement, based on differences in interpretations and experiences. This highlights complexities of questions of justice in terms of green spaces, ecosystem services and ecosystem disservices in this context of deprivation.

Although the whole situation is not clearcut, a key issue emerging from the case of Kya Sands settlement is how to enhance and build on (not destroy or eliminate) current benefits from green infrastructure that stand out, navigating inherent intricacies. This means a great deal for the way of intervention ought to happen there because disturbing existing benefits in a context of such socio-economic and socio-ecological vulnerability has justice implications. Considering the residents' existing beneficial relationship with the natural environment and addressing detrimental aspects is key to just sustainability in the informal settlement. The remaining two cases, in the next two chapters, show how this relationship with the natural environment affected and was impacted by two types of intervention programmes in informal settlements.

CHAPTER SIX

IN SITU INFORMAL SETTLEMENT INTERVENTION AND GREEN INFRASTRUCTURE: THE CASE OF RUIMSIG SETTLEMENT

6.1 INTRODUCTION

Given the relationship that people living in informal settlements have with the natural environment as is evident in Kya Sands, I consider how *in situ* intervention affected and were impacted by this relationship through the case of Ruimsig informal settlement. Located about thirty-five kilometres from the Johannesburg CBD in the western periphery, Ruimsig settlement presents an example where reblocking (an *in situ* intervention) was carried out with contributions from a variety of actors. Hence, 'co-production' can be applied to aspects of the Ruimsig intervention project. At the time of writing in late 2015, Ruimsig was the only informal settlement where reblocking had taken place in Johannesburg. The chapter presents the processes and outcomes of *in situ* intervention in Ruimsig informal settlement, with aspects that are related to just sustainability shown. Whereas the previous chapter discussed the case of Kya Sands settlement, and contributed insights into the relationship with green infrastructure, also shedding light on aspects of just sustainability, the Ruimsig case examines the impacts of reblocking on the relationship that the residents have with the green infrastructure.

Information on Ruimsig's emergence, growth and level of service at the beginning of this chapter provides a background and sheds light on the impact of growth of the informal settlement and basic services on natural ecosystems. The chapter then describes ecosystem services and ecosystem disservices associated with green infrastructure, pointing out how intertwined these are. It then describes the actors involved, their roles, and issues that hampered reblocking, pointing to what these mean for justice as well as injustices. Having identified ecosystem services and ecosystem disservices in the settlement, the chapter discusses how reblocking changed the residents' perception of and affected practices related to green spaces. The chapter ends by exploring the conditions in two stands, which furthers understanding on how reblocking affects or did not affect domestic green spaces in the settlement.

6.2 THE EMERGENCE AND GROWTH OF RUIMSIG INFORMAL SETTLEMENT

The location of Ruimsig informal settlement in relation to the wider Johannesburg metropolitan area was shown in figure 4.1 in Chapter 4. A stone quarry lies to its far north, the up-market Ruimsig residential area (after which the settlement is named) to its west while the Roodepoort Athletic Stadium is located to its south-east. The informal settlement is adjacent the Ruimsig Golf course to the south (see figure 6.1). On the south-eastern edge, the settlement is bordered by a small wetland that is not connected to any perennially flowing water body (see figure 6.2). But the wetland is part of Johannesburg's Jukskei catchment and one of the features making up the highly bio-diverse Roodepoort ridge system (CoJ, 2008b). Proximity to a wetland presents an opportunity to examine how aspects of *in situ* intervention (through re-blocking) in the settlement affect the residents' relationship with natural ecosystems.



Figure 6.1 Map showing Ruimsig settlement and surroundings areas
Adapted from Google Satellite Image January 2016

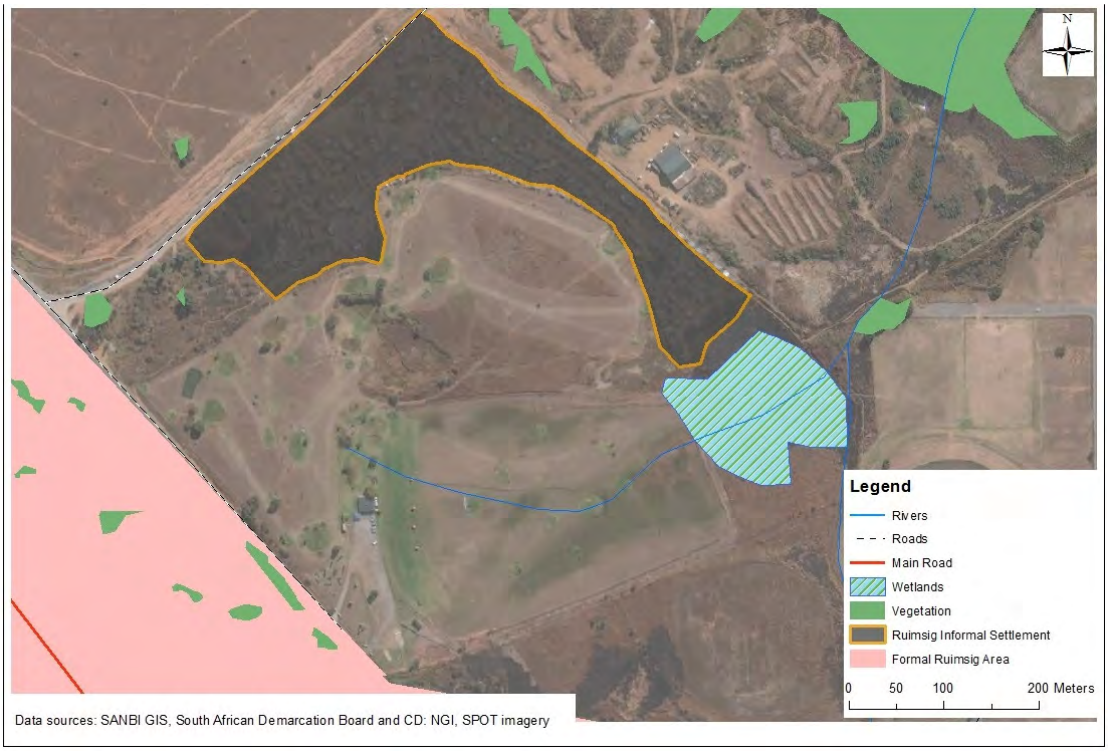


Figure 6.2. Map showing Ruimsig informal settlement and adjoining wetland
Produced by Samkelisiwe Khanyile, 2016

Ruimsig informal settlement is on municipally owned land, a 5.2 hectare property described as '121/183 – IQ private road' in the City of Johannesburg's database (CoJ, 2010a). The settlement falls under the administration of City of Johannesburg in Region C and Ward 97, although Mogale City claims the settlement belongs to her ward 23 since Ruimsig settlement sits on the judicial boundary between CoJ and Mogale City (personal communication, Ruimsig Community leader, 31 July 2014 and Former CoJ Housing Officer, 28 August 2014, also see figure 4.2 in Chapter 4). Through interaction with the residents and key informants, I realised that the settlement is divided into four sections, namely Wetland, Spaza, Shebeen and Church. These contiguous sections, shown in figure 6.3, are named after a landmark building/space in the concerned area. The Wetland section includes areas close to the wetland while the Shebeen, Spaza and Church sections cover areas around the respective landmark.

The establishment of Ruimsig informal settlement is linked to two residential facilities that provided rental accommodation for workers employed in a nearby farm in the 1980s. One of the residential facilities was known as 'Peacock house' (personal communication, Ruimsig Resident 9, 12 July 2014). Figure 6.4 shows the

locations of the two residences highlighted in yellow dotted line in the 2000 image. The municipality acquired the nearby farmland around 1998 (CoJ, 2010b) which was rezoned from peri-urban agricultural to residential and recreational use, probably before or after parts of it was sold. The Roodepoort Athletics Stadium, Ruimsig Country Golf course and up-market Ruimsig residential area were later developed on the rezoned land. The two residential facilities that earlier accommodated farm workers later housed construction workers during development of the stadium and up-market residences (personal communication, Ruimsig Community leader, 31 July 2014).

In 1996, one of the two residential facilities was razed by fire and the other was demolished. To secure alternative accommodation, the erstwhile tenants built shacks in the surrounding undeveloped land (personal communication, Ruimsig Resident 9, 12 July 2014). Over time, the portion of land covered by shack dwellings increased (see figure 6.4). The first two clusters from which shack dwellings expanded from are highlighted in red lines in the 2000 image of Figure 6.4.



Figure 6.3 Image showing the four sections in Ruimsig settlement in 2015.

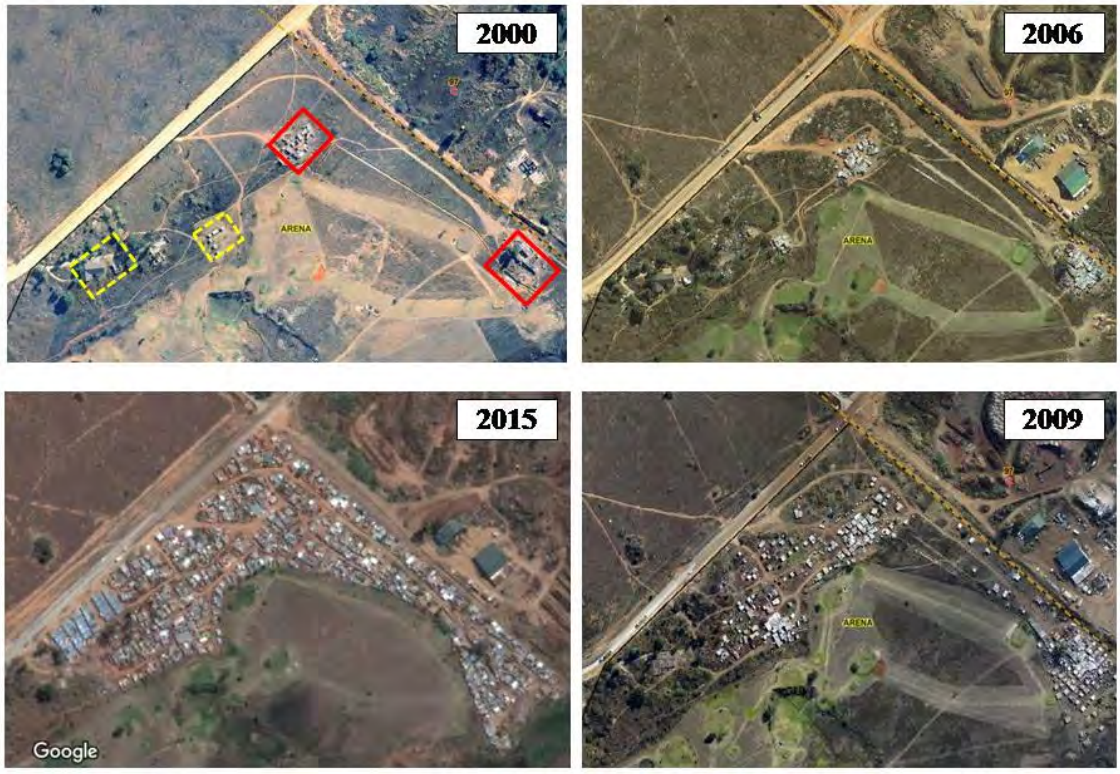


Figure 6.4. Images showing the spatial coverage of Ruimsig informal settlement from 2000 to 2015.
Based on City of Johannesburg Satellite Image and Google Satellite for 2015 Image

Ruimsig settlement grew from a few shacks in 1996 (personal communication, Ruimsig Resident 9, 12 July 2014), 58 shacks in 2007 (CoJ, 2010a) to about 290 shacks in 2010 (CoJ, 2010b). The settlement accommodated approximately 780 people in 2010, based on the Household Enumeration Report that preceded re-blocking (CoJ, 2010b). 'In 2011, we were having 369 shacks. We assumed there are three people per shack, which brought us to over 900 people', recalled one of the community leaders (personal communication, Ruimsig Community leader, 31 July 2014). This leader also said there were 425 shacks as at July 2014 (*ibid.*). During a follow-up field visit in early 2015, I observed that the City of Johannesburg had relocated 30 households from Taylor Road informal settlement to Ruimsig, again adding to the population of Ruimsig (Maditse, 2015). Relocation from Taylor Road, a settlement about 8 kilometres (by car) from Ruimsig, followed an eviction application, through the South Gauteng High Court, by the private developer who owns the land where Taylor Road settlement was. The Court ordered the municipality to provide alternative accommodation for Taylor Road residents who then were to be evicted by the private developer (SERI, 2015).

The growth of the informal settlement occurred through a tenancy-to-owner occupation pattern. Migrants come into the settlement, seeking a place to reside as tenants, but they normally become owner occupiers and even informal landlords later. Recent increase in the settlement since 2012 can be linked to reblocking. According to one of the community leaders, 'because people start to understand that our area is quite secured – we've got proper yards, some had to go home to bring their children, brothers, sisters to live here' (personal communication, Ruimsig Community leader, 31 July 2014).

Ruimsig settlement includes just and unjust situations, indicating complexity in terms of finding answers to questions of justice. The informal settlement emerged and grew within a broader city-wide context of socio-economic and spatial inequality. However, the 'sense of permanence' created through reblocking, which also influenced its growth, sounds fair to the precarious situations of those living in the settlement. That the municipality obeyed a high court order for the provision of alternative accommodation for Taylor Road settlements aligns with the course of justice. However, eviction and relocation of the residents eight kilometres away to allow private development in an up-market area is exclusionary. It is inimical to their precarious livelihoods and deepens existing spatial segregation and inequality in the city.

In terms of sustainability, the settlement's expansion involved the removal of vegetation patches in the areas where new shack construction took place. As part of green infrastructure, the vegetation patch is useful. One might say its removal is not environmentally sustainable, but viewed the other way, domestic gardens that emerge in the new stands make up for the lost vegetation patches.

6.2.1 Basic Services in Ruimsig Informal Settlement

Ruimsig settlement receives limited basic services from the City of Johannesburg. Since 2006, the municipality has been providing water, sanitation and waste collection, but there has been no electricity connection. Initially three standpipes connected to water tanks were installed at different locations in the settlement (former Ruimsig community leader, cited in South Africa SDI Alliance, 2013). During a transect walk in mid-2015, I came across a notice by the municipality showing that an unspecified number of new standpipes are to be installed in the

settlement because of the additional households relocated from Taylor Road. Following the reblocking, households were encouraged by the community leadership to connect their stands to the water supply by digging trenches and laying pipes (personal communication, Ruimsig Community leader, 31 July 2014). During one of the transect walks, I observed that some residents had extended taps into their shacks, draining out grey water into the street through small pipes and gullies.

With regards to sanitation, there were 70 VIP toilets in Ruimsig settlement just before the reblocking (South African SDI Alliance, 2013), some of which I observe were later enclosed within or relocated to reblocked stands (Figure 6.5a). Additional chemical toilets were installed by the municipality with the relocation of households from Taylor road in early 2015(See figure 6.5b).



Figure 6.5. Toilets used in Ruimsig Informal settlement: earlier supplied VIP toilets –left; more recently supplied chemical toilets - right. Source: Author's Photographs, 2015.

As in the case of Kya Sands settlement, the municipal waste collection entity (Pikitup) collects garbage deposited by the tarred road bordering Ruimsig settlement. Unlike Kya Sands settlement, I observed that Piktiup supplies plastic bags for garbage collection in Ruimsig. But 'waste can spend the entire two weeks without getting collected' (personal communication, Ruimsig Resident 9, 12 July 2014). Waste disposal in the form of littering in stands and dumping in open spaces observed in the settlement confirms the interviewees' complaint that waste collection interval by Pickitup is inadequate and the coverage limited.

Benefits realised from water provision in Ruimsig settlement have direct and indirect implications for natural ecosystems. As in the case of Kya Sands informal settlement, water from taps is used to irrigate available home gardens in Ruimsig

settlement. Since potable water is available through standpipes, the residents do not need to use water from the adjacent wetland.

Problems associated with sanitation impacts green infrastructure. Some residents (especially those on stands that have not been reblocked) complained that the locations of toilets in the settlement are far away from their shacks, thus precluding easy access. People living in shacks far from toilets have no option than to defecate in containers or plastic bags at night and later dispose these into vegetated open spaces or the wetland. Some residents defecate directly in vegetated open spaces or the wetland. A resident observed that 'if you go to the wetland, there's a lot of shit because many people don't have toilets. That shit causes diseases' (personal communication, Ruimsig Resident 7, 12 July 2014). This kind of situation was not so strongly expressed in the Kya Sands interviews – it was not complained about in this way, therefore it presumably is less of a problem in Kya Sands than compared with Ruimsig.

The low-level of waste collection in Ruimsig impinges on green infrastructure. Uncollected waste disposed in green open spaces or dumped in the wetland are a source of pollution. Like the riparian corridor in Kya Sands settlement, these spaces allow people to get rid of their waste, but at the same time such action decimates the wetland's functioning as green infrastructure. I observed that grey water disposed into gullies on the streets seeps into the ground, but part of it flows by gravity into the wetland. These threaten the health of flora and fauna in the wetland. They are inimical to the functioning of natural ecosystems and capacity to deliver ecosystem services.

6.3 GREEN INFRASTRUCTURE IN RUIMSIG SETTLEMENT

Before exploring the reblocking of Ruimsig and its impacts on green infrastructure, I briefly identify natural ecosystems in the settlement, considering the associated ecosystem services and ecosystem disservices. Similar to the case of Kya Sands settlement, ecosystem services and ecosystem disservices and interplay between them were mainly identified through semi-structured interviews with the residents and observations from transect walks.

The adjoining wetland and gardens in domestic spaces are the two main types of green spaces presently available in Ruimsig settlement. They are also the main sources of ecosystem services. The wetland, which is near the settlement, extends over an approximate area of 300 square metres. The wetland is only water-logged in summer. Water reeds grow in and around it. Gardens within stands are the other type of green space in the settlement. They generally include plants/flowers in containers, trees, creepers on fences and edible plants grown on the ground. Figure 6.6 to 6.8 shows different types of gardens.

Food, a provisioning ecosystem services, is harvested from the domestic gardens. Maize, vegetables (e. g. spinach) and fruits (e. g. banana, see figure 6.6) are common food products. During a day of field work in July 2014, I observed that the garden shown in figure 6.7a was planted with spinach. Maize was later grown and had been harvested in that garden when I visited again in April 2015 (Figure 6.7b). Harvested food items are consumed and sold when in excess. In 2013, a resident 'managed to harvest three bags of maize coming from this garden' and added 'I cultivate for my children. So unless I harvest enough, I can't sell' (personal communication, Ruimsig Resident 7, 11 July 2014). These same resident harvests reeds from the wetland (another provisioning ecosystem service) which he sun-dries and sells to thatch roof builders (Figure 6.8). This contrasts the present situation in Kya Sands settlement where reeds have disappeared from the encroached wetlands. Instead of reeds, at present, bricks are salvaged from rubble dumped in the wetlands.

During my transect walks, I observed that firewood (fuel for cooking and heating) is harvested from trees in nearby undeveloped land. Two residents confirmed my observation saying, 'We buy firewood, and sometimes we fetch it from that side' (personal communication, Ruimsig Resident 7, 11 July 2014) and 'we go look for firewood far away then we come back to make fire' (personal communication, Ruimsig Resident 3, 11 July 2014).



Figure 6.6.A stand with banana trees and nurseries in Ruimsig settlement.
Source: Author's Photograph, 2014.



Figure 6.7.In Ruimsig settlement, a garden is planted with spinach in July 2014 (left) and the maize and pumpkin grown is recently harvested in April 2015 (right).
Source: Author's Photographs, 2014.



Figure 6.8 Reeds harvested from the wetland stored in a stand in Ruimsig settlement. Source: Author's Photograph, 2014.

In addition to provisioning ecosystem services, I identified ways in which green infrastructure in the settlement delivers socio-cultural and regulatory services. Plants grown in containers in indoor and outdoor spaces (figure 6.9) add a sense of aesthetics and pride in the home. With regard to air quality control, a resident acknowledged that 'I can't sit under a tree because I do not have one ... But, although I don't have one I believe it [the trees] helps us with oxygen' (personal communication, Ruimsig Resident 3, 11 July 2014). The wetland, being part of the Roodepoort ridge system**,** functions as a natural drainage for runoff from the settlement and adjoining Ruimsig golf course.



Figure 6.9. Indoor and outdoor plants in containers offer sense of beauty in Ruimsig.
Source: Author's Photographs, 2014

Although the afore-mentioned benefits are derived, natural systems in Ruimsig are associated with certain problems which are comparable to those reported by Kya Sands residents. Expressing fear of thickly vegetated open space, an old woman said 'passing there [through open spaces] is risky especially in winter because it is dark outside and criminals hide with trees' (personal communication, Ruimsig Resident 9, 12 July 2014). I observed that dumping in open spaces attracts rodents while mosquitoes breed in the water-logged wetland in summer. Direct defecation or throwing faeces in the wetland poses health risks. According to the CoJ Environmental Officer, test conducted on a sample of water from the wetland 'showed that there is a lot of Ecoli in the water meaning that people are actually relieving themselves in the stream or the buckets they use at night they actually throw in there' (personal communication, CoJ Environment and Infrastructure Department's Officer, 19 September 2014).

These problems further deepen conditions of deprivation and disadvantage in the settlement. As a result of these problems, the wetland serves as a source of ecosystem services and ecosystem disservices at the same.

6.4 CO-PRODUCING INFORMAL SETTLEMENT INTERVENTION: RE-BLOCKING IN RUIMSIG SETTLEMENT

Based on the background explanation provided in Chapter 2, reblocking resonates with (but is not equal to or guarantee for the eventual implementation of) South Africa's comprehensive plan for 'phased *in situ* upgrading approach to informal settlements' (Department of Housing, 2004:12). Reblocking - the reconfiguration of spaces, including the layout of dwellings, in informal settlements - was initially associated with World Bank upgrading projects in Asia about four decades ago. Within the last five years, Ikhayalami, a South African not-for-profit organisation (closely associated with Shack Dwellers International and headed/owned by the SDI director's sister) has led reblocking efforts in some South African informal settlements, including Ruimsig.

The following sub-sections describe the role of various actors and hurdles involved in the co-produced *in situ* intervention. I also point out aspects of processes and 'product' of the reblocking related to green infrastructure and those having implications for just sustainability.

6.4.1 Actors and their roles in Ruimsig re-blocking

As one of Johannesburg's settlements under Shack Dwellers International (SDI)'s Informal Settlement Network (ISN), Ruimsig tapped into the network's socio-political relationship with the state to initiate community-based improvement, although the municipality's commitment to long-term development was not apparent (personal communication, Ruimsig Community leader, 31 July 2014). As I learnt through interviews, the community's aspiration for improvement materialised through reblocking, which impacted the residents' relationship with green infrastructure. Their aspiration materialised as a result of the convergence of diverse actors interested in responding to community-based groundswell around the policy shift from informal settlement eradication to *in situ* upgrading. These actors, who also became project partners, were drawn from an academic institution (University of Johannesburg's Architecture Department), professional practice (26'10 South Architects), SDI- affiliated organisations and the state (CoJ and NUSP). Through ISN's relationship with the municipality, reblocking in Ruimsig involved engagements with the municipality's Housing Departments at the metropolitan and regional level (personal communication, former CoJ's Department of Housing Officer, 28 August 2014).

Architecture students in University of Johannesburg, together with some residents (referred to as 'community designers') in the course of a 7-week university-community studio mapped Ruimsig's existing layout and developed a new one with consideration for green open spaces (see figure 6.10 for final version of the layout). Based on a philosophy of 'folding of the studio into the field' and interest in a 'subversive approach to architectural practice' (personal communication, UJ Lecturer, 21 August 2014) the studio produced a new layout proposing to tie in the natural ecosystems as a resource. The adjoining wetland was re-designed to better attenuate runoff from the settlement and adjoining golf course, while allowing a small garden and sports area (personal communication, UJ Lecturer, 21 August 2014 and former UJ Student, 1 October 2014).

In line with the principle of equitable portions generally agreed on by the community, all stands were to be resized to between 100 and 150 square metres (personal communication, Ruimsig Community leader, 31 July 2014). This meant

stand sizes reduced (for those more than 150sqm), increased (for those less than 100sqm) or remained the same in the two sections. A woman who lost part of her gardening space remarked disappointedly that 'they cut my yard and gave it to the lady who stays next door. As you can see other people's yards are bigger, so mine is small because they cut it' (personal communication, Ruimsig Resident 11, 18 July 2014). The new settlement layout tries as much as possible to accommodate formal town planning requirements in terms of road width etc., while minimally disrupting the existing layout. This means quite substantial change which a truly *in situ* upgrading process might have avoided, given that the Upgrading of Informal Settlement Programme (UISP) programme, if followed correctly, exempts settlements from existing formal spatial planning standards.

After the university-community studio ended, 26'10 South Architects, a Johannesburg-based architectural practice did CAD-draughting for the final settlement layout (see figure 6.10). The practice, whose professional hours were remunerated by Goethe Insitut, also supported implementation of the new layout in a section of the settlement (personal communication, 26'10 South Architect's Principal, August 2014). Reblocking this section in particular had an impact on the wetland.



Figure 6.10 Re-blocking layout for Ruimsig settlement
Source: Informal Studio: Ruimsig & 26'10 South Architects

NGOs affiliated with the SDI Alliance in South Africa - Community Organisation Resource Centre (CORC), ISN, SELAVIP and Ikhayalami led and dominated the re-blocking process. ISN facilitated partnership meetings with the municipality — City of Johannesburg. CORC led enumeration in the settlement in 2010 and later managed financial contributions by the residents through the Community Upgrading Finance Facility (CUFF). SELAVIP and later Ikhayalami provided technical coordination during implementation; procuring and installing new shacks in the settlement (South African SDI Alliance, 2013).

The City of Johannesburg had initial buy-in in the reblocking as it saw the process as a way to avoid protests and litigation for substantive intervention by the residents. The municipality also wanted to

> 'have a test model of incremental upgrading. But ...won't take incremental upgrading as it comes from UISP or probably as defined by NUSP, but purely looking at improving the livelihood of people where they are and improving the living conditions where they are' (personal communication, Former CoJ Department of Housing Officer, 28 August 2014).

Essentially, the City identified with the desire for *in situ* improvements by the residents, but was not ready to make the long-term commitments that UISP involves. As a result, the City's engagement with the NGOs/community and the Mayor's later declaration of an 'experimental' pilot project for alternative informal settlement upgrading in Johannesburg (Tau, 2014) were not backed up by commitments for long-term *in situ* intervention and development.

Although the reblocking was led by SDI-affiliated organisations, the community played certain significant roles. The community, represented by residents (3 men and 5 women) who participated in the 7-week studio, informed and influenced the new layout (personal communication, Former UJ student, 1 October 2014). According to the residents, community meetings were held every Sunday between July and September 2011 for information dissemination, discussions on the plans and implementation. The studio and weekly meetings created space for participatory decision-making, thus giving the residents a voice on improvements in the settlement. The domesticated and non-confrontational space of engagement is also an incentive for greater participation by women. While being non-confrontational by encouraging the inclusion of women, it discourages litigation for the sake of justice.

In this situation, SDI-affiliated organisations leading the reblocking cannot take the state to court for not duly considering and making long-term upgrading commitment as BNG and UISP requires.

The community's participation included financial contributions. Each household was to contribute R500 towards the procurement of shacks, but not everyone could afford to pay the amount when it became due (South African SDI Alliance, 2013). A situation like this is exclusionary and a downside of the contributory financing model promoted by the SDI in informal settlements. This however does not mean that the model of contributory financing is outrightly unjust.

Residents contributed sweat equity in assembling the new shacks and resizing the stands, although 'as time went by people became less interested ... There were few who did understand, but there were others who said we can't do this thing, we need to be paid ... we can't work for free' (personal communication, Ruimsig Community leader, 31 July 2014). Notwithstanding this loss of interest, involvement in implementation served as a means to skills acquisition for some of the residents.

By early 2013, 80 shacks had been reblocked, based on the new layout in the wetland and church sections of Ruimsig (South African SDI, 2013). Shacks located in the flood-prone wetland area were relocated to new stands in undeveloped areas of the settlement. New 17 square metre shacks (blue and white) were installed in the resized stands (see figure 6.11).



Figure 6.11. Two stands with new shacks and a garden in a reblocked area of Ruimsig settlement.
Source: Author's Photographs, July 2014/April 2015.

6.4.3 Hurdles of reblocking and its impact on green infrastructure in Ruimsig

The process of reblocking in Ruimsig encountered some impediments, such that the project teetered and only two of four sections in the settlement were reblocked at the time of field work in early 2015. These problems, considered below, essentially hindered positive impacts of the reblocking on the resident's relationship with green infrastructure.

When asked why reblocking had stopped, the CoJ Housing officer who liaised with the community on the project responded that:

> ‘things that delayed the project were, one, leadership instability — the changing of leadership was one problem; two, Ruimsig being in two wards was not making the task easy: Ruimsig is in ward 97 in Johannesburg and ward 23 in Mogale City’ (personal communication, Former CoJ Housing Officer, 28 August 2014).

The first reason (leadership problems) presented by this officer confirmed what one of Ruimsig’s community leaders told me earlier. The leader admitted that ‘the challenge now I can say is the community — it is commitment from the leadership... They don’t have that commitment since there is this thing of new leadership... [and] you can’t do anything without the leadership’s buy-in’ (personal communication, Ruimsig Community leader, 31 July 2014). While my research could not engage with the difficult and complex dynamics and the impact of the re-blocking process on this, the leadership problem clearly deterred reblocking in the other two sections and demand for long-term *in situ* improvements. As a result of leadership problems in the settlement, the municipality (City of Johannesburg) is at times sceptical of representations made by or engaging with the leaders (personal communication, Former CoJ Housing Officer, 28 August 2014). This reality plays into the dilemmas or difficulties of implementation delays already mentioned in relation to the planned pedestrian bridge in Kya Sands settlement.

The second reason (a municipal/ward boundary dispute) presented by this officer was dismissed by the Ruimsig leader I interviewed as ‘a political game’ (personal communication, Ruimsig Community leader, 31 July 2014). Although Ruimsig settlement sits along the municipal/ward boundary between the City of Johannesburg and Mogale City, the Ruimsig leader believes

> ‘it doesn’t affect the reblocking in any way because both councillors [in ward 97 of CoJ and Ward 23 of Magale City] have been informed... We found out now from [the Municipal] demarcation board there is nothing like Mogale City mentioned in all of the reports. It is Ward 97, which is City of Johannesburg’ (*ibid*.).

Having historically provided limited municipal service (water, sanitation and waste collection) in Ruimsig, the City of Johannesburg tacitly admits that the settlement sits within its ‘territory’ (CoJ, 2010a). Unnecessary wrangling about which municipality Ruimsig settlement belongs provides an avenue for the state to dodge

or delay its constitutional responsibility of progressive realisation of the right to housing.

Apart from boundary dispute, the 'Not in My Backyard' (NIMBY) principle played out through the Ruimsig North Home Owner's Association (RNHOA), an association which represents the neighbouring up-market Ruimsig area (personal communication, Former CoJ Housing Officer, 28 August 2014). The association objected to reblocking, probably hoping the City would relocate the settlement elsewhere since re-blocking to them must have looked like a process that would entrench the settlement. But upon realising potential benefits from *in situ* improvements and that the municipality allowed the project, the association became interested, hoping that the reblocking outcomes would support good neighbourliness between the up-market and informal settlement community. However, more recently, the association has expressed concern with the growth of the settlement while reblocking has stopped (Pheto, 2014). Its members are worried about the impact of Ruimsig settlement on crime level and property values, a concern that usually promotes eradication of informal settlements and leads to the elimination of the above-mentioned benefits derived from green infrastructure.

Some Ruimsig residents also hampered reblocking. Two groups of residents – shacklords and those with large stands (over 150 square meters) lobbied against re-blocking. The community leader I interviewed admitted there are 'a lot of shacks and as soon as you start this thing [reblocking] you are going to disturb them. Their tenants have to move out and they don't want that' (personal communication, Ruimsig Community leader, 31 July 2014). The former CoJ Housing Officer also acknowledged 'resistance that came from parts of the settlements where people felt that, for example, this reblocking need to cut my yard now [and] I'm going to lose my tenants' (personal communication, Former CoJ Housing Officer, 28 August 2014). This group of residents do not want reblocking because it will affect their sources of income and livelihood. For instance, a big stand that is resized through re-blocking will lose some space available for gardening. Sustaining a resident's (e.g., a shacklord) source of income would therefore mean perpetuating deprivation for another resident who might be a tenant. On the other hand, not reblocking prevents

equitable sharing of space so that an erstwhile tenant receives owned and secure domestic space which as I show in the next section, is useful for gardening.

6.5 THE IMPACT OF RUIMSIG'S CO-PRODUCED RE-BLOCKING ON GREEN INFRASTRUCTURE

Outcomes and processes related to re-blocking in Ruimsig do not only have positive and negative implications for justice; they result in some benefits that are related to environmental sustainability. Benefits related to sustainability, to an extent, confirm Jack Olwethu's (a designer working for CORC) perception that acknowledging and utilising informal and poor communities' capacity to solve their own problems through reblocking reveals 'already thought out solutions to environmental problems' (Jack, 2014:28). I provide an example of this in the next paragraph.

An interesting outcome of the community's participation in decision-making and planning is the decision that areas earmarked as green open spaces should be developed with a food garden rather than a park. Regarding the community's preference for a garden, a resident said 'because we will be able to harvest food, a park has no use, especially in a black society because [if starving] I am less likely to simply leave my house to stay at a park' (personal communication, Ruimsig Resident 14, 18 July 2014). One of the community leaders recalled that

> 'there was even an idea whether a park or garden. But we said a garden is much more important than a park because people have to feed themselves. Most people here are not working, if you have a garden you can plant cabbage, spinach and have something to feed yourself... But what benefit will a park be when you don't have something to feed yourself' (personal communication, Ruimsig Community leader, 31 July 2014).

The resident's preference for a materially productive green space goes against the norm in top-down state-led interventions where open spaces are developed with parks in newly established townships. As will become evident in Chapter 7, parks were developed in open spaces in Cosmo City, an example of a newly established township. This preference also goes against findings in Kya Sands settlement (in Chapter 5) where available 'parks' and open spaces speak to the multiple cultural and recreational needs and creativity of the residents, which seem to have been crowded out by the co-produced plan for reblocking in Ruimsig.

Although the garden has not been established, the residents prefer it to a park because it can serve a source of food (provisioning services) and other ecosystem services (space for social interaction – socio-cultural ecosystem service; temperature control – regulatory ecosystem services). The park only supplies other ecosystem services but not food, a provisioning service. Through the communal gardens, residents hope to derive benefits that meet their basic needs at little or no cost. With the garden, a resident anticipates that 'we [will] take a break from buying vegetables, so we can plough for ourselves [and] can even start selling what you harvest' (personal communication, Ruimsig Resident 15, 18 July 2014).

There is need for realism on material and monetary benefits anticipated from the proposed communal garden. The experience of the Thandanani Support Group on their communal garden in Kya Sands settlement (in Chapter 5) where 'only two people would buy, and maybe [we'll] make R12 that day' (personal communication, Kya Sands Resident 11, 06 June 2014) shows the need for an arrangement through which the proposed garden can yield substantive material and monetary outcomes.

The situation whereby Ruimsig residents prefer a garden to a park provides evidence to my earlier inference from the literature. A number of studies show that informal settlement residents places higher demand on provisioning ecosystem services compared with other kind of ecosystem services (Cilliers *et al.,* 2013; Waters, 2013; Shackleton *et al.,* 2014). Social, cultural, economic and ecological 'transactions' associated with communal gardens (such as the one proposed in Ruimsig) can shape them as inclusive spaces that foster socio-ecological justice in disadvantaged urban communities (Ferris *et al*., 2001).

6.5.1 Creating spatial opportunities for greening

Another interesting impact of reblocking in Ruimsig is the reported increase in domestic gardening. As I learnt through the interviews, the creation of owned and secured domestic space through the equitable demarcation of stands and erection of perimeter fencing makes the curtilage (space around dwellings) safe and useful for home gardening. Nine of the seventeen residents I interviewed made statements affirming that the reblocking created opportunities for a domestic garden. Through reblocking these residents received new or larger stands that provide space for home gardening. This is evident from statements like: 'Because this house is bigger than

the last one I had. And it's right because I can do everything that I want to do. I now plough things like maize and spinach' (personal communication, Ruimsig Resident 5, 11 July 2014); 'They gave people big stands, so if you are not lazy you can commence gardening in your own yard' (personal communication, Ruimsig Resident 13, 18 July 2014). Residents also observed that 'now there are spaces within the shacks. People now have their own gardens since they have yards because then there were no yards, it was just one door directly next to another' (personal communication, Ruimsig Resident 14, 18 July 2014).

Reflecting on the re-blocking project, Principal of 26'10 South Architects (the practice that finalised the new settlement layout and partially participated in implementation) said 'since we started from there, comparing 2012 till now [2014], it's a lot greener - in terms of the colour green, in terms of the plants ...I can see a difference although I cannot quantify it' (personal communication, 26'10 South Architect's Principal, August 2014). University of Johannesburg's MTech director thinks 'reblocking sets a kind of rule where one can now build and not build ...That by default leads to a positive response to open space or landscape' (personal communication, UJ Lecturer, 21 August 2014). This 'kind of rule' referred to is ephemeral without security of tenure for the residents.

Three of the residents I interviewed made statements that indicate opportunities for home gardening reduced after reblocking. These residents either experienced reduction in their stand size, thus limiting space available for domestic gardening, or had their shacks relocated. Relative differences in soil conditions between previous and new locations – from a location with more fertile soil to a less fertile soil discourages domestic gardening. 'I once had a garden this side but I think the soil is not as fertile because I am now unable to get fresh vegetables like where on the one I had before. The garden I had there was fresh', a resident who was relocated from the wetland area reported (personal communication, Ruimsig Resident 8, 12 July 2014).

Apart from spatial opportunities for domestic gardening, the residents I interviewed acknowledged that reblocking, to a small extent, improved quality of the environment thereby reducing some of the environmental burdens associated with living in the informal settlement. A woman acknowledged that 'now that the space has opened up, it's no longer like before, we [now] relate better with the natural

environment' (personal communication, Ruimsig Resident 5, 11 July 2014). Another resident said, 'this space is bigger ... I am now able to get fresh air as a result of the open space, compared to the congestion that side' (personal communication, Ruimsig Resident 6, 12 July 2014). I observed that relocation of shacks from the wetland area reduced the experience of flooding.

These improvements were minimal as certain aspects of the environment, e.g. waste collection and air pollution (from burning of firewood) are still problematic. With only two sections reblocked, increasing population and the absence of long-term intervention leading up to *in situ* upgrading, the impacts of reblocking on environmental quality in Ruimsig settlement are short-term.

6.5.2 Exploring the impact of reblocking in two stands

To further understand how re-blocking led to spatial opportunities for greening, I homed in on two stands in the reblocked wetland section, exploring how the stands have changed between 2011 and 2015. I was able to locate, explore and assess the two stands (called Stand Beta and Gamma) and their shacks because the University of Johannesburg Architecture students sketched and documented the spaces in 2011, prior to reblocking (see figure 6.12 and 6.14). I visited the stands during field work in early 2015 and with permission of the residents, made approximate on-site measurements and observations to sketch a 2015 version of the stands (see figure 6.13 and 6.15).

The first case, Stand Beta, is owned by Mr. A, a former construction worker who also once operated a food stand on Hendrik Potgieter road in Roodepoort, about 5 kilometres from the informal settlement. He owns a car and lives in one of the shacks in the stand with his partner and children. Mr. A rented out two shacks on his stand to another family and a young man. Stand Beta was not relocated during reblocking but the perimeter wall was slightly adjusted to allow for a wider road. From figure 6.12 (sketched in 2011), the only green space available is a small patch of vegetation behind the VIP toilet in the stand.

Four years after reblocking, configuration of the stand has changed (see figure 6.13). The patch of vegetation behind the toilet is now absent. At the time of field work in April 2015, the hitherto green space is now occupied by discarded materials,

resulting from demand for storage space within the stand. However, creepers on the wire mesh fencing remained. I can therefore say there is no other evidence significantly pointing to increased spatial opportunity for greening in Stand Beta.

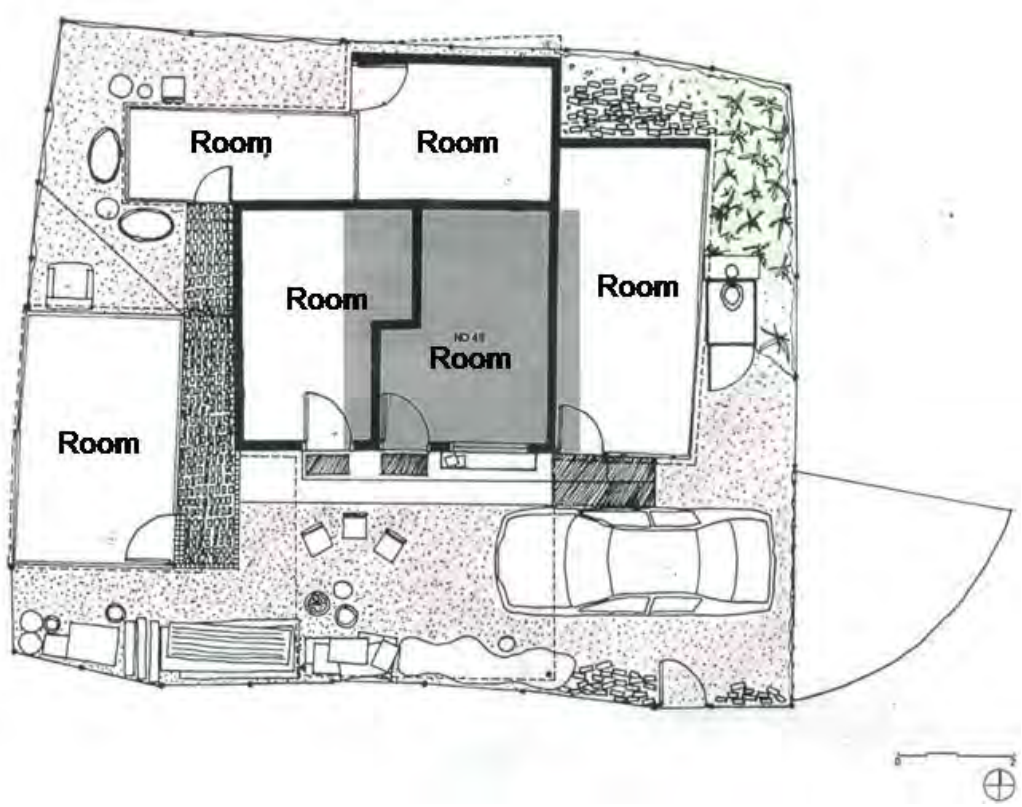


Figure 6.12. Sketch of Stand Beta in 2011, by University of Johannesburg Architecture students.



Figure 6.13. Sktech of Stand Beta in 2015, by the Author.

The second case, stand Gamma, owned by Mr. T is unlike stand Beta. The stand, which is approximately 160 square metres, contains shacks and a caravan house and large gardens (see figure 6.14). It is located by the wetland. Mr. T lives with his wife, teenage son and tenants who occupy two of the rooms. His was the only household who refused to relocate from the wetland area during reblocking. He prefers benefits derived from his large garden and the wetland to problems associated with these spaces. He said

> 'I didn't want to move because I have worked very hard on my yard... I also asked them if they [reblocking team] would give me a farm similar to this one if I moved, and they said no. [So] I couldn't just leave my garden because it helps me to raise my children' (personal communication, Mr T., July 12, 2014).

Although Mr. T did not relocate, changes have taken place in his stand between 2011 and April 2015, the time of my field work. He has added two rooms (shacks) and consolidated some walls by replacing zinc/scrap materials with bricks. He has taken up more space from his surrounding for gardening and the stand which was evidently not clearly demarcated back in 2011 is now demarcated (See figure 6.15). His refusal

to relocate highlights how space is crucial to livelihoods, based on green infrastructure, which is in turn vital to the survival of poor informal settlement residents.

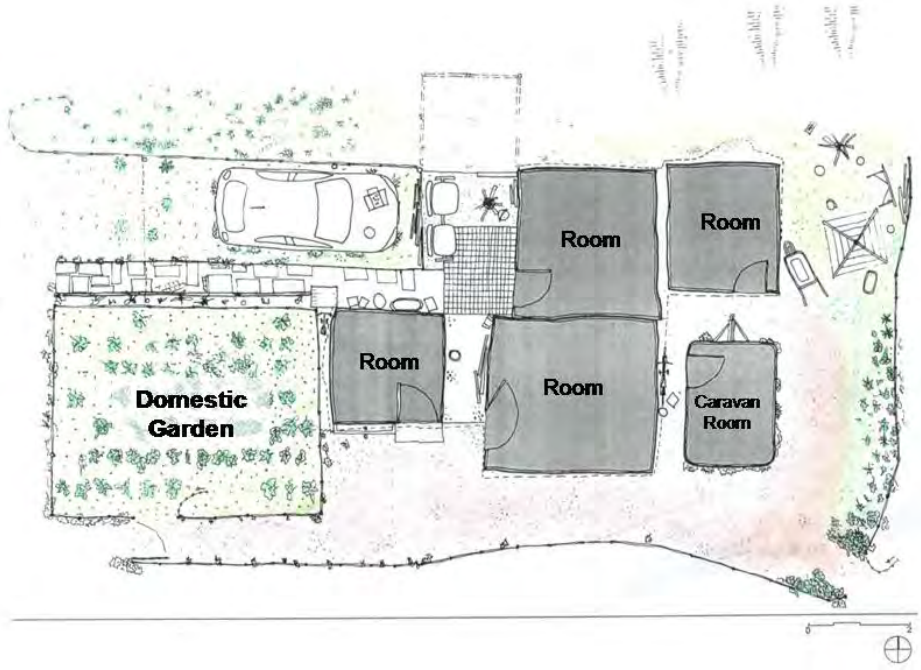


Figure 6.14. Sketch of stand Gamma in 2011, by University of Johannesburg Architecture students.

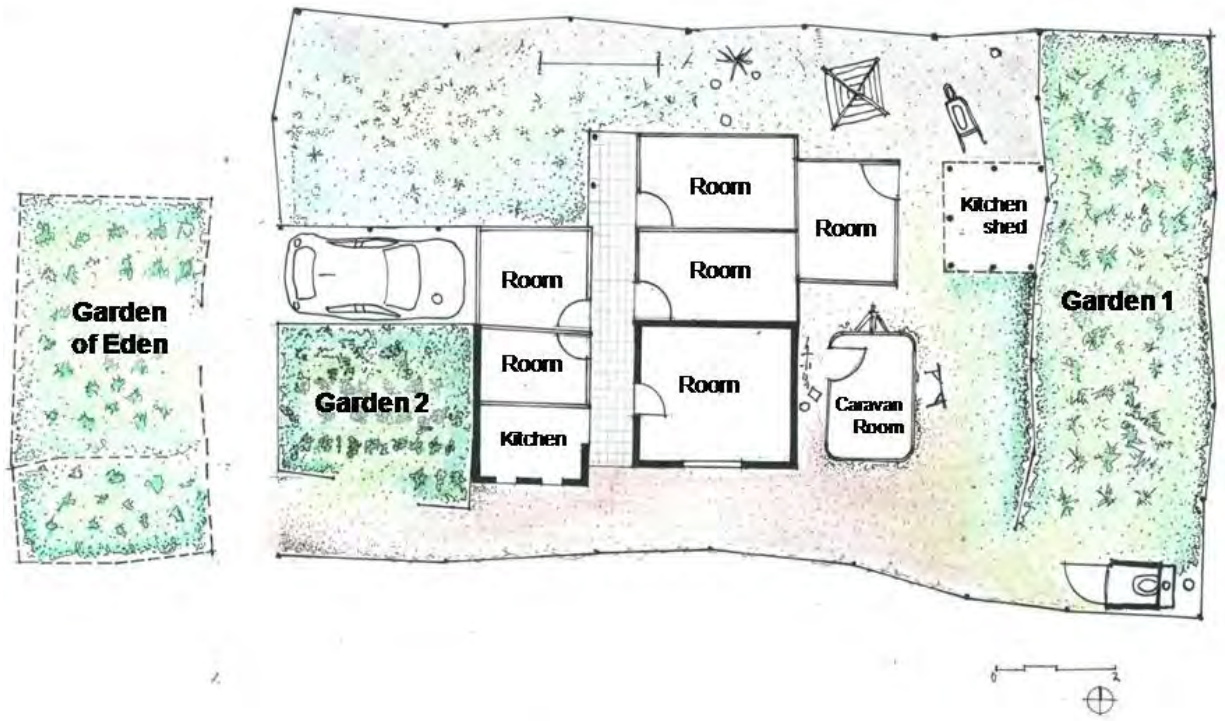


Figure 6.15. Sketch of stand Gamma in 2015, by the author.

These are just two cases, amongst over 80 stands already reblocked. The main message from the cases is that reblocking will not automatically lead to or guarantee increased gardening (and greening) at the domestic level. As stated when discussing domestic gardens in Kya Sands settlement in Chapter 5, more space and standardised plot sizes will not automatically increase greenery in the settlement. Rather, techniques and resources for gardening where little space is available, must accompany spatial reconfiguration when intervention takes place in an informal settlement.

6.6 CONCLUSION

Through the case of Ruimsig informal settlement, this chapter has shown how co-produced *in situ* improvement impacts the way residents relate with green infrastructure. A clear message from the Ruimsig case is that *in situ* informal settlement intervention can lead to better environmental quality and a more environmentally sustainable settlement. But this is not automatic and not that straight forward.

The co-production of reblocking can result in outcomes related to inclusion and equity. But these often involve different kinds of situations the can be considered exclusionary or countering the course if justice. The processes are complicated and might be misleading and unpredictable as SDI's arrangement and reblocking model applied in Ruimsig settlement shows. How the co-produced re-blocking in the settlement fulfils and falls short on principles of just sustainability is discussed later in chapter 8.

The reblocking of Ruimsig – a short-term project brings to the fore potential benefits that can emanate from *in situ* interventions. Much greater impact on quality of life and the environment can be targeted with long-term substantive interventions. As in the case of Kya Sands, achieving just and sustainable situations in this informal and disadvantaged context depends on harnessing (rather than annihilating) residents' beneficial relationship with green infrastructure through *in situ* intervention.

CHAPTER SEVEN

RELOCATION AS INFORMAL SETTLEMENT INTERVENTION AND ITS IMPACT ON AND RELATIONSHIP WITH GREEN INFRASTRUCTURE: THE CASE OF COSMO CITY

7.1 INTRODUCTION

Cosmo City, a township established in part for a selection of former residents of Zevefontein, Riverbend and Skosana informal settlements, exemplifies many aspects of South Africa's relocation intervention for informal settlements. The Department of Human Settlement regards Cosmo City as 'one of the very first projects in the country to put to test the ideals of an Integrated Human Settlement' (Department of Human Settlements Gauteng Province, 2012). Aspects of Cosmo City are relevant for studying just sustainability consequences of South Africa's approach of relocating people from informal settlements into new housing development. The case of Cosmo City, considered in this chapter, exposes short-comings in this approach in terms of the way low-income urban residents relate with natural ecosystems.

While the case of Ruimsig settlement, discussed in the previous chapter, shows how reblocking as an *in situ* intervention approach impacts the relationship that residents have with green infrastructure, this chapter shows how relocation of informal settlement residents into new and distant housing developments impacts benefits (ecosystem services) and problems (ecosystem disservices) emanating from green infrastructure. Being concerned with just sustainability when relocation takes place, this chapter describes previous situations in the three informal settlements, presenting and analysing empirical findings about ecosystem services and ecosystem disservices, to provide a backdrop for the current conditions in Cosmo City. Green infrastructure, with services and disservices involved, across different scales in Cosmo City, are discussed. The chapter compares previous situations in the informal settlements with present conditions and trends in Cosmo City, showing the changing relationship with green infrastructure and implications for just sustainability in relation to relocation of informal settlements.

7.2 COSMO CITY: HOUSING DEVELOPMENT FOR HOUSEHOLDS RELOCATED FROM INFORMAL SETTLEMENTS

The South African state, through the then Northern Metropolitan Council in 1997, announced the proposal for a housing development in the north-western periphery of Johannesburg. Land earmarked for the development is located 35km from the Johannesburg Central Business District (CBD)(Cowden, 2006; Onatu, 2012). The green-field housing development, named Cosmo City, was conceived to accommodate households to be relocated from informal settlements, thus fighting housing backlog and promoting integration by offering low-cost and middle-class housing in the same suburb (Haferburg, 2013). It was commissioned by the City of Johannesburg (municipality) and Gauteng Provincial Department of Housing and delivered through a public-private partnership arrangement. Both the municipality and provincial government appointed CODEVCO as developer. CODEVCO is officially a joint venture between Basil Read Developers (a private construction company) and Kopano KeMatla Trust, whose sole beneficiary is the Congress of South African Trade Unions (COSATU) (McDiarmid, 2006, Haferburg, 2013).

Cosmo City was conceived as an integrated housing scheme in which 'people across class, social and racial lines' would live and share amenities (FIN24, 2007). As a result, the township includes fully subsidised housing for low-income households, rental social housing, partially subsidised credit-linked housing and bonded housing for middle income households. Fully subsidised houses (RDP houses) take up 40% of all the houses in Cosmo City (Haferburg, 2013). They are located in extensions 2, 4 and 6 (see figure 7.1) and were planned for households from Zevenfontein and Riverbend informal settlements and Skosana settlement. According to the City of Johannesburg, a greater portion of the fully subsidised houses (2 899 of 5 000 units) was allocated to households relocated from Zevenfontein settlement (CoJ, 2012). The municipality also explained that apart from allocations to households from the three informal settlements, aged and disabled persons, military veterans and child-headed households from Diepsloot were also allocated fully-subsidised houses in Cosmo City (Olifant**,** 2012).

Although first announced in 1997, construction only started in Cosmo City in January 2005. Wealthy property owners in the neighbouring up-market areas and

members of the Jukskei Crocodile Catchment Area Forum (JCCA) objected to the development, litigating against it in the Johannesburg High Court. They argued that Cosmo City, proposed to include low-income housing, would negatively affect the value of their properties. The court eventually dismissed their application after JCCA was unable to provide the required surety for legal costs and failed to ensure representation during the court hearing (Cox, 2004; McDiarmid, 2006). The Provincial Township board also dismissed their appeal in October 2004 (McDiarmid, 2006).

Although JCCA's objections did not succeed through litigation, their concerns were considered in the settlement's layout. 'These guys [JCCA] were saying [that the development] is only possible as along we are not going to see these shacks (they meant RDP houses). [As a result] high value housing [on the eastern and southern edge] protects the value of properties in the neighbouring areas' (personal communication, Planact Officer, 27 October 2014) while low-income houses on the western side border existing small holdings.

Apart from objections fuelled by worries about property values, which tend to perpetuate urban segregation and promote exclusion, genuine concerns about the environment also delayed the development. The land earmarked for Cosmo City contains habitat of giant bullfrogs, a Near-Threatened species in South Africa (du Preez and Cook, 2004). Property owners used the endangered bull frog habitat as a pretext to prevent the housing development (personal communication, Planact Officer, 27 October 2014). A 'Specialist Giant Bullfrog Study' is required 'when a proposed development or other man-made disturbance will threaten a Giant Bullfrog population and/or habitat that a bullfrog population uses for breeding, foraging, over wintering and/or dispersal' (Yetman, 2007: unpaginated). This bullfrog study was conducted as an integral part of the mandatory EIA before development commenced in Cosmo City. After considering the issues at stake, the Gauteng Department of Agriculture, Conservation and Environment (GDACE) issued a stringent record of decision on the EIA report in January 2003 (Ruiter, 2009). Later in this chapter, I explain some of the conditions attached to protecting natural ecosystems in the record of decision.

Issues about the giant bullfrog in the development of Cosmo City pit the social against the environment, showing how the justice-environment interaction is not clear cut. The bullfrogs, a specie whose decline is dramatic in the Gauteng Province (Cook, 2002) are 'bio-indicators of environmental health, especially of wetlands' (Carruthers, 2011:154) and 'very much part of South Africa's natural heritage' (Measey, 2011:2). That the development of Cosmo City presents a threat to this notable amphibian is illustrative of conflict between socio-economic development and biodiversity conservation. The solution proffered to this conflict in the record of decision, as will be shown later, is limiting and short-sighted, again reiterating how it is not easy matching the ideals and realities of socio-economic justice and environmental sustainability.

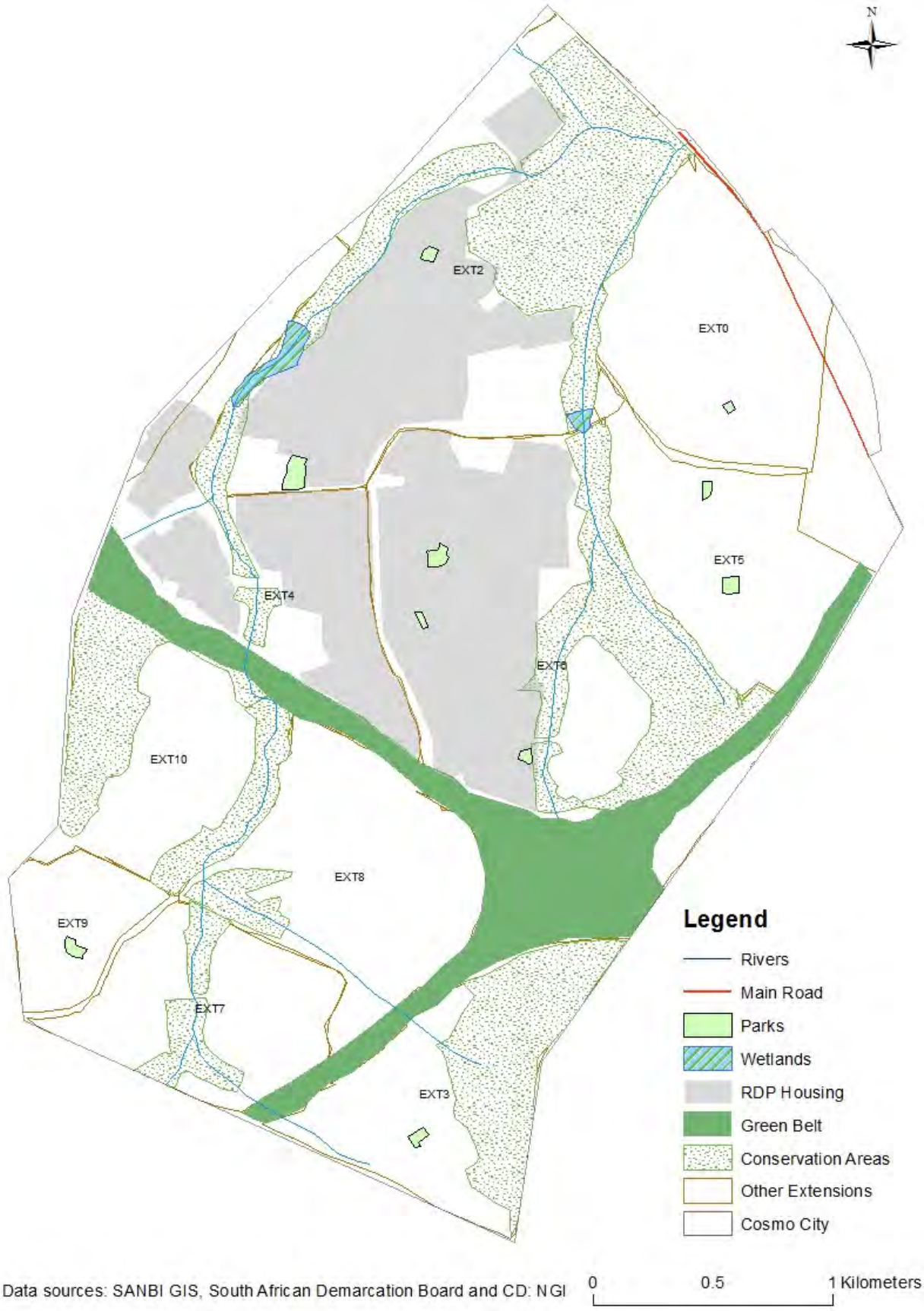


Figure 7.1. Map of Cosmo City showing the extensions (including the RDP housing), parks and green belt.

7.2.1 Green Infrastructure in Cosmo City

Given the intense contestation over the development of Cosmo City in an environmental fragile area and the use of environmental arguments in that contestation, detailed information is available on the biome, biodiversity and species. The 1 150 hectare township is traversed by a permanent stream with wetlands and two perennial streams. The Giant African Bullfrog inhabits the watercourse and wetlands (Golder Associates, 2010). The natural ecosystem, highveld grassland (Egoli Granite Grassland) sub category, also includes a variety and high density of bird life (Van der Merwe, 2006).

Housing development in an ecologically fragile area such as the one in which Cosmo City is located, in terms of South African regulations, requires the conduct of an Environmental Impact Assessment (EIA). Although I could not access the EIA report, I learnt that the record of decision stipulates that 250 hectares of land containing blue and green spaces be demarcated as a 'green belt' in order to retain the integrity of the natural ecosystem (personal communication, Basil Read Officer, 13 November 2014). This not-to-be-developed space was enclosed with a 2.4 metre high concrete palisade fence 42 km in perimeter, intended to prevent arbitrary access into and activities in the green belt (see figure 7.10) (ibid).

The record of decision on the EIA mandated an 'Environmental Management Plan for Construction Phase', which the developer and contractors were responsible for, and 'Environmental Management Plan after Construction' which the City of Johannesburg was to be responsible for (*ibid.*). It also required environmental education or enlightenment of the residents about the green belt and other green spaces. Based on this requirement, awareness programmes about the natural environment took place just before residents in the three informal settlements were relocated to Cosmo City. Incoming Cosmo City residents were educated about green spaces in order to instil pro-environmental behaviour. One of the residents recalled that

> 'We were taught ... that we may plant things but not big trees because they might damage the house. Yes, we were told that even when we see snakes in that area [the green belt] we should not kill them and we should not break down the palisade. They told us not to litter around the parks' (personal communication, Cosmo City resident 12, 20 September 2014).

Another resident recollected that

> 'they would say twenty people will be moving [to Cosmo City] on Monday then they train the twenty people before coming here, they teach them about the environment ... the training said that if you are washing a car, do it on the grass so that the grass can be wet. If maybe you are washing something you should take that water and put it in your plants' (personal communication, Cosmo City resident 4, 6 September 2014).

The residents I interviewed and the Basil Read Officer in charge of environmental compliance before people began to live in the township did not mention whether the training warned of the dangers of soil pollution from car oil and certain detergents. These issues were presumably not addressed, leading one to assume that the environmental training was at a very shallow level, setting out do's and don'ts rather than providing a grounded understanding of how natural ecosystems function, what threatens them and how to preserve them.

Apart from the blue and green spaces in the green belt, areas earmarked as public open spaces in Cosmo City included parks. Forty-four areas summing to a total of 57.5 hectares, with ratio of one park to 256 households, were earmarked as public open spaces (Naidoo, undated), but only 10 of these areas have been developed as parks as at 2014 (personal communication, Basil Read Officer, 13 November 2014). The notion that no resident should walk more than 10 minutes before reaching a public open space underlay setting aside 44 areas (*ibid.*). The 10 parks developed (see figure 7.1), though of varying sizes, cover approximately 3.8 hectares total area (analysis based on Google earth in November 2015). In addition, Basil Read 'have planted more than twenty-two thousand trees... in the schools and some of the parks in conjunction with [Johannesburg] City Parks and some of the streets' (personal communication, Basil Read Officer, 13 November 2014).

Domestic gardens in private spaces, where residents grow food or do landscaping, are also a notable component of green infrastructure in Cosmo City. I discuss ecosystem services in relation to these gardens later in this chapter. The Johannesburg-based NGO, Food and Trees for Africa (FTFA), have notably contributed to the establishment of domestic gardens in Cosmo City. Unlike the case of Kya Sands informal settlement where FTFA does not make any form of intervention even if invited, an FTFA Officer (personal communication, 12

November 2014) explained that its Trees for Homes programme had distributed over ten thousand fruit and indigenous trees to low-income households in Cosmo City over a period of ten years. Households received these free of charge, in addition to being trained about planting, within the last ten years (*ibid.*). FTFA's distribution of plants in Cosmo City has generally been funded by private and public organisations wishing to fulfil social responsibilities or commemorating certain events such as World Water Day or Arbor Day (FTFA, 2015).

The components of green infrastructure in Cosmo City wholly or partly resulted from formal planning, making them more formal in comparison with Kya Sands, which is an informal settlement. Later, I present the multi-faceted ways the residents relate with these green and blue spaces, benefiting ecosystem services and also experiencing ecosystem disservices.

7.3 THE THREE INFORMAL SETTLEMENTS FROM WHICH RELOCATIONS TOOK PLACE TO COSMO CITY

As mentioned earlier, low-income housing units in Cosmo City were planned for and allocated to households relocated from Zevenfontein, Riverbend and Skosanna informal settlements. Cosmo City is located about 12km and 6km away from Zevenfontein and Riverbend settlements' former locations respectively. This section describes and analyse the pre-relocation situation in the three informal settlements, although the bulk of available information is on Zevenfontein settlement. Zevenfontein is more documented because it is the largest of the three informal settlements and Planact, an NGO, actively accompanied the community in the run-up to the relocation.

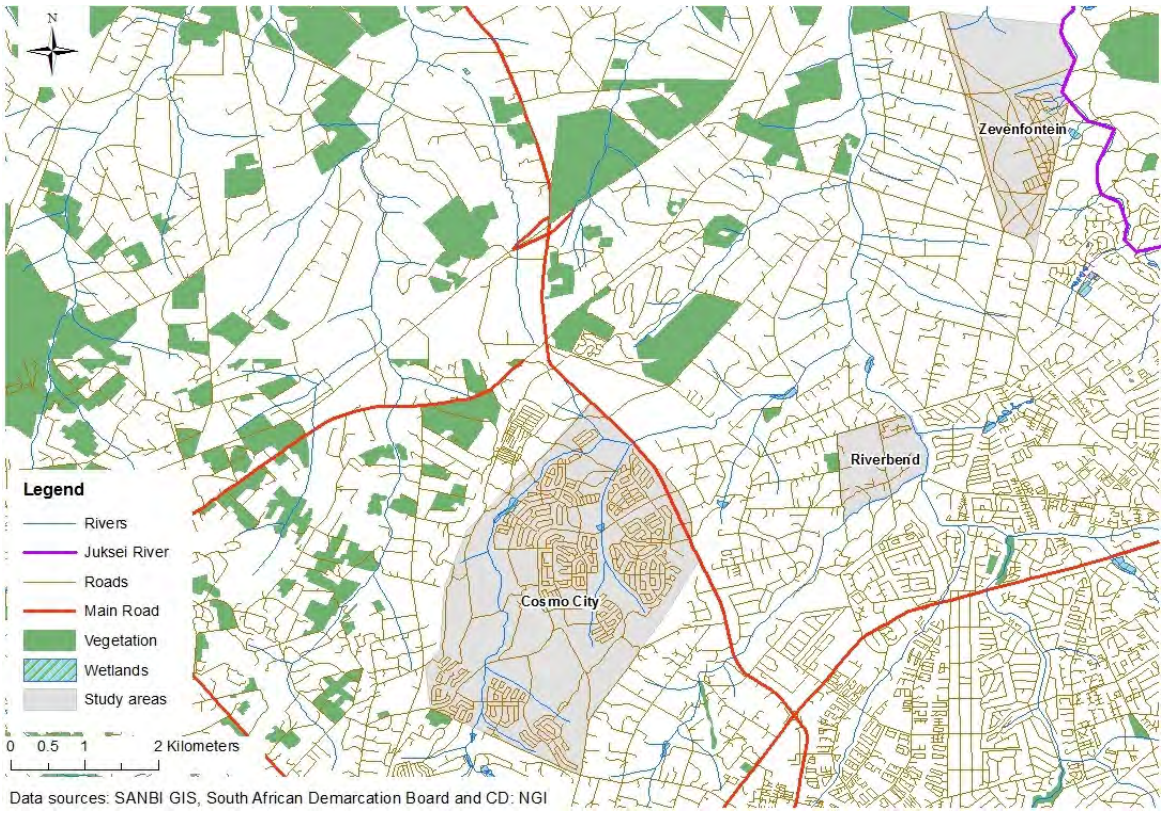


Figure 7.2. Map showing Green and Blue spaces around Zevenfontein and Riverbend settlement and Cosmo City.
Map produced by Samkelisiwe Khanyile

Zevenfontein Informal Settlement

The first area, Zevenfontein, also known as 'eSgodiphola' (meaning valley in isiZulu) was the biggest informal settlement in the north-west of Johannesburg in the 1990s, having been established in late 1980s (personal communication, Cosmo City resident 8, 10 September 2014). The informal settlement started with some families who lived in shacks on a farmland, owned by Mr. Charles Rass, in the Zevenfontein area (Beall *et al.,* 2001). The farmland was close to the Jukskei River (Brett, 2006). Most of the early occupants worked at Johannesburg North Dumping, a waste recycling company. In the recollection of one of the early occupants who was relocated to Cosmo City, there were about 16 shacks when the settlement started in the late 1980s (personal communication, Cosmo City resident 8, 10 September 2014). By 1989, there were 40 families living on the farmland (each paying about R30 rent a month) and 70 families in 1990. In September 1991, Zevenfontein residents were evicted by the Transvaal Provincial Authority (TPA). After their shacks were demolished, the residents refused to leave. With the intervention of a

local Democratic Party official, they moved to a neighbouring farmland (Beall *et al*., 2001). Notwithstanding the eviction and relocation, the settlement grew - from 250 shacks in mid-1991 it enlarged to contain at least 650 shacks in October 1991 (Beall *et al*., 2001).

The settlement continued growing but the size was reduced through partial relocation. A resident remembered that Zevenfontein was left with about 1 540 shacks after part of it was relocated to state subsidised houses developed in Diepsloot Township in 1995 (personal communication, Cosmo City resident 8, 10 September 2014). According to the Department of Housing in the City of Johannesburg (CoJ, 2007b) Zevenfontein accommodated 2 251 shacks in 2007. Satellite images through the City of Johannesburg shows an increased spatial footprint from 2000 to 2006 (See figure 7.3), confirming that the settlement grew during this period. The settlement declined from 2006 to 2009, the period when relocations to Cosmo City were taking place.

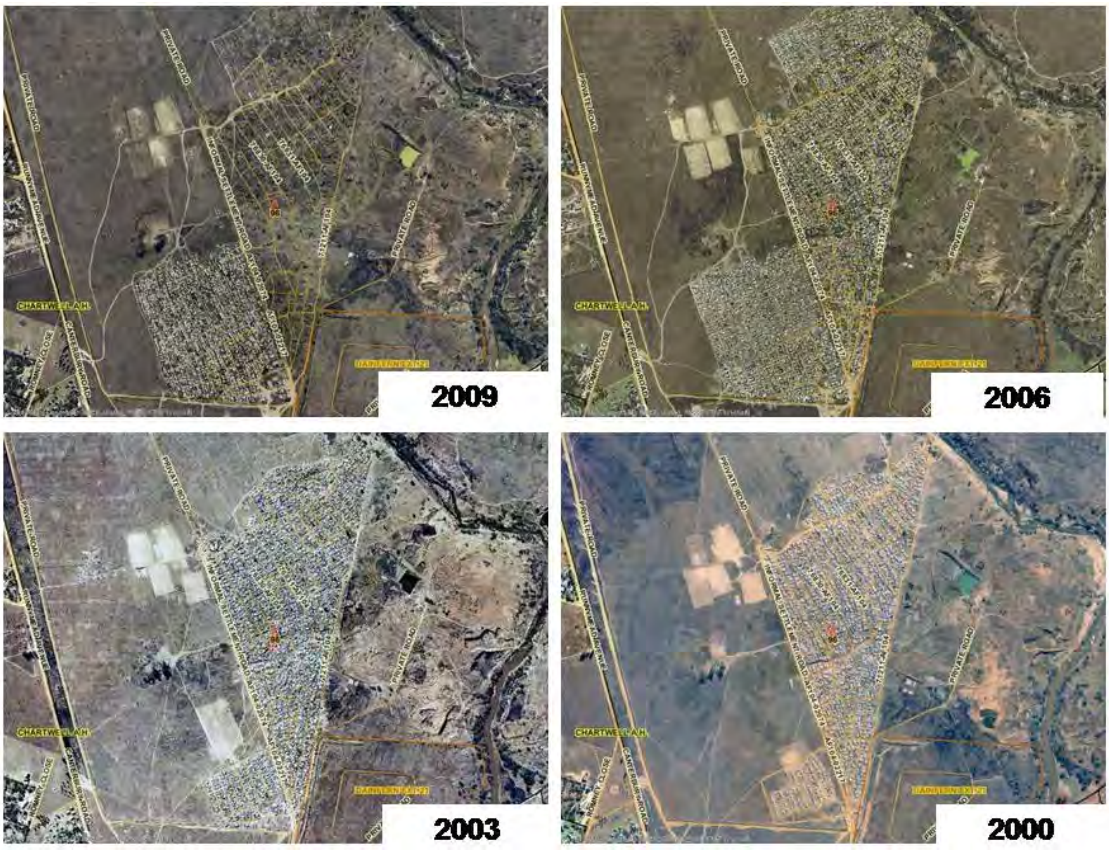


Figure 7.3 Satellite image of Zevenfontein between 2000 and 2009.
CoJ Powerpoint Database of Informal Settlements, 2010.

Zevenfontein settlement grew despite opposition from the neighbouring up-market gated Dainfern area which secured a court order that the Transvaal Provincial Authority (TPA) should evict Zevenfontein residents in September 1991(Beall *et al*., 2001). Also in January 1992, when Zevenfontein had grown to accommodate 750 families, the TPA planned to relocate the residents to Diepsloot. But ratepayers in the Diepsloot area protested against the proposed relocation. In February 1992, the TPA changed its plans and undertook to relocate the residents to Bloubosrand – some 7 km away, but the Bloubosrand Residents' Committee resisted this plan (Cooper *et al*., 1993). Later, the 1992 resistance from the Diepsloot area was overturned by the court, thus paving the way for the earlier mentioned relocation that took place in 1995 (Roux, 1993). In the late 1990s, as already mentioned, the prospect of relocating residents from Zevenfontein settlement to the proposed Cosmo City was resisted by the JCCA.

Issues of justice and inequality in relation to Zevenfontein have been analysed in various publications. It is clear that resentment and resistance from neighbouring middle-income and up-market areas raise issues around landlessness and homelessness, poverty and plenitude, and rights, making it obvious that the 'post-1990 democratic spirit was tried and tested at Zevenfontein and was found wanting' (Muller, 1994:3). Marginalisation of the poor within 'competing interests between property owners and the propertyless and eventual overturning of ratepayers' resistance by the court affirms the place of a justiciable right to housing by tackling entrenched urban inequality and securing justice' (Roux, 1993:539). The case shows how the economic, social and environmental burdens of a group are perpetuated in order to achieve the material and social prosperity of another, which is a 'profound example of pervasive socio-economic, political and environmental injustice' (Brett, 2006:229).

With the relocation of the qualifying residents to Cosmo City, a newly established township 12km away by car, Zevenfontein informal settlement was eventually wiped out. As shown in figure 7.4a and b, a golf course forming part of the Dainfern Golf and Residential Estates and the gated Steyn City luxury estate which is under construction has now taken up the land that Zevenfontein settlement formerly occupied.



Figure 7.4a 2009 Satellite Image of Zevenfontein settlement
Source: City of Johannesburg powerpoint database of informal settlements, 2010.



Figure 7.4b 2016 Satellite Image of area where Zevenfontein was located, showing an approximate spatial footprint of the resident.
Image sourced from Google earth satellite image, January 2016.

Riverbend Informal Settlement

The second area, Riverbend informal settlement, was much smaller than Zevenfontein settlement. Referred to as 'Riverbend AH' in the City of Johannesburg's database of informal settlements, it contained 220 shacks in 2007 (CoJ, 2010a). Although CoJ's database claimed the settlement was established in 1985, I could not ascertain this in the course of interviews. Nevertheless, I learnt that Riverbend started on land formerly used as a chicken farm. A former Riverbend resident recalled that 'it was rooms [where] they were selling chickens before, but the owner of the place took out those chickens and gave us the plot' (Cosmo City Resident 1, 30 August 2014). With informal consent of the farm owner, the facility was later subdivided and taken up by economically weak, job-seeking migrants in need of accommodation (Cosmo City Resident 1, 30 August 2014). Shacks were later built on the land. Like Zevenfontein, Riverbend informal settlement was located near the Jukskei River. 'That's why it is called Riverbend, [because] there was a river there' (personal communication, Planact Officer, 27 October 2014).

No material providing hard evidence (for example, data sets) on the type of green space in Zevenfontein or Riverbend settlement was found. However, as evident from two pictures of Zevenfontein I was able to access (figure 7.5a and b) and mentioned by the residents, the settlement contained trees of different sizes in domestic and public spaces. Spaces around shacks are used for domestic gardens which include a variety of vegetation. Green infrastructure in Zevenfontein and the other two settlements provide ecosystem services and are also associated with ecosystem disservices. Perspectives of the residents on these services and disservices are discussed later in this chapter.



Figure 7.5a. A portion of Zevenfontein settlement (before relocation) showing trees, adjoining veld, sloping land (towards the river) and neighbouring up-market Dainfern estate.
Undated picture, Sourced from and used with permission from Planact.



Figure 7.5b. Zevenfontein settlement (in 2008) shortly after the residents moved to Cosmo City. Shacks have been cleared but evidence of trees and vegetation patches in the settlement remain
Picture taken by Kristen Kornieko (used with permission).

Both Zevenfontein and Riverbend settlements received interim basic services from the municipality. In Zevenfontein, water was made available initially by trucks and later through communal standpipes, while sanitation was provided via communal chemical toilets (personal communication, Planact Officer, 27 October 2014). The

municipality also provided large open-topped containers called skips for waste dumping and later graded roads in the settlement (CoJ, 2010a). Communal standpipes and chemical toilets were supplied in Riverbend (*ibid.*). These services reduced pressure on natural systems in and around the settlements. For instance, in Zevenfontein, 'people used to go and drink in the river - every form of water... [but] when truck water came, it was a blessing; it is clean at least and you have more water' (personal communication, Planact Officer, 27 October 2014).

In order to struggle for improved lives and environment, Zevenfontein and Riverbend residents were organized under the Community Development Forum (CDF) initiated with assistance of Johannesburg-based NGO Planact in 1999. The CDF, dominated by Zevenfontein residents and based within the settlement, served as platform for community organisation and means of engagement with the state for interim services and substantive intervention (personal communication, Cosmo City Community Development Forum Leader, 30 August 2014 and Planact Officer, 27 October 2014).

Ideally the CDF should have facilitated meaningful participation of residents in the proposed Cosmo City project, but 'there was minimum community participation in the plan[ing process], and that was very worrying' (personal communication, Planact Officer, 27 October 2014). Allegations of poor transparency and ethnicity were made against the CDF (Brett, 2006). In a former Zevenfontein resident's understanding, these allegations were responsible for poor participation. She said 'before we were involved with the town planner, but the leaders were only interested in their stomach, so we were not involved in everything that was happening until [we] were going to move' (personal communication, Cosmo City Residents 4, September 6, 2014). The participation process, weak as it was, had no regard for the residents' relationship with the green infrastructure in their informal settlement.

Skosana Settlement

The third area from which households were relocated to Cosmo City is the Skosanna informal settlement. Workers on the then Cosmo farm, mainly drawn from the extended Skosana family resided in the small settlement which sat on a small part of the land where the Cosmo City township was being planned and today where Cosmo City's Sqodipola High School is built (personal communication, Cosmo City

Resident 16, 22 November 2014). Skosana settlement was close to small streams and wetlands that are part of the Jukskei catchment and presently part of Cosmo City. The settlement initially grew through natural growth among the farm worker families because the then Cosmo farm owners (who employed the residents) disallowed people who were not farm workers or their relatives from living in the area (*ibid*.). However, migrants who were not farm workers later moved into the settlement from late 1980s, at the eve of the end of the apartheid era when the apartheid-era pass laws had been repealed. The families lived in self-built, thatch-roofed mud dwellings while working on the Cosmo farm. Being already located on the land designated for Cosmo City Township, Skosanna farm settlement residents were the first to be relocated to new low-income houses developed in the township in November 2005 (*ibid*.).

7.4 ECOSYSTEM SERVICES AND ECOSYSTEM DISSERVICES BEFORE INTERVENTION (RELOCATION) IN THE INFORMAL SETTLEMENTS

Accounts by former residents and inferences from available publications on Zevenfontein, Riverbend, Skosanna show that natural ecosystems in around the informal settlements served as source of ecosystem services. Food (a provisioning ecosystem service) from domestic gardens in the three settlements contributed to household consumption, or was at times sold. 'At Sgodiphola [Zevenfontein settlement], people used to farm' (Cosmo City Resident 11, 20 September 2014), 'people planted in the yard and even outside whereby people planted things like large amounts of corn' (Cosmo City Resident 13, 20 September 2014). A resident recalled that in Riverbend settlement, 'we had lots of gardens there. We were planting cabbage, tomatoes, everything. I was selling and I was cooking for the crèche' (Cosmo City Resident 1, 30 August 2014).

Apart from food, gardens added beauty to the domestic environment – a socio-cultural ecosystem service. A former Zevenfontein resident recalled that 'I planted some roses without the roots to make flowers, I did not have to buy flowers I just planted them myself... the flowers made the house to look very beautiful' (Cosmo City Resident 12, 20 September 2014). Corroborating this, Hill and Heerdeen's (2003:24) anthropological account of emic perspectives in Zevenfontein showed that 'a large stand [that] have been landscaped with stones, walls, plants and trees' ... fulfils 'human need to display one's self-image to one's self and to other people'.

Given that Zevenfontein, Riverbend and Skosana farm were informal settlements, there was no park or any other formally developed green open spaces in the three areas. Nevertheless, 'there were trees next to the river' (Cosmo City Resident 12, 20 September 2014) which notably moderated the micro-climate (a regulating ecosystem service) and provided timber for shack construction. Stephani Durrand's Masters Dissertation on social support networks, based on a six-month participant observation in Zevenfontein settlement in 1992, provides evidence on these. In her research diary of 25th October 1992, she recorded that 'at the Jukskei River not far from the community border, a man was collecting wood [from the trees] to repair his parents' shack, when he was confronted by four people ... three of them had been sitting in a nearby tree' (Durrand, 1995:86). This recorded incident shows that trees within and around the settlement were harvested for timber used in construction and also provided a shaded space to sit.

With respect to the watercourse and the associated riparian corridor, the Jukskei River was useful to the Zevenfontein and Riverbend residents like the North Riding stream was useful to the first occupants in Kya Sands informal settlement. According to figure from Statistics South Africa, 171 of the entire 6 627 households in informal settlements in Ward 96 (where Zevenfontein and Riverbend are located) of Johannesburg municipality reported to have used water from the Jukskei River around year 2000 (Stats SA, 2001).

Interviews with Cosmo City residents affirmed the usefulness of the Jukskei river and the riparian corridor. In Zevenfontein, 'people used to fetch drinking water there [Jukskei River] when the tap water was not working' (Cosmo City Resident 6, 6 September 2014) while some 'washed their clothes there because we didn't have water' (Cosmo City Resident 10, 20 September 2014). A resident remembered that

> 'where it [Riverbend settlement] passed the Juskei river was beautiful. There were stones there, so we used to go there and chill when it was hot we were swimming... We had cows, sheep and goats and they used to drink water there, which was nice' (Cosmo City Resident 1, 30 August 2014).

People living in the settlements fished and swam in the river. A man told me that he usually strolled to the riparian space for sight-seeing during leisure time (Cosmo City Resident 3, 6 September 2014). In her research diary of 6th November 1992, Durrand (1995:87) wrote that 'I walked around, especially by the river, and saw

some lovely spots with trees and children playing around on the banks'. This record further shows recreational functions of the river and the riparian space.

Although not directly connected to the Jukskei River, but similar to the experience in Zevenfontein and Riverbend, residents in Skosana settlement used water from the surrounding streams for laundry and to water their cattle. When large volumes of water (e. g., for swimming) was needed, they visited the Jukskei River and far-flung Crocodile Rivers (Cosmo City Resident 16, 22 November 2014). Reeds in the surrounding wetland were harvested and used for thatching the roofs of the mud dwellings that the Skosana families used to live in (*ibid*.).

Although the Jukskei River and streams around the Skosana family settlement were useful, they presented real dangers and perceived threats (ecosystem disservices) to the poor communities. Drinking from the river was not safe. 'People used to go and drink in the river- every form of water [but] that river is not clean' (personal communication, Planact Officer, 27 October 2014). Durrand (1995:87) observed that 'before the TPA delivered regular supplies of fresh water many people fell ill from drinking the polluted river water'. Some of the residents I interviewed explained their wariness of the water quality. But they had no option than to use the river in the absence of clean and potable water.

Apart from health related problems in the Jukskei River, there is a high risk of drowning, usually after rainfall because of the absence of a proper bridge across the river. A former Riverbend resident recalled that 'when it rained people die there, even two of my kids nearly died there as they were crossing from school' (Cosmo City Resident 1, 30 August 2014). A media report that a tree fall during a wind storm (of up to 50km/h) killed a Zevenfontein resident in 2005, provide evidence of another detrimental outcome from vegetation (Smillie *et al*., 2005).

People who lived in Zevenfontein settlement were limited in benefiting from the Jukskei River due to a popular belief that the river hosts a spiritually dangerous snake. 'Washing of clothes and fishing was very dangerous because there were three snakes in there but no one saw them... You can only go there in the morning and evening; you can't go there at 12am or 12pm' (Cosmo City Resident 8, 10 September 2014). The big snake 'has a spirit as people believe ... but it only comes

out of the river in the afternoon. So people [only] go there in the morning and evening' (Cosmo City Resident 6, 6 September 2014).

The range of multi-faceted benefits derived from natural ecosystems in and around the three settlements served as means of survival for the residents and improved quality of environment. Although not an easy task, these benefits from green infrastructure, if harnessed, would have supported the course of redress for the historically disadvantaged citizens who resided in the settlements. On the other hand, real dangers and perceived threats associated with green infrastructure in these settlements must have deepened the residents' situation of historical disadvantage and exclusion. The associated ecosystem disservices would have exacerbated their precarious conditions, thus heightening the need and agitation for justice through appropriate informal settlement intervention.

7.5 ECOSYSTEM SERVICES AND ECOSYSTEM DISSERVICES AFTER RELOCATION IN COSMO CITY

Moving away from the erstwhile informal settlement environments, this section turns to the natural environment within the newly established township, Cosmo City. Field observation during transect walks coupled with explanations by the residents and key informants reveal multi-faceted benefits related to provisioning, regulating and socio-cultural ecosystem services at the domestic, public open space and riparian scales. Green infrastructure providing these benefits is also associated with ecosystem disservices — certain problems, negative experiences and perceptions. The course of events on green infrastructure presents realities, showing that ecosystem services are intertwined with ecosystem disservices in more complicated ways than thought of at the planning stage for Cosmo City.

7.5.1 Benefits from domestic green spaces

Although not all households on stands/plots have planted a garden, I observed that at least half of entire stands in the low-income area include a garden, though of different forms, sizes and content. Firstly, the gardens provide food - tomatoes, spinach and cabbage, which augment what is purchased from the market (see figure 7.6). A resident admitted that 'I planted pumpkins. I shared them with my neighbours here' (personal communication, Cosmo City Resident 2, 30 August 2014) while another explained that 'I benefit very much from my garden because I

can plant tomatoes' (personal communication, Cosmo City Resident 15, 20 September 2014). Secondly, aesthetic gardens with plants such as flowers, lawns, shrubs, creepers and privet hedges beautify the environment (see Figure 7.6).



Figure 7.6. Home gardens developed for aesthetics. The lower left picture shows PET bottles filled with water placed on the ground to keep away animals (e.g. dogs, rodents) that can destroy plants.
Source: Author's Photographs, 2013/2014.

Road verges in some areas are used for gardening or landscaped (see figure 7.7). Households who have gardens and own the respective stands plant/tend these verges, thus serving as an extension of existing domestic gardens. Not all the road verges in Cosmo City are cultivated or landscaped. I observed that a few verges are used for street trading while the majority are untended especially when the space is very small.

Apart from the street verges, available open spaces nearby dwellings are also cultivated. As shown in figure 7.8, I observed that some residents cultivated the servitude under electricity powerline near their house. This open space therefore serves as an extension of a domestic garden where available.



Figure 7.7. Road verges landscaped (left) and used for food gardening (right).
Source: Author's photographs, August 2014.



Figure 7.8. Servitude of Electricity power lines cultivated with vegetables and maize
Source: Author's photograph, March 2016.

Many gardens are well developed because they are induced by outside support, and the case of Food and Trees for Africa (FTFA) is notable since the support was sustained over time, allowing re-planting where necessary. A resident acknowledged that FTFA 'gave us plants such as the peach trees... They taught us [how to grow] but most of them did not grow because this area is not fertile... they came back the following year to give us more trees to plant' (personal communication, Cosmo City Resident 6, 6 September 2014). An annual garden competition organised by Basil Read when people first moved into Cosmo City also encouraged the development of some gardens because the best gardens (in terms of quality and quantity) were rewarded in kind (not monetarily) to encourage greening at the domestic level (personal communication, Basil Read Officer, 13 November 2014).

Some residents who do not have a garden provided some reasons for not having one. A middle-aged man who works as a metered taxi driver complained that his work schedule does not allow him meaningful time to tend a garden (Cosmo City Resident 7, 6 September 2014). Rodents also constitute a nuisance to domestic gardens, hence a reason why another respondent has not established a domestic garden. Sharing her experience, the young woman said 'this place has a lot of rats - big rats, so planting is like playing around because they will eat up everything' (Cosmo City Resident 5, 6 September 2014). Furthermore, FTFA's mode of operation in Cosmo City tends to be exclusionary. Since 'most of these things happen during the week when most people are at work. They [FTFA] can only train those who do not work' (personal communication, Cosmo City Resident 6, 6 September 2014). Distributing plants and conducting training about gardening during the weekdays, though it might be targeted at unemployed residents, excludes interested but employed residents from participating in the pro-environmental activities and deriving respective benefits.

Notwithstanding the external efforts and relative success with gardening in Cosmo City, the ensuing situation has seen curtilage spaces used and useable for gardening being built-up or paved, thereby reducing the quantity and quality of greenery in stands. As an illustrative case, a resident said,

> 'as you can see in my house there is no grass, but before there was grass, I took it all out because every month I must pay somebody to come and cut the grass. And then in winter the grass looks somehow... so it is high maintenance. And here sometimes when you have grass, water is a big

> problem, because water can be finished and you go and buy because we have meters ... every month they give us 6,000 litres per stand, but when you use it for gardening it gets finished'(personal communication, Cosmo City Resident 4, 6 September 2014).

Here, cost associated with management of domestic gardens is a problem because the residents are poor, being unemployed or under-employed. Free water supply to each stand is capped at 6,000 litres per month thus making water available limited. Available resources are channelled to meet basic necessities of life such as food rather than spent on keeping the stand green.

Apart from costs, decline in domestic green spaces is also attributed to the construction of unapproved additional structures (known as back-yarding), ostensibly for rental and commercial purposes. Signifying the pattern, a resident stated that 'I had flowers. I just removed everything to build these rooms' (Cosmo City Resident 11, 20 September 2014). Basil Read Officer in Cosmo City acknowledged that the garden competition assumed that

> 'people can have plant covers, lawns on their yards, plant trees then that will hold the soil instead of getting it washed onto the road. It was coming up so well and we had [to stop] it ... once the City could not control the illegal buildings. People did not care about gardens anymore. All they wanted was to build rooms to let out and make money'. (personal communication, Basil Read Officer, 13 November 2014).

As reported in the media, recent efforts by the municipality to demolish unapproved additional structures in Cosmo City were met with violent protests (Hawker, 2015). Being unemployed or under-employed, and to make up for lost livelihood as a result of relocation to Cosmo City, the residents use additional structures as the main or additional source of income. Since informal settlement intervention happening through the development of Cosmo City has not led to meaningful empowerment or poverty alleviation for most of the relocates, it makes sense that back yards, and the provision of informal rental accommodation in particular, is preferred to gardening.

7.5.2 Usefulness and problems associated with Parks

Parks, developed by the municipality through Johannesburg City Parks and Zoo (JCPZ), are a notable green open space in Cosmo City (see figure 7.9 for three of such parks). In 2006, JCPZ commissioned Thabo Munyai, South Africa's first black landscape architect, to design the first four parks each covering between 3 000 and

6 000 square metres (Bullivant, 2012). Mr. Munyai interpreted pedestrian movements to create patterns that informed the park design, so that people can walk through the parks on pathways without destroying the grass (Cox, 2006). Apart from vegetation, some of which are indigenous, the parks contain play equipment, sport fields and different types of seating. The parks established so far are developed through a 'service delivery' approach by JCPZ. They stand in contrast to the 'parks' created by people themselves in Kya Sands informal settlement. The self-constructed and small 'parks' in Kya Sands were organic, responding to the residents' diverse socio-cultural needs and preferences.

Notwithstanding the shortcomings and contrast, parks in Cosmo City are useful. Most of the residents I interviewed acknowledge that the parks are most useful for children who play and participate in social activities within the space. I also realised that children are taken to parks by parents/family members or by teachers from the school/crèche. Because of the attractions present, a resident even thinks 'school children dodge school to sit in the park' (personal communication, Cosmo City Resident 13, 22 September 2014).

The Parks are also useful to adults as a place to relax and socialise. Not only that, 'the park makes this place look nice' (personal communication, Cosmo City Resident 3, 6 September 2014). A resident admitted that 'when I am bored I sometimes go and sit at the park' (personal communication, Cosmo City Resident 12, 6 September 2014). Another resident explained that

> 'you can just go there to refresh your mind, seeing people is stress relieving even when you do not talk to them just seeing them is relaxing you feel like your problems go away. So I like the park it is inspiring, maybe when I see you at the park with your partner and I had stress it motivates me; you end up laughing alone' (personal communication, Cosmo City Resident 5, 6 September 2014).

It is noteworthy that the parks serve as an inclusionary space, to an extent furthering the ideals of social integration intended when Cosmo City was conceived. I was told that children across socio-economic classes – from low-income subsidised housing, social housing and credit-linked housing in different extensions interact through recreational and social activities taking place in the parks (personal communication, Cosmo City Community Development Forum Leader, 30 August 2014).



Figure 7.9 Three of the ten existing parks in Cosmo City
Source: Author's Photographs, 2014.

With regards to a sense of ownership and involvement of the residents in managing the parks, a woman recalled that

> 'we were involved [through the volunteer] Community Works Programme to clean the parks [...] because we love our Cosmo city and the parks of our children so when there are papers and everything we go there and clean... but because City Parks can't work with us we left it [...] when jobs come, we are volunteers; they [City Parks] hired people of EPWP to do it. When the money is not there and those people are not there anymore they want us to be there, so now we refuse to be controlled' (personal communication Cosmo City Resident 4, 6 September 2014).

The residents conflicted with the municipally owned entity – JCPZ because they were not co-opted into the short-term, remunerated Expanded Public Works Programme (EPWP) which only employed a few Cosmo City residents (Cosmo City Chronicle, 2015). This situation shows that participation as an ideal of socio-ecological justice can be complicated, especially when viewed in the light of existing formal institutional arrangements and funding mechanisms.

Over time, the parks are being associated with drug use, alcoholism and malevolent loitering, which make the park environment criminal and violent — at times involving damage to park infrastructure or plants. As mentioned, 'children are benefitting from the park because they are playing there, [but] the problem is that these big brothers [youths] demolish the parks and drink there, then our parks started to be ugly' (personal communication, Cosmo City Resident 4, 6 September 2014). I observed some of these problems during my transect walks, noticing how residents are limited and at times prevented from benefiting ecosystem services associated with the notable green spaces that have been created in the form of planned parks. In this situation, the parks' functioning as inclusive spaces and means of social integration in Cosmo City also diminishes.

7.5.3 Functioning and trajectory of the green belt/riparian strip

Based on an informal side to the relationship with green infrastructure in Cosmo City, the green belt, that is, the stream, wetlands with the flora and fauna, are used in certain ways, which questions the need for the concrete palisade in the first place. I was told that the stream is used for baptism by some Christian religious denominations that also congregate within the green belt (personal communication, Cosmo City Resident 3, 6 September 2014). While some 'people will go there and

harvest trees for medicines' (personal communication, Basil Read Officer, 13 November 2014), domesticated animals 'such as sheep and cattle... are eating grass on the other side [the green belt and] ... sometimes see cows drink from there', a resident claimed (personal communication, Cosmo City Resident 6, 6 September 2014). I also observed animal grazing during one of the transect walks.

The green belt provides a visually pleasing environment if one ignores the high concrete palisade. One resident claimed to do bird watching since 'beautiful birds are coming here because they are attracted by the wetland' (Cosmo City Resident 1, 30 August 2014). An old man who likes to see plenty of water walks in to enjoy the scenery after rainfall (personal communication, Cosmo City Resident 3, 6 September 2014). In another resident's perception, the riparian space contributes to temperature moderation (regulating ecosystem service). He said

> 'when I'm coming back late in the night, it works for me. If I'm next to the river I can feel the coolness. Starting from around 5pm late; then it's cool and the temperature is coming down because of the river' (Cosmo City Resident 7, 6 September 2014).

Although useful for compatible purposes, certain negative experiences – ecosystem disservices – are also associated with both green and blue spaces in the green belt in Cosmo City. Some of these are real dangers, while others are merely based on perception. A resident, whose house is located next to the wetland, complained of dampness in her building. She said 'my place is wetland ... It was wet all over here especially when it rains you can see it in the ground and in the house' (Cosmo City Resident 1, 30 August 2014). That this stand's proximity to the wetland predisposes it to dampness is questionable. Legislation guiding the establishment of townships does not allow the erection of any building within a 1:100year flood line. Hence, dampness should not have taken place if this law was followed. The problem might also have arisen from bad building materials or poor construction. It might have been as a result of an underground stream feeding the wetland, which geotechnical survey did not pick up. Whatever is the cause, the problem shows that formal planning is not perfect.

In Cosmo City, proximity to the green belt is associated with experiencing the nuisance of insects, especially mosquitoes in summer. A resident said 'it [the wetland] causes too much mosquitoes and we've got bitten like nothing and I have

too much pimples during the summer time, after it rains and its wet' (Cosmo City Resident 2, 30 August 2014). Mosquitoes and rodents are also problems associated with proximity to wetlands in Kya Sands and Ruimsig informal settlements.

The green belt in Cosmo City separates subsidised housing for low-income households from the credit-linked and bonded housing accommodating middle-income households. Rather than supporting an integrated and inclusive community, it is evident to any observer that the green belt performs a disservice. As Huchzermeyer (2011:28) puts it, the green belt acts as 'an impenetrable barrier that prevents any contact between the social classes'. This is reminiscent of apartheid-era fragmented and exclusionary planning paradigm where different racial groups within cities were spatially segregated by buffer strips from green belts or cultivated/park land (Social and Economic Planning Council, 1994 cited in Parnell and Mabin, 1995). Though contributing to environmental sustainability, the green belt is therefore not contributing to justice in this context.

Arising from the residents' relationship with the green belt, palisade fencing cordoning it off were pulled down at different points (See figure 7.10). Access into the green belt allows the earlier mentioned compatible uses as well as short cuts, or in the local terminology 'doubling-up', waste dumping and untoward and clandestine activities such as smoking, way-laying, robbery. Confirming what other interviewees said, a community leader explained that 'people break the fence to go and see their friends and to go to Shoprite [the shopping mall] on the other side because of distance' (Cosmo City Community Development Forum Leader, 30 August 2014). Sattelite Images showing short cuts/double ups across the green belt and roads in the township as at August 2016 (late winter) are shown in Figure 7.11 and 7.12.



Figure 7.10. Broken palisades fencing at different points around the Green Belt in Cosmo City.
Author's Photographs, 2013/2014

Doubling up in Cosmo City highlights very common design and planning failures, especially in terms of integrating pedestrian routes. In Cosmo City, the houses were combined to form suburban havens which effectively exclude any crisscrossing movements on foot (Haferburg, 2013). Considerations for pedestrians walking, being the dominant form of mobility in the low-income areas, were not properly matched with the approach of enclosing the green belt. This dilemma of environmental and social or economic demands or requirements, especially by the poor, is seldom successfully resolved. The response to planning based on poor understanding of pedestrian behaviour is that people create more convenient pedestrian routes and pathways. As already well documented in the literature, minimal distance between origin and destinations is a critical factor for pedestrians (Agrawal, Schlossberg & Irvine, 2008; Yang & Diez-Roux, 2012; Rodriquez *et al.,* 2014).

The design assumption that people could be excluded from the greenbelt through concrete fencing, with no consideration for design interventions inside the natural area, unwittingly contributed to the area being taken advantage of by criminals. Residents I interviewed spoke about mugging, molestation and murders in this space. As a result of these problems, residents in the bonded houses planned to wall themselves off the low-income areas after discovering that 'each and every time they chase criminals at night, if a house is broken, they run through this area [the green belt] back to the RDP extension' (Basil Read Officer, 13 November 2014). But their plans 'did not go nicely with the councillor and everybody else, they say no you can't build a wall there, you divide the community'(*ibid*.). Walling off the better-off areas further divides a community already separated by the fenced green belt.

Waste dumping and sewerage blockage/bursts are other problems associated with the green belt. These are apparent to any observer walking through the space. A resident attributed dumping to inadequate municipal waste collection service (Cosmo City Resident 7, 6 September 2014), another feels it is because 'we are just untidy beings' (Cosmo City Resident 12, 20 September 2014), while the municipality links poor coverage of waste collection service to over-population in the township. A municipal official admitted there are 'lot[s] of challenges in a sense that we need to have upgrades. There are constant blockages... because Cosmo was not built for the kind of services it's currently giving; it's very densely populated' (CoJ Department of Environment and Infrastructure Officer, 19 September 2014). The overloaded sewer system in Cosmo City spills sewerage into the stream which alongside dumped waste makes part of the green belt emit a bad smell. As a result, the quality of water in the stream and wetland is compromised. Some residents even emphatically call what is meant to be water in the stream 'sewerage'. A young mother said 'like this river of sewage they are ashamed [of it] because children are going to get diseases from the smell of that sewage' (Cosmo City Resident 15, 20 September 2014).

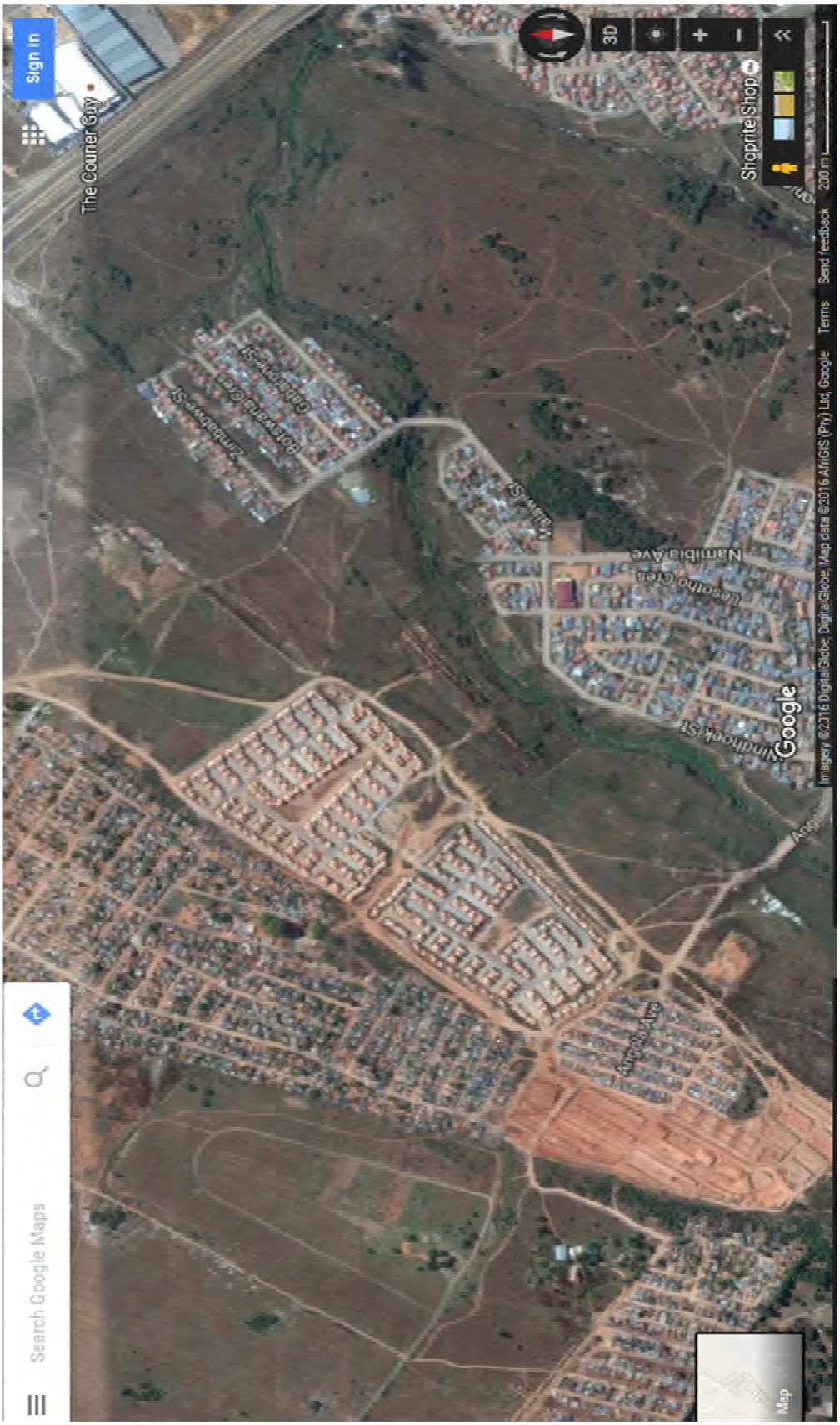


Figure 7.11. Sattelite Image showing short cuts/double ups in Cosmo City
Adapted from Google Satelitte Image, September 2016



Figure 7.12. Sattelite Images showing short cuts/double ups in Cosmo City
Adapted from Google Satelitte Image, September 2016

Cosmo City was designed with a very poor understanding of socio-economic and socio-ecological realities that were likely to shape the area in the post-occupation phase. Everything did not turn out as simple as the Cosmo City planners had assumed. Notably, the 'solution' of putting a concrete fence around the green belt - a conservation approach that was assumed would work is very limiting. Also, apparently, enlightenment programmes about the green belt and green spaces, as mandated by record of decision on the EIA were not fruitful. The situation shows that blocking off the poor residents from the green belt is not a good solution to conservation and environmental sustainability.

While the trajectory regarding green infrastructure might be sobering, it is also positive when seen the other way round. It shows residents' way of reacting to exclusionary and unjust situations in planning and management of green infrastructure. It can be construed as thriving survivalism manifest through a flourishing relationship with the natural environment, especially in a situation where the same type of green infrastructure includes both detrimental and beneficial outcomes. Ultimately the trajectory highlights contradictions inherent in the planning and management of green infrastructure, especially when socio-economically weak people are involved. It brings to the fore some of the shortcomings inherent in relocation as an informal settlement intervention approach.

7.7 BETWEEN THE OLD AND NEW: HOW HAS RELOCATION IMPACTED GREEN INFRASTRUCTURE AND ECOSYSTEM SERVICES?

It is necessary to compare the residents' relationship with green infrastructure in the three informal settlements – Zevenfontein, Riverbend and Skosana with Cosmo City

in order to understand how just and sustainable relocation is as an intervention approach for informal settlements. It is apparent, and cannot be disputed, that Cosmo city amounts to an improvement from the conditions in the three informal settlements in terms of dwelling types, tenure security, permanence of services, and availability of infrastructure. However, accounts by people who formerly resided in the settlements show that relationship with green infrastructure in Cosmo City through its urban spatial arrangements is not necessarily altered in significantly beneficial ways. Their explanations are presented in this section.

Although at least 6 000 litres of free potable water is supplied to each stand in Cosmo City (payments are made for use beyond 6 000 litres a month), people who formerly resided in the informal settlements lamented the present impossibility of deriving certain benefits from the streams because of odours (from sewer spillage). They compare and contrast streams in Cosmo City with the Jukskei River, which is larger and not reported to produce any unpleasant odour. A resident feels 'This is not a serious river ... That one was much bigger and people washed their clothes there, some came fishing there and some could even swim there' (Cosmo City Resident 12, 20 September 2014). To the residents, water (though of questionable quality) from Jukskei River which was near their settlements is always available and used at no cost. Municipally supplied potable water through communal standpipes in Zevenfontein and Riverbend settlements, similarly in Kya Sands, is used at no cost and not capped. However, in Cosmo city, access to water, though potable and of better quality is capped and therefore seen as limiting.

Since access to and use of resources from the natural environment are limited, largely informal and not entirely free in the formal township, residents complained that living in Cosmo City is more expensive than the informal settlements. While a man who formerly lived in Zevenfontein said 'that side the cost of living was lower, this side everything is expensive' (personal communication, Cosmo City Resident 8, 10 September 2014), a woman explained why. She said 'Zevenfontein was better than Cosmo City because here money speaks, everything is money... whereas there life was cheap because ... I can go and fetch wood from the bush and come and cook. Here being unemployed is a challenge because you use electricity, water' (personal communication, Cosmo City Resident 4, 6 September 2014). These positions are in

line with Huchzermeyer's (2001) review which shows that relocation from informal settlements to formal housing entrenches individualisation. In the absence of socio-economic upliftment, individualisation is burdensome. Its negative impacts might be lessened when there is proper access to resources from the natural environment.

Another reason the residents feel green infrastructure is less beneficial at present is the difference in soil fertility between Zevenfontein/Riverbend and Cosmo City. Although both present and former areas once served as farmlands, it is reported that the soil in Cosmo City is less fertile compared with Zevenfontein and Riverbend settlements. Zevenfontein 'is better because the soil there was fine, if you make something there, it was quick' (Cosmo City Resident 8, 10 September 2014). Despite each household having a curtilage of not less than 200 square metres (each house is about 36sqm on around 250sqm stand) usable for gardening, lower productivity as a result of soil conditions discourages gardening at the domestic level.

Reflecting on the difference between the settlements and Cosmo City, the Planact officer who facilitated the Community Development Forum in Zevenfontein and Riverbend settlements and still involved with Cosmo City said,

> 'in Zevenfontein, we used to see self-initiatives – people having backyard gardens, people planting trees. If I were to rate, I would say Zevenfontein is greener than Cosmo City. The RDP [subsidised low-income housing] side is a typical township, with poor tree-planting; people not very keen on doing door-size food garden' (personal communication, Planact Officer, 27 October 2014).

In contrast to the above situations, parks make a difference in Cosmo City. There were no parks in or nearby the three informal settlements, hence no notable ecosystem service derived from this formal public open space. In terms of the aforementioned socio-cultural and regulating ecosystem services derived from parks in Cosmo City, the township includes much improvement in comparison with the informal settlements. Incompatible activities in the park shows the downside which was absent in the informal settlements.

In Table 7.2, I summarise the residents' perspectives based on a comparison between the informal settlements and Cosmo City. Although benefits and detriments from green infrastructure are intertwined and not that simple, certain aspects stand out. I

put forward those aspects that stand out in the table. These were found through engagement with Cosmo City residents and observation on realities within the area.

Table 7.1 Summary of Ecosystem services in Zevenfontein, Riverbend and Skosana informal settlements versus Cosmo City

Ecosystem Service type	**Before relocation – in the informal settlements**	**After relocation – in Cosmo City**	**Remarks/Comments**
Provisioning service	In the absence of potable water for drinking, laundry, sanitation etc, water is sourced from the Jukskei river and nearby streams.	Water is sourced exclusively from taps in each stand. Available stream in polluted not useful as a source of water	Direct reliance on natural ecosystems for water cease with relocation to the formally serviced area.
	Available domestic gardens provide food consumed by households Edible fishes are caught in the Jukskei River	Available domestic gardens provide part of food consumed by households Small animals hunted in the green belt	The opportunity of home gardening increased with relocation to bigger and individual plots. Not all households take the opportunity.
	Timber for shack construction is harvested from surrounding trees. Reeds for shack (thatch) roofing are sourced from nearby wetlands.	Subsidized houses, which are already completed before occupation, do not need timber from local trees. Electricity supplied precludes use of timber as fuel	Relocation resulted in a higher living standard. Socio-economically weak households find it difficult to cope, especially without free access to natural ecosystems for timber and other products
Regulating service	Available trees and vegetation patches regulate micro-climate (temperature)	Available trees and range of formally planned green spaces regulate micro-climate (temperature)	With greater quantity of green infrastructure, Cosmo City should benefit from more regulating services
Supporting services	The areas' different contribution to and benefit on this category of service could not be identified		
Socio-cultural services	Recreational activities - swimming, fishing, relaxing took place mainly around the riparian corridor of Jukskei River	Recreational activities only permitted in formally developed parks and open spaces, although activities like bird watching and sight-seeing takes place informally within the green belt	Fencing off the natural areas and pollution of the water-body discourages and disallows certain recreational activities that the residents are used to within the green belt
	Gardens and vegetated open spaces contribute to aesthetics	Landscaped gardens and formally developed green spaces make the environment aesthetically pleasing	Formal development of green spaces in Cosmo City provides visual appeal that might be lacking in the informal settlements
	Religious activities took place in the open veld	Religious events take place in formally designated places and in the green belt. People are baptised in the stream.	

7.8 CONCLUSION

The case of Cosmo City in Johannesburg, examined in this chapter, shows how relocation as an informal settlement intervention approach impacts the relationship between low-income residents and green infrastructure. The course of events in the informal settlements and run up to the development of Cosmo City reveal the complexity of issues related to justice, urban fragmentation, as well as concerns about environmental sustainability. Satisfying the varying demands for redress and equity as well as a sustainable environment by the different actors/stakeholders – the poor residents, the up-market neighbours, the state and its agencies is not a straightforward task.

While relocation from informal settlements into new housing environment tends to formally create spatial opportunities for green spaces, these are not fully taken up at the domestic level. Restricted access to nature (in the green belt) can be attributed to planning and design processes that disregarded or were poorly informed about the socio-economic and socio-ecological realities of the residents. Shortcomings of the relocation approach particularly came to the fore in terms of the residents' multi-faceted relationship with natural ecosystems in their former informal settlements compared with Cosmo City.

The key issue emerging from the chapter is that intervention in and for informal settlements must realistically recognise and respond to the poor residents' many layers of interaction with and interdependence on the natural environment. This needs to be acknowledged and harnessed for a sustainable and just future in low-income informal urban areas.

CHAPTER EIGHT

TOWARDS JUST SUSTAINABIILITY: CROSS-CASE ANALYSIS OF FINDINGS ON GREEN INFRASTRUCTURE AND INFORMAL SETTLEMENT INTERVENTION

8.1 INTRODUCTION

The last three chapters presented and analysed findings from the case studies of Kya Sands, Ruimsig and Cosmo City. This chapter undertakes a synthesis, cross-case analysis and discussion of these findings, linking the issues that emanate with relevant positions from the literature and the conceptual and evaluation framework adopted in this thesis. Bringing issues from the three case study areas together allows an exploration of what might be needed for just and sustainable informal settlement interventions in Johannesburg. Although the three case studies are not representative of the diversity of informal settlements across the city, they speak to the realities of living within informal settlements in the city.

The chapter begins by with a summary of ecosystem services and ecosystem disservices across the three cases, and afterwards acknowledges the intertwining between services and disservices. These put the following discussion on the potentials of ecosystem services, and the spatial dimension to it, in perspective. The chapter interrogates findings from the willingness to pay survey in Kya Sands settlement in relation to justice for the disadvantaged. Analysis of co-production and co-management in the light of principles of just sustainability presented, showing possibilities and inherent complexities in relation to informal settlement intervention follows. The chapter ends with a comparison between *in situ* intervention and relocation through the case of Ruimsig and Cosmo City to show how both approaches meet the requirements of just sustainability set out in the evaluation framework presented in Chapter 3.

8.2 ECOSYSTEM SERVICES AND ECOSYSTEM DISSERVICES IN THE THREE CASE STUDY AREAS

Findings from the three cases clearly demonstrate ecosystem services and ecosystem disservices obtained as residents interact with green infrastructure. Table 8.1 summarises these, showing the place of ecosystem services in the lives and livelihoods of the low-income residents. The place of ecosystem services is further

illustrated through the fact that living in Zevenfontein and Riverbend would have been nearly impossible if the Jukskei River did not provide water before the potable water was supplied through taps. This is the same situation for Kya Sands where the North Riding stream provided water for early occupants. With the absence of electricity in Kya Sands residents, cooking or heating will be difficult if there is no opportunity to fetch firewood from trees in and around the settlement or from what landscape contractors dump in the settlement. Mr. T's refusal to relocate from the wetland area in Ruimsig also shows how he lives on material benefits from the wetland.

Table 8.1 Summary of Ecosystem Services and Ecosystem Disservices reported and observed across the three cases

Green Space	**Kya Sands**	**Ruimsig**	**Cosmo City**
Domestic Gardens	Food, aesthetics, wind and temperature control	Food, aesthetics, temperature regulation	Food, aesthetics, temperature regulation
	Vegetation serves and breeding ground for mosquitoes. It also attracts rodents.		
Public non-riparian space	Recreation in informal parks and sports field	Proposed garden to provide food	Recreation and social activities in formal parks
			The parks are associated with drug use and malevolent loitering
Blue Spaces (streams, wetlands and riparian corridor)	Water; Construction sand; Recreation for children; Dumping in the wetland	Reeds for thatch roofing; Recreation; Dumping	Baptism; Religious meetings; Recreation; Dumping; Animal grazing
	Foul smell; flooding; mosquito breeding; rodent infestation; phobia of dangerous aquatic animals, including the health risk and problems associated with these.		
Thick vegetation within and nearby the settlement	Firewood/Timber	Firewood/Timber	
	Vegetation blocks illumination; It serves as hiding place for miscreants	It serves as hiding place for miscreants	Bordering vegetation reminiscent of apartheid-era planning paradigm; It also serves as hiding place for miscreants

Domestic gardens across the three areas serve as source of food and vegetation that beautify the environment. Riparian corridors in the three areas are used for waste

dumping. Whereas in Kya Sands, the North Riding stream serves as a source of water and recreational space for children, the streams and wetland in Cosmo City and in Ruimsig do not serve these purposes. While the self-constructed informal parks in Kya Sands respond to the residents' recreational and other socio-economic needs, Ruimsig residents prefer a garden to a park. While some of the residents in Cosmo City, and formerly in Kya Sands, meet for religious meeting in the riparian corridor, this practice was not reported in Ruimsig. What all these mean is that informality in relation to green infrastructure is expressed in diverse ways which might not readily be predicted.

The situation in the three areas indicate preference for provisioning ecosystem service, among other services – regulating, socio-cultural and supporting ecosystem services, following the adopted Millennium Ecosystem Assessment's (2005) categorisation. For instance, Ruimsig residents' preference for a public green space (community garden) to a park in the course of reblocking shows the value placed on material benefits from green infrastructure. Kya Sands residents' reliance on materials such as firewood, water, bricks directly derived from or accessed through the natural environment is a further illustration. Materials, especially food, derived from domestic gardens also present evidence along this line across the three areas.

The case studies therefore enrich what is already known in literature, as explained in Chapter 2. A number of studies show that residents in informal settlements in general place more demand on provisioning ecosystem services compared with other ecosystem service types because the poor depend directly on the natural resource environment for their lives and livelihood (NadKarni, 2000; Cilliers *et al*., 2013; Waters, 2013; Shackleton *et al*., 2014). Over and above the situations in the literature, in relation to Wallace's (2007) classification, residents in the case study areas place more demand on ecosystem services relating to adequate basic resources (food, water, energy) compared with those relating to a benign environment and socio-cultural fulfilment. In this situation, the poor residents prefer harvesting firewood from trees to micro-climate and air quality control of the same trees because provisioning ecosystem services is more fundamental to survival in comparison with other services.

8.3 THE INTERTWINING OF ECOSYSTEM SERVICES AND ECOSYSTEM DISSERVICES

Analysis of findings from the three areas show that processes and outcomes of low-income residents' relationship with green infrastructure are intertwined in terms of benefits derived and problems experienced. That means service and disservice are not clearcut. Interaction with the same natural ecosystem or green space results in ecosystem services and ecosystem disservices. What someone regards as ecosystem services today might be undesirable and regarded as a disservice by the same or another person at another time. What can be interpreted as a service by poor people who live in an informal settlement might compromise the use and benefits from the same natural ecosystem in formal and up-market residential areas and *vice versa*.

The thread of two-sided complexity runs through the three cases. This binary is illustrated in the situation where benefits (for example, food, temperature control) are drawn from vegetation within a domestic garden, but it also increases the mosquito and rodent population. While the riparian space is appreciated and useful for its natural greenery, it is a space where miscreants hibernate or malevolent loitering takes place. The wetlands which are useful for runoff control and water treatment, with the need for the residents to salvage beneficial materials (bricks and firewood) and make a living, are used for dumping which considerably reduces their regulatory capacities. The streams which are an appreciated open space useful for recreation, in the absence of effective refuse collection, is used for dumping thus comprising the recreational value and safety of children.

These forms of contradiction can be categorised — some are related to the lack of basic services, and they would be alleviated if, for instance, refuse collection was efficient, or residents did not have to rely on the streams for water and recreation. Others apply only to minorities or particularly to vulnerable groups such as women, small children, and tend to remain hidden, unlikely to be addressed unless articulated. Others are related to the informal 'privatisation' of open spaces for livelihoods, with their implicit exclusions. These categories can be connected to principles of justice in the three case study areas and to informal settlement intervention.

This suggests complexities in the different views of ecosystem services and ecosystem disservices. These complexities stand out when the realities of those living in informal settlements are considered in the light of relevant formal and informal institutional arrangements and requirements at the municipal level.

8.4 THE POTENTIAL OF ECOSYSTEM SERVICES FOR A JUST AND SUSTAINABLE FUTURE

While ecosystem services are in some way intertwined with ecosystem disservices, certain aspects of ecosystem services stand out. It is necessary and possible to enhance these aspects in order to achieve a 'better quality of life for the disadvantaged now and for all into the future' (Larsen *et al*., 2014:15) 'in a just and equitable manner, whilst living within the limits of supporting ecosystem'(Agyeman *et al*., 2003:5). Ecosystem services that have a direct bearing on the poor informal settlement residents' survival and well-being are particularly important in this regard. They support livelihoods and can tackle poverty, thus improving the quality of life in these low-income and disadvantaged urban areas.

Enhancing ecosystem services is closely related to interventions in informal settlements. Reblocking in Ruimsig settlement led to the emergence of spaces used and usable for greening activities, especially domestic gardens. In the case of Cosmo City, moving people into new stands provided opportunity (space) for gardening at the domestic level, although rapid backyard densification did away with the potential for greening. While the situation in Ruimsig and Cosmo City show that informal settlement intervention can support green infrastructure, the reality of ecosystem services depicted in Kya Sands raises questions about the best intervention approach. How would the private entrepreneurial parks and the bridge be dealt with in the relocation or in an *in situ* upgrade? Through which approach would dependencies on green infrastructure for ecosystem services be secured best? It is recommendable that intervention in and for informal settlement builds on existing beneficial relationship with green infrastructure, and also considers socio-economic realities.

Regarding the enhancement of regulating and socio-cultural ecosystem services in the informal settlements, certain green infrastructure interventions are suggested. The sports field, a component of green infrastructure in Kya Sands settlement, can be vegetated. An appropriately vegetated sports field can provide temporary storage for

runoff after precipitation, thus complementing any form of drainage infrastructure available. It has hitherto functioned as an inclusive space where self-expression and other socio-cultural transactions take place, and greening it will enhance the experience for the community. Greening the field, however, must consider local realities and not disrupt the residents' informal connection to it. Le Roux's (2014) explanation of an informal soccer pitch in Kwathema Township (East Johannesburg) is instructive in the regard. The state authorities decided to vegetate the soccer pitch but with erratic maintenance and bureaucratic outside control, the field rapidly fell into disuse.

It is obvious that the wetlands in Ruimsig and Kya Sands, which have been a receiver of waste, need to be cleaned up and reconstructed in order to enhance regulatory ecosystem services. According to Langergraber (2013), this intervention is simple to maintain, cost effective and promotes a natural process of water regulation. However, cleaning and reconstructing the wetlands are not enough if the problem of waste collection and disposal within the settlements is not duly addressed. Also, interventions to enhance regulatory functions of the wetlands will be misplaced if problems from upstream (for instance from the adjoining industrial area and sewerage pipes interfacing with the stream in Kya Sands or the adjoining golf course in Ruimsig) are not adequately addressed.

The spatial factor in enhancing ecosystem services

Since green infrastructure exists in space at different scales, a spatial dimension to the enhancement of ecosystem services is critical. Through equitable reconfiguration of the settlement's layout, residents in Ruimsig received space used for domestic gardening. Green spaces in public areas were also earmarked in the settlement. In Cosmo City, each of the low-income households relocated from informal settlements received RDP houses with curtilage space useful for gardening. In Kya Sands settlement, some residents complained about space limitations. They believe with ample stand space, they can have gardens. But is more space really the solution and how much space is enough?

The reality, apparent from the case of Cosmo City, is that the prevailing socio-economic conditions in the low-income communities bring pressure for back-yard accommodation, trumping desires to develop gardens. This means densification is

and will most likely continue as an outcome in informal settlement intervention. The situation therefore calls for creative techniques of low and no-space plant growing technologies, but the technologies themselves are not enough. Based on Architect Stephen Lamb's reflection on vertical gardens, the uptake of low-space greening system depends on the residents' understanding and appreciating the systems (personal communication with Stephen Lamb via skype, 11 November 2014). Relevant training and resources towards the understanding and acceptance of low-space gardening systems are therefore needed in settlements where only little space is available.

8.5 WILLINGNESS TO PAY FOR GREEN INFRASTRUCTURE: CAN IT LEAD TO JUST SITUATIONS IN INFORMAL SETTLEMENTS?

The survey of residents' willingness to pay conducted in Kya Sands shows the value placed on the four types of green space (stream rehabilitation, community allotment garden, community park and children's' park) and the interest in enhancing benefits (ecosystem services) derived from green infrastructure. Over 83% of the survey respondents were willing to pay for green spaces developed by entrepreneurial residents. This preference shows that the low-income residents seem to have faith in the user-pay mechanism existing within the settlement, which involves some levels of exclusions. Literature has shown the positive self-reinforcing dynamics and poverty alleviating impacts of entrepreneurial residents in informal settlements (Fox, 2014; Gulyani and Talukdar, 2010). With this being the preferred mode, it is possible to view the settlement as a place with 'an immense set of untapped markets and potential capitalist subjects', thus leading one to 'romanticis[e] the entrepreneurial flair of [the] residents' (McFarlane, 2012:2798).

Considered critically, the user-pay, market-based approach to green infrastructure, as Kya Sands residents prefer, is generally accompanied by negative corollaries. Poor quality service delivery and exploitative pricing are significant outcomes in low-income communities where the approach have been implemented (Kacker and Joshi, 2012; MacFarlane, 2012; Thieme, 2015). The notion that user-pay mechanism will effectively deliver and manage an amenity such as green spaces usually dooms the entrepreneurial development route to failure in meeting the needs of disadvantaged groups, especially those in informal settlements (Hansen, 2014). Problems also emerge when the state wants to formally deliver services and amenities. The

established informal entrepreneurs directly or indirectly resist what the state proposes because they have already made a thriving informal business. It is therefore a potentially exclusionary approach which falls short in terms of inclusion as a principle of justice.

That over half of the responding residents are not willing to pay if the green spaces are developed by the municipality is telling in terms of the citizens' expectations from the state. As evident in the survey results and supporting statements, the residents, some of whom are tax-payers, believe the state has the resources and constitutional responsibility to make the necessary interventions. The settlement's precarious condition is a clear evidence that the state has not fulfilled its obligations or deployed resources as appropriate but needs to do so.

Returning to the goal of the willingness-to-pay survey, it is clear that at least half of Kya Sands residents are willing to pay for the development and use of green spaces in the context of intervention in the informal settlement. Not less than 40 percent of the residents are willing to pay at least 20 rands for each of all four types of green spaces, irrespective of who developed it. Based on these survey results, the user-pay mechanism through entrepreneurial residents is preferred. However, it is not recommendable as the best route for equitable and unclusive interventions. Making people pay for this basic amenity (green space) would be problematic, because not everyone will be able to afford it. This has potential to perpetuate existing inequalities and socio-economic disadvantage in the low-income and informal settlement.

8.6 CO-PRODUCTION AND JUST SUSTAINABILITY IN RELATION TO INTERVENTION IN INFORMAL SETTLEMENTS

The reblocking of Ruimsig informal settlement can be classified as a case of co-production because the *in situ* intervention took place through an arrangement that involved the residents and a variety of actors from state as well as non-state institutions (Mitlin, 2008; Roy, 2009; McFarlane, 2012; McGranahan, 2013; Ahiers *et al*., 2014). This section shows how the co-production case only partly advances the concept of just sustainability. On the other hand, it also shows how aspects of the co-production arrangement contradict the course of justice, indicating difficulties

inherent in achieving justice and environmental sustainability on their own and together as just sustainability.

The relative level of community participation in the co-produced intervention in Ruimsig particularly resonates with the principle of participation in just sustainability. In line with Sen's (2009) arguments, the low-income and disadvantaged residents in Ruimsig informal settlement functioned as assets rather than liabilities, as resourceful rather than burdensome. The residents performed the role of co-designers and co-deliverers for the relevant services, rather than being mere receivers and consumers entangled in a client-eletist relationship. Through external professional support networks their capacities and capabilities were deployed with the aim of securing improvements in the informal settlement.

This situation in Ruimsig settlement resonates with Larsen *et al.*'s (2014) account. Reflecting on their experience in an impoverished Detroit neighbourhood, Larsen *et al*. (2014:15) acknowledge that 'community efforts can advance elements of sustainability and social justice'. Evidence of the community's roles in the reblocking strengthens Agyeman's (2013) explanation on the conceptual link between co-production and just sustainability. From the perspective of informal urban housing in a developing country, the Ruimsig case tend to reinforce the notion that discourses of environmental sustainability and socio-ecological justice might be mutually constitutive (Agyeman and Evans, 2003; Agyeman, 2008).

On the other hand, aspects of the reblocking intervention in Ruimsig show that co-production does not advance certain principles inherent in the concept of just sustainability, demonstrating that co-production is not intrinsically just. For instance, the situation where not every household in Ruimsig was capable of equally contributing finance when due and benefiting in the reblocking, is exclusionary. In addition, intra-community conflict and leadership problems in Ruimsig, and also alleged in Zevenfontein informal settlement in the run-up to the relocation to Cosmo City, show inherent limitations of co-production. The absence of consensus and amplification of difference shows that achieving the just sustainability principles of integration and inclusion is difficult in the realm of informal settlement intervention.

Socio-political and socio-institutional dynamics leading up to the reblocking's stalemate in Ruimsig highlight the place of social and political factors in co-

produced informal settlement intervention; factors that Mitlin (2008) observed often receive little consideration. Problems that emanated in the case also provide a basis to question Baptista's (2008) position that democratic institutions and participatory governance leads to just sustainability. The dynamics echo the notion that social and institutional structures, processes and relationships producing and reproducing material distribution play a critical role in achieving justice and sustainability. In other words, local governing processes and actors are crucial to the emergence of communities where just sustainability praxis is entrenched (Armstrong and Stratford, 2004).

A further drawback in co-production is that it tends to take responsibility away from the state, especially where the state has clearly stated and constitutionally enshrined obligations and the citizens possess certain rights. For instance, as quoted in Chapter 2, Section 26 and Section 24 of the South African Constitution, the right to housing and a sustainable environment is indicated as well as the state's responsibility towards the realisation of these rights. When marginalised communities get into relationships with the state through co-production arrangements, they at times find it difficult to criticise or take rights-based action (in the cause of justice and environmental sustainability) against the state — against the state's failure to fulfil its legal obligations. As an NGO, SDI's model of informal settlement intervention has particularly been criticised for supporting (or failing to counter) the state's unjust, exclusionary and at times unsustainable urban agenda (Roy, 2009; Huchzermeyer, 2011).

8.7 CO-MANAGEMENT AND GREEN INFRASTRUCTURE: POTENTIALS AND PITFALLS IN LOW-INCOME URBAN ENVIRONMENTS

The course of events and negative trajectory associated with green infrastructure at different scales in Cosmo City signify the residents' response in context of poverty and unemployment. They represent an upshot of inherent but under-considered socio-cultural and socio-ecological phenomena among the residents. While these corollaries can be linked to incognisance on local realities, they also show that conditions set out by record of decision on the EIA report, though implemented, were largely not useful.

The decision to fence off the entire green belt was oblivious of the socio-economic and socio-ecological realities that are now shaping Cosmo City at the post-occupancy stage. Essentially, this recommendation has failed, as it has not helped to significantly preserve the ecological integrity and biodiversity value of the natural ecosystems. Already Lindsey et al. (2012) and Durant et al. (2015) posit that fencing is not always a good conservation solution, especially when it hampers processes of benefiting ecosystem services.

Also, the recommendation that educational and enlightenment programmes must be conducted for all relocating residents has failed. It is not enough that the residents were merely told what to and what not to do regarding the green belt and the natural environment in general. A more extensive level of involvement of the residents should have been used. As opposed to bureaucratic management by the state, governance of green spaces in Cosmo City should take place through the leadership and meaningful participation of those who primarily relate with the spaces – that is the residents. It is at this junction that the concept of co-management comes in. The situation in Cosmo City calls for co-management, which Tidball and Krasny's (2007:152) explains as 'active participation of city residents who take it upon themselves to build healthier sustainable communities through planning and caring for socio-ecological spaces and the associated flora, fauna, and structures'. The community's preference for a communal garden in Ruimsig and self-initiated parks in Kya Sands hint of the existing sense of ownership and responsibility within informal settlements which are ingredients for the co-management of green spaces.

As explained while reviewing literature in Chapter 3, utilising the co-management approach, a community-based natural resource governance paradigm, generally in low-income urban communities, would ideally involve decentralised decision-making, sharing responsibilities, duties, rights, tasks, entitlements and risks between the state and the community (Carlsson and Berkes, 2005; Armitage *et al*., 2007). It should include an arrangement whereby the local community is a stakeholder: The residents make inputs in decision-making on green infrastructure rather being a receiver of top-down decision semerging from outsiders – professionals and state institutions. This arrangement can provide common ground for appropriate attitudes and dispositions towards green and blue spaces – natural ecosystems. According to

Colding *et al*. (2006), co-management can even reduce costs associated with the management of green infrastructure and also improve functioning and resilience of the natural ecosystems.

As explained, co-management has the potential to fulfil elements of justice as presented in the just sustsinability framework. However, implementing co-management, especially in a low-income community like Cosmo City, might not be that straight-forward. It would be challenging, based on Enengel *et al*. (2012) and Cundill *et al*.'s (2013) notes on the inherent complexities in co-management. Incorporating principles related to just sustainability might be very difficult because of heterogeneity in the low-income area. Being a context of urban poverty and inequality, co-management of green infrastructure as part of natural resources will need to tackle legitimacy, communication challenges, trust and commitment issues (Graham and Ernstson, 2012) that tend to derail associated initiatives. Conflict between the volunteering Cosmo City residents who were cleaning the parks and Johannesburg City Parks and Zoo, and stalemate resulting from it as mentioned in Chapter 7; illustrates one of the possible contradictions. Co-management in the context of Kya Sands might lead to conflicts because it will disturb the few residents who claim 'ownership' and use parts of the riparian space for livelihood activities.

These difficulties do not mean that co-management is entirely irrelevant in a context like Cosmo City or any other low-income urban community. Efforts that work with existing and potential contradictions and complexities are needed to ensure that a co-management approach to natural ecosystem keeps just sustainability in view on situations in informal urban areas.

Bringing together the two concepts that are linked to just sustainability, one can possibly argue that co-production in the absence of co-management has the potential to defeat initiatives that aim at improving quality of the environment. Co-management in the absence of co-production might have to deal with precedents of exclusion that might preclude an appropriate sense of ownership. Where informal settlement intervention is co-produced, building on positive aspects of the co-management of natural ecosystems functioning as green infrastructure can work towards the achievement of sustained improvement in the quality of life and environment.

8.8 *IN SITU* UPGRADING VERSUS RELOCATION: THE CASE OF RUIMSIG AND COSMO CITY

The approach that informal settlement intervention takes has implications on how just and/or sustainable the ensuing situations will be. Informal settlement intervention exemplified in the cases of Ruimsig and Cosmo City, in Chapters 6 and 7 respectively, offer an opportunity for comparison between *in situ* intervention and relocation approaches. Although not offering straightforward answers that do not lend thesemselves to an easy better-worse comparison, the cases present a chance to contrast how *in situ* intervention and relocation meet up with certain principles of just sustainability. In Table 8.2, I juxtaposed the two cases based on findings from the fieldwork, comparing them based on certain principles set out within the just sustainability framework earlier presented in Chapter 3.

A notable comment by a Ruimsig resident who is also one of the community leaders, usefully weighs *in situ* intervention against relocation in terms of the social context and the natural environment and is quoted here. He argues that

> 'RDP [which involves relocation] is not a solution. I prefer reblocking... because now we are totally attached to this particular area that we don't want to go anywhere. We are used to this environment. We are used to everything here. That's why I think it is better... As soon as you take someone, you are interfering with the status quo… There is this emotional impact of the process. But when you leave the people and they live like they do it is much better to maintain the understanding' (personal communication, Ruimsig Community leader, 31 July 2014).

Table 8.2 Comparing Ruimsig (in situ intervention) with Cosmo City (relocation): which is more just and sustainable?

	Aspect(s)	***In situ* Intervention (reblocking) – Ruimsig**	**Relocation - Cosmo City**
Empowerment	Livelihoods; Skills Acquisition; Poverty Alleviation	Reblocking did not include any deliberate livelihood or poverty alleviation program. However, *in situ* intervention sustained easy links to sources of livelihood within and outside the settlements, implying poverty was tackled incrementally. It retained and enhanced existing dependence on and livelihood that are based on surrounding natural ecosystems. The residents' involvement in planning and implementation of re-locking (construction of new shacks) led to the acquisition of certain skill sets which were useful in the long run.	Relocation took residents away from sources of livelihoods within and nearby the settlements. It implied that transportation costs are incurred for travel to places work. 'There was no consideration for livelihood strategies for the communities' as the municipality 'dusted off one old bylaw that says it is illegal to trade in a house – that it is not a commercial but a residential site' (personal communication, Planact Officer, 27 October 2014). This institutional disposition is anti-poor as it destroys home-based livelihoods. Although there were no programmes targeted at poverty alleviation initially, much later, activities by NGOs such FTFA, Planact target empowering the residents, for example through gardening and entrepreneurial training.
Participation	Decision-Making; Co-design; Implementation	Co-production of the *in situ* intervention to an extent involved participation of the residents in decision-making, planning and implementation, although the arrangement was dominated by SDI-affiliated NGOs.	The relocation was a top-down, state-led intervention with minimal levels of community participation. There are no significant inputs from the benefiting communities in the new development.
Inclusion	Integration; Diversity; Non-Discrimination	Non-South Africans and rural migrants who already own a house elsewhere were not excluded from the re-blocking (personal communication, Alex Opper, 21 August 2014). They had an opportunity to receive a stand thus retaining the community's diversity. Women were actively involved in the processes leading up to reblocking	South Africans and non-South Africans living in the informal settlements who do not qualify for the state-subsidised housing were excluded for benefitting in the relocation program. The green belt is instrumental to segregation in the entire Cosmo City community. Conversely, the parks serve as inclusive spaces where children across socio-economic classes relate
Fairness	Redress; Social capital;	Social networks within the settlement are retained, thus enhancing existing sense of	Existing social networks in the informal settlements are disrupted through relocation.

	Spatial justice	'community'. In situ intervention furthers the constitutional ideals of socio-spatial justice and inclusive spatial planning	Relocation is construed by the state as a means of redress for those historically disadvantaged through and beyond apartheid. Relocating informal settlements on well-located land in good locations implies spatial displacement
Ecology	Quantity and Quality of Green Space and Natural Ecosystems	Equitable distribution of stands presented opportunity for greening at the domestic level and in public spaces. But insecure tenure hampers this. The community preferred and earmarked materially and non-materially productive green open spaces, namely a community garden.	Stand space (with secure tenure) useable for domestic gardening is delivered to each household. The state developed parks and other green open spaces that result in non-tangible outcomes. Efforts are made to conserve the integrity of the green belt, but this failed.
Environmental Quality	Impact on Quality of the environment	Environmental burdens, especially flooding, experienced by the wetland reduced with the relocation of shacks.	A less polluted environment is created with the establishment of a new township with new houses in the green-field project.

As shown in Table 8.2, the case of Ruimsig settlement which epitomises *in situ* intervention, fulfils more principles related to human quality and social justice and is therefore more just when compared with relocation of Zevenfontein, Riverbend and Skosana residents to Cosmo City. This confirms the speculation emanating from the review, in Chapter 3, of the two informal settlement intervention approaches in South Africa. Upgrading of Informal Settlements Programme (UISP) – an *in situ* approach suggests a more just approach in comparison with relocation to subsidised housing.

This study considers natural ecosystems/green infrastructure which is an aspect in the broad spectrum of environmental sustainability. This limited aspect considered nevertheless show that improvement in the quality of the environment in the brown-field *in situ* intervention in Ruimsig is not substantive compared with the environment emanating from the green-field development of a new township. Creating spatial opportunities for greening show that both approaches can potentially lead to a 'green' community.

The two cases present a lesson for the situation in Kya Sands settlement. As contained in the national housing policy document, it is possible that informal settlement intervention result in housing contexts where 'developments are in balance with the carrying capacity of the natural systems on which they depend for their existence' (Department of Housing, 2004:12). To achieve this, a sustainable approach will need to deliberately incorporate environmental sustainability plans that recognise and taps into the residents' existing beneficial relationship with green infrastructure. Also, an inclusive approach to improving the quality of life with and not just for the residents is necessary.

8.9 CONCLUSION

Bringing the three cases together, this chapter shows that informality in relation to green infrastructure is expressed in diverse ways that cannot readily be predicted. The multi-faceted interactions between informal settlement residents and green infrastructure involve ecosystem services and ecosystem disservices, with both intertwined. If harnessed, ecosystem services have the potential to improve the quality of life in informal settlements. The cases demonstrate that creating spatial opportunities for green infrastructure at different scales will not automatically enhance the supply of ecosystem services. There is also doubt that the preference for

a user-pay model on green infrastructure and ecosystem services in Kya Sands implies a just approach. Comparison between interventions in Ruismig and Cosmo city suggests that *in situ* is more just in comparison to relocation from informal settlements to subsidised housing.

Implementing the concepts of co-production and co-management in informal settlement intervention might support just and sustainable situations but these are not straight-forward. As the cases show, the approaches will have to deal with intricate situations. This shows that seeking to achieve just sustainability in informal settlement intervention is not clearcut. While highlighting the difficulty in avheieving just sustainability, the cross-analysis made in this chapter provides a background for overall conclusion of the thesis in terms of just sustainability in relation to green infrastructure in informal settlement intervention.

CHAPTER 9

SUMMARY AND CONCLUSION

9.1 INTRODUCTION

Having reported, analysed and discussed the findings from the cases of Kya Sands, Ruimsig and Cosmo City in the context of socio-spatial inequality in Johannesburg, this last chapter provides a summary of the findings and draws conclusions on the case studies and entire thesis. To demonstrate that the objectives of the research have been achieved, the chapter begins by revisiting the research questions posed at the outset in Chapter 1, showing how findings across the cases answer the questions. The chapter goes further to show how the findings make original contributions to the body of knowledge. It also discusses limitations of the research and goes on to identify possible areas for future research emanating from the study. The thesis concludes with remarks on what the overall findings mean for the discourse regarding green infrastructure and possibility of just sustainability in interventions in and for informal urban settlements.

9.2 REVISITING THE OBJECTIVES OF THE THESIS AND RESEARCH QUESTIONS

The research set out to identify different types of ecosystem services and ecosystem disservices related to green infrastructure in informal urban areas, through the case studies of Kya Sands, Ruimsig and Cosmo City. It also aimed to provide insights, with the conceptual framing of just sustainability, in relation to green infrastructure in informal settlement intervention in Johannesburg. To achieve these objectives, I posed an overall research question which was devolved into three sub-questions. These questions guided the research process. Here, I revisit the sub-questions, identifying aspects of findings from the three case studies that provided answers to them and also addressing the overall research question.

Research Question 1: *What are ecosystem services and ecosystem disservices that green infrastructure provides to residents of informal settlements or areas that emerged through relocation from informal settlements?*

In Chapter 2, I reviewed the literature on green infrastructure, ecosystem services and ecosystem disservices *per se* and then in relation to informal urban settlements.

This review showed various dimensions of benefits (ecosystem services) and detriments (ecosystem disservices) involved in the different ways informal settlements are connected to natural ecosystems across developing countries. Honing in on the Johannesburg context, findings from the case study areas in Chapter 5, 6 and 7 demonstrate empirically how the residents of these areas derive a range of ecosystem services benefits from natural ecosystems. Pertinent information in this regard was gathered through extracts from available literature, by means of semi-structured in-depth interviews with residents and key informants and non-participant observation during transect walks. Thus, it was possible to demonstrate the different dimensions of provisioning, regulating, socio-cultural and supporting classification (based on the Millennium Ecosystem Assessment, 2005) of ecosystem services. All classes of the ecosystem services demonstrate the potential for incremental improvement in the quality of life of the residents and environment quality in the low-income areas.

Findings from the cases studies concur with certain positions in the literature, and suggest that the residents in the low-income communities place a premium on provisioning ecosystem services, in comparison with other kinds of services. As Wallace (2007) explains, provisioning services involve the supply of materials and resources such as food, water, which are basic for human survival.

The multifaceted ecosystem services associated with the urban poor have implications for the way substantive interventions by the state or non-state entities ought to occur in and for informal settlements. Interventions that restrict access to benign and beneficial interaction with natural ecosystems literarily imply a denial of the existing relationship with green infrastructure, especially relations on provisioning ecosystem services which involve the supply of resources that are basic for human survival.

The findings also show a range of ecosystem disservices which fall into the categories of either being based on perception or causing real problems, as proposed by Dunn (2010). All the undesirable aspects and disservices, both real and perception-based, are related to issues of security/safety, health (physiological and psychological), aesthetics, and the financial implications of harm and nuisances.

These tend to deepen existing disadvantages and deprivation in the low-income areas.

The cases demonstrate that ecosystem services and ecosystem disservices are intertwined and not that straightforward. Both services and disservices include layers of intertwining when considered against each other or against a host of socio-economic, socio-cultural and socio-political issues. Complexities also emerge when they are considered in the light of inclusion and redress for the disadvantaged and marginalised. This basically implies that considerations on green infrastructure in the realm of informal and low-income urban housing must be holistic.

Research Question 2: *How do formal interventions (either in situ or relocation) impact the relationship between residents and green infrastructure?*

Chapters 6 and 7 examined the impact of informal settlement intervention on the relationship Ruimsig and Cosmo City residents have with green infrastructure. In Ruimsig settlement, *in situ* intervention through reblocking resulted in spatial reconfiguration that created opportunities for greening, especially domestic gardening. Spatial reconfiguration of the settlement led to minimal improvement of environmental quality in the settlement. The intervention in Ruimsig was co-produced, that is, the reblocking involved the community, SDI-affiliated NGOs, the state and other actors. Co-producing the intervention involved processes and resulted in outcomes related to equity and inclusion. It also included situations that were exclusionary.

In the case of Cosmo City, relocation from informal settlements into a new housing environment tends to formally create spatial opportunities for greening. But these were not fully taken up by the residents due to socio-economic and socio-ecological realities which were not duly considered at the planning and design stage. Relocation into new housing environments with permanent infrastructure and services tends to reduce dependency on the natural ecosystem for certain provisioning ecosystem services such as water, which is supplied through taps. Formal connection to electricity is available; so dependence on firewood from trees for fuel is reduced. The course of events leading up to the relocation and post-occupancy trajectory around green spaces reveal shortfalls in relation to certain principles of justice, as well as

concerns on matching environmental sustainability with socio-economic development.

Juxtaposition between findings from the cases of Ruimsig and Cosmo City regarding certain principles related to just sustainability show that *in situ* intervention is more just, in comparison with relocation. In terms of green infrastructure, an aspect of environmental sustainability, relocation as exemplified in Cosmo City, tends to create new green-field and non-polluted environments. The aspects of just sustainability considered in the two cases present lessons on the way intervention should occur in the third case study — in Kya Sands settlement.

Research Question 3: *How might informal settlement interventions better meet the requiremnents of just sustainability?*

This thesis, through the three cases, reveals how principles of just sustainability have been realised or otherwise in terms of green infrastructure in informal settlement intervention in two ways. First, enhancing ecosystem services in informal settlements hold the potential for improvement in quality of life and environment, thus advancing the course of redress and fairness as well as facilitating empowerment for the socio-economically and environmentally disadvantaged.

Secondly, an analysis of the concepts of co-production and co-management in the light of just sustainability in the cases of Ruimsig and Cosmo City shows possibilities (and potential contradictions) in terms of achieving just sustainability in relation to informal settlement intervention. Drawbacks to achieving just sustainability through the co-produced intervention and co-management of green infrastructure are manifest through inherent dynamics related to matching the variety of intra-generational and inter-generational concerns in the setting into which informal settlements are embedded.

Notwithstanding the drawbacks and difficulties, aspiring for and working towards just sustainability is necessary. Just sustainability should be kept in view. This implies that equity and inclusion must be the key conditions the focal point against which considerations on green infrastructure associated with informal settlement environments are constantly assessed, counterbalanced and developed.

Brought together, findings that provide answers to the three sub-questions listed above also address the overall research question guiding this thesis. The three case studies have shown the ways residents in informal settlement relate with green infrastructure and how interventions impact this relationship in the light of just sustainability.

9.3 CONTRIBUTIONS TO KNOWLEDGE

This study contributes to the growing body of knowledge on green infrastructure, by offering insights from the perspective of informal settlements and low-income urban housing, a context that has not received adequate attention in the literature and in practice globally and in South Africa. It expounds on the utilisation of a green infrastructure approach and development of green spaces in in low-income residential urban environments.

Considering the various dimensions of the relationship between residents and natural ecosystems in the three case studies (Kya Sands, Ruimsig and Cosmo City) and erstwhile informal settlements (Zevenfontein, Riverbend and Skosana) enhances an understanding of ecosystem services and ecosystem disservices. Findings on benefits obtained (ecosystem services) in the areas provide additional evidence for the usefulness of green infrastructure, especially in relation to socio-economically and disadvantaged people living in informal settlements. Findings on negative experiences and perceptions on green infrastructure - ecosystem disservices, which are not presently well-known or properly understood in relation to informal housing, to an extent address gaps in the literature. This study is therefore novel in the sense that it co-considers the positive as well as negative aspects of residents' relationships with natural ecosystems in the under-explored realm of informal settlements.

This study addresses a knowledge gap regarding environmental aspects in the discourse on informal settlement interventions. By engaging with the context preceding and following substantive intervention in informal settlements, the study speaks to the appropriateness or otherwise of intervention approaches from the bio-physical and ecological perspective. Based on the evaluation framework developed, the study points to levels of participation, inclusion, fairness, empowerment, redress across the three case studies. This shows how certain principles of justice and

environmental sustainability might be or might not be pursued in the course of intervention in and for informal settlements.

Analysis on how justice and injustices (and what constitutes them) manifest in relation to green infrastructure across the three cases is useful. Combining it with a comparison of the extent to which intervention approaches are environmentally sustainable contributes to the concept of just sustainability. It reveals how intertwined and complicated the issues related to just sustainability are in the context of informality.

Apart from improving understanding in these realms, the study is potentially useful for policy and programme refinement regarding the development and management of human settlements for the socially, economically and environmentally disadvantaged in Johannesburg and beyond through informal settlement intervention.

9.4 LIMITATIONS OF THE STUDY

This thesis is based on a cross-sectional study, that is, the research was conducted at within a short period. It employed a qualitative methodology, using a case study design and qualitative data collection methods. As a result, the findings are largely derived from perspectives of the residents and key informants and not based on positivist quantitative evidence. The case study approach involved only three areas in the entire Johannesburg which were purposively sampled and not intended to be representative of all informal settlements across the city.

Only two forms of informal settlement interventions – *in situ* improvement through reblocking and relocation into new housing were considered. As indicated in Chapter 4, this methodological approach has limitations in terms of generalising across all informal settlements in Johannesburg and beyond or for the various kinds of informal settlement intervention approaches available.

The study does not delve into trade-offs regarding ecosystem services, especially how the benefits are valued in relation to other capitals, e.g. having/accessing a job versus continued direct benefits of services from natural ecosystems. As a result, it could not link trade-offs to frameworks based on natural capital, such as Sustainable Livelihoods Framework as developed by Du Plessis and Napier (2001) in relation to Sustainable Human Settlements.

Also, only green infrastructure was considered of the various components of sustainability. This limited focus does not allow categorically worse-better conclusions on environmental sustainability.

9.5 SUGGESTIONS FOR FUTURE RESEARCH

Analysis of findings from the three cases brings to light possible areas that future research can build on. First, analysis of the multi-faceted ways informal settlement residents relate with green infrastructure was based on qualitative data. Given that the study did not rely much on quantitative data on ecosystem services and ecosystem disservices, it would be useful to seek quantitative dimensions to the findings. For example, how many kilogrammes of food is harvested from home gardens and what percentage of household food requirements does it represent? What level of temperature control or volume of runoff attenuation/reduction do different components of green infrastructure in informal settlements offer? What are the financial implications of the phenomena of ecosystem disservices such as mosquitoes from home gardens or the wetland? Quantitative evidence on these issues should usefully inform necessary trade-offs in the intertwining of ecosystem services and ecosystem disservices in the realm of low-income urban settlements.

Another emerging issue is the need to focus on natural ecosystems serving as a source of livelihood in the areas. For example, home gardens provide food or other materials that are sold and generate additional income for households. As evident in the case of Cosmo City, this aspect of livelihoods is threatened by informal developments and densification. Investigating this realm is worthwhile, since livelihoods are crucial to the success and sustainability of informal settlement interventions. It is necessary to better understand how livelihoods based on natural ecosystems can contribute to socio-economic development and the related socio-spatial implications. This area particularly speaks to the overarching need to move certain benefits (ecosystem services) to scale, for instance producing more food in gardens and taking gardening to a more rewarding level for those engaging in it in informal settlements. The Sustainable Livelihoods Framework would be useful at this point.

A longitudinal research strategy based on a combination of qualitative and quantitative methods, though seemingly large-scale, would be useful. On-going and

proposed informal settlement intervention projects across cities in Africa present opportunities for such long-term studies. Given the heterogeneity of informal settlements, it would also be useful to examine how other informal settlement intervention approaches in other cities impact residents' relationship with green infrastructure.

As mentioned earlier, green infrastructure/ecology was the only aspect considered of the various components of environmental sustainability. Other aspects which contribute to urban metabolic flows – energy, water, transport and waste — deserve consideration in relation to informal settlement intervention approaches. Considering these aspects can provide additional and broader evidence on which of *in situ* or relocation is actually eco-friendly (through reduced greenhouse gas emissions) and ultimately more environmentally sustainable.

Having shown how residents' relationship with green infrastructure results in various categories of ecosystem services through the case studies, it is useful to investigate how these services contribute to adaptive capacity and resilience. Understanding how different approaches to informal settlement intervention impact these contributions will be useful for addressing the vulnerability of the disadvantaged residents to various forms of shocks and stresses.

9.6 CONCLUDING REMARKS

This thesis shows that careful assessment of the relationship between those living in informal settlements and green infrastructure — their interaction with natural ecosystems — should influence the approach to informal settlement interventions. It should inform whether to relocate or make *in situ* interventions. It is only by considering and building on, rather than eliminating beneficial aspects of this relationship and interaction, that intervention in and for informal settlements can truly work towards principles related to justice for the disadvantaged and marginalised as well as a sustainable environment.

It is also clear from the case studies that achieving just sustainability in relation to green infrastructure in informal settlement intervention is not straightforward, but also not impossible. Given the positive and negative dimensions, and as demonstrated through the connection between co-production, co-management and

the concept of just sustainability, careful attention to certain issues is needed. This attention implies navigating (with foresight rather than hindsight) the multiple dimensions, intricacies and potentially negative dynamics obtainable in contexts into which informal settlements are embedded.

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Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 ADEGUN

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER H14/03/15**
PROJECT TITLE	Informal settlement intervention and green infrastructure: Exploring just sustainability in the case of Kya Sands and Cosmo City in Johannesburg
INVESTIGATOR(S)	Mr OB ADEGUN
SCHOOL/DEPARTMENT	Architecture and Planning
DATE CONSIDERED	28 March 2014
DECISION OF THE COMMITTEE	Approved Unconditionally
EXPIRY DATE	11/05/2016

DATE 12/05/2014 **CHAIRPERSON** _____ (Professor T Milani)

cc: Supervisor : Prof M Huchzermeyer and Dr B Boshoff

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10000, 10th Floor, Senate House, University.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

_____ _____/_____/_____
Signature **Date**

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

City of Johannesburg
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09 May 2014

To Whom It May Concern

Dear Sir/Madam

PERMISSION TO CONDUCT RESEARCH FOR PhD STUDIES

The Innovation & Knowledge Management (IKM) is a unit within the Group Strategy, Policy Coordination and Relations (GSPCR) with the mandate to inculcate a culture and practice of learning and sharing within the organisation including collaborating with relevant external stakeholders and ensure replication and promotion of better practices.

One of our key objectives is to develop and maintain an organisational repository on Research & Development initiatives including reports and studies related to key City initiatives which knowledge can be used and shared for learning purposes.

Our unit has been approached by Mr Olumuyiwa Adegun, School of Architecture and Planning, University of the Witwatersrand, who is conducting research focusing on the consideration of bio-physical assets connected to informal settlements and townships established from informal settlements, and how the people relate with it as green infrastructure. His research involves two case studies in Johannesburg (Cosmo City and Kya sand township informal settlement) and interviews with some knowledgeable people. The research aims to add to the literature on climate change adaptation and informal settlements. The study will help in widening our understanding on climate change and informal settlements. It will also help in understanding household adaptive capacity.

The findings will be of benefit to the City for our internal learning purposes as well as relevant to policy development and to inform local communities on their adaptation capacities and how they can enhance or optimise them.

It is with this in mind that IKM supports Mr Olumuyiwa's request to engage and interview relevant internal stakeholders within the City of Johannesburg provided that the final PhD report will be shared with the City for our repository purposes.

Your assistance and support during this research period will be greatly appreciated and should you have any further enquiries please do not hesitate to contact me.

Thank you



Pakiso Harvey Phalatse, APR

Director:
Innovation & Knowledge Management
Group Strategy, Policy Coordination and Relations

Tel: (011) 407 6771

PARTICIPANT INFORMATION SHEET

(INFORMAL SETTLEMENT/TOWNSHIP – TRANSECT WALK)

Dear Participant,

This serves to introduce myself, OlumuyiwaAdegun, a PhD candidate being supervised by Prof. Marie Huchzermeyer and Dr Brian Boshoffin the School of Architecture and Planning, Wits University.

I am researching how informal settlements and natural systems (e.g. wetlands) and spaces (riparian corridor, open spaces)relate. The study's results will be potentially useful towards the development and management of urban human settlements for the poor.

I am inviting you to be a part of this study. You are selected because your settlement/township is chosen as one of the case study areas. Your participation will involve a walk, with some other residents, across a part of the township/settlement during which you would be required to look, listen, observe, and be asked questions. You may also be required to produce diagrams of certain places in the settlement/township as it comes to your mind. This would take between 40 and 50 minutes, at any period of the daythat members of the walking group agree on.

This study is purely for academic purposes and does not constitute any promise for interventions or change by any government unit or private entity.Your participation does not involve payments or benefits from me or anyone else.Participation is voluntary, and at your own risk.Please let me know at any stage you would like to discontinue your participation, for whatever reason. No penaltiesare associated with your participation or refusal to participate. You may ask me to repeat and explain any question you are not clear with. You may refuse to answer questions you feel uncomfortable with. Your identity will be anonymous, i.e. I will not use your name in my report. Confidentiality cannot be guaranteed on information given during the transect walk since issues are discussed in a group setting. However, other participants will be encouraged to keep information shared during the walk confidential.

Results from this study will be reported in my PhD thesis, (which, once I have graduated will be available on the university's website) at seminars/conferences and in academic papers which I'm required to write. Summary of the study can be made available, if you so request.

If you have any questions, feel free to contact me or my supervisors through the details below.

Many thanks.

PhD Candidate: OlumuyiwaAdegun (Student No- 375253),
+27784297932; olumuyiwa.adegun@students.wits.ac.za
Supervisor: Professor Marie Huchzermeyer/ marie.huchzermeyer@wits.ac.za/0834242457
Co-Supervisor: Dr Brian Boshoff/brian.boshoff@wits.ac.za /0732677176

PARTICIPANT INFORMATION SHEET

(KEY INFORMANTS - PERSONS AFFILIATED WITH FORMAL INSTITUTIONS)

Dear Participant,

This serves to introduce me, OlumuyiwaAdegun, a PhD candidate being supervised by Prof. Marie Huchzermeyer and Dr Brian Boshoff, in the School of Architecture and Planning, Wits University.

I am researching how informal settlements and interventions, relate with natural assets (especially the hydrological related ones)serving as green infrastructure. The study aims to improve understanding oninformal settlement intervention from a bio-physical perspective. Results of this academic study will be potentially useful towards the development and management of just and sustainable urban human settlements for the poor.

I would like to invite you to be part of this study. You are selected based on the knowledge and experience you have on the themes the study involves. Your participation will involve a semi-structured interview session, which will take between 25to 45 minutes, at any period of the day that is convenient for you and at a location suitable to you.

Your participation is voluntary, and does not involve payments from me or anyone else.Please let me know at any stage you would like to discontinue your participation, for whatever reason. There are no penalties associated with your participation or refusal to participate. You may ask me to repeat and explain any question you are not clear with. You may refuse to answer questions you feel uncomfortable with. Your identity will be anonymous, i.e. I will not use your name or position in my report, unless you give me permission to do so, or prefer me to do so. The information I receive from you will be confidential, that is, I will use it only for this study and will not make it available to anyone else, for whatever purpose.

Results from this study will be reported in my PhD thesis, (whichwill be available on the university's website after graduation) at seminars/conferences and in academic papers which I'm required to write. A summary of the research can be made available, if you so request.

If you have any questions, feel free to contact me or my supervisors through the details below.

Many thanks.

PhD Candidate: OlumuyiwaAdegun (Student No- 375253),
Cell phone: 0784297932; olumuyiwa.adegun@students.wits.ac.za

Supervisor: Professor Marie Huchzermeyer/Cell phone: 0834242457/marie.huchzermeyer@wits.ac.za

Co-supervisor: Dr Brian Boshoff/Cell phone: 0732677176/brian.boshoff@wits.ac.za

(INFORMAL SETTLEMENT/TOWNSHIP – INTERVIEWS)

Dear Participant,

This serves to introduce myself, OlumuyiwaAdegun, a PhD candidate being supervised by Prof. Marie Huchzermeyer and Dr Brian Boshoffin the School of Architecture and Planning, Wits University.

I am researching how informal settlements and natural systems (e.g. wetlands) and spaces (riparian corridor, open spaces)relate. The study's results will be potentially useful towards the development and management of urban human settlements for the poor.

I am inviting you to be a part of this study. You are selected because your settlement/township is chosen as one of the case study areas. Your participation will involve an interview session. The interview will take between 30 to 50 minutes, at any period of the day that is convenient to you and at a location within the settlement/township suitable to you.

Your participation is voluntary, and does not involve payments or benefits from me or anyone else. This research is purely for academic purposes. It does not constitute any promise for interventions or change by any government unit or private entity.You may ask me to repeat and explain any question you are not clear with. You may refuse to answer questions you feel uncomfortable with. Please let me know at any stage you would like to discontinue your participation, for whatever reason. There are no penaltiesassociated with your participation or refusal to participate. Your identity will be anonymous, that is, I will not use your name in my report. Information given through the interviews will be confidential, which means that I will use it only for the study.

Results from this study will be reported in my PhD thesis, (which, once I have graduated will be available on the university's website) at seminars/conferences and in academic papers which I'm required to write. Summary of the study can be made available, if you so request.

If you have any questions, feel free to contact me or my supervisors through the details below.

Many thanks.

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Co-Supervisor: Dr Brian Boshoff/brian.boshoff@wits.ac.za /0732677176

PARTICIPANT INFORMATION SHEET

(INFORMAL SETTLEMENT/TOWNSHIP –FOCUS GROUP DISCUSSION)

Dear Participant,

This serves to introduce myself, OlumuyiwaAdegun, a PhD candidate being supervised by Prof. Marie Huchzermeyer and Dr Brian Boshoffin the School of Architecture and Planning, Wits University.

I am researching how informal settlements and natural systems (e.g. wetlands) and spaces (riparian corridor, open spaces)relate. The study's results will be potentially useful towards the development and management of urban human settlements for the poor.

I am inviting you to be a part of this study. You are selected because your settlement/township is chosen as one of the case study areas. Your participation will involve a focus group discussion. The focus group will involve a small group discussion with me, the PhD researcher, and will take between 40 to 50 minutes, at any period of the dayand location within the settlement/township that members of the group agree on.

Your participation is voluntary, and does not involve payments from me or anyone else.You may ask me to repeat and explain any question you are not clear with. You may refuse to answer questions you feel uncomfortable with. Please let me know at any stage you would like to discontinue your participation, for whatever reason. There are no penalties associated with your participation or refusal to participate. Your identity will be anonymous, that is, I will not use your name in my report. Confidentiality on information given through the focus group cannot be guaranteed since issues are discussed in a group setting. However, all members of the focus group will be encouraged to keep information shared during the discussion confidential.

Results from this study will be reported in my PhD thesis, (which, once I have graduated will be available on the university's website) at seminars/conferences and in academic papers which I'm required to write. Summary of the study can be made available, if you so request.

If you have any questions, feel free to contact me or my supervisors through the details below.

Many thanks.

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Co-Supervisor: Dr Brian Boshoff/brian.boshoff@wits.ac.za /0732677176

ISHIDI LEMININGWANE YOBAMBA IQHAZA

(Izakhiwoeziyimijondolo/Ilokishi)

MbambiweqhazaOthandekayo,

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ISitshudenisePhD: OlumuyiwaAdegun (Student No- 375253),
School of Architecture and Planning, Wits University, Private Bag 3, Wits 2050, Johannesburg.
+27784297932; muyiwaadegun@yahoo.co.uk; olumuyiwa.adegun@students.wits.ac.za
Abaphathi: OSolwazi Marie Huchzermeyer/marie.huchzermeyer@wits.ac.za/0834242457
Dkt. Brian Boshoff/brian.boschoff@wits.ac.za /+27117177708

CONTIGENCY VALUATION SURVEY - WILLINGNESS TO PAY (WTP) FOR GREEN INFRASTRUCTURE IN KYA SANDS SETTLEMENT

Dear Respondent,

I, Olumuyiwa Adegun, PhD Candidate in the School of Architecture and Planning, University of the Witwatersrand, request your voluntary participation in this survey. This survey intends to find out how much you are willing to pay if the mentioned green infrastructure is to be developed in Kya Sands Settlement. It is solely for academic purposes. Please answer the questions truthfully. Your response is anonymous and answers will be treated confidentially. There is no payment for participation or sanction for not participating.

Many thanks.

OB Adegun
olumuyiwa.adegun@students.wits.ac.za
Room 219, John Moffat Building
School of Architecture and Planning
University of the Witwatersrand, East Campus
Wits 2050, Johannesburg

SCHOOL OF ARCHITECTURE & PLANNING

1. Gender: Male ☐ Female ☐
2. Age: less than 18 yrs ☐; 18-24 yrs ☐; 25-34yrs ☐; 35-49 yrs ☐; 50-65 yrs ☐; over 65 yrs ☐
3. Marital Status: Single ☐; Married ☐; Co-habiting ☐; Divorced ☐
4. Household Size: 1 ☐; 2-4 ☐; more than 4 ☐
5. Kya Sands Section where you reside: A ☐; B ☐; C ☐; D ☐; E ☐; F ☐; outside Kya Sand ☐
6. How long have you been living in Kya Sands? Less than 3 months ☐; 3-12 months ☐;
   Between 1 and 5years ☐; Between 5 and 10 years ☐ Over 10 years ☐
7. Education level: Primary ☐; High School (Didn't Matriculate) ☐; High School (Matriculated) ☐; College ☐;
   University/Technikon ☐; Post-graduate ☐
8. Monthly household income? Less than R1500 ☐; R1501-3500 ☐; R3501-9000 ☐; Over R9000 ☐
9. Would you be willing to pay to use green spaces shown in the table below, if it were developed in the settlement by a <u>member (entrepreneur) of the community</u>? Yes ☐; No ☐
   If yes, how much are you willing to pay monthly?

	Green Space Type	R0	R1 -20	R21- 50	R51- 100	R101- 200	R201- 500	Over R500
1	Play park (with vegetation and play equipment) for children							
2	Community Park (with vegetation) for all							
3	Individual lot in a Community food garden							
4	Cleaning and maintaining the river, and planting vegetation in its surrounding							

10. Would you be willing to pay to use green spaces shown in the table below, if it were developed in the settlement by an <u>NGO</u>? Yes☐; No ☐
    If yes, how much are you willing to pay monthly?

	Green Space Type	R0	R1 -20	R21- 50	R51- 100	R101- 200	R201- 500	Over R500
1	Play park (with vegetation and play equipment) for children							
2	Community Park (with vegetation) for all							
3	Individual lot in a Community food garden							
4	Cleaning and maintaining the river, and planting vegetation in its surrounding							

11. Would you be willing to pay to use green spaces shown in the table below, if it were developed in the settlement by the <u>municipality?</u> Yes☐; No ☐
    If yes, how much are you willing to pay monthly?

	Green Space Type	R0	R1 -20	R21- 50	R51- 100	R101- 200	R201- 500	Over R500
1	Play park (with vegetation and play equipment) for children							
2	Community Park (with vegetation) for all							
3	Individual lot in a Community food garden							
4	Cleaning and maintaining the river, and planting vegetation in its surrounding							

Amount willing to be pay for various green spaces by a range of developers.

Green Space Type	Amount per month	Entrepreneurial Resident	%	NGO	%	Municipality	%
Stream and riparian corridor rehabilitation and maintenance	Not paying	42	22.34	53	28.19	114	60.64
	R1-20	87	46.28	80	42.55	41	21.81
	R21-50	27	14.36	27	14.36	15	7.98
	R51-100	13	6.91	11	5.85	3	1.60
	R101-200	10	5.32	10	5.32	9	4.79
	R201-500	4	2.13	3	1.60	4	2.13
	Over R500	4	2.13	2	1.06	1	0.53
	Undisclosed	1	0.53	2	1.06	1	0.53
Lot in a community garden	Not paying	34	18.09	52	27.66	113	60.11
	R1-20	80	42.55	74	39.36	35	18.62
	R21-50	29	15.43	27	14.36	13	6.91
	R51-100	16	8.51	16	8.51	14	7.45
	R101-200	14	7.45	12	6.38	6	3.19
	R201-500	8	4.26	4	2.13	6	3.19
	Over R500	6	3.19	2	1.06	1	0.53
	Undisclosed	1	0.53	1	0.53	0	0.00
Community Park	Not paying	37	19.68	51	27.13	111	59.04
	R1-20	88	46.81	93	49.47	46	24.47
	R21-50	30	15.96	21	11.17	13	6.91
	R51-100	20	10.64	13	6.91	9	4.79
	R101-200	9	4.79	7	3.72	6	3.19
	R201-500	1	0.53	1	0.53	3	1.60
	Over R500	3	1.60	2	1.06	0	0.00
Children Play Park	Not paying	31	16.49	50	26.60	108	57.45
	R1-20	94	50.00	87	46.28	51	27.13
	R21-50	31	16.49	31	16.49	12	6.38
	R51-100	18	9.57	11	5.85	6	3.19
	R101-200	9	4.79	5	2.66	5	2.66
	R201-500	4	2.13	4	2.13	5	2.66
	Over R500	1	0.53	0	0.00	1	0.53
	Sub-totals	188	100	188	100	188	100