

Linking Ecosystem Goods and Services to Sustainability, Risks and Opportunities: Informing decision-making in the Msunduzi Municipality, KwaZulu-Natal, South Africa.

By

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Abstract

Sustainable development's wide scale adoption has resulted in the rapid emergence of the field Sustainability Science. This trans-disciplinary field of research attempts to understand the interconnectedness, relationships and complexity between the natural environment and society. To understand these relationships and integration between the natural environment, the economy and society within a sustainability context, an ecosystem goods and services (EGS) approach can be taken. EGS research is being incorporated into mainstream environmental decision-making and strategic thinking, particularly within the corporate sector, however, adoption has been slow. The Corporate Ecosystem Services Review (ESR) is a framework, developed by the World Research Institute (WRI), which aims to assess the dependence and impact that a company has on EGS through a systematic approach. This methodological framework can be adapted into a tool that assists in more informed environmental decision-making at a local government level. This adapted tool highlights EGS issues within particular open spaces and links these issues to sustainability targets and identifies risks and opportunities for local government. For this research, the ESR tool was tested on open spaces within the Msunduzi Municipality, KwaZulu-Natal, by adapting the ESR methodological framework to relate to local government decision-making and by incorporating existing tools and strategic documents, namely the Environmental Management Framework (EMF) and the Spatial Development Framework (SDF), into the EGS assessment tool. Site-specific EGS issues were identified at two open space study sites through posing different development scenarios, and results from testing the tool revealed linkages between EGS and risks and opportunities for sustainability. The tool has applicability to local level decision-making, particularly in the early stages of development planning, by providing a more holistic input into the environmental decision-making process.

Declaration

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Mrs Dayle Trotter-Richardson (supervisor)

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List of Acronyms

- CEA - Cumulative Effects Assessment
- CEC - Committee on Environmental Coordination
- DAEA - Department of Agriculture and Environmental Affairs
- DAFF - Department of Agriculture, Forestry and Fishing
- DEAT – Department of Environmental Affairs and Tourism
- DAEA&RD - Department of Agriculture, Environmental Affairs and Rural Development
- DME - Department of Minerals and Energy
- DWE - Department of Water and Environment
- ECA - Environment Conservation Act (Act 73 of 1989, South Africa)
- EGS - Ecosystem Goods and Services
- EIA - Environmental Impact Assessment
- EIP – Environmental Implementation Plan
- EKZNW - Ezemvelo KwaZulu-Natal Wildlife
- EMF - Environmental Management Framework
- EMP - Environmental Management Plan
- EMS - Environmental Management Systems
- ESR – Corporate Ecosystem Services Review
- IEM - Integrated Environmental Management
- IDP - Integrated Development Plan
- MA - Millennium Ecosystem Assessment
- MDG - Millennium Development Goals
- MEC - Members of the Executive Council
- NEAF - National Environmental Advisory Forum
- NEPA – National Environmental Policy Act, USA
- NEMA – National Environmental Management Act (Act 107 of 1998, South Africa)
- NFSD - National Framework for Sustainable Development (2008), South Africa,

SCC - Sustainability Criteria Checklist

SDF - Spatial Development Framework

SEA - Strategic Environmental Assessment

SEMP - Strategic Environmental Management Plan

SIA - Social Impact Assessment

TEEB – The Economics of Ecosystems and Biodiversity

WBCSD – World Business Council for Sustainable Development

WEF - World Economic Forum

WRI - World Research Institute

WSSD - World Summit on Sustainable Development

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Chapter One Introduction

1.1 Introduction

Global climate and biodiversity patterns are in a state of flux which can predominately be attributed to human activities driven by the pursuit of economic growth, political power, spiritual fulfilment and intellectual gain (Goodstein, 2010). Over the last few decades the realisation that our natural environment has a finite carrying capacity with intricate relationships and thresholds between abiotic and biotic entities has led to an emerging hegemony of living according to sustainability principles, that is maximising societal development and growth while ensuring the protection and conservation of the natural environment for future generations (Kates *et al.*, 2005; Leiserowitz *et al.*, 2005). This ideology of ‘balancing’ the relationship between the natural environment and society has resulted in the emergence of an array of fields of research, such as sustainability science, that is focused on improving the capability of the natural and built environments to provide solutions to meet the needs of an expanding global population whilst at the same time offering answers to the challenges of resource depletion, biodiversity loss and climate change (Komiyama and Takeuchi, 2006; Clark, 2007). Many of the solutions to global community challenges, such as water and food security, can be found in the way in which the environment is managed and understood through the lens of sustainability science as it offers a proactive, efficient and effective stance towards environmental management practices and policies (Aronson *et al.*, 2010).

Continued research into the processes, interactions and relationships of our built, economic, physical and natural environments creates a better understanding of how nature can be utilised in the most sustainable way and to ensure that development and economic needs are brought in line with the needs of the natural environment (Arima, 2009). One such research avenue to achieve this goal is to investigate the planet’s ecosystems and the goods and services they provide (EGS) (Tallis *et al.*, 2009). These complex systems, consisting of both intra- and inter-specific relationships, are essential to nearly everything which man requires for survival. From the air we breathe, food we eat, industrial revolutions sparked, manufactured items produced, even the creation of electricity can all be attributed to past and present functioning ecosystems. These processes are as a result of the productive nature of ecosystems. Ecosystems produce goods and services which we as humans utilize, most without noticing, contemplating or appreciating the full value to our day-to-day lives

and are a vital component to the development of economies and societies (Daily *et al.*, 1997; Daily *et al.*, 2000; Tallis and Kareiva, 2005). As such, EGS should be seen as a crucial piece of the sustainability ideology and therefore ought to be a key focus of research and understanding and bring EGS into the discourse of the decision-maker (Tallis *et al.*, 2008). Considering the natural environment through an economic perspective of EGS has a universal appeal as it quantifies natural resources in monetary terms, and allows built, financial and human capital to be compared to natural capital. This allows for the risk associated with losing natural capital to be compared to the opportunities presented through conservations, preservations and restoration. This means that not only is human and financial capital regarded as important aspects of development, so too is natural capital and the production function of ecosystems (Turner and Daily, 2008).

Research by Costanza *et al* (1998) on valuing ecosystems on a global scale is considered a seminal paper where the economic value of the world's ecosystems were estimated to be worth on average US\$33 trillion per annum in 1998. While such macroeconomic research possesses limitations and potential errors, it emphasises the importance of EGS to the global economy. Balmford *et al* (2002) estimated that the benefit to cost ratio for conserving our remaining wild areas was 100:1. This highlights the importance of natural resources and provides a strong case for sustainable usage of the EGS, which has been strengthened by increasing research on the dependence that businesses, governments and people have on EGS (Daily *et al.*, 2009; Ground Truth, 2009; SRK Consulting, 2009; TEEB, 2010a; TEEB, 2011). The impacts on ecosystems from the demand for social-development, economic growth and the pressures of an increasing population are highlighted by large-scale ground-breaking international research such as the Millennium Ecosystem Assessment (MA) (MA, 2005a) and The Economics of Ecosystems and Biodiversity (TEEB, 2010b).

In 2003, the international initiative entitled the Millennium Ecosystem Assessment (MA) was designed to investigate the state of the world's ecosystems at multiple scales and the functionality of these ecosystems to deliver goods and services. The assessment focused on the interaction between human wellbeing and livelihoods and the EGS provided by the environment (Bohensky *et al.*, 2004; Carpenter *et al.*, 2006). The MA investigated the drivers, such as climate change and urban expansion that cause change to the functionality of ecosystems which have implications on human wellbeing. Major international projects such as the MA and the Millennium Development Goals (MDGs) built on existing work by leading researchers to produce a conceptual framework

which highlighted EGS as a provider to society, how society benefits from these services and how our actions have implications for service provision (Tallis *et al.*, 2008; Carpenter *et al.*, 2009). These key projects brought to the attention of decision-makers the importance of recognising EGS as a key assets in service provision and highlighted the risks of not doing so to human wellbeing (Daily and Matson, 2008; Daily *et al.*, 2009). This is a notion that has been picked up by heads-of-states and government ministers in a G8+5 summit, (a group that consists of the heads of state from the G8 nations and the five heads of state from the leading emerging economies), in 2007. Leaders agreed to initiate a process whereby the global economic value and benefits of biodiversity could be analysed so that the costs of biodiversity loss and the lack of environmental policy integration are highlighted should ineffective and unsustainable conservation practises be maintained. This process resulted in a global study entitled The Economics of Ecosystems and Biodiversity (TEEB) which released seven documents that address the importance of integrating ecosystem-based economic thinking into mainstream economics; global, national and local policy development; business models and the general public (TEEB, 2010b).

The TEEB study provides a link between the complex and multidisciplinary science of biodiversity and ecosystems to the discourse of multilateral, national and local policy and practices with the intention of natural capital values being fully reflected in public and private decision-making (TEEB, 2010b). The TEEB reports highlight numerous recommendations and provide solutions to complex EGS assessment dilemmas by exploring current and future research and highlighting successful case studies, some of which will be carried through into this research. However, while global perspectives provide invaluable insights into the complex study of EGS, local perspectives and understanding are crucial if the goals of sustainability are to be upheld. Grassroots or local level policies based on an EGS approach may have direct positive benefits to affected ecosystems and provide unique opportunities, as it is at this level that real change can be implemented. The advantages of taking an EGS approach have been noticed by the private sector where companies are beginning to investigate the role of EGS in their business processes (TEEB, 2011).

The TEEB for business study (TEEB, 2011) highlights corporate-based EGS assessments that are integrated into business sustainability strategies as companies start to realise the relationship between biodiversity and their bottom line. Business risks increase as ecosystems are destroyed and EGS productivity declines due to their business operations. By developing strategies to reduce this

risk and internalise biodiversity issues, business can turn these risks into opportunities. Increasingly consumers are taking the environment into consideration when purchasing products, as their understanding improves of how companies relate to EGS in their manufacturing process. Businesses have started to internalise the threat posed by EGS loss by implementing strategies to reduce the risk to business growth prospects through corporate based EGS assessments, such as the WRI's Corporate Ecosystem Services Review (ESR) (Hanson *et al.*, 2008). Local and regional policy makers can look to adapting corporate EGS methodological frameworks to highlight environmental risks and opportunities for a local government that can translate into business risk and opportunities. Adapting these frameworks can result in better informed and sustainable orientated environmental decision-making. However, for EGS orientated decision-making to be effective it has to be relevant to a country's current environmental legislation, policies and practices. In South Africa this is essential if we are to understand our dependence on our natural resources for economic growth and service delivery.

South Africa's environmental policies are influenced by the concept of sustainable development in that they aim to achieve economic growth, social development and environmental protection and preservation. This notion can be seen from the National Constitution (Act 108 of 1996) through to all levels of governance; national, provincial and local. This notion is carried through into statutory and voluntary mechanisms or tools for environmental management such as environmental management frameworks (EMF) and strategic environmental assessments (SEA) in what is termed Integrated Environmental Management (IEM). The very nature of IEM means that it needs to keep up to pace with international and local best practise. EGS based assessments are slowly becoming part of environmental management best practise and are gaining importance in various aspects of IEM (Cowling *et al.*, 2008). These assessments are starting to become an important part of managing growth and development both in a reactionary sense, with environmental impact assessments (EIA) and in a precautionary sense, with EMFs and SEAs. Assessing the EGS that are supplied to society and understanding the economic and societal value of these ecosystems can significantly improve environmental and land use planning, decision-making and policy formulation. South African municipalities are required by law, through the Municipal Systems Act (Act 32 of 2000), to undertake an Integrated Development Plan (IDP), which is expected to incorporate the principles of IEM when determining strategies for development and economic growth (Republic of South Africa, 2000). Yet few municipal IDPs refer to EGS in their IDPs and therefore those communities are at increased risk of losing a sustainable supply of natural resources

(SRK Consulting, 2010b). This can be changed by exploring a appropriate economic theory, sustainability reporting and risk assessment techniques that can be used to enhance strategic decision-making surrounding EGS and their associated value to people and the local economy. Taking a trans-disciplinary approach to decision-making, that includes the economy, society and the benefits of healthy functioning EGS, will result in more sustainable usage of natural resources. Some municipalities have taken this proactive stance and following the example of international best practise, have incorporated EGS based assessments in their strategic environmental and land use planning, such as the Msunduzi Municipality in KwaZulu-Natal.

The Msunduzi Municipality (Pietermaritzburg and surrounding areas) in KwaZulu-Natal, South Africa, is a proactive municipality with regards to strategic environmental planning and has prepared an EMF for the area under its governance. The main aim of this EMF is to streamline the EIA process and to assist in local level decision-making through the identification of environmental attributes in the Municipality and the associated development opportunities and constraints. The EMF process recognised the importance of assessing ecosystem goods and services in the Municipality, however, a detailed investigation and valuation thereof has not yet been conducted.

The current research aims to develop on the EMF process by using corporate based EGS assessment frameworks to assist in the Municipality to make more informed decisions. EGS based assessments could be viewed as essential to effective local government environmental management as they can deliver on the goals of sustainable economic growth and social development while achieving environmental objectives. Drawing from international and local research, key aspects of the Msunduzi EMF and a corporate EGS assessment methodology, a tool is developed that will aid the municipality in incorporating EGS into environmental decision-making. This tool will result in EGS being viewed in a municipal development context so that local decision-makers could increase their understanding of EGS and the benefits this has for the provision of services to society. It is important to mention that this approach is a relatively new concept in South Africa and supporting literature and case studies of this type of application are limited.

1.2 Aim and objectives

To develop an adapted corporate-based EGS assessment and risk tool to assist in the local government environmental decision-making process, by focussing on the local case study of the Msunduzi Municipality. This will be achieved through the following objectives:

1. Review theory on Sustainability Science, past and current EGS research approaches and applications and Integrated Environmental Management in South Africa, to achieve an understanding of how EGS-based approach can be incorporated into local government decision-making;
2. Adapt an existing corporate-based EGS assessment methodology to develop a tool that identifies site-specific EGS and highlights associated risks and opportunities for local government environmental decision-making;
3. Pilot this tool on two open space study sites in the Msunduzi Municipality, focusing on the EGS issues to assess how the tool would function;
4. Consider the strengths, weaknesses and applicability of this tool with a local government department for its effectiveness in environmental decision-making.

1.3 Potential Outcomes

The research aims to demonstrate how corporate-based EGS assessments can highlight broader environmental challenges in response to development pressures. The potential outcomes of this research are the following: (i) an improved understanding of how EGS assessments have been used in the past, what the current trends are in EGS based decision-making research and how corporate based EGS assessments can be adapted to be used in the local government environmental decision-making process; (ii) an adapted structured tool that will aid in highlighting priority EGS within a localised case study area, (iii) respond to the question of what the trends and drivers are of EGS change within those areas, (iv) what the business risk and opportunities are for the municipality as a result of changing EGS; and (v) by working with the Msunduzi Municipality, develop an appreciation of whether this adapted tool can be useful to assist in local government environmental decision-making.

1.4 Structure of Thesis

This thesis includes a literature review (Chapter Two) that explores the role of sustainability in environmental management, the state of global environmental management, environmental, resource and ecological economics, EGS and their links to policy making and risk within a corporate sense and lastly IEM in South Africa. This chapter is followed by a background chapter (Chapter Three) on the Mankweng Municipality's environmental management policies and initiatives. This chapter provides context for the reader who may not be familiar with the extensive and innovative work that has been achieved with regards to environmental management policy within the municipality. Chapter Four details the research design undertaken and how an established corporate EGS assessment has been adapted for a local government context. This section forms part of the findings of this research and provides a manual for how the ESR framework has been adapted to be applicable to a municipal context. The findings chapter (Chapter Five) provides the results from piloting the adapted methodology on two case study sites. The discussion chapter (Chapter Six) discusses the strengths, weaknesses and applicability for each phase of the adapted tool with reference to Chapter Five. Chapter six discusses how this tool is placed in relation to Chapter Three and the literature of Chapter Two. The thesis culminates in Chapter Seven with conclusions that link back to the aim and objectives of the research.

Chapter Two Literature Review

2.1 Introduction

This chapter explores the links between sustainability, economics, business, environmental science, ecosystem goods and services (EGS) and local governance. Thus, the nature of this research requires an underlying theoretical driver that encompasses all of these subjects. The discourse of Sustainability Science is used to inform the conceptual framework, however, this theoretical base will not be the predominate focus in the literature review but serves as an overarching framework.

As a result of the trans-disciplinarily nature of this research this chapter is subdivided into four sections. The first section explores the emergence of Sustainability Science as a research field and examines current international thinking and trends within Sustainability Science, how this science can be used for the application of effective environmental management and, in particular, EGS assessments. The second investigates the evolution of global environmental management and environmental assessment from both a governance and research perspective. This section is informed by key global research, conferences and studies that have relevance to environmental management. The following section focuses on the international and South African contexts of ecosystem goods and services. An overview of the terminology, definitions and clarifications is presented in conjunction with an examination and investigation into key global, regional and local EGS research and studies. The roles EGS play with regards to environmental management, policy making and the business environment are described. The final section details environmental management in South Africa with particular reference to IEM. This section provides an overview of South Africa's policies and legislation, institutional structures and tools for implementation and monitoring which relate to the country's IEM system. It investigates the possibility of EGS assessment being used as a tool for IEM in South Africa and reviews studies which have attempted to mainstream EGS into environmental governance.

2.2 Sustainability Science

2.2.1 Emergence and definitions

Meeting the ever increasing needs, from both a basic and indulgent perspective, of expanding economies and populations is achieved through the exploitation of natural resources with little

recognition for the dependence on these resources (Goodstein, 2010). Natural resources are perceived as endless and therefore societal development and expansion is perceived as only being limited by technological constraints. However, the realisation of our reliance on these finite natural resources has resulted in a developmental paradigm shift, meeting the needs of economies and increasing human populations in a sustainable manner which promotes resource restoration and conservation (Folke *et al.*, 2002; Kates *et al.*, 2005; Dasgupta, 2007). The Brundtland Commission entitled 'Our Common Future' (Brundtland, 1987), recognised that the human and environmental spheres are not, as previously thought, independent spheres but are in fact inseparable. The definition of sustainable development arising from the Brundtland Commission is to make development sustainable, that is, to make certain development meet the needs of the present but should not impact and compromise on the ability of future generations to cater for their needs.

The concept of sustainable development has provided the foundation for the mega-conferences and reports such as the 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil and the World Summit on Sustainable Development (WSSD) held in 2002 in Johannesburg, South Africa. The development of the Millennium Declaration and Millennium Development Goals (MDG) in 2000, emphasises the notion that sustainable development requires a balance between environmental, social and economic demands – the 'three pillars' of sustainability (Seyfang, 2003). As a result, there has been widespread adoption of sustainable development, as it draws on and connects different disciplines and fields and now can be applied in numerous environmental, social and economic contexts and situations. It has emerged as a key field of research in international research programs, academic institutes and independent scientific communities and has led to the science of sustainability. Sustainability Science is a field of research that attempts to understand the primary characteristics of the relationship between the natural environment and society and allowing for science and technology to play a key role in achieving the goals of sustainable development (Kates *et al.*, 2001; Clark and Dickson, 2003; Clark, 2007).

Sustainability Science attempts to bridge the divide between knowledge makers, takers and users to achieve growth and development in a sustainable manner. There is a strong focus on the creation and use of knowledge to address essential issues relating to the development of the economy and society. It presents an opportunity for science and technology to play a key role in the sustainable development discourse and research programs. Sustainability Science is characterised by user-

inspired research (creating and deploying knowledge for its intended end use), that takes into account the role that sciences have for achieving sustainable goals and placing an emphasis on the relationship between humans and the natural environment. Sustainability Science acknowledges the limitations that arise from the complexity of using science to understand the key issues that need to be addressed to achieve sustainable development (Kates *et al.*, 2001; Clark and Dickson, 2003; Parris and Kates, 2003; Kates *et al.*, 2005; Burns *et al.*, 2006; Clark, 2007; Burns and Weaver, 2008; Kajikawa, 2008).

A key characteristic of Sustainability Science is the promotion and utilization of the notion of trans-disciplinarity. The core of this science requires the co-production of knowledge through intra-, inter- and trans-disciplinary research (Komiya and Takeuchi, 2006). This approach ensures the research and dialogue between knowledge makers, users and takers. Sustainability Science points out that a trans-disciplinarity approach is fundamental if effective research is to be carried out, however, this does not guarantee that the knowledge created will be utilized, managed and interpreted correctly by the end users (such as decision-makers) or will be placed into realistic and sensible effect to achieve the goals of sustainability. Lawrence and Depres (2004) point out that a number of requirements need to be addressed to ensure that dialogue is established between knowledge makers and takers and knowledge's interaction with society. Some of these requirements include: acknowledgement of the complexity that exists between society and nature; avoidance of fragmentation and isolation of knowledge and expertise; and the exchange of knowledge between the researchers and society. These requirements must be met or at least acknowledged for the trans-disciplinary nature of sustainability to be effective in research and knowledge creation and sharing.

Audouin and Hattingh (2008) view trans-disciplinarity as a fundamental aspect of enhancing environmental assessment and management. They propose that development needs to be redefined so that it goes beyond the current understanding of meeting the basic needs of society, to increasing the opportunities for people to achieve their potential. This development should be focused on the enhancement of individuals' and communities' welfare, wellbeing and quality of life rather than being centred on economic growth and commoditization. Thus, social-ecological relationships need to be viewed as complex and interlinked systems that cannot be viewed in isolation but should regard the relationships as crucial as the components themselves. Therefore the relationships

between wellbeing, growth and nature have to be considered in the development process. Audouin and Hattingh (2008) believe holders and creators of specialist knowledge and the key stakeholders involved should have a clear understanding of the boundaries and limitations brought about by this complexity of social-ecological systems. These boundaries, however, can be adjusted according to new technological advances or increased participation from specialist knowledge, and reduced if stakeholder engagement is incorporated at an early stage in the design of environmental assessment and management projects. This trans-disciplinary approach is considered a vital component of sustainable development and ultimately sustainability as a whole. Sustainability Science is, by definition, trans-disciplinary in approach and therefore should be considered in all aspects of a sustainability based project or task.

2.2.2 Sustainability in South Africa

South Africa's position with regards to sustainability is highlighted through the National Framework for Sustainable Development (NFSD) which states that:

“South Africa aspires to be a sustainable, economically prosperous and self-reliant nation state that safeguards its democracy by meeting the fundamental human needs of its people, by managing its limited ecological resources responsibly for current and future generations, and by advancing efficient and effective integrated planning and governance through national, regional and global collaboration” (DEAT, 2008 pg 6).

It is a vision which is institutionalised by the people-centric Constitution of South Africa and draws on the objectives of the MDGs in conjunction with existing economic and environmental legislation, plans and policies. The NFSD identifies the following pathways to achieve sustainability: (i) develop and improve on systems that integrated planning and implementation; (ii) promotion of the sustainable utilization of ecosystems and efficient use of our natural resources; (iii) economic development via investing in sustainable infrastructure; (iv) the development of sustainable human communities and settlements and; (v) providing a fitting response to the emerging challenges that face human development, economic growth and the environment.

South Africa follows an integrated systems approach to sustainability. The ideals of sustainability are driven by social, economic and environmental systems therefore sustainability would fail if these systems were not nested and embedded in one another then integrated and implemented

through the governance system that prescribes a regulatory framework (Figure 2.1). With this integrated approach the socio-political or societal and the economic spheres are constrained by the limits imposed through the environmental or ecological spheres.

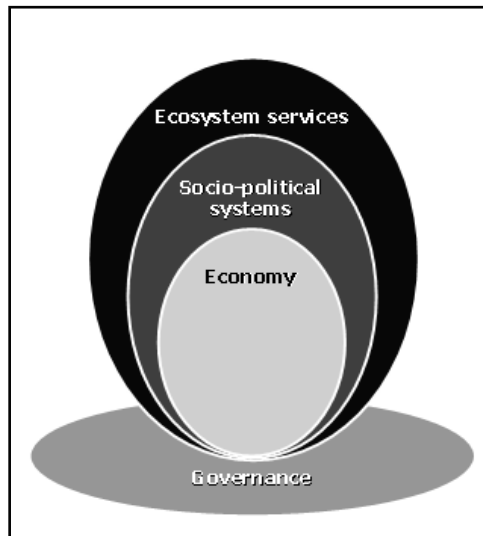


Figure 2.1: The conceptual representation of the integrated systems approach to sustainable development (DEAT, 2008)

Sustainable development can be achieved if associated key challenges are addressed and goals are achieved in a manner where all four systems, namely the environment, society, economy and governance stay compatible and inclusive of each other. In other words, if one system, such as ecosystem services is not considered or incorporated then the entire process is deemed unsustainable. The same can be said for lack of direction, implementation and monitoring in the governance systems, or a failed economic or social-economic policy or plan. In a country which displays both developed and developing world characteristics, such as South Africa, social and economic development agendas overshadow environmental ones. Decision-makers often implement development strategies and plans at the expense of the environment in an attempt to deliver basic services. True sustainability cannot occur, while the environment sphere (ecosystem services) is disregarded as this will have detrimental and long lasting effects for wellbeing and the economy. If short-sighted decision-making is to be avoided then adherence to the integrated systems approach is crucial (DEAT, 2006; DEAT, 2008).

It is crucial to realize that these systems have to interact with each other so that one benefits the next if sustainability is to be achieved. For example, the maintenance, preservation and development of ecosystem services can have major benefits for all remaining systems. This model

highlights the linkages that the environment has to society and the economy thus ensuring that these linkages are carried forward into plans and policies in differing spheres of governance and society. This is a vital component in answering key questions raised by Sustainability Science as the trans-disciplinary nature of the model provides solutions to the complexities that arise from nature-society interactions.

To achieve a better understanding of how these systems interact with each other, a more detailed examination of the governance structures that exist in South Africa and the ecosystem services that our environment provides will be presented in section 2.5.

2.3 Global environmental management

Society's pursuit of natural capital ascendancy has resulted in the exploitation, depletion and degradation of both renewable and non-renewable resources and resultant depletion of the Earth's natural capital. The consequences of this is that society has had a profound effect on the natural environment and in many cases a negative effect on goods and services produced by our ecosystems (Carpenter *et al.*, 2009). This has negative implications for a society which is highly dependent on these natural resources and the goods and services it provides. Therefore the way in which society utilizes the available capital has to be monitored and managed to achieve sustainable usage of resources. Globally, this has resulted in the emergence of environmental management as a consequence of key global conferences, research and development initiatives, educational and technological advancements and governmental policy formulation and implementation. Consequently, the increase in awareness of environmental management has seen a shift in the manner in which society utilizes and perceives natural capital (Seyfang, 2003).

There is a growing trend amongst governments and business to achieve economic and societal growth through more sustainable methodologies and ideologies (Clark, 2007). Sustainability Science now features more regularly as a predominant influence in environmental assessment and management objectives. However, there is still a divide between what is being 'said' and what sustainable trends are being achieved. Adopting a more sustainable approach to environmental management can represent distinct ideas and issues to different communities under different sets of circumstances and objectives. For instance, the goals and objectives in a highly industrialised

country are different to those in an impoverished and underdeveloped community (Dasgupta, 2007; Aronson *et al.*, 2010).

2.3.1 Evolution of environmental assessment and management

As a response to the green revolution in the 1950s and 1960s, the United States of America (USA) became the first country to legislate and implement the process of environmental impact assessments (EIA). It did so under the legislation entitled the National Environmental Policy Act (NEPA) of 1969. This became the blueprint for environmental governance and had a significant impact on similar pieces of legislation worldwide, with Australia, Canada and New Zealand being the initial countries to adopt the NEPA framework. It is currently estimated that 100 countries and several international agencies have implemented and incorporated some form of EIA legislation or policy into their environmental governance structures (Audouin and Hattingh, 2008). The early development phases of EIA were a reactionary response towards the economic growth discourse and were strongly focused towards the biophysical aspects of the environment. Methodologies were established that aimed to investigate the impact of development and growth. These methodologies involved the use of checklists and matrices to determine the predicted significance of impacts on the environment and what environmental entities, such as water, land, air and biodiversity, these impacts affect. This involved the simplification and fragmentation of the EIA project so that the cause and effect relationships could be identified and an environmental management plan (EMP) drafted (Sadler, 1996; Audouin and Hattingh, 2008).

The Brundtland Commission Report in the 1980s and the Earth Summit in 1992 focused on the notion of sustainable development, and EIA was viewed as a key driver, enforcer and monitor. This resulted in sustainability issues being adopted into EIA projects and highlighted the crucial role and interconnectedness that social-ecological relationships have between the natural environment and economic growth. The 1990s saw the emergence of Strategic Environmental Assessments, which prescribed a more precautionary approach compared to the reactionary stance of EIAs, thereby expanding the scope and effectiveness of environmental management and decision-making. SEAs, take a more strategic approach and are an opportunity to apply sustainability principles to guide development. This laid the foundation for the future of environmental assessment and management to shift a way from being purely biophysical to include social and economic concerns and thus incorporate sustainability (Audouin and Hattingh, 2008).

The EIA process in South Africa developed comparatively late contrasted to the rest of the developed world. In 1996 the government of South Africa released the Green Paper on an Environmental Policy for South Africa (DEAT, 1996). This consultative process was known as the Consultative National Environmental Policy Process (CONNEPP) and was designed to enable all stakeholders in South Africa to contribute to the development of an environmental policy. The first EIA regulations in South Africa were promulgated through the Environment Conservation Act 73 of 1989 (ECA). This was a first step in South Africa's move towards environmental management, as prior to that EIA's were undertaken at the discretion of the government or on a voluntary basis. This shift to integrate environmental management into legislation was a vital stage in implementing and achieving Integrated Environmental Management (IEM), a concept which a task team, commissioned by the Council for the Environment in 1983, initially designed and proposed to instil environmental ethics, philosophies, principles, guidelines and processes in environmental management for South African society. The concept and implementation of IEM provided a convenient method of integrating environmental management issues and processes into development driven decision-making (Sowman *et al.*, 1995; Audouin and Hattingh, 2008), (South Africa's environmental management system is discussed further in Section 2.5).

Environmental management faces a complex dilemma and challenges and effective planning and decision-making is vital if these complexities are to be addressed, particularly in the South African context, as it is a country dominated by a political agenda of development at all costs, with little regard to the consequences on the environment (Armstrong and Peart, 2000). Decision-making is, however, aided by the ever growing availability of relevant environmental management and development tools (as prescribed by the principles and components of IEM such as EIAs or SEAs) and are enhanced by research frameworks (such as Sustainability Science, Resilience Theory and ecosystem goods and service assessments) that attempt to investigate and explain the relationships and interactions with social and ecological systems (Sowman and Brown, 2006). More recently the links between the type of environmental research and assessment, the economy and decision-making are becoming ever apparent, with the realisation of the crucial importance of a healthy environment to a strong economy and productive society (Daily *et al.*, 2009; Perrings *et al.*, 2011; Salles, 2011). This has led to the rise in prominence of resource economics in environmental

assessments with a strong focus on identifying and quantifying the benefits that society receives from nature.

Environmental managers and practitioners recognise that nature conservation and development do not result in trade-offs but that in fact investments made into the sustainable use and restoration of ecosystems can lead to economic, social and environmental benefits. These links between the environment, society and the economy are being realised through assessing ecosystem goods and services (De Groot *et al.*, 2010; TEEB, 2010b).

2.4 Ecosystem Goods and Services (EGS)

2.4.1 Overview

EGS can be defined as the benefits that society can gain through direct or indirect means from healthy functioning ecosystems. They are the processes and end products that nature yields that, when fully functioning, have a positive impact on society. These processes and end products are considered in the economy as natural capital. EGS, and the associated natural capital, are critical for the function of Earth's life support systems and thus an important component to economic and social wellbeing (Costanza *et al.*, 1998; Daily *et al.*, 2000; Heal, 2000; Boyd and Banzhaf, 2005; Nelson *et al.*, 2009). For EGS to maintain their role as sustainers, facilitators, supporters and regulators of life, effective management plans and policies need to be implemented at all levels from local to national with varying applicability that will account for the socio-ecological nature of the economy. In most economies and businesses this is unfortunately not the case. When compared to other forms of capital such as financial or labour capital, EGS are often neglected and are therefore poorly understood in a business context (Daily *et al.*, 2000). The consequence of this is the degradation and loss of EGS and therefore the loss in benefits available to society, increasing the scarcity of our natural resources.

EGS can be one of three characteristics that describe what is being provided from an ecosystem; a good, a service or an attribute. An ecosystem good is that which can be utilized as a final good or as a secondary good in part of the production process (Turpie, 2009). For example, fish can be used as a final good in terms of a meal or it can be processed into other food items. In another example, wood can be used for fire and energy purposes or can be used as a secondary good in furniture

manufacturing. A service is a physical, chemical or biological process that contributes to economic production as a n i ntermediate or f inal good, such a s t he s oil nut rition c ycle t hat a llows f or agricultural processes to function (Daily, 1997; Turpie, 2009). The quality of service provision is directly linke d to the f unctioning of ecosystems. Fully f unctioning ecosystems w ill r esult in decreased costs in production as ecosystems provide a higher grade or quality service. Ecosystems also possess a t hird characteristic, namely attributes. These include the intangible benefits that we receive from the environment fulfilling spiritual, recreational and sense of being or place needs that exists in society (Tallis and K areiva, 2005 ; Turpie, 2009). All t hree o f t hese cha racteristics ar e generally t ermed as ecosystem s ervices, however, it is impo rtant to r emember tha t th ere is a distinction between varying EGS.

The Millennium Ecosystem Assessment (MA) Report (2005a), which provides a framework for the assessment of ecosystems and wellbeing, characterizes EGS i nto four cat egories, namely: (i) provisioning, (ii) r egulating, (iii) c ultural, (which all di rectly impa ct hu man wellbeing) a nd (iv) supporting services (which are essential for the maintenance of the other services). EGS are a link to society in that they provide environmental security, basic materials for wellbeing and physical, spiritual a nd c ultural h ealth a nd nour ishment. Changes i n E GS w ill a ffect t he l ivelihoods of communities, t he w ellbeing of s ociety a nd t he pr oduction a bility of t he e conomy w hich w ill ultimately hinder the freedom and choice available to society (Figure 2.2).

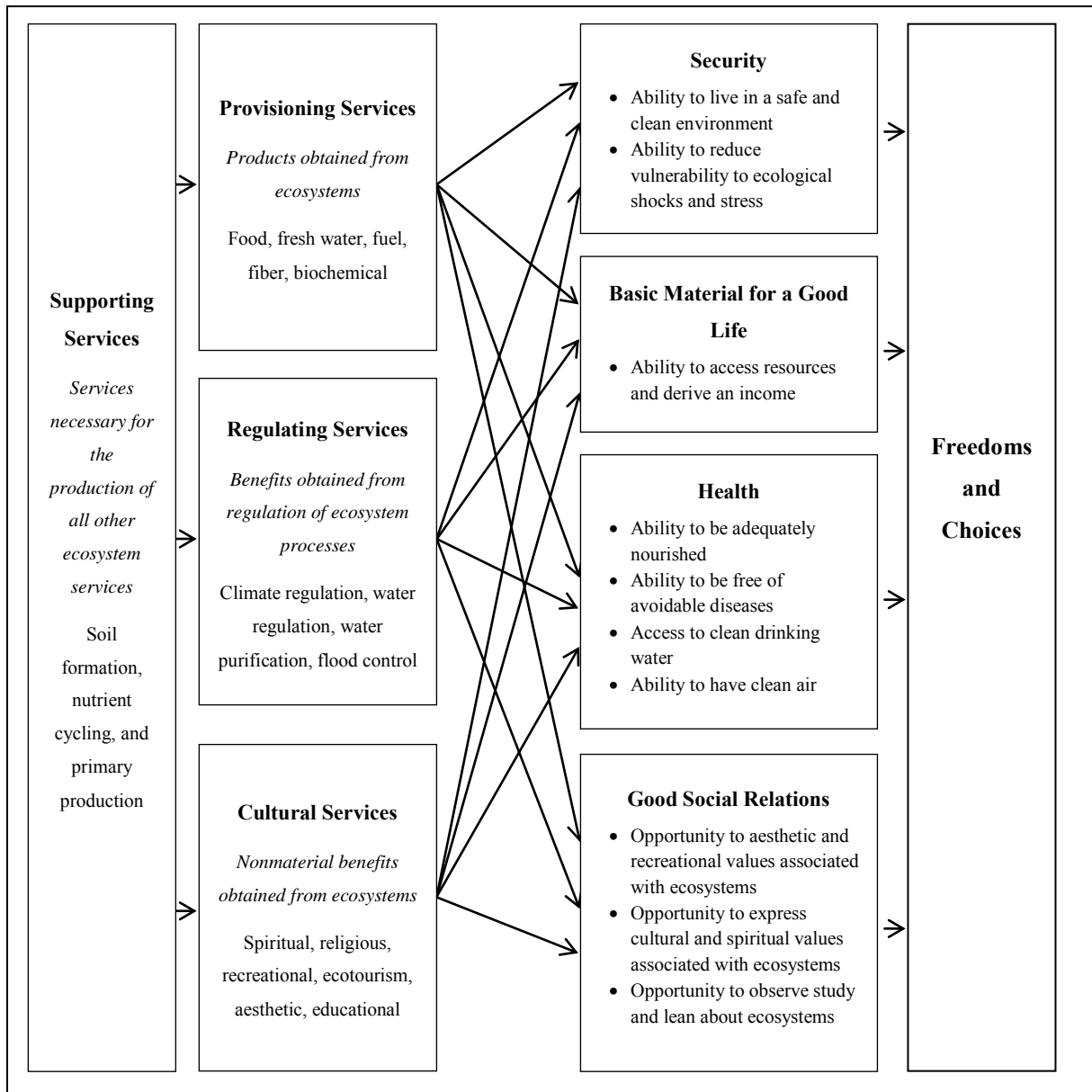


Figure 2.2: The links between ecosystem goods and services to the choices and freedom of human wellbeing, as outlined in the Millennium Ecosystems Assessment (Millennium Ecosystem Assessment, 2005c)

The four EGS categories (Figure 2.2) directly relate to, and influence, the determinants and constituents of human wellbeing (livelihoods). Therefore changing the functional capability of these services will directly impact on: (i) security, which is the ability to live in an environmentally clean and safe area and the ability to reduce vulnerability to environmental risks and stresses; (ii) basic materials needed for a good life, which refers to the ability of an individual or community to utilize available resources to earn an income and improve livelihoods in a sustainable manner; (iii) health, which is affected by the non-functioning of ecosystems which cannot regulate diseases and bacteria effectively, resulting in communities being at risk to diseases and illness due to poor environmental

quality; and (iv) good social relations, which are key for individuals and communities to express a sense of place, for ecosystems to represent culture or spiritually, and the opportunity for recreational activities or scientific research. These four constituents are what the MA research highlights as dependents of healthy ecosystems and links the importance of ecosystems and human livelihoods and wellbeing (MA, 2005a).

The MA Report (2005a) emphasizes short and/or long-term drivers of change that result in changes in the functionality of ecosystems (Figure 2.3). Indirect drivers, such as socio-political, economic and/or technological improvements, and direct drivers, such as land use change, urbanization, introduction of invasive alien species, loss of biodiversity, consumption patterns and climate change will impact the EGS quality and quantity therefore affecting social wellbeing and livelihoods. These drivers of change can occur at global, regional and local scales and at varying temporal scales.

The issue of scale is important to consider as assessing the supply of EGS or implementing management interventions needs to occur in a multi-scale and multi-temporal approach to incorporate drivers that occur over a range of scales. This highlights the need to include complex ecosystem dynamics in EGS management frameworks. Ecological scales and economic scales both become crucial and have to be considered in EGS assessment. This includes institution scales, EGS supplied to households, state or to the global community and spatial scales that consider the distance of EGS to the 'market' (Dasgupta, 1996 ; De Groot *et al.*, 2010). Strategies and interventions have to consider and make provisions for these varying scales (Figure 2.3).

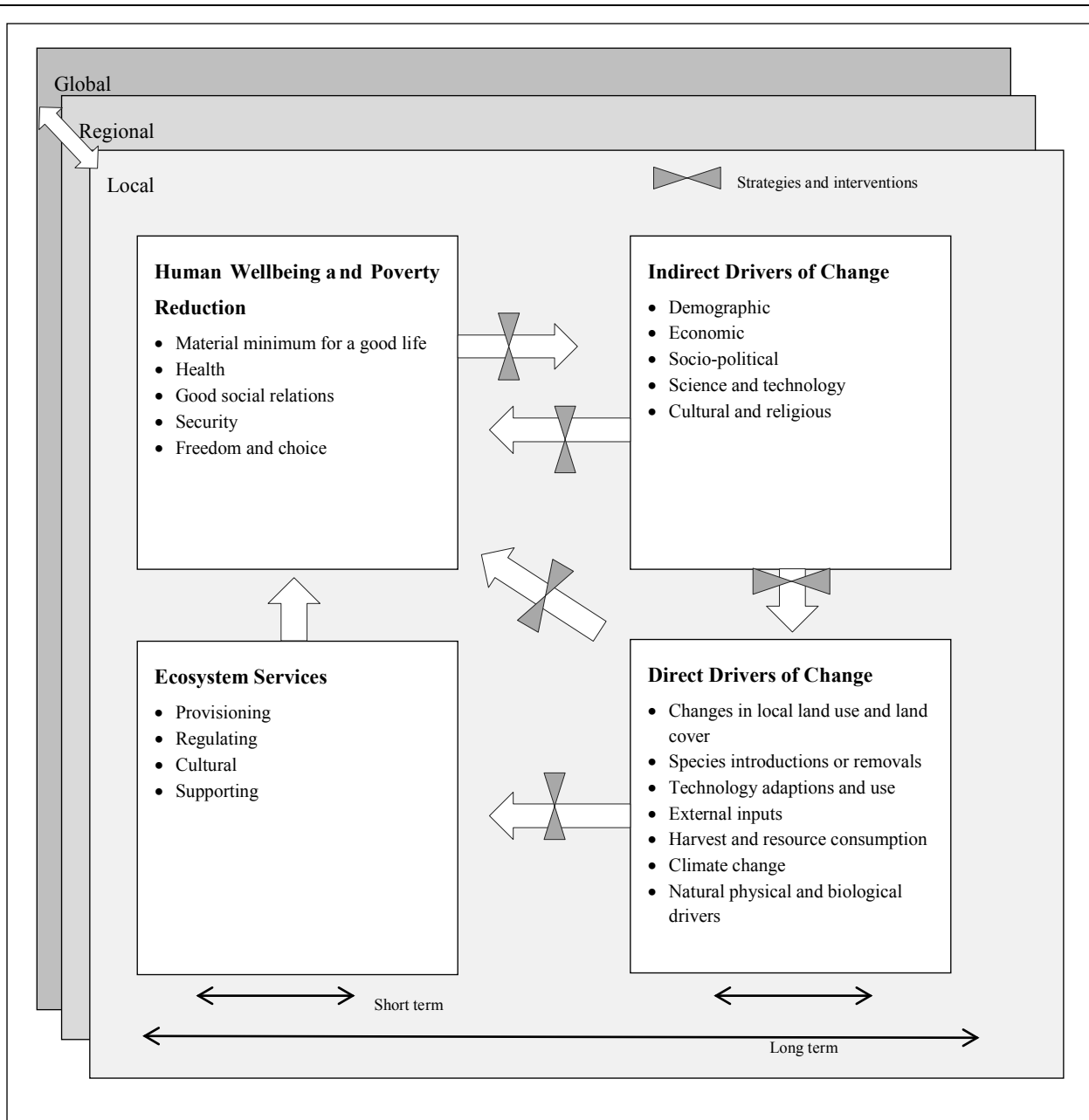


Figure 2.3: The conceptual framework on varying scales for the Millennium Ecosystems assessment (Millennium Ecosystem Assessment, 2005c)

The MA framework, if implemented by environmental managers and decision-makers, provides a more holistic approach to environmental management and decision-making. This framework requires that drivers of change are considered over varying scales (Figure 2.3) and the implications that these drivers have for society and wellbeing are integrated (Figure 2.2) (MA, 2005b; Dick *et al.*, 2011). Applying the principals of this framework to other tools will ensure that a holistic approach is considered in EGS assessments and can assist in more informed local level decision-making and policy formulation.

2.4.2 Ecosystem Goods and Services and local level policy-making

The role of EGS and associated natural capital is becoming recognized as a valuable asset and needs to be managed accordingly. While there is substantial theory regarding the importance of these life supporting services (Daily *et al.*, 1997; Costanza *et al.*, 1998; MA,2005b; Tallis and Kareiva, 2005 ; TEEB, 2010b), there is little implementation and mainstreaming of EGS based assessments into policy formulation (Daily *et al.*, 2009; Fish, 2011). There needs to be advances in the spatial mapping of services, design of appropriate plans, policies and programs for governance systems and incorporating the contexts of the vastly differing biophysical and social issues and parameters (Daily and Matson, 2008). However, since the release of the 2011 TEEB study for Regional and Local Policy-makers (TEEB, 2010a), this perceived lack of implementation in mainstream policy is changing with an increasing number of cases being reported within the TEEB documents (TEEB, 2010b).

The TEEB study for Regional and Local Policy-makers (TEEB, 2010a) discusses how the natural environment, and particularly the goods and services that it provides, can reduce the pressures that a municipality (local government) faces in delivering multiple municipal services. The study highlights that natural systems can save a municipality money by providing EGS free of charge, such as water provision, waste-water treatment, flood protection and urban climate regulation. The wellbeing of society, which resides in the municipality, is dependent on the provision of these EGS to facilitate conditions and materials for industry, agriculture and other services. Delivering on long-term municipal responsibilities such as climate change, food security and water scarcity can be achieved by maintaining and enhancing the capacity for future EGS production. Elliman and Berry (2007), found that natural systems can filter water for human consumption more cost effectively than man-made filtration plants could in the Catskill watershed, New York State. The cost to secure the drinking water for New York through restoration and purchasing amounted to US\$ 2 billion, by comparison a man-made equivalent would have cost US\$ 7 billion.

Robrecht and Lorena (2011) identified in the TEEB study six key benefits for municipalities by assessing EGS and adopting an ecosystem services approach in municipal management: (i) quality of life improvements; inhabitants within the municipal area can enjoy improved standards of living as a result of locally produced EGS from healthy ecosystems. Services such as micro-climate regulation and air filtration can have positive health and productivity benefits; (ii) reduction in

public spending; local municipalities have limited budgets with which to deliver key public services such as clean water. Investing in water catchments can have positive and cost effective long-term benefits and through conservation and enhancement of EGS provide services such as flood protection and water purification; (iii) attracting investment; the municipality can provide opportunities for local economic development by being attractive to investors. Productive ecosystems can provide the necessary inputs into business process at reduced costs and therefore become an attractive option for companies to establish themselves in the municipality. This investment will bring with it job opportunities and wealth creation for the local community. For example if the municipality would like to attract tourists, it is dependent upon the recreational, cultural and biodiversity value of ecosystems. Or to attract industries such as food and beverage companies which are dependent on clean water and agriculture on pollination services, the municipality has to provide these services; (iv) reducing poverty; EGS and livelihoods are interconnected, especially when considering how the poor rely on EGS for the provision of basic needs. Developing sustainable land use management practices that safe-guard EGS production can result in increased potential for income generation for the poor and improve service delivery; (v) protection from natural disasters; ecosystems play an important role as a buffer from natural disasters such as floods or droughts, and can save the municipality money and protect lives if the EGS are fully functioning; (vi) becoming a municipal ‘leader’ in green investment compared to other municipalities; cities can attract investment (over other municipalities), political accolades and international recognition for being proactive in the conservation of biodiversity to enhance EGS. Investing in green infrastructure can reduce the energy demand for the urban area and potentially sell energy back into the grid (if such feed-in tariff mechanisms are possible).

These six factors provide a strong case for municipalities to consider the role EGS have in providing citizens with basic services, alternative livelihood and diversified business opportunities and increased wellbeing. However local governments, particularly in South Africa, are continually under pressure to deliver municipal services in the short-term and environmental concerns are often side-lined and these benefits are not fully realised. The TEEB study for Local and Regional Policy Makers (TEEB, 2010a) provides three solutions that local governments and policy makers can do to utilize ecosystem services for local development; (i) using existing environmental instruments; environmental assessment and public management tools such as environmental impact assessment (EIA), strategic environmental assessment (SEA), environmental management framework (EMF), local tax incentives and spatial planning can all have a direct impact on ecosystem services; (ii)

develop local solutions; implementation of new instruments such as payment of ecosystem services or clean development mechanisms can help to address biodiversity issues; (iii) advocate environmental concerns at a higher policy level; promoting and successfully implementing environmental policy at local level can influence policy change at a regional or national level (TEEB,2010a). The benefits and solutions that the TEEB study provides for local level governments to integrate EGS assessments can be realised if the relationship between natural capital and human welfare is better understood. This has resulted in the increase of more systematic approaches (Cowling *et al.*, 2008; Naidoo *et al.*, 2008; Turner and Daily, 2008) to EGS assessment, modelling and valuations that can help mainstream EGS into decision-making (Morse-Jones *et al.*, 2011).

A study carried out on ecosystem service assessment by Sippelt *et al* (2011) determined that recognising local and national trade-offs, off-site effects, biophysical realism of ecosystem data and models and the comprehensive involvement of all stakeholders will allow for consistency and a more holistic approach to EGS assessment application. EGS assessments need to shift from a valuation focused technique to more holistic user-inspired and user-useful systems that aim to make more practical choices (Fish, 2011; Salles, 2011). These approaches and the approach advocated in the TEEB for Local and Regional Policy Makers report (2010a) draws attention to the benefits for local governments in assessing ecosystem services. Carrying out such assessments can provide a broad picture that can produce local strategies and policies that could minimise the risk from poorly functioning ecosystems and maximise the opportunities from improved EGS provisions and therefore reducing municipal costs. It can therefore be argued that it makes economic sense for municipalities to have a clear understanding of the risks and opportunities presented to them as a result of their natural capital stocks. The private sector has realised this importance of incorporating EGS assessments into their business models. Realizing the risks and opportunities that their dependence on EGS has can provide a competitive advantage over the competition (TEEB, 2011). This progressive drive within business of incorporating sustainability principles and addressing EGS dependence is linked to changes in investor preferences and research conducted by the business organisations such as the World Economic Forum and World Business Council for Sustainable Development. Chief Executive Officers (CEO) of businesses are heeding the advice of such institutions and investors and are starting to internalise the risk and opportunities associated with ecosystem services.

2.4.3 Linking corporate risk and vulnerability to EGS

Global business organisations such as the World Economic Forum (WEF) and the World Business Council for Sustainable Development (WBCSD) have indicated that not recognising their dependence and impact on EGS is a substantial risk for economies and businesses (WBCSD, 2011; WEF, 2011). While there are limited academic articles to back up the business case for EGS assessment, the TEEB for Business study (TEEB, 2011) provides case studies where businesses are rewarded for analysing their dependence and impact on ecosystem services. The MA Synthesis Report (2005a) focuses on four main findings from the Ecosystems and Wellbeing Report that relate directly to the consequences of degrading EGS. The report suggests that the human need for economic growth has led to the irreversible loss of biodiversity. This loss of diversity results in the degradation of EGS functioning and ultimately places humans at severe risk from environmentally related disasters.

The WEF, in their 2010 Global Risks Report (WEF, 2010) document, highlight biodiversity loss as a ‘risk to watch’ that potentially can have an impact on the economic stability of a region. However, in the subsequent year’s Global Risk Report (WEF, 2011), biodiversity loss formed part of the water-food-energy nexus with its link to climate change as one of the three main clusters of risk that are impediments to economic and social growth. The report mentions that the insatiable demand for development, economic growth and an increasing population are the key drivers of these risks. These drivers could result in irreparable environmental damage as increasing short-term consumption and production rates begin to undermine long-term sustainability. This could create further economic disparities, promote social and political instability and cause geopolitical conflicts. Other environmental risks that are included in the global risks landscape include; air pollution, biodiversity loss, climate change, earthquakes and volcanic eruptions, flooding, over-fishing and storms and cyclones, with climate change ranked the number one chronic risk when considering both likelihood and impact, with the fiscal crisis and economic disparity placing second and third respectively.

While the WEF risk report provides a macro-scale outlook for economies, the WBCSD makes a business case for corporations to consider and analyse their dependence on ecosystem services. The WBCSD, which represents 200 global companies campaigning for sustainable development, argues that if businesses can value their EGS dependence it can result in more informed decision-making,

increase revenue, save costs, increased consumer and investor confidence and an improved public perception (WBCSD, 2011). The WBCSD guide to ecosystem valuation (WBCSD, 2011), suggests that companies need to factor ecosystem values into business decision-making to reduce their risk to production, profits and performance as a result of ecosystem degradation. Analysing, managing and restoring ecosystem services can lead to increased access to new markets and new business opportunities. Companies have to become aware of the increasing 'green' consciousness of shareholders, customers, communities and consumers that are demanding that environmental and sustainability issues are addressed, reported and accounted for.

The TEEB for Business study (2011) points out that operational, reputational market and product and financial risks that result from a decline in ecosystem services are often underestimated and not considered in business decision-making. Companies neglect to assess their full value chain with regard to the direct and indirect impacts of ecosystem degradation. However, this limited understanding of EGS is changing, as far-sighted companies are acknowledging the greening preferences of investors, customers and consumers and the increased attention to carbon emissions and climate change. Global stock exchanges require their listed companies to report on their sustainability activities, such as the Johannesburg Stock Exchange Socially Responsible Investment Index (JSE SRI) and global companies are volunteering to undertake carbon and sustainability assessments such as the Carbon Disclosure Project or the Global Reporting Initiative (Kolk, 2003; Gray, 2006; Kolk *et al.*, 2008; Brown *et al.*, 2009). However, while companies are starting to assess the dependence and impact on EGS there are still challenges of incorporating these assessments into their core operations and business decisions (TEEB, 2011).

The growing development of business tools that assist a company in identifying and managing biodiversity loss is useful to tackle this challenge. The increasing numbers of tools available to the corporate sector are assisting in integrating EGS concepts into their business strategies and improving business decision-making (Waage *et al.*, 2008). Tools such as InVEST (Daily *et al.*, 2009) and ARIES (Villa *et al.*, 2009) provide multi-assessment ecosystem assessments while ISO14001 and Corporate Ecosystem Services Review (Hanson *et al.*, 2008) (ESR) provide a broader strategic look at risk assessment at varying stages of project lifecycles or value chains (TEEB, Waage *et al.*, 2008; 2011).

There is a business case to consider the role that ecosystems have within the business sector and from a large business perspective it would seem a good business strategy to understand this relationship through taking an ecosystem services approach. The TEEB for Business study sets out the business case for the inclusion of this approach into mainstream business practices and processes and synthesises the current state knowledge. These corporate based tools, which have been developed as a result of considering EGS in business operations and functions, can assist in incorporating this ecosystem approach into policy and decision-making. Adopting an ecosystems approach to environmental management will allow policy and decision-makers to realise the win-win trade-offs that can exist between the environment, society and the economy just as business has done (Daily *et al.*, 2009; De Groot *et al.*, 2010).

2.5 Integrated Environmental Management (IEM) in South Africa

South Africa's relatively late development of environmental governance in the 1980s gave rise to the notion of Integrated Environmental Management (IEM). The concept was first introduced to the public through a document entitled Integrated Environmental Management of South Africa by the Council for the Environment in 1989 (DEAT, 2004c). IEM is a term that represents the multifaceted nature of environmental assessment practice and implementation in South Africa. It acts as a guiding term and provides important frameworks, principles and guidelines to what is often viewed as a complex environmental management approach. It has a fundamental task of providing integrated and cooperative environmental governance to achieve the aims of sustainability in a holistic and inclusive manner. This ideology became embedded in the discourse of environmental management in South Africa in the 1990s. However, there was a strong focus on one tool of implementation, notably EIAs, which have a project level reactionary focus and therefore do not hold true to the principles of sustainability (Nel and Kotze, 2009). This has led to the development of new tools, such as environmental management systems (EMS) and strategic environmental assessments (SEA), which have a much wider scope of application and implementation (DEAT, 2004c), and which were designed to meet the political and sustainability challenges of South Africa. These challenges are, in part, brought about by the state and future state of the natural environment.

2.5.1 South Africa's environment and economy– setting the scene

In a report undertaken in 2006 and published in 2007 by the South African Department of Environmental Affairs and Tourism entitled South Africa's Environmental Outlook: Report on the State of the Environment, key environmental issues are identified that potentially have major implications for South Africa and its citizens (Table 2.1)

Table 2.1: Priority environmental issues facing South Africans (adapted from DEAT, 2006)

Theme	Issue
Atmosphere, inland water, marine and coastal ecosystems	Air quality (indoor and ambient), climate change, ozone depletion, water availability and quality, over utilization of marine stocks, sea level rise, protection and management of inland and coastal ecosystems
Biodiversity, ecosystem health and land	Over exploitation of natural resources, habitat degradation and loss, invasive alien species, sustainable management, land use change and productivity, land degradation, land reform
Economy and environmental governance	Economic growth, unemployment, resource consumption, research and development in technology, institutions, laws, policies and plans, participatory governance, social corporate responsibility
Human settlements and vulnerability	Urbanization and migration, service provision, waste management, food security, exposure to hazards and disasters, coping capacity
Population and wellbeing	Population change (demographic shifts), poverty eradication, HIV and AIDS, inequality

The identification of these priority environmental issues are crucial, as it provides a basis from which various tools, policies and mitigation techniques can be implemented under the principles of IEM. This highlights the complexity that exists between issue identification and mitigation. Prioritising one issue above another without investigating the cumulative impacts (impacts on the other systems) can result in unsustainable trade-offs and mitigation techniques, such as attempting to combat unemployment through increased job creation from development which could result in increased environmental problems. However, mitigating some of the se priority issues can be achieved through recognising the role that biodiversity plays in the provision of EGS. The sustainable utilization of EGS can form an integral role in economic growth and social wellbeing.

South Africa is characterised as a country which has elements of both third and first world features and thus has an interesting dynamic between the relationship of socio-economic growth and environmental protection. Blignaut and de Wit (2004) summarize the challenges that have direct and indirect economic impacts which affect the economy and the natural environment. Increased urbanisation with little growth in service provision results in growing rural/urban slums; an underperforming agriculture sector results in increased subsistence farming which requires more arable land therefore infringing on unaltered landscapes; low percentage of conserved or protected habitat therefore impacting the functionality of the biosphere; high energy needs met by the burning of non-renewable coal resources resulting in increased emissions and reduced air quality; and limited water resources placing pressure on the maximum usage available without dropping below the environmental reserve percentage.

These issues all impact on both the environment and man-made environments with consequences for the economy and ultimately society. These issues affect the sustainability of the South African economy both in environmental and financial sense. A heavy dependence on non-renewable energy sources to drive economic growth can be limiting as this is obviously not sustainable in the long-term, alternatively a push to expensive renewable energy can impact on financial feasibility and attractiveness for investors. Water scarcity can restrain development as there will be limited resources available to meet the demand, therefore investments into alternative measures can prove to be costly. Given the largely 'first-world' economic growth and development aspirations of the South African government, varying social, socio-economic, economic and environmental conditions will ultimately place pressure on the natural resources. This is compounded by the need for job creation and alleviation of poverty that many South Africans face every day. The availability and quality of natural resources such as air, land and water will be compromised unless the sustainability objectives outlined in the country's legislation are implemented and put into practise (Blignaut and de Wit, 2004).

There is no question that South Africa needs to develop economically and socially to reduce the poverty gap, however it is the method or mode of development that needs to be assessed. This is the challenge facing policy and decision-makers to address the varying environmental and socio-economic issues that are prevalent in South African society. Environmental, resource and ecological

economics need to be perceived as key methods of addressing these issues through the use of tools and frameworks which are available as it speaks the language of decision-makers and government officials. There needs to be proactive encouragement of a trans-disciplinary approach in which various sustainability-driven approaches are adopted and key role-players informed in order to have an input in policy development (de Wit, 2004). One such approach is to take an ecosystem services approach whereby economics and ecosystems are integrated to understand the effects of policy development and implementation on humans and natural systems (Daily, 1997; Costanza *et al.*, 1998; Farber *et al.*, 2006; Gomez-Baggethun and Perez, 2011). A goods and services approach linked to ecological economics is one that needs to be seriously considered in the IEM discourse as an effective tool for environmental management in South Africa. The challenge now becomes how to incorporate ecological economics effectively into IEM. To achieve this, an understanding of the role that this field of economics can play in IEM needs to be presented

2.5.2 Key environmental laws, legislation and policies

van der Linde (2006) describes that, at a national level, in South Africa there are three main legislative mechanisms that exist in relation to the protection of the environment. The first mechanism is the establishment of environmental issues through either a rights-based approach or through a regulatory approach via the Constitution. The second mechanism is the protection of the environment through environmental framework legislation, and the third mechanism is the implementation of specific environmental legislation that encompasses the diverse nature of the environment. In reality, a combination of all three is required to achieve effective environmental protection. In the case of South Africa, the National Environmental Management Act 107 of 1998 (NEMA), being the principal legislation with regards to environmental management, corresponds with the second mechanism of framework legislation.

South Africa's infamous history pre-1994 has resulted in today's transitional, dynamic and sometimes complex political, social-economic and environmental relationships. This transition has resulted in major changes in the way law and legislation interact with environmental issues (Sowman and Brown, 2006). The Constitution of South Africa is the primary driver and offers concise guidance with regards to environmental law. The state has been instrumental in initiating and implementing new legislation to encourage effective environmental management (Paterson and Kotze, 2009). One major shift in environmental law was the inclusion of an environmental right in the Bill of Rights (Feris, 2009). Section 24 of the Constitution states that every South African has the right to: "an environment that is not harmful to their health or wellbeing and the right to have

the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that-

- i. prevent pollution and ecological degradation;
- ii. promote conservation; and
- iii. Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development". (Republic of South Africa, 1996; du Plessis, 2009; Feris, 2009; Nel and Kotze, 2009)

Sustainability and environmental degradation issues are addressed in the Constitution by making reference to the right to a healthy environment which is protected for future generations while securing sustainable development at no expense to the natural environment. New government, governance, legislative and procedural plans were enacted to protect, monitor and regulate environmental resources and mitigate any harmful impacts on the environment. While the constitution should not be viewed as a 'miracle law' it does provide a strong legal platform and foundation in which environmental challenges can be addressed (Kidd, 2008). For achieving the goals outlined in Section 24, legislation and institutional structures need to be installed that could effectively implement the ideals of our environmental right through policies, plans and processes.

NEMA provides an overarching legislation framework for environmental management and enforcement in South Africa. It facilitates and coordinates, as a vehicle of integrated environmental management, cooperative environmental governance, trans-disciplinarity, and regulation of public non-compliance (van der Linde, 2006). This framework allows for other complimentary sectoral laws such as: National Environmental Management: Biodiversity Act 10 of 2004, National Environmental Management: Protected Areas Act 57 of 2004, National Environmental Management: Air Quality Act 39 of 2004, National Environmental Management: Waste Management Act 39 of 2007 along with other laws that relate to marine and coastal areas, water resources, mining, pollution and forests (Paterson and Kotze, 2009). NEMA provides the framework for achieving cooperative governance through establishing principles aimed at decision-makers on matters that affect the environment, or organizations and institutions. These principles attempt to promote co-operative governance and procedures for managing environmental functions that are exercised by the state (Kotzé, 2006).

The principles outlined in NEMA state that the management of our environment must be for the betterment of society and the economy and that development must be socially, economical and environmentally sustainable. The principles outlined in NEMA have varying features that are common to other internationally accepted principles, such as the polluter pays and the precautionary principle (Kidd, 2008). These principles, in light of the nature of trans-disciplinarity, should form the basis when conducting EGS assessments, for instance sections 2(4)(a)(i, v & vi) identify that ecosystems degradation should be avoided or greatly minimised to enhance sustainable development. The principles outlined in NEMA are the fundamental basis for the development or deployment of environmental tools and institutional mechanisms as outlined in section three.

2.5.3 Government and governance

The structure of South Africa's governance is determined by what is stipulated in the Constitution, the judiciary and the legislature. South Africa's Constitution follows a decentralised approach meaning that government can be broken down into three spheres, namely: National, Provincial and Local (Section 40(1) of the Constitution) (Republic of South Africa, 1996). Each of these spheres has varying authority and control with regards to environmental issues (Figure 2.4) (Sowman and Brown, 2006; du Plessis, 2008).

The national sphere (indicated as the national executive, Figure 2.4) includes Presidential and Constitutional directives which play a major role in which national departments and institutions conduct their portfolios and mandates. The national executive authority is vested in the President of South Africa who, in conjunction with his ministerial cabinet, is responsible for the initiation and implementation of national legislation and policy, co-ordinates the functions of state departments and performs other executive functions. In an environmental context, the Minister of the Department of Environmental Affairs (DEA) (formerly known as the Department of Environmental Affairs and Tourism (DEAT)) forms part of the ministerial cabinet and has the authority with regards to environmental legislation. However, various other national departments, such as the Department of Minerals and Energy (DME) and the Department of Agriculture, Forestry and Fishing (DAFF), have a key influence on environmental policy formation. This can lead to integration and complexity issues and the splintering of policy and associated departments, which provides a challenge for effective IEM and cooperative environmental governance in South Africa (du Plessis, 2008; du Plessis, 2009; Muller, 2009).

South Africa's nine provinces, each with their own government structures, form the provincial sphere of the South Africa's government arrangement (the provincial executive, Figure 2.4). The provincial government possess their own legislative and executive authority for their area of jurisdiction, in this case within their provincial boundaries. Authority over decision-making and provincial legislation implementation is vested with the Premier of the province in conjunction with the Members of the Executive Council (MECs). The provincial sphere consists of several departments, which differ from the national departments, and have varying roles with regards to environmental management. For example, in the province of KwaZulu-Natal, the Department of Agriculture, Environmental Affairs and Rural Development (DAEA&RD) (formerly known as the Department of Agriculture and Environmental Affairs (DAEA)), is the competent authority with regards to environmental decision-making (du Plessis, 2008; du Plessis, 2009; Muller, 2009).

South Africa has 284 municipalities that fall within the sphere of local government. This level of government (the local executive, Figure 2.4) has the closest relationship and contact with communities and therefore has a pivotal role in promoting and implementing the plans, policies and legislation that are prescribed from the higher spheres of governance. Therefore local government is a major role player in supporting socio-economic and environmental initiatives (Sowman and Brown, 2006). According to the Constitution, local governments have the right to govern at their own initiative, in accordance to and prescribed by provincial and national legislation and policies. National and provincial governments cannot impede and compromise the municipality's capacity to initiate, execute or perform its functions. The municipality is responsible for certain environmental issues that occur within its borders such as basic service provision, waste and sanitation services, infrastructure maintenance and development, and parks and recreation provisions (du Plessis, 2008; du Plessis, 2009; Muller, 2009). However, while local authorities are the closest to 'on the ground' issues, they are in most cases the least equipped to fulfil their environmental obligations. This is as a result of limited financial and human capital resources, and if resources are available, they are usually prioritised towards socio-economic objectives, such as housing or service delivery, rather than environmental management objectives (COGTA, 2009).

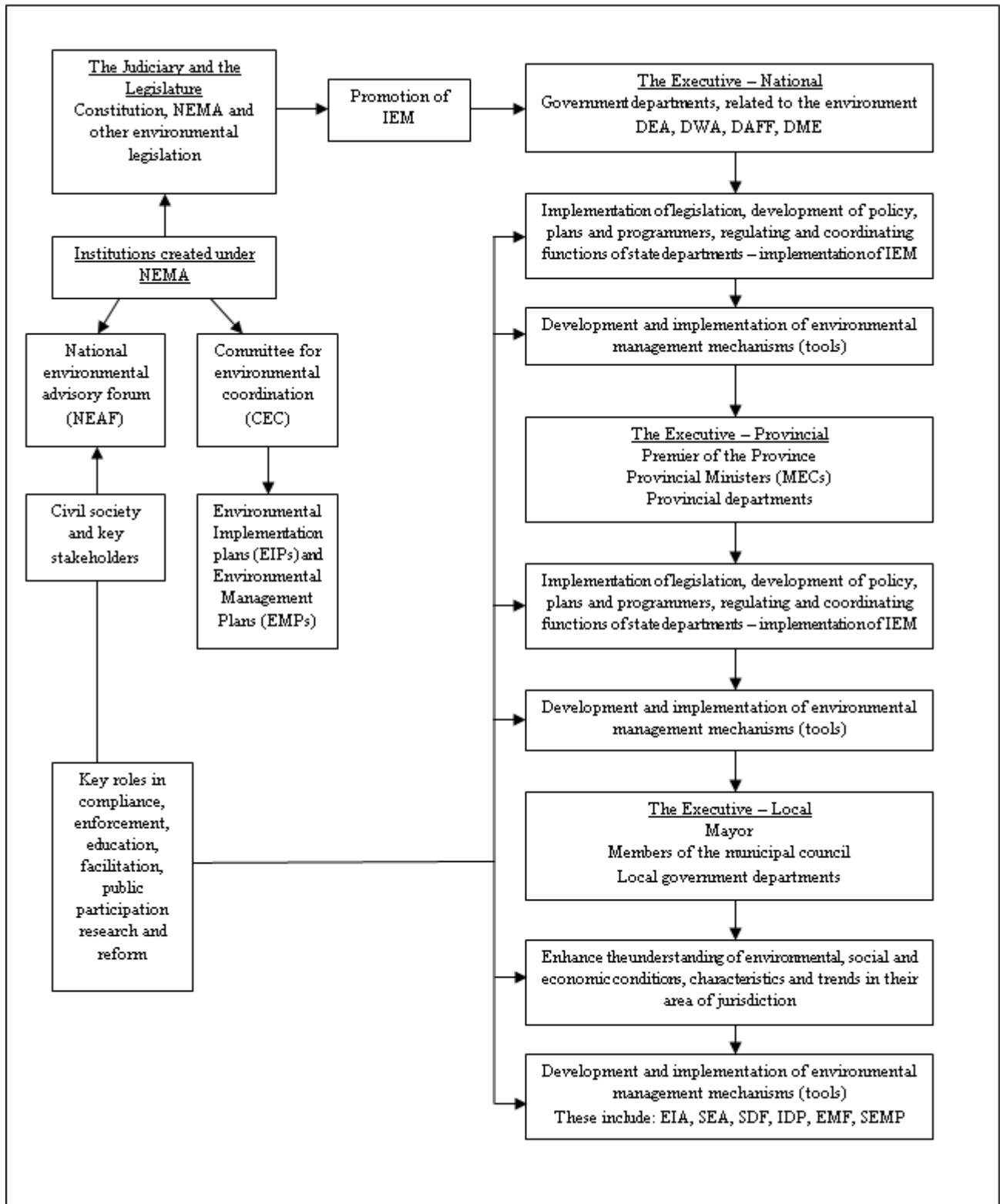


Figure 2.4: The role of the three spheres of government in relation to the institutional structures and IEM in South Africa (du Plessis, 2009)

While the government can be classified into three spheres, the environmental governance issue has to be a cooperative effort between public, private and civil society role-players (Figure 2.4). These role-players form a vital part of the IEM approach as it relates to the integrated and cooperative aspects of such an approach. The corporate sector, research institutions, universities and other centres for higher learning, non-government organisations, non-profit organisations and watchdog agencies all assist in South Africa's environmental implementation, compliance monitoring and enforcement. IEM, founded on the Constitution, calls for a transparent and consultative process with regards to environmental decision-making, therefore inclusion of these cooperative governance structures is vital. Malan (2009) highlights that a multi-dimensional and highly cooperative government is essential in environmental management to promote sustainability. Cooperative governance under Chapter 3 of the Constitution prescribes intergovernmental relations, co-management and increased partnership and collaboration. This reaffirms Burns *et al* (2006) trans-disciplinary model to advance sustainability in South Africa. Sustainable development through sustainability will only be effective if there is involvement from political, corporate, research spheres, and the general public which can be achieved as a result of successful cooperative governance.

A key challenge to the effectiveness of IEM is the cooperative nature of this decentralised approach. Environmental management and development planning tend to operate in isolated pillars in South Africa and there is a need to integrate environmental issues into development planning, particularly at a local level, for more effective decision-making. All three spheres of government and the various other contributors to governance, have a major role to play in environmental management activities (Nel and Du Plessis, 2004). Fragmentation of legislation and institutions can become a major hindrance to this system and therefore a strong reliance on a solid constitution is critical. The Constitution of South Africa provides specific definitions, principles and responsibilities for a strong basis to apply cooperative governance that could result in effective environmental management (Malan, 2009). The implementation of environmental legislation and policies can occur at all three levels of government, however, national legislation and policies are used to inform provincial ones and provincial legislation and policies help inform local initiatives. Ultimately the implementation of IEM at local level will result in that municipality increasing its understanding of the environmental, social and economic conditions, characteristics and trends in their area of jurisdiction. This is achieved through the use of environmental management and planning related mechanisms, some prescribed by legislation as compulsory such as EIAs, IDPs and

SDFs while others are voluntary, such as SEAs and SEMPAs that are adapted to suit the needs of that particular municipality.

2.5.4 Key environmental management mechanisms (tools)

Effective IEM is dependent on the implementation and deployment of a suite of environmental management mechanisms and tools that are used by specialists and practitioners to support decision-making. DEAT's IEM overview Information Series (DEAT, 2004c) provides a range of IEM tools and mechanisms that are available for government officials, practitioners and researchers. Environmental and planning tools should be considered as processes and have different applicability for different situations and hierarchy of activities (Figure 2.5). For example, risk assessment and economic resource analysis has applicability at a planning and feasibility stage at a project level while SEA provides issue identification at a strategic level. Sustainability analysis has applicability at levels and stages of the hierarchy.

Although this map of tools (Figure 2.5) is an indicative diagram and the tools are constantly evolving, it does provide an overview of the relationships between the tools available in South Africa and potential areas of implementation. These tools should be seen as a process in that they evolve as they will differ between projects and areas of implementation. There are also differences in the way these tools are implemented at a project level or at a strategic level and the way the resultant outcomes are interpreted and utilized. However, some of these tools can become cross-cutting in that they relate to both a strategic level and project level and can provide outputs that can identify issues and options, assist in monitoring and evaluation and provide input into design and planning. These tools that can achieve this cross-cutting approach have to include stakeholder engagement and sustainability analysis (Figure 2.5).

At a local level, some municipalities are attempting to develop and implement these tools so that they provide cross-cutting outputs. For example in the Munsuzi Municipality, the Greater Environmental Management Framework (EMF) Project includes strategic level documents such as a strategic environmental assessment and a state of the environment report, but also provides project level tools such as the spatial decision support tool which seeks to inform planning and design at a project level.

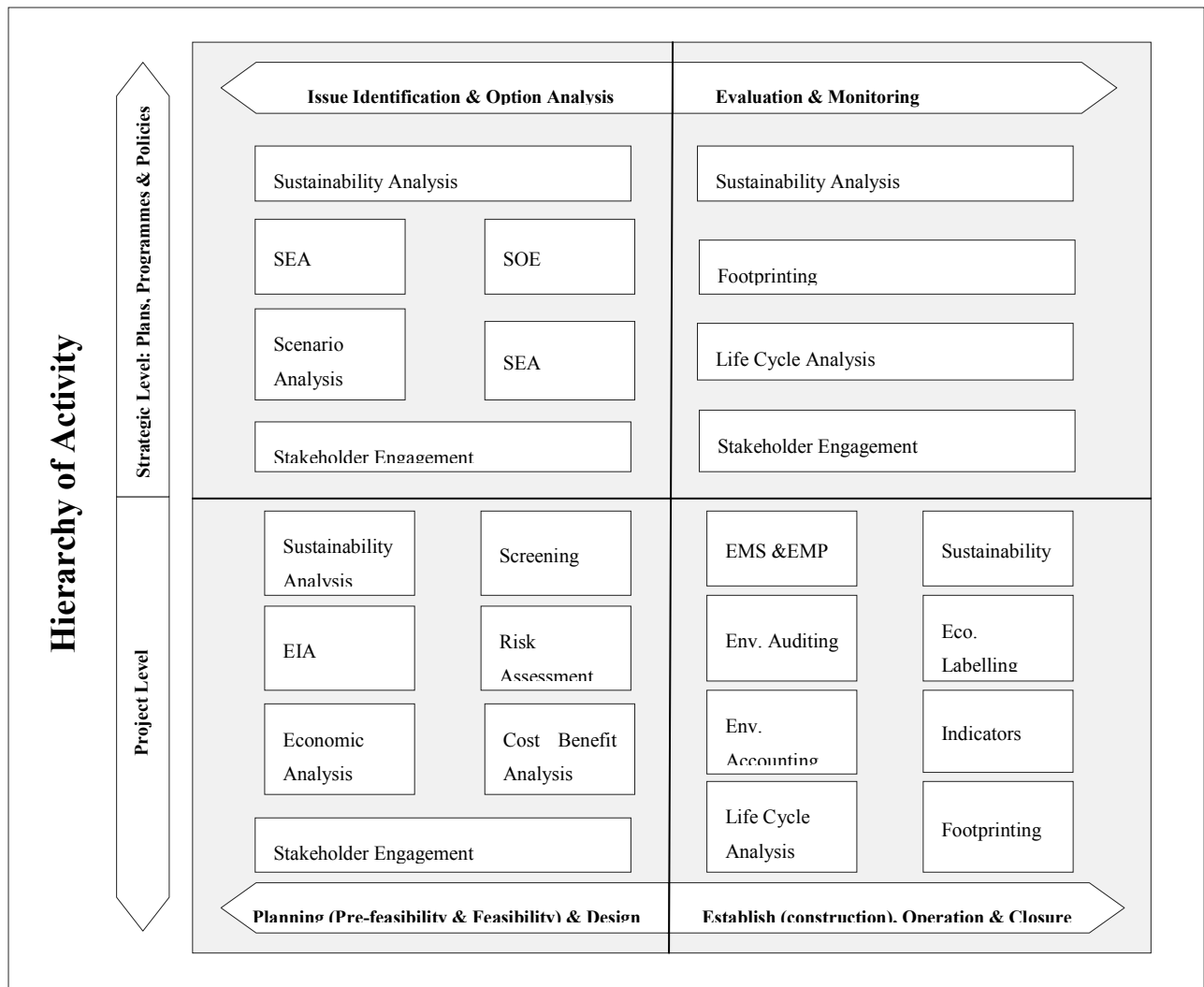


Figure 2.5: IEM mechanisms and tools in relation to level of activity (hierarchy) and activity life cycle (issue identification, planning, construction (operation) and monitoring) at which they could be used (adapted from DEAT, 2004c)

Despite these tools important to the effectiveness of IEM, there is little empirical research available in a South African context, with the exception of EIA and SEA research (however, this does not form part of the scope of this research). For the context of this research, the tool that is developed has its foundations in the project level focused environmental economics and the ecological risk assessment tools (IEM Information Series 16 (DEAT, 2004b) and information series 6 (DEAT, 2004a)), and in the strategic orientated tools such as SEA and scenario analysis. Although this tool is not directly influenced by these guidelines it does take into account the principles in developing the methodological framework. This is important as the tool will be used by government officials and therefore needs to be in accordance with and adaptable to other governmental departments.

The DEAT (2004b) document entitled Environmental Economics, Integrated Environmental Management, provides the main reference point for practitioners and decision-makers with regards to the role that environmental economics plays in IEM in South Africa. There is a strong focus towards the economic and monetary valuation of natural resources (including EGS) with various methods prescribing how to value environmental resources. Turpie (2009) highlights some of the key problems associated with a monetary valuation focus of the environment. Valuation methodology is often considered controversial in that it is prone to bias, that is the outcome of the valuation can be highly influenced by the perceptions and motives of the assessor. There is also a situation where undervaluation can result in the loss of sensitive ecosystems as they may not hold high monetary value or are difficult to monetise, such as intrinsic EGS (Salles, 2011; Seppelt *et al.*, 2011). Furthermore, social issues are often not incorporated into the monetary valuation, as in most cases biodiversity is often linked to people's welfare in terms of income. However, these values do not take into account the true value of biodiversity and its link to welfare benefits, risk, food security and sense of financial safety (Turner *et al.*, 2003; Salles, 2011). These values fail to take into account the risks and uncertainty of impacts to ecosystem services as a result of development.

Ecological risk assessment (ERA) focuses on the probabilistic investigation and nature of uncertainty and variability with regards to the impacts of development on the environment (DEAT, 2004a). Decisions around risk are based on the context of social, economic and environmental systems in which the risk is assessed. ERA evaluates the potential for unfavourable ecological effects or ecosystem degradation occurring as a result of the impacts of one or more stressors, often development. ERA is used by decision-makers who integrate the results of the risk and environmental, socio-economic and socio-political assessments to reach a decision that benefits the livelihoods of society. Decisions that have been reached without recognition of ecological risks will have severe consequences for human welfare. ERA falls in line with IEM principles as it aims to balance socio-economic and development objectives with environmental limits to ecological function and quality, assisting in the development and implementation of plans, policies and programmes (DEAT, 2004a).

These environmental tools and mechanisms can be integrated at all levels of government and governance and, through the application of these various tools, actions and products are developed that are inclusive of various stakeholder requirements and sustainability ideals, thus promoting the principles of IEM.

2.5.5 Concluding remarks

An understanding of the country's legal framework, the relationships that exist between the tools available to environmental practitioners and the institutional structures that exist are vital to conduct research that aims to improve the effectiveness of environmental governance and sustainable development in South Africa. Without this understanding any proposed tools, guidelines or methods will lack grounding and context and not achieve the aims of IEM or sustainability. This IEM framework provides the basis for this research to create a new tool that can be utilized by the varying spheres of government at different levels of the hierarchy of activity, to enhance effective management of our environmental resources by assessing ecosystem services. This tool relies on the existing environment management and planning mechanisms described earlier in the chapter, but will attempt to bridge the gap between these mechanisms through the enhanced understanding of ecosystem goods and services and their role in IEM and sustainability at a local level.

2.6 Conclusion

The literature review outlines the background and theoretical framework for EGS and IEM in South Africa and provides the sustainability science context in which this research is grounded in. The emergence of sustainability science has had a key influence on the shaping of global conferences, policies and plans which has aided in changing the landscape of environmental management. This has resulted in the increasing prominence of sustainable development in the governance discourse with emphasis on the three pillars of sustainability, namely, the environment, the economy and society. Understanding and researching the dynamics and relationships that exist between these three pillars is fundamental to sustainable development. These relationships can be explored by being aware of the productive capabilities of natural resources known as ecosystem goods and services (EGS). EGS are changing the way in which the importance of biodiversity conservation can be stressed to decision-makers and underline the 'win-win' trade-offs that can exist between the environment, society and the economy. This approach has been adopted into global and leading businesses that look to assess their dependence on biodiversity and what changes to ecosystem services means to a company's performance and business decision-making. Businesses are beginning to see that changes in EGS have potential impacts to their survivability and therefore are starting to internalise sustainability strategies into their business plan. This could be seen as a blueprint for local government to assess their need for functioning EGS to provide services to the inhabitants of the municipality. EGS assessment could be seen as a new approach to be incorporated into the IEM dialogue and could provide opportunities for more informed decision-

making. These new approaches to environmental management should be reflected in an integrated manner in policy, regulations and legislation. Through adopting sustainability principles, environmental management and planning tools can help decision-makers to promote sustainable development. An ecosystem services approach, when implementing various tools and mechanisms within the different governance structures and institutions, can assist in achieving the principles outlined in the Constitution of South Africa and emphasised in IEM and contribute to the evolution of environmental management in South Africa. Building on the literature, Chapter Three provides an overview of the existing environmental and land use planning management tools used in the Msunduzi Municipality as the case study.

Chapter Three

Msunduzi Municipality – the case study

3.1 Introduction

This chapter provides the background context for the Msunduzi Municipality, the case study municipality, of the biophysical, environmental and land use management decision support tools that have been undertaken in the Municipality. These tools include the Greater Msunduzi Environmental Management Framework (EMF) project and the Spatial Development Framework (SDF). The information presented in the greater EMF and SDF, and associated spatial datasets are used to inform the EGS based assessment tool that is developed through this research (presented in Chapter Four). The local setting for the Msunduzi Municipality's EMF and SDF and associated environmental and land use decision support tools are described. The processes, components and data that form the greater EMF project and the SDF are presented.

3.2 Local Setting

The Msunduzi Municipality falls within the district municipality of Umgungundlovu and contains the capital city of the province of KwaZulu-Natal, Pietermaritzburg (Figure 3.1). The Municipality covers an approximate area of 640 km² (64 000 ha) and encompasses a diverse range of land use types including: urban, rural, industrial, agriculture and afforestation. The city of Pietermaritzburg is located in the north eastern section of the municipal boundary and exhibits a distinct altitudinal gradient from west to east that results in a marked climatic gradient that is reflected by differing temperature, rainfall and vegetation zones. As a result there are four broad ecosystem types present in the municipality: wetlands, grasslands, forests and savannahs (Institute of Natural Resources, 2008b). Due to Pietermaritzburg's strategic location between Durban and Johannesburg and that the city is the capital of KwaZulu-Natal, large development pressures (namely infrastructure capacity) exist but this also presents development opportunities. The Municipality's open spaces provide development potential and play a crucial role in the economic growth of the city. However the loss of these open spaces could impact the provision of ecosystem services that could compromise the Municipality's potential to deliver on these development opportunities. Therefore, it is critical that growth and development be aligned with environmental constraints to reduce the impact to ecosystem services (SRK Consulting, 2010a). To assist in achieving this balance, the use of environmental and land use decision support tools have been implemented by the Municipality. The

greater EMF project undertaken by the Msunduzi Municipality was considered a success by the municipality and used as a pilot site for the development of a national EMF guideline document.

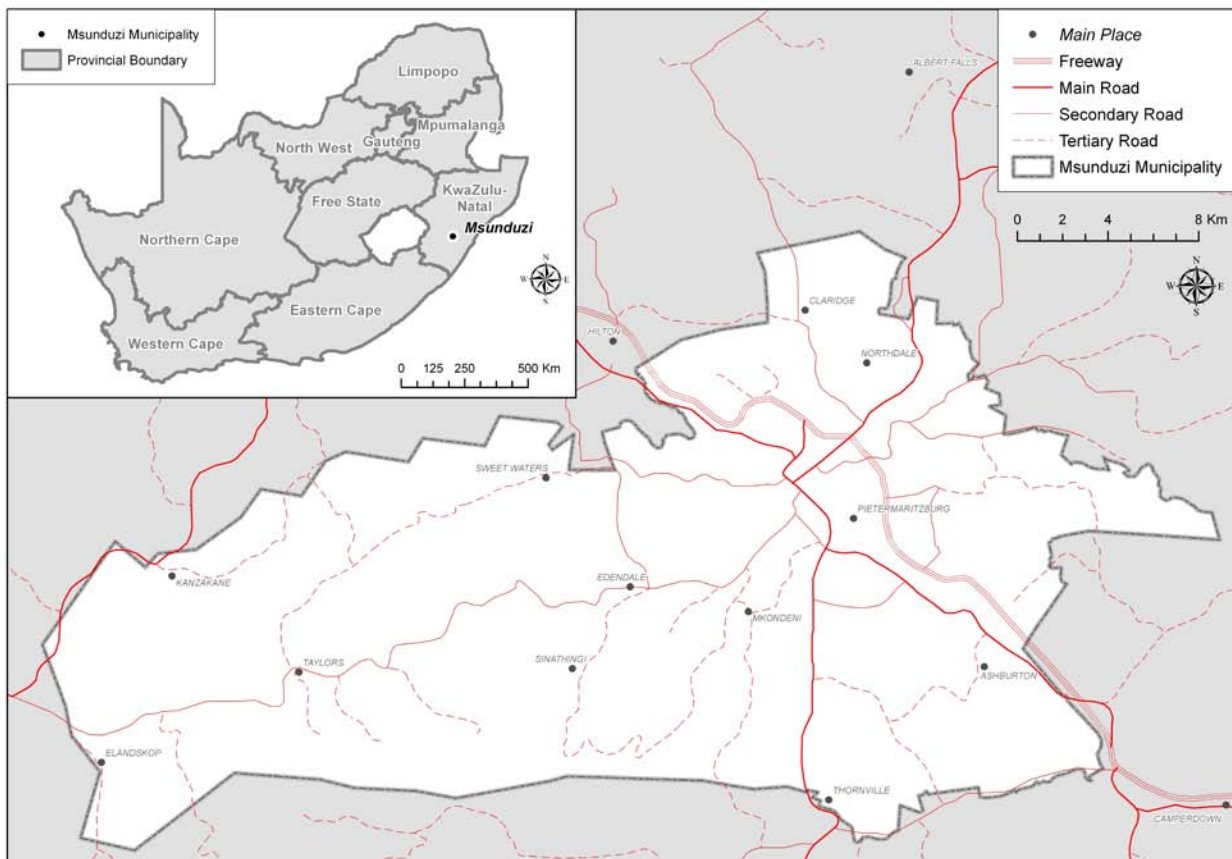


Figure 3.1: Locality map of the Msunduzi Municipality (Pietermaritzburg and surrounding area). Supplied by the University of KwaZulu-Natal Cartographic Unit

3.3 The Msunduzi Municipality’s environmental and land use management decision support tools

The Msunduzi Municipality has identified the need to develop suitable policies and tools that will better inform environmental decision-making and development planning that is in line with the economic, environmental and social sustainable development agenda (SRK Consulting, 2010a). Therefore, in 2007 the DEA and the KwaZulu-Natal DEA&RD, appointed engineering and environmental consulting company SRK Consulting to undertake the task to develop the greater Msunduzi Municipality Environmental Management Framework (EMF). The greater EMF was to produce a series of comprehensive environmental policy documents that would better inform planning and utilization of the environmental resources within the Municipality. This series of documents that make up the greater EMF are: A *Status Quo* (A State of the Environment) report, Strategic Environmental Assessment (SEA), Environmental Services Plan (ESP), Strategic Environmental

Management Plan (SEMP) and an Environmental Management Framework (EMF) (Figure 3.2). The EMF process produced a Spatial Decision Support Tool (SDST) and a consolidated environmental attributes map (CEAM). Furthermore, the Municipality complies with the Municipal Systems Act (no. 32 of 2000) through the preparation of an Integrated Development Plan (IDP) which is represented spatially through the Spatial Development Framework (SDF). The greater EMF project and the SDF result in the Msunduzi Municipality being an excellent case study due to the quantity and quality of environmental data available.

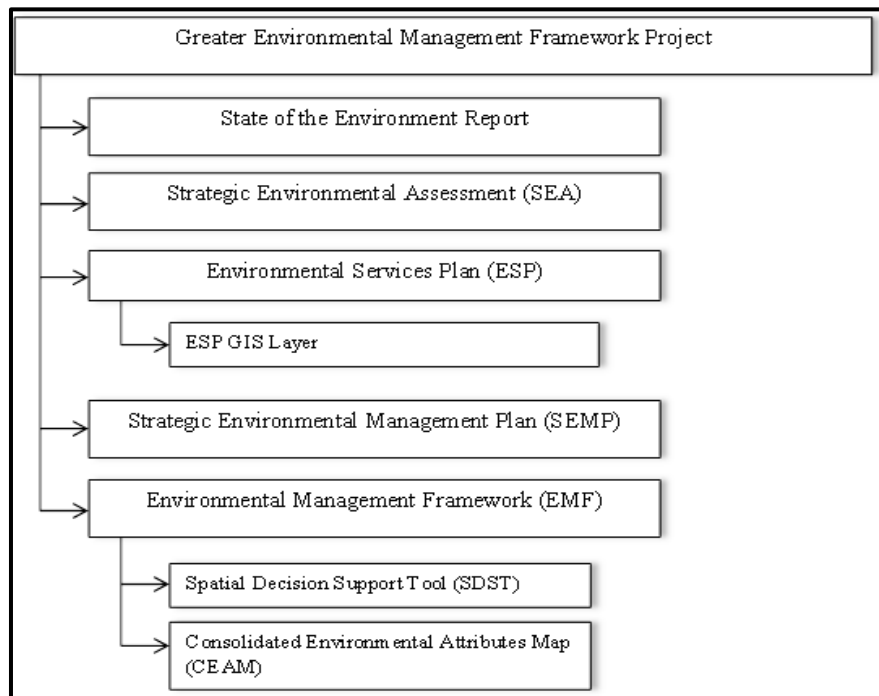


Figure 3.2: The different documents produced as a result of the EMF process (SRK Consulting, 2010a)

3.3.1 The Greater Msunduzi Environmental Management Framework (EMF)

The Msunduzi EMF was a pilot project for the DEA, who were in the process of developing EMF regulations and guidelines, and provided national governance and financial support for the project. The provincial department, DAEA&RD, will be legally bound to the EMF once it has been gazetted and will have to consider the EMF findings as part of their environmental authorisation process (Section 5 (2) of NEMA Reg. 547 2000; Republic of South Africa, 2010). The Municipality is the custodians of the data and are responsible for the review of the EMF, every five years, and for the public dissemination of the EMF tool. SRK Consulting, in partnership with the Msunduzi Municipality were contracted to prepare an EMF document as a component of the Greater EMF Project.

3.3.1.1 EMF

The function of the EMF is to provide a platform for informed decision-making and provide a framework from which future plans, programmes and policies can be assessed. One of the main objectives of the EMF is to identify suitable or unsuitable areas for development. This would provide a valuable data set and information base to assist decision-makers and developers alike and streamline the environmental management process, particularly EIAs. Another objective of the EMF is to identify environmentally sensitive areas that require management and conservation to ensure the provision of EGS. The EMF process for the Msunduzi Municipality achieved these objectives by identifying and mapping environmental attributes, characteristics and functions within the municipality to form a consolidated environmental attributes map (CEAM). From this an interactive GIS based software package, called the Spatial Decision Support Tool (SDST) was developed, which utilized the CEAM dataset to produce a report that identified the environmental, engineering, services provision and social constraints for the Municipality area. The EMF report highlights these attributes and spatially specifies areas of environmental importance and areas under development constraints through a development sensitivity index (SRK Consulting, 2010a).

These attributes are based on specialist studies undertaken for the EMF which included: wetland areas identification, biodiversity significance, catchment hydrology and surface water, topography, air quality, cultural and access and provision of services. For example, the wetland study (Institute of Natural Resources, 2008a) identified and mapped wetland and established buffer zones and identifying constraints and the biodiversity report (Institute of Natural Resources, 2008b) highlighted and identified the ecosystem types present in the municipality. The study carried out an extensive flora and fauna species identification process and a biodiversity score was attached to areas of high biodiversity significance, which was then scored as an irreplaceability value. The Environmental Economics study (PDG, 2009) included a preliminary valuation for the EGS within the municipality based upon a transfer value methodology. However, the report did not include an EGS inventory per ecosystem type and suggested that this be carried out as further research, with a particular focus on wetlands and grasslands. The catchment hydrology study (SRK Consulting, 2009) was scaled down due to budget and time constraints. However, a 1:100 year flood line buffer was determined for areas that would require a more detailed assessment should development be undertaken in these areas. The report suggested that a more detailed study be undertaken to assess the effects of development on the catchment hydrology systems. The surface water report (Ground Truth, 2009) identified the pressures that were placed on the catchments with regards to the

threats, limits of a acceptable change and a desired state of the environment. This allowed the municipality to have a set of sustainability criteria that could be used to assess projects, policy, plans or programs (SRK Consulting, 2010b). The SEA sustainability framework (Table 3.1) was sub-divided into four categories: biophysical, social, economic and governance, with the National Framework for Sustainable Development (NFSD) and the Msunduzi IEM Policy objectives informing the sustainability criteria for each category. The governance section differs slightly as the national objective is informed from the Environmental Governance and Institutional (EGI) Framework policy document. For example, a biophysical NFSD objective is to promote efficient and sustainable use of natural resources (1.1.1 in Table 3.1). This objective then informs six municipal strategic objectives, such as to ensure the water quality from rivers, streams and wetlands is beneficial to human wellbeing (1.2.4). These six objectives that form the municipal strategic objectives then inform twelve sustainability criteria to be considered in the environmental and land use decision-making. For example, wetland areas, streams and rivers are preserved, rehabilitated and managed to maintain ecological function (1.3.5). This process is continued to the three broad categories (social, economic and governance). The Msunduzi SEA sustainability criteria forms an important part of a phase of the adapted tool (presented in Chapter Four) and therefore this section in this chapter provides the background information.

Table 3.1: Sustainability criteria for the Msunduzi Municipality determined from the SEA process (SRK Consulting, 2010b pgs 44- 48)

<u>Msunduzi SEA sustainability criteria</u>		
1. Biophysical	1.NFSD sustainability objective	1.Efficient and sustainable use of natural resources.
	2.Msunduzi IEM Policy strategic objectives	1. To preserve the City's biodiversity and minimize the loss of species resulting from the development of the City.
		2. To conserve and promote sustainable use of indigenous trees in the City.
		3. To maintain air quality at levels that is not a threat to the environment and human wellbeing.
		4. To ensure that the quality of water from rivers, streams and wetlands is suitable for the maintenance of biodiversity and the protection of human well-being.
		5. To plan for and facilitate a shift from the use of non-renewable to renewable resources.
		6. To accentuate the importance of energy and its role in development and the negative effects that energy production may have on the environment.
3.Sustainability Criteria	1. Degraded areas are identified and rehabilitated to limit soil erosion and promote land productivity.	
	2. Aquatic ecosystems are in a healthy state to ensure that the resource remains fit for all other uses and minimum water quality targets are maintained.	

		3. Areas of high biological diversity are utilised and managed to promote the ecosystem goods and services they supply.	
		4. Alien invasive species are controlled and managed to prevent further infestation.	
		5. Wetland areas, streams and rivers are preserved, rehabilitated and managed to maintain ecological function.	
		6. Flood prone areas are managed to promote ecosystem goods and services and minimise flood risks and impacts to flood regimes.	
		7. Areas of geotechnical or geological risk or instability are delineated and are avoided in land development.	
		8. High potential agricultural land is used (or can potentially be used) for sustainable Agricultural production.	
		9. Compact, human-orientated land development patterns use land efficiently.	
		10. Minimum air quality standards for the protection of human health and wellbeing and natural systems are maintained.	
		11. A carbon neutral state is achieved through appropriate greenhouse gas emission reductions, the use of alternative technology and carbon off-setting schemes.	
		12. The use of renewable resources is promoted and the reliance on non-renewable resources is reduced.	
	2. Social	1. NFSD sustainability objective	1. Basic human needs must be met to ensure resources necessary for long-term survival are not destroyed for short-term gain.
		2. Msunduzi IEM Policy strategic objectives	1. To ensure the quality of potable water meets the minimum legislated standards.
2. To provide an effective and efficient waste management system.			
3. To protect the City's landscapes and townscapes.			
4. To ensure that the physiological and psychological effects of noise, shock and vibration levels do not exceed legislated standards.			
5. To preserve and improve the cultural heritage of the Msunduzi area.			
3. Sustainability Criteria		1. A basic level of water supply is provided to all residents without affecting the integrity of natural ecosystems.	
		2. All residents have an income; access to appropriate, secure and affordable housing; and, have access to public services to meet basic needs and live with dignity.	
		3. Communities vulnerable to environmental risk are identified and strategies are developed to minimise risk and promote human wellbeing.	
		4. The waste stream to landfill has been reduced to a minimum, with recovery, re-use and recycling of materials undertaken as standard practice.	
	5. Efficient and effective liquid waste management protects human health and the natural environment.		
	6. An efficient, safe, integrated and convenient network of public transport, bicycle routes and pedestrian access is provided.		
	7. Services, amenities, buildings, facilities, community parks and open spaces are accessible to all people; and, safe, clean and pleasant environments are provided that protect and enhance human health and wellbeing and improve the overall quality of life.		
	8. High quality, affordable formal education is available and accessible for students of all ages.		
	9. Indigenous ecological and cultural knowledge is developed and integrated to planning and management processes.		
	10. The city's sense of place and cultural and natural heritage resources are protected and maintained.		
3. Economic	1. NFSD sustainability objective	1. Socio-economic systems are embedded within, and dependent upon, eco-systems.	

	2. Msunduzi IEM Policy strategic objectives	1. To promote sustainable environmental, social and economic development.
		2. To emphasize the interdependence between poverty, economic growth and the environment.
	3. Sustainability Criteria	1. Development is informed by social needs and the improvement of quality of life and does not compromise the biophysical environment.
		2. Alternative sustainable livelihood strategies are promoted.
		3. An equitable and broad range of employment opportunities exist that provide workers with income to support themselves and their families.
		4. Infrastructure and facilities are well-maintained to meet the needs of residents and business in ways that reduce environmental impacts.
		5. Most of the daily food needs of Msunduzi are sustainably grown, processed and packaged in urban and rural agricultural schemes in the city and surrounding agricultural areas.
		6. Green design principles are used to ensure environmental efficiency and minimise use of resources.
		7. Clean, renewable and efficient energy sources; and, transportation options that reduce fossil fuel dependence are promoted, so as to reduce energy costs and produce low greenhouse gas emissions and other air contaminants.
		8. City finances are managed responsibly and include full life-cycle cost perspectives, including long-term maintenance, repair and replacement costs.
9. The cost of ecosystem goods and services are integrated into development planning.		
4. Governance	1. EGI Framework sustainability objective	1. An enabling environment for on-going dialogue between all roleplayers is created.
	2. Msunduzi IEM Policy strategic objectives	2. To form and support environmental education initiatives that will enable Msunduzi communities to use resources sustainably.
	3. Sustainability Criteria	1. Environmental issues are prioritised and the council is committed to achieving environmental Sustainability.
		2. Environmental issues and priorities are embedded into the Performance Management System and Key Performance Areas of all components of the municipality; and, are integrated into municipal planning.
		3. Decision-making processes are defensible, clear and transparent
		4. Participation in LA21 is increased and the public is encouraged to participate in planning initiatives.
		5. Capital investment projects undertaken or facilitated by the Municipality adhere to legislated requirements and Integrated Environmental Management principles.
		6. Msunduzi is prepared to respond rapidly and to deal effectively with known hazards and emerging threats, to limit the adverse impacts of events and effectively manage emergencies.
		7. Access to environmental information is facilitated and encouraged.
8. Regular monitoring is undertaken to report on progress towards sustainability so that the city can learn and adapt as needed.		
9. Communities are informed, empowered and involved in the process of democratic governance.		

The SEA document (SRK Consulting, 2010b) provides limits to acceptable change, indicators, targets and strategies to attain these sustainability criteria. These recommendations set out by the

SEA to meet the biophysical criteria and include the development and implementation of a municipal Environmental Services Plan (ESP). These recommendations are: assess, develop or implement strategies and actions to assess wetlands; environmental risk and vulnerability; air quality constraints model; areas of agricultural importance; state of rivers assessment; alien invasive clearing program and plan to identify and rehabilitate degraded ecosystems to increase EGS productivity. The social category recommendations include developing an urban greening program, identify communities at risk from environmental factors and identify and classify municipal cultural heritage resources. Economic strategies recommended include the undertaking of a detailed EGS assessment with a focus on wetlands and grasslands to understand the economic value that these EGS have for the municipality, develop market and incentives strategies to promote sustainability, use the sustainability criteria in all municipal plans, policies and programs and include the EMF findings in the IDP and SDF review to identify areas suitable for sustainable development. Governance recommendations comprised of developing a sustainability criteria appraisal checklist to be used with municipal plans, policies and programs, build awareness of the Local Agenda 21 forum and promote sustainability awareness and cooperation between the varying governmental departments and agencies. The SEA document feeds into other documents within the Greater EMF Project and informs the ESP document.

3.3.1.3 Environmental Services Plan (ESP)

The M sunduzi ESP Report (Institute of Natural Resources, 2009) was initially planned as a Municipal Open Space System (MOSS), however, a shift in focus, decided by the Municipality and the consultants, resulted in the report having new objectives. This was to identify areas that are to be set aside to maintain EGS through a process of identifying both biophysical and social objectives and use values. This shift in emphasis meant that the report changed name from a MOSS to the ESP as this more adequately describes the study. The ESP report was divided into two components namely, areas to maintain ecosystem goods and services, and the identification of social criteria.

The first component, areas to maintain EGS productivity, attempted to design a system that would maximise the availability of EGS productivity for future generations and ensure the ecological viability within the municipality. The areas highlighted in the report were heavily influenced by the work carried out for the EMF in the biodiversity specialist study and the resultant conservation plan. Protected areas, areas of high irreplaceability, terrestrial and riparian corridors were identified

as priority areas to maintain EGS within the Municipality, based on the presence of keystone and red-data species. These data was incorporated into a spatial system that produced maps of these key areas to maintain EGS functionality.

The ESP report (Institute of Natural Resources, 2009) suggested eleven recommendations or ‘ways forward’ to ensure the ESP for EGS areas becomes an important and useful tool for biodiversity protection and informed decision-making. Some of these recommendations include: (i) the development of an implementation and refinement plan for the ESP; (ii) increased support from decision-makers and political leadership whereby a stronger approach to quantifying EGS to leaders needs to be developed so that there can be a more sound promotion of better management plans for EGS; (iii) support and the creation of partnerships with local communities needs to be developed and incentives need to be started that will encourage better understanding of EGS and therefore better influence management strategies, this includes education and awareness programmes; and (iv) integration with existing programmes on sustainable land management that take into account broader conservation programmes and initiatives. This includes better integration across municipal, district and provincial boundaries as the functioning EGS will have trans-boundary implications.

The second component of the ESP report focused on social criteria to classify and rate the level of EGS provided from a social, cultural and ecosystem importance value within the municipality when implementing the ESP. The social criteria identified included: function, usage frequency, social services, economic value, visual adsorption capacity and heritage value. Case studies from other open space system assessments were used to inform criterion matrices in which to rank the social importance of EGS so as to identify and prioritise the importance of open spaces within the municipality (Institute of Natural Resources, 2009).

3.3.1.4 Strategic Environmental Management Plan (SEMP)

The SEMP formed part of the greater EMF project along with the EMF and the ESP. The SEMP provides an operational framework for implementing the amended Integrated Environmental Policy for the Msunduzi Municipality. The SEMP provides a strategy to monitor and evaluate progress and transgressions towards environmental objectives identified in the SEA and provides a foundation for future work to be undertaken that will ultimately add value to the environmental goals and objectives. One of the action plans highlighted in the SEMP is that the Municipality will develop an

environmental services plan that will assess the state, importance and economic value of EGS available within the Municipality and how best to conserve functioning EGS. The action plan addressing EGS falls under the economic section of projects to be incorporated into the IDP and therefore into the SEMP. The strategic outcome of the EGS assessment, identified in the action plan, is to include the economic value of EGS in development planning so that the economic cost of a loss of EGS can be accounted for. The strategic objectives linked to this are: to promote efficient and sustainable use of the Municipality's natural resources and to emphasise the interdependence between the environment, economic growth and social progress. The tasks highlighted in the action plan include: (i) the identification of EGS within the Municipality; (ii) the identification of priority EGS as identified in the ESP; (iii) identify methods for valuation of EGS and which method should be preferred; (iv) the collection of information that relates to EGS such as spatial, function and monetary data; (v) undertake a valuation of EGS within the Municipality; and (vi) the development of a scorecard that will rate the impacts to EGS based on individual development projects. This research attempts to provide a solution to achieve action number six, by developing a tool that can rate impacts to EGS of individual projects.

3.3.2 Spatial Development Framework

The SDF forms part of the Msunduzi Municipality's IDP and provides spatial recommendations and alternatives for future development within the municipality (Msunduzi Municipality, 2009). The SDF's primary focus is the spatial opportunities for future development in the municipality and the economic and social implications of this future development. Although the SDF mentions sustainable environments as one of its spatial goals, the majority of the goals are focussed on land use utilization and change (development of urban areas and activities). The SDF is intended to provide a general framework which will drive land use change and future urban growth and is seen as the municipality's response to planning for the future growth and change that the municipality will most likely undertake. An outcome of the SDF process was the spatial identification of future development areas, comprising of economic potential, residential growth areas, urban agriculture areas and industrial areas. This land use management support tool could become an exceedingly valuable resource when used in conjunction with an EGS study as development will have direct impacts on the environment's ability to produce EGS (Msunduzi Municipality, 2009).

3.4 Conclusion

This chapter provides background context to the environmental management and land use decision support tools that the Msunduzi Municipality has undertaken. The information and data derived from the greater EMF project and the SDF provide the necessary inputs for implementing the phases of the adapted tool that is discussed in the research design chapter (chapter four). The original and adapted Corporate Ecosystem Services Review (ESR) tools are explained in the next chapter and form the research design for an EGS based tool that could be used by the municipality.

Chapter Four Research Design

4.1 Introduction

EGS based assessments for environmental decision-making is a relatively new approach resulting in new methodologies and frameworks being developed to quantify and interpret the value of EGS. EGS based assessments that are utilized by local government for decision-making are generally based on an ad-hoc methodology that is often conducted by consultants. Results from these assessments need to be not only applicable to environmental departments at a local level but also accessible for other departments such as town planning, transportation or health services. Therefore there is a need for tools to be developed that allow local government decision-makers to be able to rapidly evaluate EGS assessments to save costs and capacity in the decision-making process. However, no standardised tool for this application exists in South Africa. Therefore this research employs the Corporate Ecosystem Services Review (ESR) tool (Hanson *et al.*, 2008) that has been utilized by the corporate sector in response to assessing their dependence and impact on EGS. In this research, the municipality is considered as a business in which it assesses its dependence and impact on ecosystem services to be delivered to its customers and consumers, the inhabitants of the municipality and surrounding areas, by planning or approving development on open spaces. Just as a business provides goods or services to its customers, a municipality must manage the provision of goods and services to its inhabitants. The natural environment, in the form of EGS, provides these goods and services that are critical to the functioning of the municipality, such as clean water, recreational facilities, liquid waste management and air quality. Therefore an environmental management decision support tool, based on the ESR methodology, can assist the municipality in assessing the impact and dependence that land use change has on EGS.

In this chapter the theoretical framework adopted is discussed, which includes quantitative and qualitative techniques, data classification, case study analysis approaches and purposive sampling strategies. The chapter addresses case study site selection, key stakeholder selection, data collection and limitations within the methodology. The final section of the chapter explains the structure of the original ESR framework and its implementation in the private sector and how this framework was adapted from a corporate based review to be used in a local government context. Each of the five phases of the adapted tool are explained and how it differs from the original ESR tool. As this

research is focused on adapting an existing methodology it is predominately desktop study orientated and verified with limited field work and questionnaires.

4.1.1 Quantitative and Qualitative Techniques

There has been a distinction made in the scientific community between quantitative and qualitative research techniques and data collection methodologies. Quantitative methods form the basis for most physical geography research and involves mathematical reasoning, modelling, statistical analysis and experimentation. The data derived from this method are usual numeric in nature and examined through hypothesis testing and statistical techniques (Clifford *et al.*, 2010). Qualitative methods are more humanistic in nature and are explorative and descriptive of human emotions and actions. These methodologies explore the intangible aspects of geography through the use of interviews, discussions and participant involvement or observation. Qualitative data collection allows the complexities of the socio-economic realm to be examined by geographers and allows for a greater understanding of our everyday life (Dwyer and Limb, 2001). Despite the ever evolving nature of environmental research, both techniques remain important within the field (Clifford *et al.*, 2010). If research is undertaken under the framework of sustainability then both techniques are crucial to develop an understanding of the complexities of the relationship between the economy, environment and society. Due to the nature of this research, focused on adapting an existing tool and predominantly desktop based, qualitative techniques were used as a primary means of data collection and interpretation.

4.1.2 Primary and secondary data

Data collected and used for research in geography can be characterised broadly into two types: primary and secondary data. Primary data refers to data that have been collected and generated specifically for the research being undertaken by the researcher. These data relates directly to the researcher's needs and can include activities such as fieldwork sampling, interviews and laboratory work. These data has been generated to meet the needs of the researcher and are therefore most relevant in answering their research question. However, primary data can be costly, time consuming and resource intensive (Montello and Sutton, 2006). Secondary data differs in that it is data that has been collected independently and not for the purpose of the research being undertaken but is used in the research. Examples would include census surveys, scientific publications, archives, government agencies or spatial imagery databases. Secondary data can be less resource demanding as it often consists of large datasets that would be impossible for the research to collect on their own. This

type of data is growing in importance for innovative research and policy development and influences the type of knowledge that is produced and how it is produced (St Martin and Pavlovskaya, 2010). The application of secondary data can be extremely varied and is reliant on the purpose of a application and the nature of the research. It can be the primary focus in research projects where the purpose is to collect evidence from other research, it can be used to describe characteristics of objects or places thus providing context, provides a basis for comparison or offers a benchmark for analysis based on other research (Salles, 2011). This research predominately utilized secondary data as the research was intended to test the applicability of certain methodological frameworks and techniques.

4.1.3 Case study approach

An intensive research methodology can use a case study approach to establish how mechanisms or processes operate under a certain set of conditions or circumstances to produce measurable observations (Inkpen, 2005). Case study approaches are not meant to be representative of large scale broader patterns but rather a means to highlight issues of causality, interconnectedness and practices at a much smaller scale (Herod and Parker, 2010). While case studies provide detailed information on the research question they are not representative of generality. However, the detailed information that is collected can reveal relationships that can be used to modify or generate models and frameworks (Perrings *et al.*, 2011). This research utilized the case study approach to test how the adapted ESR tool would function as if used by the 'end user' if conducting an EGS assessment. Two study sites within the municipality were chosen as case studies, to pilot the adapted methodology with the municipality.

4.2 Study site selection, data collection and analysis

4.2.1 Case study site selection

A case study approach was chosen as the appropriate way to test the adapted ESR framework to meet the objectives of the research. The case study, the Msunduzi Municipality, was chosen due to the extensive spatial data in the EMF and the researcher has developed a good working relationship with the Municipal Environment Department. Through discussions with the Department, two sites of interest were identified. Selection of these sites was based on the strategic importance placed by the Department as a result of planned development activities on or near the study sites and their importance as an open space or non-transformed land to the municipality. This provided the

opportunity to work through the adapted methodology as if it was being applied by the municipality in a ‘real world’ situation, as this research is focused on the development of a new tool using the ESR framework. Descriptions of the two study sites are provided in the results section of the document as it forms a component of phase one of the adapted methodology.

4.2.2 Key stakeholders and expert identification

The Msunduzi Municipality Environmental Department was considered as the primary stakeholder and end user of the adapted tool and therefore most of the discussion, interviews and workshops were conducted with representatives from this Department. Other experts were consulted at various stages within the research to provide expert insight (Table 4.1). All people interviewed gave consent to the use of their names as no confidential or sensitive matter was discussed or used in this research.

Table 4.1: Chronological listing of all stakeholders and experts interviewed

Person interviewed	Date	Affiliation and title	Reason for interview	Type of interview conducted
Marita Thornhill	25/03/2010	Strategic Environmental Management Consultant at Thorn-Ex, (past Head of Environmental Planning and Coordination at the Provincial Department of Agriculture and Environmental Affairs (DAEA))	Provide insight into the fields of strategic environmental management, environmental tool development and environmental governance. Input used to formalise Masters research proposal	Semi-structured
Jenny Mitchell	29/03/2010	CEO of the Institute of Natural Resources	Provide insight into the fields of strategic environmental management, environmental tool development and environmental governance. Input used to formalise Masters research proposal	Semi-structured
Keagan Allan	23/04/2010	GIS Operator and GIS Manager at SRK Consulting, developer of the Spatial Decision Support Tool (SDST) for the Greater EMF project	Information about the spatial data used for the EMF and how the data was used to develop the SDST	Semi-structured

Philippa Emanuel	09/04/2010 21/04/2010 (follow-up interview)	Senior Environmental Scientist at SRK Consulting, lead scientist for the Msunduzi Greater EMF project	Information gathering of the Greater EMF project and the specialist studies undertaken. Further information about the EGS specialist study undertaken for the Greater EMF project	Semi-structured
Rodney Bartholomew and Jessica Brislin	25/11/2010 24/05/2011 (follow-up interview and site visit) 28/07/2011 (follow-up interview and site visit) 03/08/2011 (follow-up interview) 19/08/2011 (feedback questionnaire)	Rodney Bartholomew, Manager: Environment, Conservation & Forestry Department Msunduzi Municipality Jessica Brislin, Environmental Scientist: Environment, Conservation & Forestry Department Msunduzi Municipality	Presentation of project proposal, initial feedback on project potential, discussions on the different phases of the adapted tool, implementing adapted tool on study sites, final discussions and feedback	Semi-structured, focused discussions, workshops and site visits
Dave Cox	03/08/2011	Principal Scientist at the Institute of Natural Resources	Information on the proposed activity planned for one of the study sites used to test-run the adapted ESR tool	Semi-structured
Myles Mander	08/08/2011	Director of Futureworks and Eco-futures, resource economist specialist	Discussion about the strengths and weaknesses of the ESR tool and where improvements could be made to ESR tool for a local government context	Semi-structured
Kate Pringle	29/08/2011 20/09/2011 (follow-up email)	Environmental Scientist at the Institute of Natural Resources	Provide information on her experiences on developing a similar EGS based tool for decision-making	Informal discussion at the IAIAAsa Conference 2011, email correspondence
David Gengan	11/08/2011	Manager: Investment Promotion, Economic Growth and Development Msunduzi Municipality	Provide insight into how another department within the municipality would view a EGS based tool to assist in environmental decision-making and how his department takes EGS into consideration in their planning and policy making	Semi-structured

4.2.3 Data collection, interviews and workshops

Data collection was through the development and implementation of the adapted ESR tool and the feedback provided from the Municipal Environmental Department. The adapted tool used primary data that was gathered from a combination of semi-structured, snowball and informal qualitative interviews with key stakeholders and experts and observations made on site visits (Babbie and Mouton, 2001). The secondary data was gathered from literature and spatial data from the Greater EMF project and SDF. Presentations, focused discussions, workshops and site visits were held with the Municipal Environmental Department where the initial research proposal was presented, each phase of the adapted tool was explained and discussed and ground truthed at the study sites. Data gathered through this process was used to refine and finalise the adapted tool and presented back to the Municipality as the final tool (Table 4.2).

All interviews with experts were conducted in a semi-structured snowball interview style where a set of questions was drafted as a guide to encompass all key topics. However at any stage of the interview other questions were asked as a result of the discussion generated (see Appendix 1 and Appendix 2). The focused discussions with the municipality followed a similar style where the different phases of the adapted tool and how they would work with each phase was discussed. The workshops were conducted with the Municipal Environmental Department and were designed so that each phase could be worked through with them to explain the methods for that phase and to provide the data needed to complete each phase. During these workshops, the strengths and weaknesses of each phase were recorded and, in some cases, resulted in amendments to certain aspects of the methods. The final feedback questionnaire was sent via email to provide final thoughts on the adapted tool which were used to determine the strengths, weaknesses and applicability of the adapted ESR tool.

Table 4.2: Chronological order showing how the ESR tool was adapted including parties involved in the process and the data that was gathered

Description	Who was involved	Data gathered
Presentation of research proposal and the Corporate ESR tool	Researcher and the managers from the Msunduzi Municipality Environmental Department	Initial feedback of applicability of research for the municipality and official support of research from the municipality and permission to use

		documents and data owned by the municipality.
Gathering of EMF and SDF documents and spatial data	Researcher, lead scientist from SRK Consulting and the Msunduzi Municipality Environmental Department	All documents and GIS data created as a result of the Greater EMF project and the SDF
Study site selection within the municipality	Researcher and the managers from the Msunduzi Municipality Environmental Department	EMF data outputs and defined site boundaries for the study sites
Initial site visit	Researcher and a representative from the Msunduzi Municipality Environmental Department	Initial observations and first visit to study sites
First presentation of adapted tool to the Municipality and discussion of each phase of the tool	Researcher and the managers from the Msunduzi Municipality Environmental Department	Initial feedback on the practicalities and challenges that could be encountered when using the tool and used to rework the adapted tool
Presentation of reworked version of the adapted tool and first workshop of phase one and two of the adapted tool	Researcher and the managers from the Msunduzi Municipality Environmental Department	Data inputs for phase one and two of adapted tool
Site visit to study sites and second workshop on phase three and four of the adapted tool	Researcher and the managers from the Msunduzi Municipality Environmental Department	Data inputs for phase three and four of adapted tool
Final discussion of the adapted tool and filling out of feedback questionnaire	Researcher and the managers from the Msunduzi Municipality Environmental Department	Data to understand the applicability, strengths and weaknesses of the tool

4.3 Corporate environmental services review (ESR) methodology

The ESR guiding document developed by the World Research Institute (WRI) with assistance from the Meridian Institute and the World Business Council for Sustainable Development (WBCSD) (Hanson *et al.*, 2008) was originally designed to assist companies to highlight their dependence on EGS and the risks or opportunities that a healthy ecosystem can provide to the business bottom line (Chapter 2 presents a detailed overview of the business case for the ESR). For this research, the ESR tool was adapted to be relevant for local government use. The Msunduzi Municipality was considered a corporation that is reviewing their dependence and impact on EGS as a result of their business decisions. In this local government context, business decisions are equated to development planning and authorisation. These ‘business’ decisions impact on the productive nature of ecosystems in producing EGS for the municipality’s customers (the inhabitants of the municipality)

as open space is lost due to development. Therefore the municipality can use this tool to assess its dependence and impact on EGS as a result of development pressures, just the same way as a company would use the ESR tool. The ESR tool requires that a scope is selected in which certain aspects of the company's operations are to be assessed and for this research open spaces (untransformed land) within the municipality were considered as the part of the 'company's' operations. However, before discussing how the ESR tool was adapted for a municipal context it is important to understand the model in its original format as a corporate review methodology. This section of the chapter serves as an introduction to the ESR tool where each phase is explained in detail to indicate how it has been adapted later in the chapter.

4.3.1 Structure of the ESR framework

The ESR framework provides five steps or phases that must be undertaken when conducting the assessment and it includes options of which personal could be involved and sources of data and information that could be relevant at the varying steps (Table 4.3): (i) selecting the scope, (ii) identify priority EGS, (iii) analyse trends in priority ecosystem services, (iv) identify risks and opportunities, and (v) strategy development. These steps are designed to provide a structured methodology for businesses to understand their relationship, impact and reliance on EGS that will ultimately highlight their business risks and opportunities based on their dependence on these natural systems. The design of this framework allows for each phase to be personalised, meeting the needs of the company or the scope that has been selected. The ESR step-wise process starts by bridging the divide between ecosystems and business process by evaluating the company's relationship with EGS. The tool then seeks to analyse the trends and drivers impacting on this relationship. This leads to the identification of business risks and opportunities which has implications on business performance, which leads to the final step of developing mitigating strategies to avoid or minimise risk and proactive business strategies to maximise or develop the opportunities.

Table 4.3 Summarised methodology of the Ecosystem Services Review (ESR) (adapted from Hanson *et al.*, 2008)

Phase	1. Select the scope	2. Identify priority EGS	3. Analyse trends in priority ecosystem services	4. Identify risks and opportunities	5. Strategy development
Activity	Identify the boundary in which the ESR study will be undertaken. This boundary should focus on one particular aspect of a company. This can include: a specific business unit, supply chain, customers, market segment, product and/or landholdings.	Determine the highest priority EGS through a systematic evaluation of the company's dependence and impact on the landscape functions (EGS) within the scope of the study area	Research, evaluate and analyse drivers, trends, conditions of EGS within the study site. This includes: the company's activities, activities of those around them, trends (natural and socio-economic), direct and indirect drivers	Identify and evaluate the business risks and opportunities for the company that have been highlighted from phase	Provides a 'way forward' for company managers to monitor, mitigate and utilize the risks and opportunities from phase 4
Who is involved	Researcher (consultant), executive managers, managers from selected scope	Researcher (consultant), executive managers, managers from selected scope, existing and new analysts and local stakeholders	Researcher (consultant), analysts and leading experts	Researcher (consultant), managers from selected scope and analysts	Researcher (consultant), executive managers, managers from selected scope and analysts
Information and data sources		Literature, in-house knowledge, key stakeholders, existing and new in-house data	Literature, in-house knowledge, key stakeholders, existing and new in-house data, leading experts, relevant publications and scientific studies, NGOs, local associations, other relevant tools and resources	Literature, in-house knowledge, key stakeholders, existing and new in-house data, leading experts, relevant publications and scientific studies, NGOs, local associations, other relevant tools and resources,	In-house knowledge, key stakeholders, NGOs and local associations
Outcomes from phase	Boundary in which to conduct the ESR	A list of five to seven priority EGS	Summary of the trends and drivers for each priority EGS	Lists, descriptions and a clearer understanding of possible risks and opportunities	A possible 'way forward' or a set of strategy options.

4.3.1.1 *Phase one: selecting study scope*

The first step outlined in the ESR is to select the scope of the study. This is to ensure that clear and defined confines are prescribed before the study begins to conduct the analysis effectively. In the case of a business, this could include any aspect of that company such as suppliers, business units, the production line, facilities and its customers. The ESR methodology literature for this phase provides three questions which can be used to assist in defining the scope: (i) which stage of the value chain is being assessed? The company can choose from a multitude of business operations and processes to be assessed and depends upon which part of the value chain is considered most important with regards to company's strategy. (ii) Who and where specifically is the assessment occurring? This question asks the user of the tool to select which individuals, aspects of a company, suppliers or customers the ESR is being conducted on and to what geographical extent. (iii) Is the selected scope of strategic importance, timely and supported? The scope needs to be of high strategic importance for the company and should offer an opportunity to influence future business decisions. This would help in achieving buy-in from senior managers and directors as support from upper management will be crucial for a successful ESR.

4.3.1.2 *Phase two: identification of priority ecosystem services*

The second step in the ESR is to assess the company's dependence and impact on EGS within the study scope. The ESR priority ecosystem services identification process is structured to be a rapid assessment that screens out EGS that do not provide a major business risk or opportunity. A company poses a risk to its customers if it degrades or depletes an ecosystem services. Conversely opportunities can arise to its customers if a company enhances ecosystem services. The ESR methodology for this phase follows a two part question progression that assists in evaluating the company's dependence on EGS and then through a further three questions, the company's impact on EGS can be assessed (Figure 4.1). These questions are asked against each potential EGS that may occur within the selected scope where a final indication of dependence and impact can be viewed in a summary matrix. After completing this question progression (Figure 4.1) the EGS which the company has a high dependence on and/or is highly impacted by EGS change should become apparent and assists in narrowing down the priority EGS. The top priority EGS are those which were answered yes in both parts, the next important EGS are those that are deemed 'high' for one part and 'medium' for the other part. This continues down to the EGS that receives a 'low' in both sections of the question progression. This phase is to be undertaken by the researcher preferably using a Delphi technique. The ESR tool suggests selecting the top five to seven EGS that

are viewed as priority EGS. These top EGS are considered as priority EGS and form the basis for the remainder of the ESR with the other EGS are screened out.

4.3.1.3 Phase three: identification of trends and drivers of priority ecosystem change

The third phase entails researching and analysing the drivers, trends and status of the priority areas identified in phase two. This phase is needed to provide insight into the condition of these areas so that business risks and opportunities can be later identified. The ERS methodology suggests five sets of questions for each priority EGS identified in phase two, that must be answered to analyse the trends and drivers (Figure 4.2) (Hanson *et al.*, 2008). These questions assess the trends and changes in the ecosystem services, what is driving these changes, what are the activities of the company and other parties on EGS and finally the indirect drivers of EGS change. These five questions (Figure 4.2) provide a framework that delivers a comprehensive understanding of the drivers and trends per priority EGS for the study area.

4.3.1.4 Phase four: risks and opportunities identification

The fourth phase is to evaluate the information on the priority ecosystems from phase three and assess what are the potential implications for the company. The main outcome from this phase is to identify what are the ‘business’ risks and opportunities arising from the trends and drivers of the priority ecosystems. The ESR methodology (Hanson *et al.*, 2008) refers to five general types of risk and opportunities that can arise as a result in changes in the priority ecosystems. (i) Operational risks and opportunities: refers to the daily company tasks, processes, expenditures and activities that are at risk or where opportunities are created from EGS change (ii) Regulatory and legal refers to risks and opportunities that arise from legal matters, laws, governmental policies and court proceedings. (iii) Reputational risks and opportunities refer to the company’s image, brand name and relationships with the general public, stakeholders and its customers. (iv) Market and product related risks and opportunities are influenced by consumer’s preferences, product or services offerings, a new evolving marketplace and other factors that impact on corporate performance. (v) Financing based risks and opportunities refer to the costs, stakeholder investments change and investor confidence level changes that can arise from EGS degradation (Table 4.4).

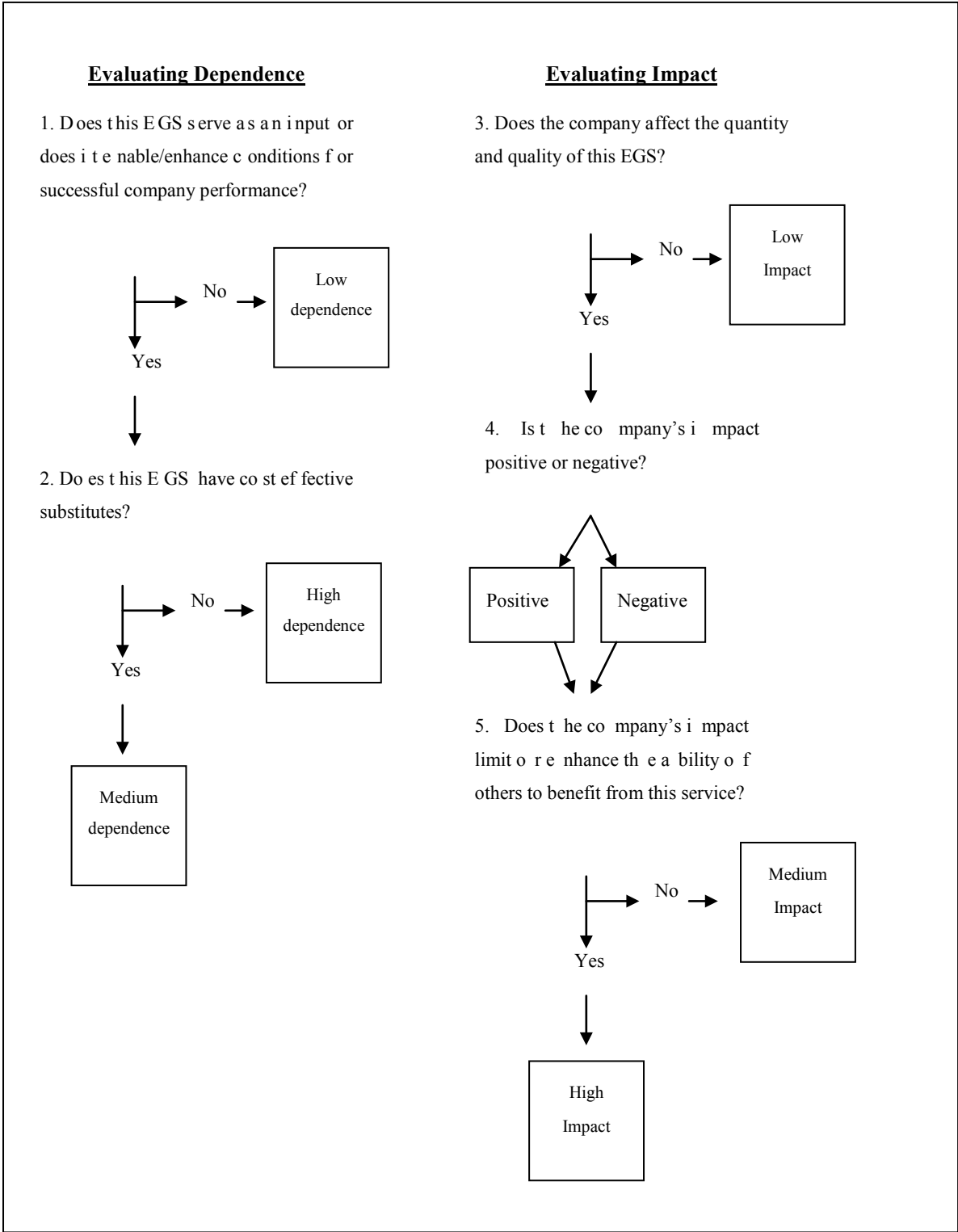


Figure 4.1: Question progression to assess the dependency and impact of a company on EGS. Forms part of phase two in the ESR methodology (Hanson *et al.*, 2008)

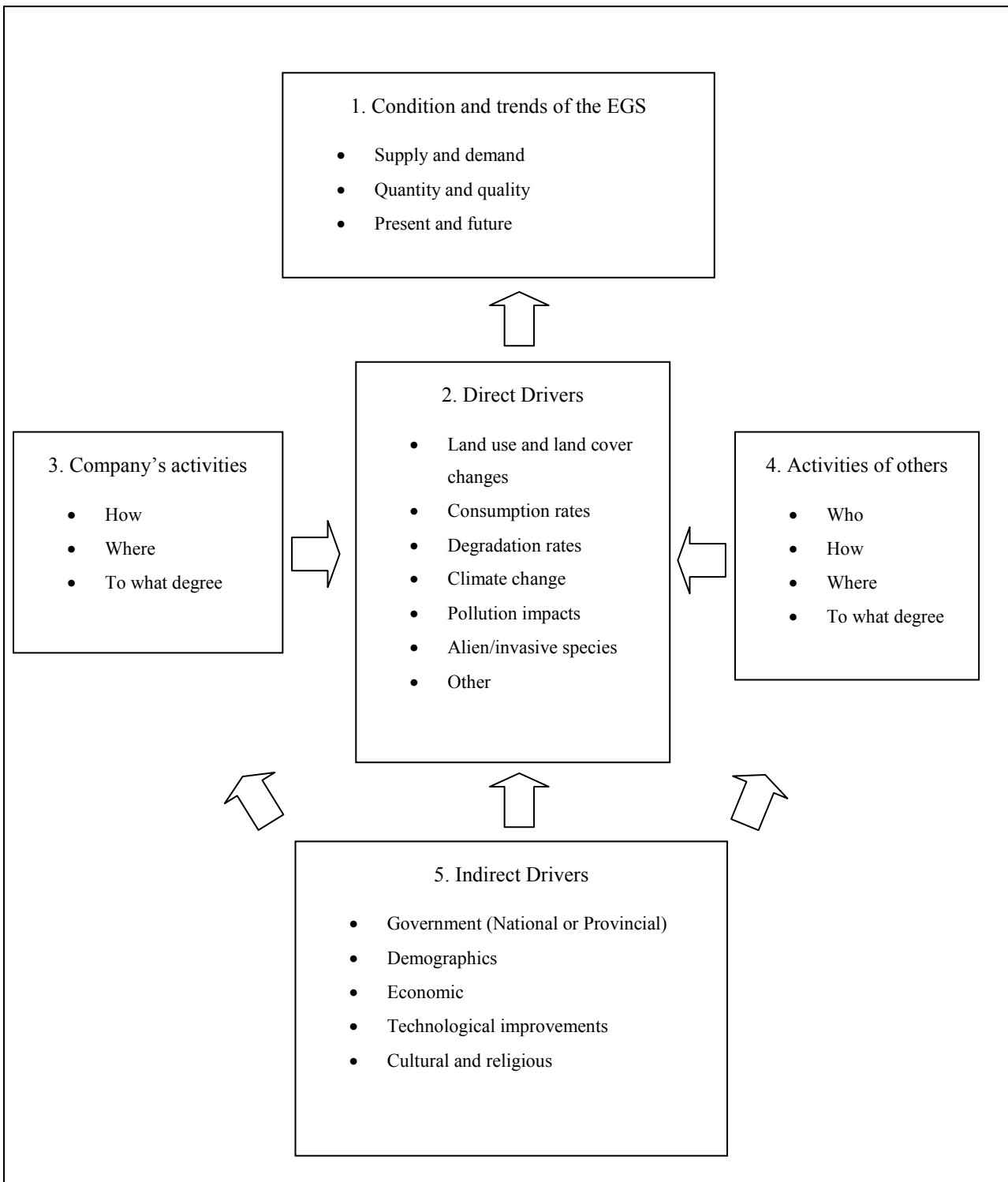


Figure 4.2: Framework for highlighting EGS trends, drivers and conditions within a company. Forms part of phase three in the ESR (Hanson *et al.*, 2008)

Table 4.4: Drivers and trends of EGS result in varying types of risks and opportunity that can be categorised into five groups (Hanson *et al.*, 2008)

Type	Risk (not exhaustive)	Opportunity (not exhaustive)
<i>Operational</i>	<ul style="list-style-type: none"> • Increased costs or scarcity of inputs • Reduced productivity or output • Operation distributions 	<ul style="list-style-type: none"> • Enhanced efficiency • Reduction in operating costs • Pollution reduction from operational processes
<i>Regulatory and legal</i>	<ul style="list-style-type: none"> • Fines • Permit and licence applications • Reduced quotas • Lawsuits 	<ul style="list-style-type: none"> • Licence to expand operations • Opportunity to influence government policy • Products to meet new regulations (providing a niche market product)
<i>Reputational</i>	<ul style="list-style-type: none"> • Damage to public image or brand • Corporate Social Responsibility failings • Public support of company 	<ul style="list-style-type: none"> • Improved brand image • Corporate Social Responsibility initiatives • Positive differentiated brand image
<i>Market and product</i>	<ul style="list-style-type: none"> • Changes in consumer/customer preference • Payments for EGS usage (i.e. carbon tax) 	<ul style="list-style-type: none"> • New markets for product • New markets for a certified product • Markets for EGS • New revenue streams from company owned/managed ecosystems
<i>Financing</i>	<ul style="list-style-type: none"> • Higher capital costs • More lending requirements • Loss in investor confidence 	<ul style="list-style-type: none"> • Increased investor confidence • Increased investment from forward thinking investors and grant institutions

4.3.1.5 Phase five: Strategies for the way forward

The final phase of the ESR framework is to develop strategies to either minimise the risks identified or to maximise the opportunities. There are three broad strategy categories that can be used to respond to the findings of the previous steps: (i) Internal changes: companies can attend to the risks and opportunities identified in previous stages through changing company activities, process and operations. (ii) Sector or stakeholder engagement: companies can partner with other leading sector institutions, collaborate with partnering industries and NGOs or restructure stakeholder transactions. (iii) Policy-maker engagement: many EGS are controlled or monitored by governmental agencies and therefore companies may need to provide input into policy formulation. Often weak government policies and their lack of enforcement or the lack of financial and human capacity are a key indirect driver on EGS change and therefore it is in the interest of the company to engage with policy makers to improve strategies to avoid EGS degradation.

4.4 Adaptation of the ESR model to a Local Municipal context

The original Corporate ESR tool was designed for a business environment and therefore required adaptations when applying the tool to fit the needs of a local municipality (Table 4.5). Municipalities are multi-faceted organisations that contain numerous departments and role-players, similar to a large corporation, therefore using a tool such as this could potentially be easily over-complicated. The adapted ESR tool assumes that it will be utilized by one department assessing the impact of development on EGS. This adapted version is focused on being a decision-support tool for the environmental department of the Msunduzi Municipality that they could use as a reactionary response to development pressures (during the EIA review phase) or a strategic action to investigate the importance of certain open space areas and the EGS supplied to communities. The adapted tool assumes that open spaces (untransformed land) and the ecosystems found in these open spaces, are producing EGS that are consumed or utilized by the inhabitants of the municipality. Therefore the adapted ESR tool is focused on the interactions of open spaces and the downstream users (inhabitants of the municipality) that benefit from the provision of those EGS. That is, what is the potential impact to risks and opportunities and ultimately sustainability within the municipality, if that parcel of open space and associated EGS is degraded or lost?

Table 4.5: The difference between the original corporate ESR framework compared to the adapted municipal orientated ESR tool

Phase	Original ESR framework	Adapted ESR framework
1. Select and understand the study area	Identify the boundary in which the ESR study will be undertaken. This is boundary should focus on one particular aspect of a company. This can include: a specific business unit, supply chain, customers, market segment, product and/or landholdings.	Identify the boundary in which the study will be undertaken. In the case of a municipality, open spaces (non-transformed and non-degraded land parcels) within the municipality are considered to be production business units producing EGS. Also collect and collate all available strategic spatial information (such as data from EMF or SDF studies) for the selected scope. This informs a development or strategy scenario that indicates what activity is going to occur on the study site.
2. Identify priority EGS	Determine the highest priority EGS based through a systematic evaluation of the company's dependence and impact on the landscape functions (EGS) within the scope of the study area	Determine the highest PEGS based through a systematic evaluation of the municipality's dependence and impact on landscape functions to deliver key EGS to its inhabitants within the scope of the study area

3. Analyse trends in priority ecosystem services	Research, evaluate and analyse drivers, trends, conditions of EGS within the study site. This includes: the company's activities, activities of those around them, trends (natural and socio-economic), direct and indirect drivers.	Research, evaluate and analyse drivers, trends, conditions of EGS within the study site. This includes: the municipality's activities, activities of those around them, trends (natural and socio-economic), direct and indirect drivers. This will then be used to develop scenarios of change for each PEGS.
4. Identify risks and opportunities	Identify and evaluate the business risks and opportunities for the company that have been highlighted from phase 3	Identify and evaluate the municipal risks and opportunities for each scenario developed in phase 3. Application of a sustainability risk and opportunity-based assessment to the sustainability criteria developed in the SEA.
5. Strategy development	Provides a 'way forward' for company managers to monitor, mitigate and utilize the risks and opportunities from phase 4	Provides a 'way forward' for municipal managers to monitor, mitigate and utilize the risks and opportunities from phase 4.

4.4.1 Phase one: selecting and understanding the study area

The study scope was selected as if this ESR framework was to be used as a decision support tool. Therefore the study scope needs to be both reflective of a potential business unit of the Municipality and something that has defined geographical boundaries. It was decided, in consultation with the Municipal Department, that two different open spaces within the municipality would be considered as the 'business units' being assessed and formed the two case study sites used to test the adapted ESR tool. These two open spaces have different land use change planned where one site is demarcated for development and the other site for conservation. These two sites allow for the adapted tool to be piloted for two different applications. In the future it is envisaged that the study scope would be the same as the open space that is under an EIA or open spaces that are deemed strategically important. This study differs from the prescribed ESR methodology by adding a fourth question to the original three; that is, what is the spatial information available for the selected scope? This question attempts to derive as much spatial information available for the selected scope that will aid in further phases of the ESR process. This spatial information included data from the EMF, SDF and data from the local conservation authority Ezemvelo KwaZulu-Natal Wildlife. These spatial data was used to gather as much information as possible on the open spaces selected as the scope. This informs the final step of this phases where a development or conservation scenario is formed.

4.4.1.1 Which stage of the value chain is being assessed?

An adapted downstream approach was chosen as this approach assessed the implications of ecosystem health on the trends, risks and opportunities highlighted by this study on the Municipality's customers. This approach highlights what the potential implications are for the Municipality. It is the stage in the value chain where interactions with ecosystems, communities and the authorities, were potentially most prominent.

4.4.1.2 Who and where specifically is assessment occurring?

For this study municipal owned open spaces that occur within the Municipality were considered as production facilities of the 'company' (the Msunduzi Municipality). Although the Municipality does not create these open space as such, as custodians of the land, they are responsible to maintain these municipal owned open spaces. These open spaces usually consist of more than one ecosystem type that produces a variety EGS that are then 'supplied' to the inhabitants or 'customers' of the municipality. For the current research, customers were assumed as the inhabitants of the areas that are linked or affected by the study scope (open spaces or ecosystems) and can include other municipal departments. This means that the Municipality could be seen as both a provider, as the production of EGS is occurring within their geographic boundary and as a customer as they are also land owners and service takers.

4.4.1.3 Is the selected scope of strategic importance, timely and supported?

Chapter three provides the case for the strategic importance of and EGS study to be undertaken. The research was developed in consultation with the Msunduzi Environment, Conservation and Forestry Department, which promotes the strategic importance of this type of research as it will add value to the Municipal Department.

4.4.1.4 What is the spatial information available for the selected scope?

Some areas had independent (such as private consultants or conservation agencies) or municipal studies that provided spatial data for the area. Their data provided invaluable information that aided in determining the priority EGS for that particular scope. Some areas required additional data to assist in determining priority EGS. Spatial data used in this research were derived, with the help of the Msunduzi Environment, Conservation and Forestry Department, from the EMF, ESP and SDF spatial data sets.

4.4.1.5 Summary of spatial findings and scenario development

The final step of this phase was to develop a scenario that informs the user of how that open space is to change under actions by the Municipality and will be used to carry out the remaining phases. This scenario could be based on existing or future plans for that open space such as a conservancy or housing developments. This scenario is informed by conducting a desktop background study on the study site by assessing all available spatial information, investigating cursory environmental and development pressures that exist on that site and ground truthing the spatial findings. These findings were placed into two categories that were used to establish the development scenario for that study site (Table 4.6). The spatial findings section is used to collate the spatial information that is available in which trends can be identified. For this research this section is informed from using the Msunduzi Municipality EMF, ESP and SDF spatial data that were available to create maps which show this data in relation to the study site boundary. The user is required to calculate the area of the study site and the approximate sizes of the varying ecosystem types found in the study site. By conducting a ground truthing exercise, environmental and developmental pressures can be identified. A cursory assessment of the functionality of those ecosystems must be carried out, although this functionality assessment is not meant to be scientifically rigorous, it is meant to provide an indication if the ecosystem is pristine, disturbed or severely disturbed. This has implications for functionality and ultimately supply of EGS as severely disturbed systems will not be ‘supplying’ usable EGS. This ground truthing section identifies potential environmental and social pressures from future development plans in the area or from surrounding communities, such as housing demands or job creation pressures. The spatial and ground truth findings were used to formulate the scenario outline for that open space. This scenario could be more strategic in that it can be used to assess future potential plans or a more reactionary scenario in that it states what has already been decided by the municipality for that open space.

Table 4.6: An overview of findings that informs the development of a scenario for the study site

	Overview of findings and Scenario outline
Spatial findings	Size of study site, area covered by key ecosystem types, summary of spatial analysis,
Ground truth findings	Brief breakdown of issues identified on site, can include visual assessment of the state of ecosystems, description of surrounding community, access to site, environmental and social pressures as determined from the ground truthing exercise
Scenario Outline	Provides an outline of the future scenario for that open space, e.g. to be developed (including what type of development) or placed under conservation.

4.4.2 Phase two: identification of priority ecosystem services

This phase provides an overview of what the ecosystems are providing for the selected scope. The point of this phase is not to provide an in-depth study but rather a snapshot of the current status. This phase uses a generic list of EGS (Table 4.7) so that the user of the tool has a standardised set of potential EGS that may be present for that study site. Each EGS or landscape function was tested using the question progression (Figure 4.3) which was developed in the original ESR framework with the understanding of the study scope determined from phase one. These questions were adapted to relate to a local government context but still evaluated the dependence that inhabitants or ‘the customers’ have to this open space and the impact a change in this open space will have to customers. The landscape functions or EGS were based on previous EGS work undertaken in the EMF and from literature (De Groot *et al.*, 2002; MA, 2005b; Hanson *et al.*, 2008; TEEB, 2010b). A more detailed EGS set may be required for different circumstances, for example a more detailed assessment in a coastal environment, however for this research marine EGS were not relevant and therefore not considered. This list of EGS was used to populate and score impact and dependence, (Table 4.8), based on the five questions used for this phase (Figure 4.3).

4.4.2.1 EGS set used for the Msunduzi Municipality

Reviewing the literature (De Groot *et al.*, 2002; MA, 2005b; Hanson *et al.*, 2008; TEEB, 2010b) potential landscape functions or EGS has been developed which describes, defines and provides examples of EGS, which could be found in the Msunduzi Municipality (Table 4.7). These services are broken into four general service types based on the Millennium Ecosystem Services report (MA, 2005b), namely provisioning, regulating, cultural and supporting services. Within each of these four general services, EGS sub-services are described in relation to the general service.

The EGS specialist study for the EMF suggests that the most important ecosystem types found in the municipality are grasslands and wetlands. This list (Table 4.7) does not exclusively refer to these ecosystems and can apply to a variety of different natural, unnatural or artificial ecosystems found within the Municipality. The reason for not focusing on specific ecosystem types is that it reduces complications in scoring the impact and dependence should the study scope consist of more than one ecosystem. Therefore, the descriptions and examples provided have been adapted to suit the Msunduzi Municipality context.

Table 4.7 Potential EGS that can be found in the Msunduzi Municipality with sub-services, descriptions and examples (MA, 2005a; De Groot, 2006; Hanson *et al.*, 2008)

Landscape functions				
	Service	Sub-Service	Description	Examples
Provisioning	Food	Crops	Cultivated lands (extensive and intensive) for human or animal consumption	Fruits, vegetables, grains
		Livestock and grazing	Livestock raised for domestic (subsistence) or commercial purposes and provision of grazing potential for livestock	Cattle, pigs, chickens, goats
		Aquaculture	Commercial fishery installations that use freshwater enclosures for the production of aquatic produce	Freshwater fish, shrimps
		Wild foods	Wild game or edible plants species captured or harvested in their natural environment	Fruits, seeds, fish, bush meat
	Freshwater	Fresh water provision	Retention of usable water for domestic, industrial, commercial or agricultural purposes or the availability of potable springs or streams	Drinking water, industrial processes, springs, cleaning, electricity generation, transport
	Biomass resources	Fuel source	Biological material that serves as a source of energy that can be derived from living or former living organisms	Fire wood, charcoal, dung, waste products from agriculture (crops) processes, peat, fodder
		Timber fibre	Products derived from plantations or natural forest systems such as craftwork materials and building materials	Logs, building material, pulpwood, paper, industrial processes
		Other fibre	Nonwood and nonfuel sources of fibre that can be used for numerous purposes	Rope, clothing, household items, twine, leather
	Genetic resources	Genetic materials	Genes used for plant improvements, biotechnology, biomimicry and animal breeding	Increase plant resistance to intolerable conditions, genetic structure or evolutionary traits to be adapted into man-made objects
	Medicinal, biochemical and pharmaceutical	Biological medicinal characteristics and value	Extraction of medicines from biological matter, use of tradition medicinal plants, biocides, food additives	Tree extracts, natural pesticides, medicinal plants, traditional medicinal practises using biological matter.
Regulating	Climate	Global	The effect ecosystems have on global climate through the release or absorption of greenhouse gases and aerosols	Forests and grasslands sequester certain greenhouse gases, livestock and certain agricultural practises emit greenhouse gases.

		Regional and local	The effect ecosystems have on the local or regional micro-climates, regional temperatures, precipitation and other climatic factors	Green spaces such as parks and forests can reduce the urban heat island effect,
	Air	Air Quality regulation	The effect ecosystems have on air quality by either being a source (emitting) or sink (extraction) of pollutants, chemicals and particulates	Forests and lakes can act as sinks for industrial emissions, vegetation fires emit particulates
	Water	Water regulation	The effect ecosystems have on ground water recharge/discharge and surface run-off and the reduction of velocity and amplitude of flood water discharge	Wetlands, flood plains and riparian zones retain water which regulates runoff and water flow during peak flow stages
		Water purification and waste treatment	Retention, filtration and breaking down of waste, detoxifying pollution and the dilution, detoxification, assimilation and transport of pollutants.	Wetlands trap and remove harmful pollutants, metals and organic materials
	Soil	Erosion regulation	The function vegetation plays in the retention of soils and sediments	Grass and tress prevents soil loss and helps reduce siltation in water bodies, vegetation holds soil in place therefore reducing the chance of a landslide
	Regulation of pest and pathogens	Disease and pest control	The effect ecosystems have on the regulation and abundances of malaria, bilharzia, black fly, invasive alien species, etc.	Forests provide a habitat for predators that feed on crop pests such as bats, snakes and frogs, wetlands, riparian zones and rivers control waterborne diseases
	Pollination		Ecosystems provide habitat for pollinators	Bees and other insects are essential for crop pollination
	Natural hazard regulation	Disturbance protection	The capacity for ecosystems to reduce the impacts of natural disasters	Natural flood barriers, decomposition reduces fire fuel load
Cultural	Aesthetic		Beauty or attractive landscape features provide an opportunity for tourism ventures	Mountains, rivers and lakes are attractive destinations for tourists because they derive enjoyment from the scenery
	Educational and science		Ecosystems provide learning, training and research opportunities	Habitat for school excursions and the use of nature for scientific study
	Recreational		Opportunity for recreational activities	Bird watching, hiking, mountain biking and trail running
	Spiritual, artistic, ethical and religious		Many belief or sources of spirituality or creative inspiration can arise from these ecosystems	Spiritual fulfilment, intrinsic value, art and photography
Supporting	Soil formation		Weathering of rock and the accumulation of organic matter	Maintenance of arable land, maintain healthy and productive soils

	Nutrient cycling		The role ecosystems have in the storage, processing, re-cycling and collection of nutrients	Decomposing organic matter increases the fertility of the soil, promotion of healthy soils and productive ecosystems
	Water Cycling		The flow of water in its three different states through abiotic entities, biota and ecosystems	Transfer of water from soil to plants to air then to rain
	Refugia, corridors and habitation		Providing habitat for wild flora and fauna maintaining biological and genetic diversity, forming the basis for many other functions, serving as a corridor area for other conservation zones	Conservation areas and untransformed land

This base level list of potential EGS found within the municipality (Table 4.7) provides the template to complete phase two of the adapted ESR model and is used in determining the priority ecosystem goods and services for the selected case study site. While all the EGS presented in this table may not be relevant in this phase, they still need to be recognised. This table is not an exhaustive list of EGS and may not cover all EGS found in that particular study area and therefore the user may need to add extra EGS if deemed necessary for that assessment, such as in arid or aquatic environments. This table is then adapted further to include the dependence and impact sections (Table 4.8). The dependence and impact values of none, low, medium and high are determined by using the question progression that guides the user in a step-like fashion to determine these values (Figure 4.3). Using this table and question progression, phase two of the adapted ESR tool was then carried out on two case study sites within the Msunduzi Municipality.

Table 4.8: Generic landscape function and EGS dependence and impact template for phase two

		Landscape functions - Airport				Municipality delivering these EGS to Customers (inhabitants of the city)		
		Service	Sub-Service	Description	Examples	Dependence (none, low, med or high)	Impact (none, low, med, high) & (+or-)	Notes
Provisioning								
Regulating								
Cultural								
Supporting								

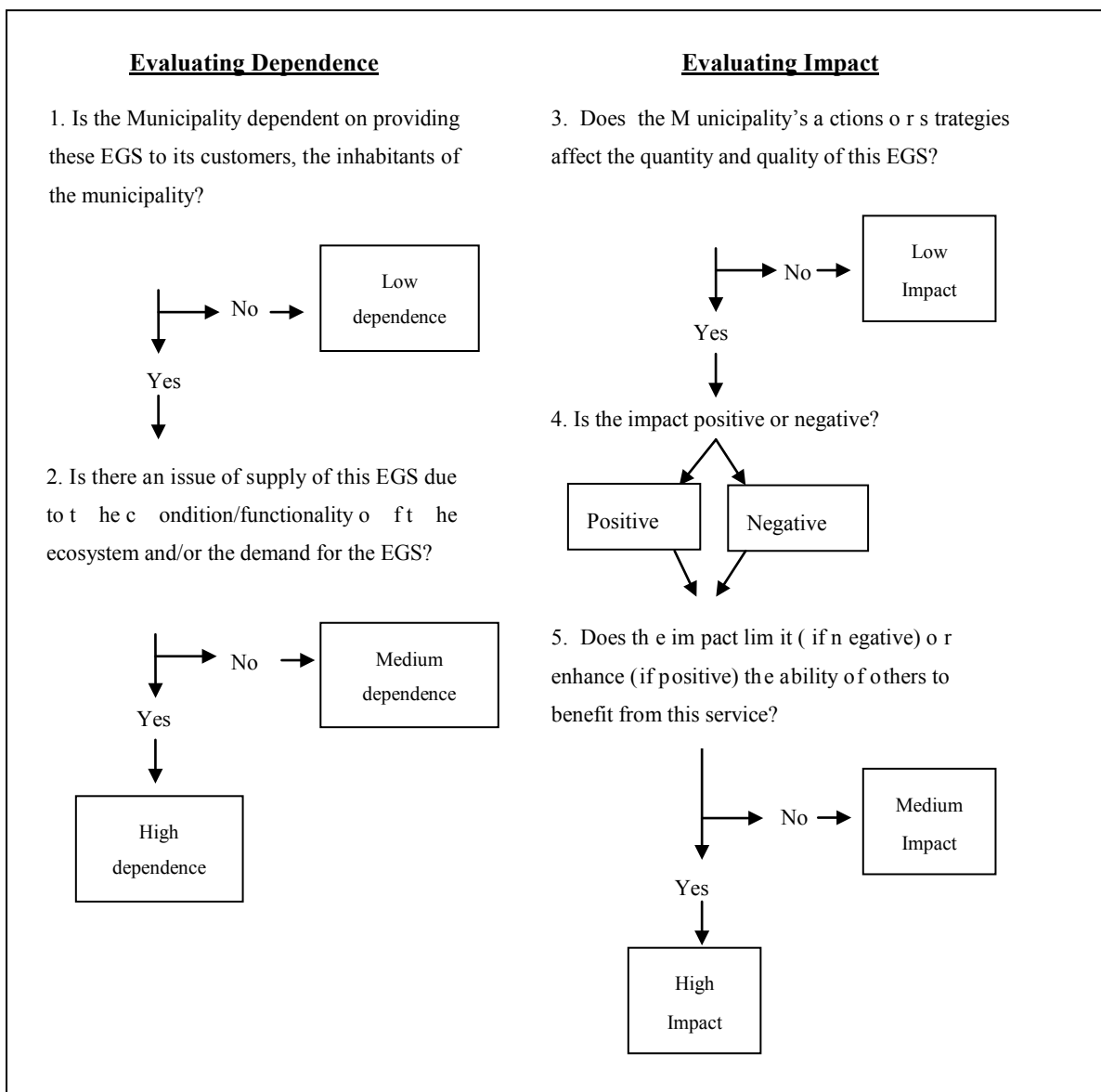


Figure 4.3: Municipal specific question progression to assess the dependency and impact on EGS. Forms part of phase two in the ESR methodology (Hanson *et al.*, 2008).

4.4.2.2 Question one – Is the Municipality dependent on providing these EGS to its customers, the inhabitants of the municipality?

This question was designed to understand whether the municipality is dependent upon this EGS to help deliver services to the inhabitants of the municipality. Another way of approaching this question is linked to supply capabilities: Are the immediate and downstream communities and activities dependent upon the supply generated from this EGS? This question is designed to assess whether inhabitants, linked to the study scope utilize this service. A no answer could represent the

lack of that service being present in the study scope therefore there is a no or low dependence. If the Municipality has a mandate to deliver this EGS to inhabitants and/or inhabitants are dependent then the answer is yes and the user should move on to question two.

4.4.2.3 Question two – Is there an issue of supply of this EGS due to the condition/functionality of the ecosystem and/or the demand for the EGS?

This question requires the user to have information with regards to the state of the ecosystems in the selected scope and to determine whether the condition affects the supply of EGS to the customers. A supply issue would occur if the functionality of the ecosystem is poor as a result of degraded systems and there is a high demand for this EGS or if functionality was not a concern but the demand is still high, the Municipality is therefore highly dependent on this EGS. There would not be a supply issue if demand for this EGS is low, however because this EGS may supply a smaller group of users and/or is required by law through a municipal mandate, the Municipality is moderately dependent on this EGS

4.4.2.4 Question three - Does the municipality's actions or strategies affect the quantity and quality of this EGS?

The next three questions assess the impact of the Municipality's actions on the EGS being assessed. If the Municipality's actions or strategies affect the EGS supplied then move onto question four, if not then these actions have a low impact. The word 'actions' refers to transforming the open space into something other than its natural state or rehabilitating the open space to its natural state. 'Strategies' refer to the future plans for that open space, i.e. there is no current 'action' on that open space, but it could form part of one of the Municipality's future strategies, such as open spaces that are demarcated for development.

4.4.2.5 Question four - Is the impact positive or negative?

This question determines whether the impact has a positive or negative affect on the EGS supplied to the customers and the response is used in the next question. Users need to decide whether the majority of the EGS beneficiaries will either be negatively or positively impacted upon. There may be a case for both a positive and negative impact occurring.

4.4.2.6 *Question five - Does the impact limit (if negative) or enhance (if positive) the ability of others to benefit from this service?*

The word ‘others’ in this question refers to the users of the EGS provided by this open space. Users, direct or downstream, will either benefit or suffer depending on the actions or strategies carried out on the open space. In other words, will the supply of this EGS be reduced or enhanced. If the answer is yes to this question the Municipality’s actions or strategies have a high impact on the EGS supplied, this impact can either be positive or negative depending on the answers to the previous question. If the answer is no, or if cost effective substitutes to supply this EGS are available, then there is a medium impact to the EGS supply.

EGS that are both high in dependence and impact were selected as priority EGS to be used in the next phase. However, priority EGS can be selected using different methods such as selecting a suite of EGS, strategic criteria or relating EGS to sustainability principles. This research is more focused on designing a tool rather than conducting a full assessment, (as it would result in going out of the scope of a Masters thesis) only two of the priority EGS were selected to be tested in phase three. If this was to be undertaken by a municipal department then all priority EGS or EGS suites would need to be analysed

One limitation of the original ESRT tool was that there is the risk of over-emphasising the provisioning EGS and neglecting the supporting EGS that underpin these EGS (Waage *et al.*, 2008). The adapted tool recognises that supporting services are, by default, important to the Municipality as they are the foundation blocks for all the other services. The Municipality could therefore regard their dependence as high for these EGS and any change to the supply of these EGS could be seen as a high negative impact. However, some of these supporting services may have more relevance in different development scenarios. Soil formation and nutrient recycling are important in an agricultural context and refugia zones and corridors are a necessity to achieve broader conservation targets. Including the supporting EGS can result in ‘double counting’ and were excluded in this research from the phases three and four, but their relevance must be noted and, where necessary, included in prioritising EGS or in the development of strategies.

4.4.3 Phase three: identification of trends and drivers of priority ecosystem change

Phase three was concerned with identifying the key trends and drivers that influence the change of the EGS in question. This phase does not differ from that in the original ESR framework. There were five questions (Figure 4.4), that each priority EGS is asked to create a clear picture of what is affecting the EGS in that study site. All five questions were answered using spatial data from phase one, site visits, interviews with relevant stakeholders and current literature. The one difference between this phase and the original is that potential scenarios are created for that particular EGS and are to be used in the next phase. This scenario represents what could likely happen to that EGS or what would be a desired outcome based on the trends and drivers and is used in the sustainability criteria checklist in phase four.

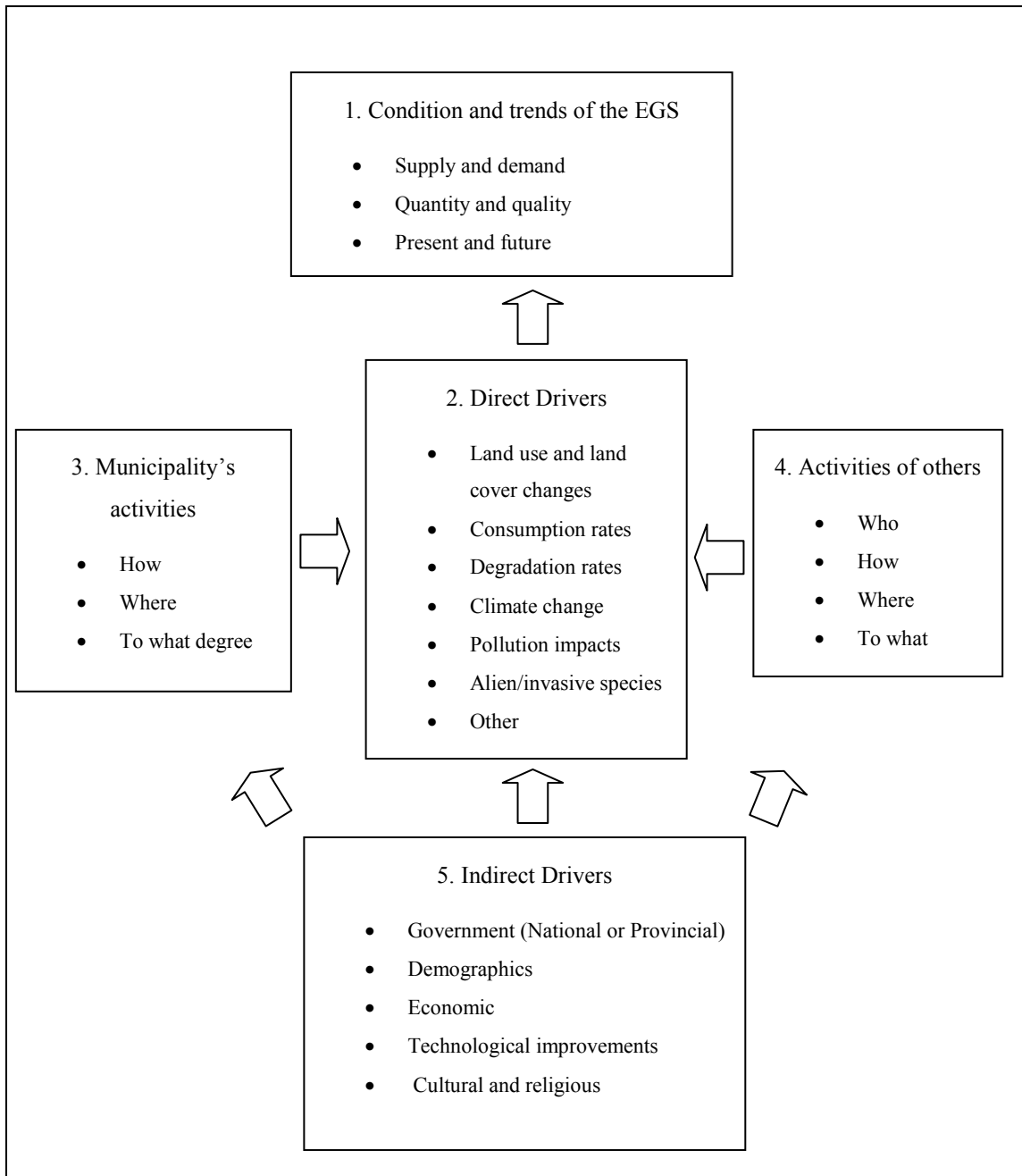


Figure 4.4: Framework highlighting EGS trends, drivers and conditions. Forms part of the third phase in the ESR (Hanson *et al.*, 2008)

This phase was adapted from the original ESR framework by adding a new component called the sustainability criteria checklist (SCC), which was intended to complement the existing trends and drivers analysis (phase three) in the original ESR methodology. The SCC was designed to assess how the scenarios developed from the trends and drivers analysis (that impact on the individual PEGS identified in phase two) affect the sustainability criteria. This process enabled a detailed analysis of the risks to sustainability that these trends and drivers pose on the EGS found within that study site. Once the SCC matrix has been completed this was used to inform a risk and

opportunities table. This table combines all the phases together and highlights the risks and opportunities that arise from the changes to the EGS. As this study focused on a municipal environmental decision-making process and the implications for sustainability, an adapted risk and opportunities table was used to show the risk and opportunities for sustainability.

4.4.4.1 Sustainability criteria checklist (SCC)

The sustainability criteria checklist (SCC) was based on the sustainability criteria developed in the SEA of the Msunduzi Municipality's Greater EMF Project. The SCC assesses how changes in the PEGS as a result of the trends and drivers identified in phase three, impact on the sustainability criteria set out by the SEA (Table 3.1 shows the sustainability criteria developed from the SEA process). The SCC differs from that of the SEA by providing a more compact checklist that combines the criteria from biophysical, social, economic and governance with more of an EGS focus. The adapted sustainability criteria (Table 4.9), incorporates one or more of the original SEA sustainability criteria with numbers that reference back the original SEA criteria (Table 3.1), should the user wish to refer to the original text to provide clarity or understanding of the adapted criteria. For example 1.2.1 refers to biophysical (1.), Msunduzi IEM Policy strategic objectives (1.2.), the first criterion in that section which is to preserve the City's biodiversity and minimize the loss of species resulting from development (1.2.1), thus providing added context should the user need to refer back.

The way the SCC was used was to test each PEGS (decided from phase two) against the following question: how will changes in the PEGS impact on the municipality meeting its sustainability criteria? The 'changes' were determined by establishing a scenario for that particular PEGS based on the drivers and trends identified in phase three. These 'changes' can both be positive and negative and depends how the users wishes to play the scenario out and the outcomes of phase three. The question was put to each criterion where the answer can be one or more of the following: direct positive impact, indirect positive impact, no impact, indirect negative impact and/or direct negative impact. Direct positive impact means that the change to the PEGS will result in that sustainability criteria potentially being met, if the PEGS change is of a negative nature then the direct negative impact should be checked in the matrix. Indirect positive impact indicates that the changes to the PEGS will indirectly result in that criteria being met, if there is a negative change to the PEGS then the indirect negative impact should be selected. If the change in the PEGS has no

influence on the sustainability criterion then ‘no impact’ should be checked. It is possible for changes in PEGS to have both a negative and positive implications for the sustainability objective of the Municipality.

Table 4.9: The Sustainability criteria checklist template which shows how trends and drivers of EGS impact on meeting sustainability goals

Adapted sustainability criteria	No. ref to SEA sustainability criteria	Direct positive impact	Indirect positive impact	No Impact	Indirect negative impact	Direct negative impact
Preservation of biodiversity to minimise loss of species, maintain areas of high biological diversity.	1.2.1; 1.3.1					
Preservation, maintaining and/or rehabilitating ecological functionality of wetlands, streams and rivers to protect; ensure aquatic ecosystem remain in a health state to ensure the quality of water is suitable for human wellbeing and within legal limits.	1.2.4; 1.3.2; 1.3.5; 2.2.1; 2.3.1;					
Minimising risk to flood prone areas; reduce vulnerabilities to communities exposed to environmental risk; manage the adverse impacts of man-made or natural disasters.	1.3.6; 2.2.3; 4.3.6					
Maintaining air quality standards to reduce threat to human wellbeing.	1.2.3; 1.3.10					
Provision of an effective and efficient liquid waste management system.	2.2.2; 2.3.5					
Rehabilitate or maintain areas prone to soil erosion.	1.3.1;					
Promote sustainable agricultural production (if land is used for agriculture) in areas with high agricultural potential; provision of daily food needs through sustainable urban and rural schemes.	1.3.8; 3.3.5					
Control and management of invasive and alien species and the promotion and conservation of indigenous species	1.2.2; 1.3.4					
Protection of landscape, cityscape; maintenance	2.2.3; 2.2.5;					

of sense of place; preservation of cultural and natural heritage resources	2.3.10					
Provision of clean open spaces or community parks that improve quality of life and promote human wellbeing	2.3.2; 2.3.7;					
Provision of educational opportunities; development and preservation of indigenous ecological and cultural knowledge; promotion of access to environmental information	2.3.8; 2.3.9; 4.3.7					
Access to income generation opportunities; emphasis on linkage between poverty reduction and the environment, promotion of alternative sustainable livelihoods	2.3.3; 3.2.2; 3.3.2; 3.3.3;					
Greenhouse gas emission reductions, carbon-offsetting schemes; reduction in dependence on non-renewable energy sources; reduction in fossil fuel dependence;	1.3.11; 1.3.12; 3.3.7					

The SCC is used to link the EGS provided by that open space to the sustainability criteria set out in the SEA. This provides a strategic element to the outcomes of this phase as it attempts to answer how a change in the EGS provided influences the chance of meeting sustainability objectives. The SCC highlights sustainability risks and opportunities and provides the link to identify business risks and opportunities for that open space for the municipality. The original ESR methodology was not directly followed for this phase where risks and opportunities were assessed based on their risk type: operational, regulatory and legal, reputational, market and product and financing but an adapted risk table was used (Table 4.10). This was directly informed from the SCC and can use all findings from the previous phases and provided an overview of sustainability risks and opportunities. Each scenario in the SCC was analysed in terms of risk or opportunity to sustainability for all relevant sustainability criteria.

Table 4.10: Adapted risk and opportunities matrix template that provides a summary of the sustainability risks and opportunities identified for each scenario

Scenario	Risk	Opportunity
1		
2		
3		

4.4.5 Phase five: Strategies for the way forward

As this research is focused on testing to what extent the ESR framework can be utilized in a local government setting, this phase was treated as a ‘recommendations’ section rather than strategy identification. Strategy recommendations would require a combination of municipal managers to agree on the findings in this phase and develop ways to implement these strategies together. This falls outside the scope of this research.

The ESR tool requires each phase to lead into the next, it can therefore become confusing as to which actions need to be undertaken and what outputs need to be achieved in each phase, so a quick reference table is provided (Table 4.11). This table allows the user to understand what actions and outputs are expected from each phase. ‘Actions’ refer to what needs to be undertaken by the user of the tool, for example gathering key spatial data in phase one or develop scenarios of ESG change in phase three. ‘Outputs’ refer to the desired findings that result from undertaking the actions in that phase, for example gathering spatial information can result in site boundary identification in phase one. Each phase’s outputs can be utilized as stand-alone findings but still require the previous phase’s inputs. For example, conducting phase two, provided there is capacity to do so, could help the municipal authorities provide input into the EIA scoping phase through recommending potential specialist studies.

Table 4.11: Summarised progression table of each phase in the adapted ESR model for the Msunduzi Municipality, with actions and outputs for each phase

Phase 1	
Actions	Outputs
<ul style="list-style-type: none"> • Gather correct cadastral information of site to accurately identify site boundary • Gather all relevant and available spatial data • Conduct a ground truthing exercise to get a understanding of issues on site and condition of ecosystems • Determine the spatial extent of site and ecosystems within the site • Formulate the development scenario that you want to test in phase two 	<ul style="list-style-type: none"> • Site boundaries • EMF, ESP and SDF maps of site (other relevant spatial maps) • Extent of ecosystem types on site • Ground truth findings of site • Scenarios of future land-use for that site (can be more than one for a comparison)



Phase 2	
<ul style="list-style-type: none"> • Add to the existing EGS template any other EGS that may be important for that site • Follow the question progression outlined in the method section for all EGS as to try and reduce confusion and to speed up the process • Identify the priority EGS based on a criteria of either an individual EGS or a suite of EGS • Colour code dependence and impact score to help in identifying the priority EGS quickly 	<ul style="list-style-type: none"> • High, medium or low scores for municipal dependence on each EGS • Identifying whether scenario(s) from phase 1 will have a positive or negative impact for each EGS • High, medium or low scores of impact of scenario(s) from phase 1 • List of priority EGS (can be clustered into related groups)



Phase 3	
<ul style="list-style-type: none"> • Establish trends and drivers for each EGS or suite of EGS • Trends and drivers need to relate specifically towards that EGS in question • Formulate scenarios that represents the likely change of that EGS 	<ul style="list-style-type: none"> • Matrices of trends and drivers for each priority EGS or EGS cluster • Scenario(s) of expected change for each priority EGS or cluster based on these matrices



Phase 4	
<ul style="list-style-type: none"> • Test scenario determined in phase three for each EGS against the sustainability criteria • Determine if the different scenarios will generally have positive or negative implications towards the sustainability goals established in the SEA • Determine the sustainability, operational, regulatory, reputational, market and financing risks and opportunities 	<ul style="list-style-type: none"> • Matrix showing how each scenario from phase 3 impacts on the sustainability criteria • Matrix showing relative risks or opportunities (and their risk/opportunity type) to sustainability for the municipality



Phase 5	
	<ul style="list-style-type: none"> • Set of recommendations to be carried out by the municipality

4.5 Limitations

One of the key limitations with this methodology was that it is not being undertaken by a team of experts but rather an individual researcher. This can lead to subjectivity in the data collection and ESR implementation. A Delphi technique could possibly have been a better approach if this framework is to be extensively used in the future by the Municipal Environmental Department. This approach will allow for a group of experts to discuss the issues and derive a collective decision on the impacts and dependence of EGS. This would not only reduce the bias that could exist if implementing the ESR tool but would bring together municipal department representatives to aid in co-operative governance.

The researcher has attempted to incorporate linkages between the case study sites and upstream/downstream ecosystems into the ESR framework. However, there is a chance that these relationships are not fully understood by the researcher and municipal departments. Therefore these implications may be neglected if implementing the adapted ESR tool and could require input from district, provincial or national perspectives as EGS cross political boundaries.

There are potentially more key stakeholders that would have an interest or be affected by the implementation of this tool, however, because this research is focused on testing if this adapted tool can be utilized successfully rather than a full scale assessment, the current set of key stakeholders are deemed the most appropriate. If this adapted tool was to be used again then the involvement of more key stakeholders, such as ward councillors or rates payers associations, could be considered.

4.6 Conclusions

The ESR model has been designed for and used by corporate operations, therefore each phase required modification to make it relevant to a local government context. There is the potential for each phase to become complex and cluttered with information, therefore it may be necessary to refer back to a summary of actions and outputs for each phase (Table 4.11) as it highlights what needs to be done and what the users should be achieving at each phase. The adapted ESR model needs to be tested to determine where the strengths, weaknesses and applicability of using such a model lie. This chapter satisfies the second objective of this research in that an existing EGS assessment tool has been adapting for use in local level decision-making. This adapted ESR tool identifies site-specific EGS issues and highlights the associated risks and opportunities for local government. The findings for the two different case study sites can be found in the subsequent chapter. This chapter (Chapter Five) provides justification and the findings for piloting the adapted ESR tool that was presented in Chapter Four, by conducting each phase systematically for each case study site.

Chapter Five Case Studies

This chapter is divided into two sections and presents the findings of piloting the adapted ESR tool for each case study. Case study one concentrates on the Pietermaritzburg Airport proposed development and case study two the proposed rehabilitation of Albany Park. Each case study section will present the findings of the phases of the adapted ESR tool.

5.1 Case Study One: Pietermaritzburg Airport Development

The Pietermaritzburg Airport is currently situated on the edge of an industrial area and a residential suburb. The airport does not have a large capacity and accommodates smaller aircraft, with daily flights to Johannesburg and Umlazi. Grassland and wetland ecosystems are present within the airport grounds and are bordered by the University of KwaZulu Natal's agricultural research station. The Municipality would like to increase capacity at the airport through developing infrastructure to support the airports operations and to offer more opportunities for increased freight to move through the airport. There are also plans to develop an industrial estate where goods manufactured would use the airport to support logistics.

5.1.1 Phase one: Study scope spatial findings

The municipality has a substantial amount of Msunduzi specific spatial data available to be utilized, as a result of the greater EMF project, to be used in this first phase of the tool. The ESP, CEAM, EMF specialist studies and the SDF provide a spatial overview of potential constraints that can be found in the study area (Table 5.1).

The Environmental Services Plan (ESP) spatial layer (Figure 5.1) indicates that the airport study site area (referred to as airport site) is a key area to maintain environmental services for the municipality and contains key riparian corridors and untransformed public open space. The Msunduzi Environmental Management Framework's (EMF) consolidated environmental attributes map (CEAM) (Figure 5.2) identifies the biodiversity and wetlands constraints for the study area. The biodiversity irreplaceability map (Figure 5.3), shows a large portion of the airport site as irreplaceable based on the C-plan process. C-plan is a GIS based tool that focuses on mapping areas of high biodiversity importance. The wetland identification map (Figure 5.4), outlines possible

locations for six wetlands on the airport site and provides buffering for the development constraint zones. The air quality constraints investigations for the airport site (Figure 5.5) shows the residential areas as being highly sensitive to air quality issues. Four sources of emissions are identified, namely: Msunduzi Municipal/Oribi Airport, Aberdare Cables, Status Paper and Hulett Fabricators. The final specialist report shows the archaeological, architectural and heritage locations that are of relevance. There are two potential archaeological sites found at the airport site, with the neighbouring Oribi village denoted as an area of historical significance and the King Edward and Oribi road buildings as areas of architectural significance (Figure 5.6).

The Spatial Development Framework (SDF) category that can be found on or neighbouring the airport site is the future economic opportunities spatial layer. The SDF findings for the airport site (Figure 5.7) designate a large portion of the site and surrounding areas to be utilized for future economic growth plans.

Table 5.1: Summary of spatial findings from available spatial data for the Airport site

Source of data and information used	Findings from data	Maps created from data
Greater EMF Environmental Services Plan (ESP) - Draft Municipal Open Space System	<ul style="list-style-type: none"> • Key area to maintain environmental services • Untransformed public open space • Key riparian corridors 	Figure 5.1
Greater EMF Consolidated Environmental Attributes Map (CEAM) - The EMF Spatial Decision Support Tool (SDST)	<ul style="list-style-type: none"> • Biodiversity constraints • Wetland constraints 	Figure 5.2
Greater EMF Specialist Reports: <ul style="list-style-type: none"> - Biodiversity study - Wetland study - Air Quality study - Heritage study 	<ul style="list-style-type: none"> • High biodiversity irreplaceability • Six possible wetland buffer zones • Highly sensitive to air quality issues • Two potential archaeological sites and adjacent to an area of historical significance 	Figure 5.3 Figure 5.4 Figure 5.5 Figure 5.6
Spatial Development Framework	<ul style="list-style-type: none"> • Future economic growth opportunities 	Figure 5.7

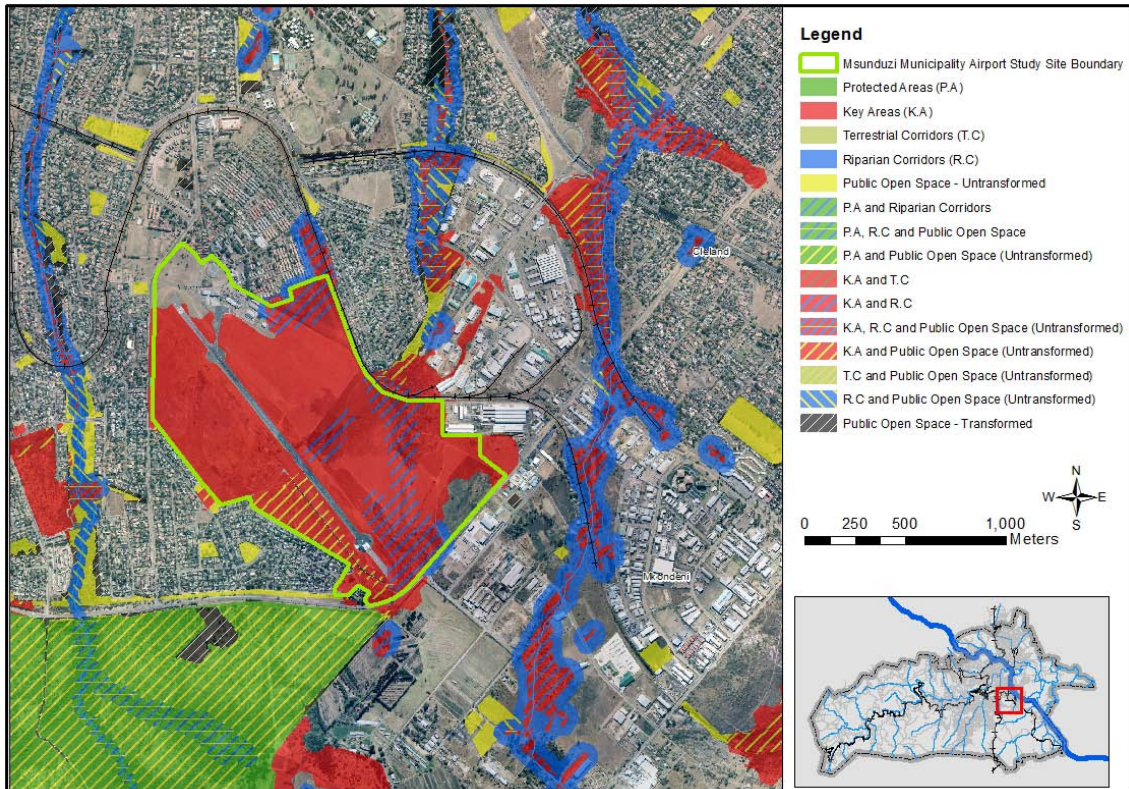


Figure 5.1: The ESP spatial findings for the airport site (adapted from Msunduzi Municipality, 2010)

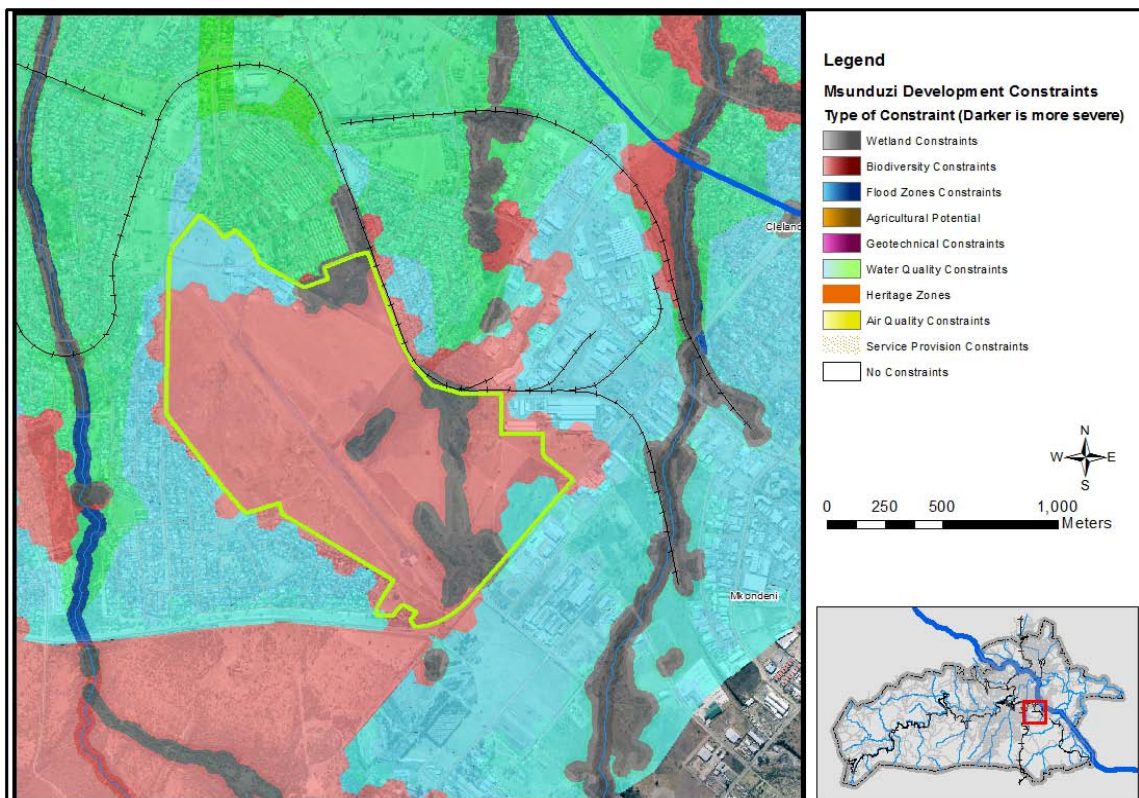


Figure 5.2: The Msunduzi EMF's CEAM layer for the airport site (adapted from Msunduzi Municipality, 2010)

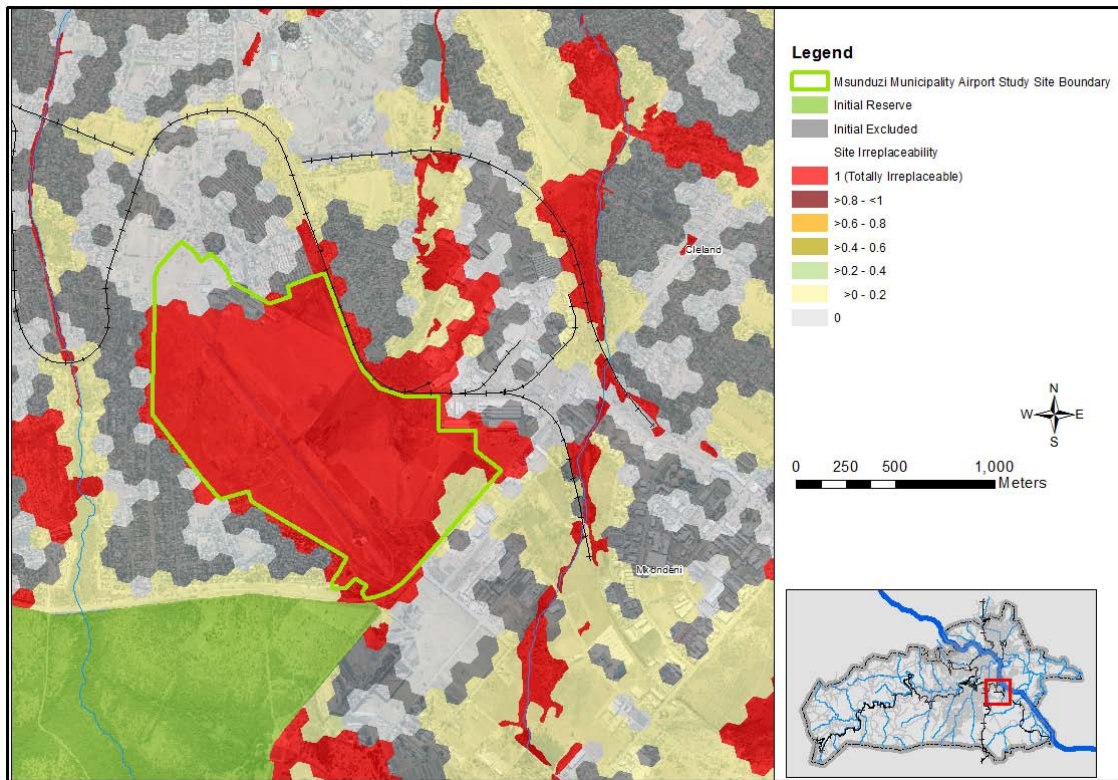


Figure 5.3: Biodiversity irreplaceability scoring for the airport site (adapted from Msunduzi Municipality, 2010)

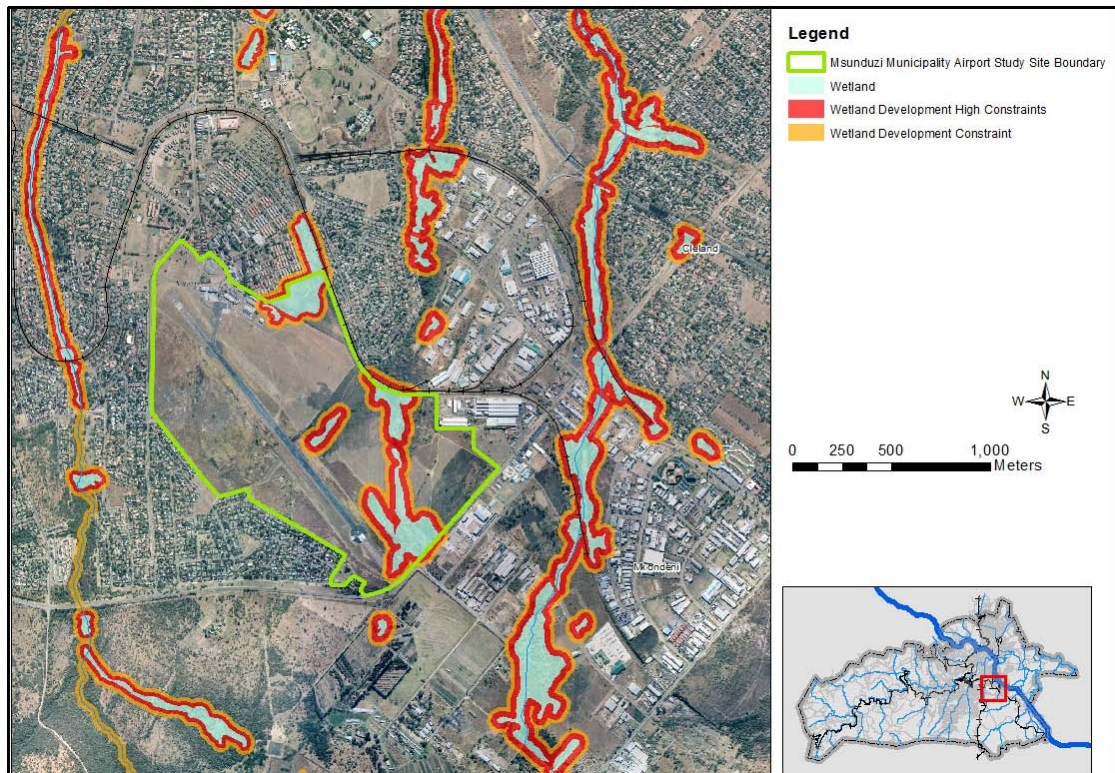


Figure 5.4: Wetland identification and constraints map for the airport site (adapted from Msunduzi Municipality, 2010)

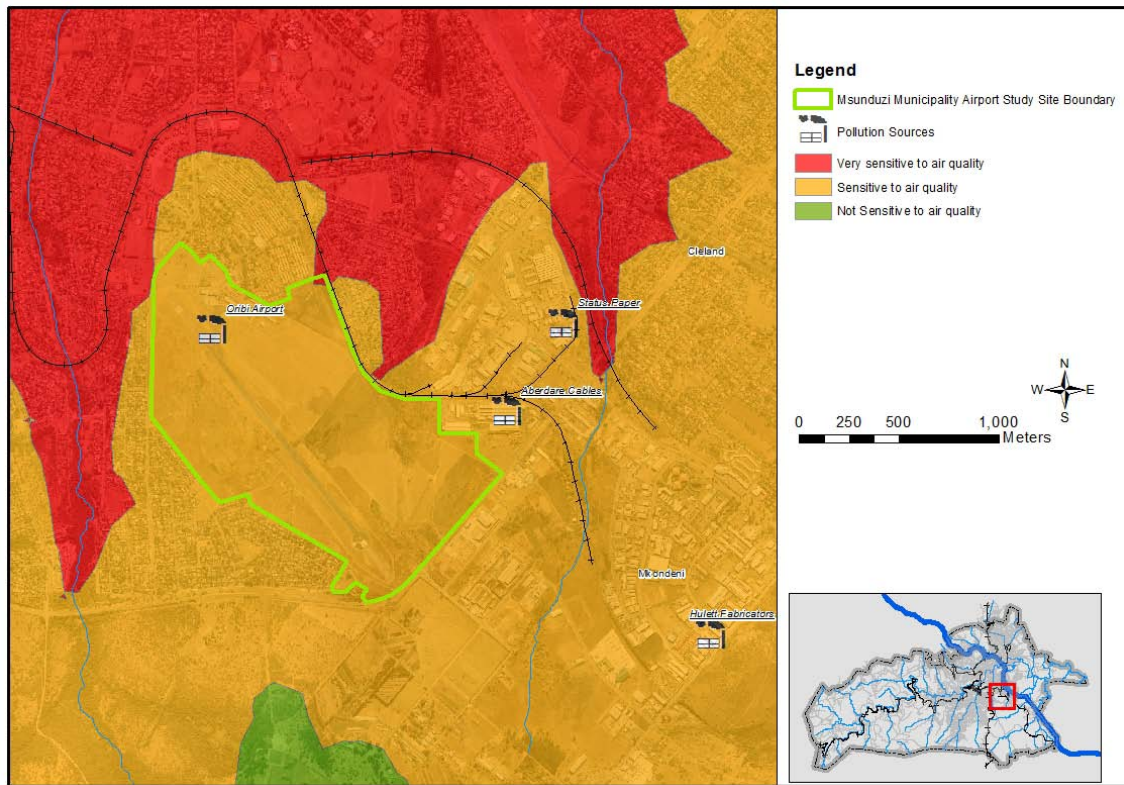


Figure 5.5: Air quality constraints identified for the airport site (adapted from Msunduzi Municipality, 2010)

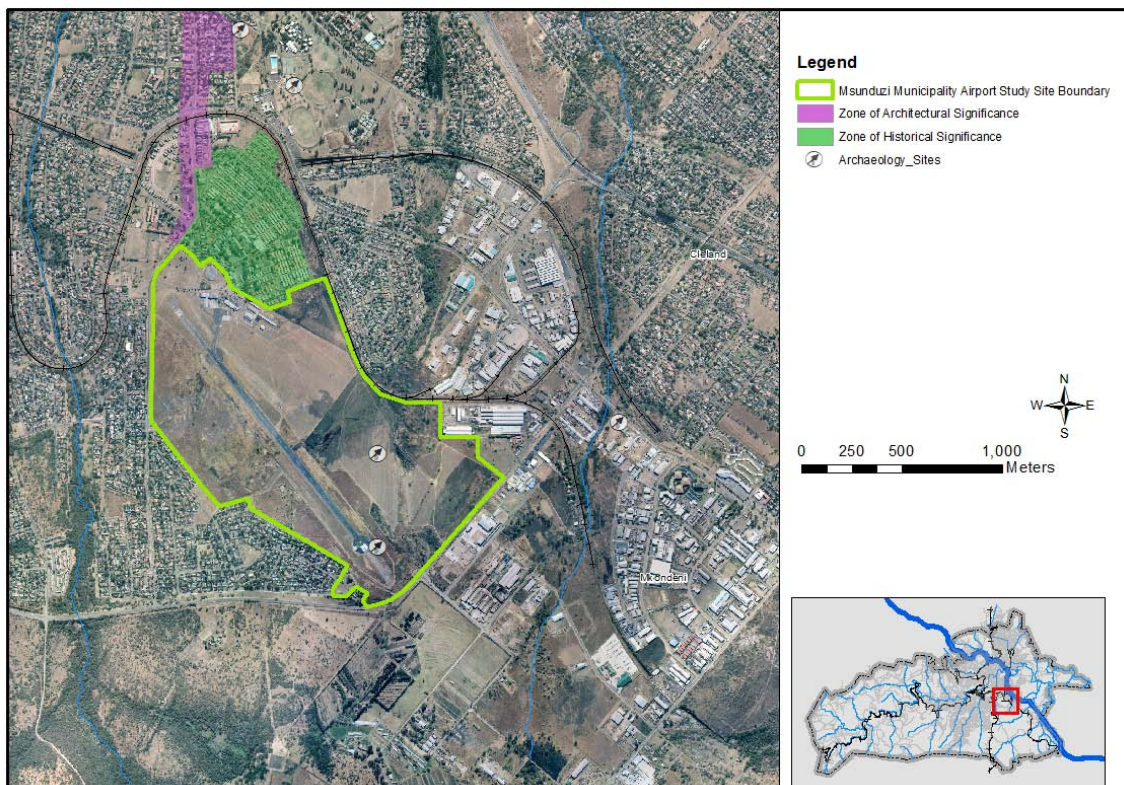


Figure 5.6: Areas of heritage and architectural importance (adapted from Msunduzi Municipality, 2010)

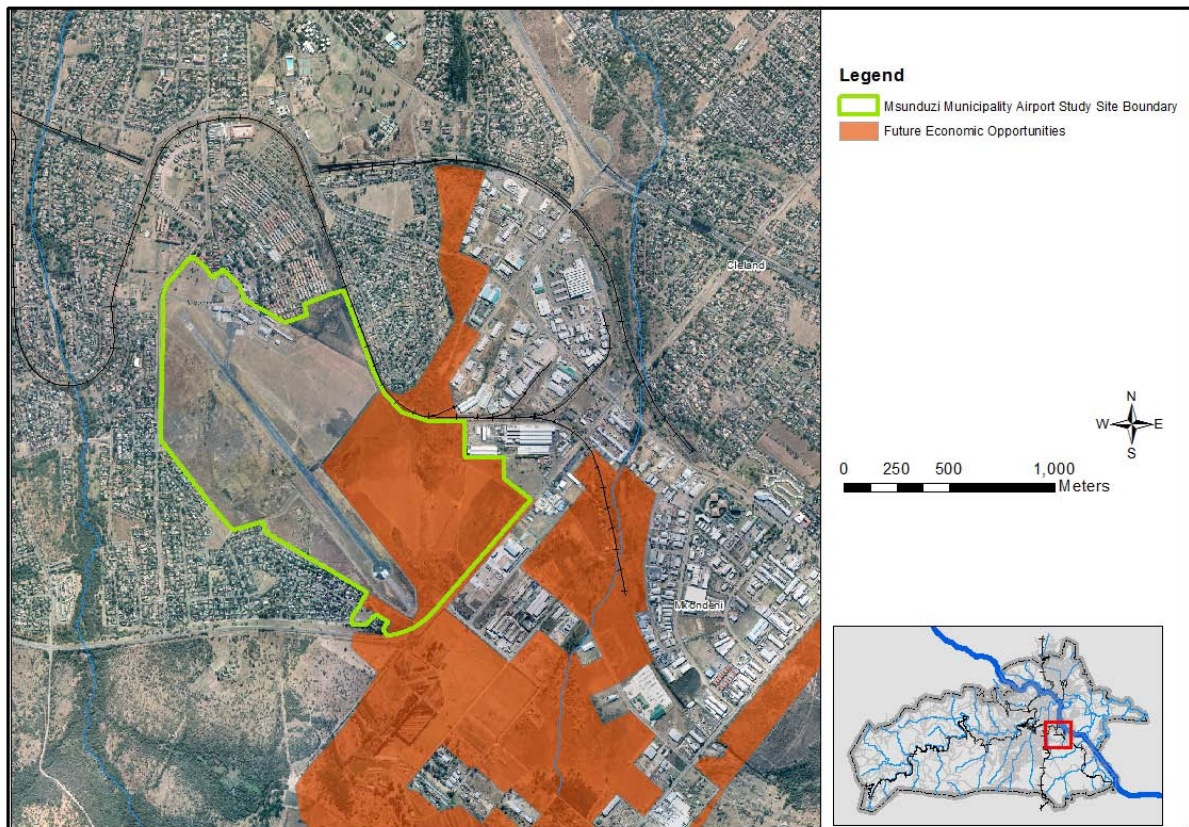


Figure 5.7: Future economic opportunities identified in the SDF (adapted from Msunduzi Municipality, 2010)

Site visits, with the Municipal Environment, Conservation and Forestry department, allowed for observations, discussions and to ground truth the results from the spatial data (Plate 5.1 and Plate 5.2). Based on the experiences of the Municipal manager for this department and on-site observations it appears that the grassland at this site is degraded due to the regular unplanned burning as a result of arson or accidental fire and illegal dumping. There are shallow soils with underlying clay and shale suggesting that the grassland would naturally be underperforming if left in a natural state (Bartholomew, 2011). The site visit confirmed that there is a riparian corridor and a wetland as indicated in the spatial findings of the EMF. The upstream section of the riparian corridor on the site appears to have been damaged as a result of trench digging for pipeline infrastructure upgrades. Digging of a new water pipe through the site resulted in-fill being illegally dumped in the riparian zones. There is existing fill that has been dumped as result of previous road upgrades and for preparation of future roads. Local residents were seen to be using the land for recreational purposes (walking their dogs) and cattle were observed grazing and drinking from the wetland.



Plate 5.1: Ground image of Airport site looking North West towards the terminal and hangar facilities, illegal dumping can be seen in the foreground



Plate 5.2: Wetland and riparian corridor found on the eastern boundary of the Airport site

Based on the spatial and ground truth findings and the planned future development, the potential land use change scenario for this open space was developed in consultation with the Municipal Department. It is proposed that the open space which makes up the airport precinct will be developed for industrial and commercial use and would do so in conjunction with the existing and upgraded airport operations. Therefore the land will be changed from an open space to a transformed landscape with industrial development as the main proposed activity. The scenario that will be used in phase two is the following: how will the municipality's actions of allowing development on the airport site impact on the EGS provided by the current *status quo*? The summary of the spatial analysis, ground truthing exercise and the scenario (Table 5.2) forms the first phase of the adapted ESR tool for the airport site and is used to inform phase two.

Table 5.2: Summary of the findings from the spatial analysis, ground truth exercise and scenario development for the airport study site

	Overview of findings and Scenario outline
Spatial findings	<p>Size of site: Approximately 163 ha, key ecosystems identified wetlands/riparian corridor (approx. 13 ha, 8% of the study site area) and grasslands (approximately 115 ha, 70% of the study site area) the remainder of the study site consists of degraded and transformed land.</p> <p>ESP findings: ESP layer identified the airport site as a key area mixed riparian corridors and public open space untransformed</p> <p>EMF findings: the EMF identified biodiversity and wetland constraints in the airport study site with the specialist reports indicating air quality and heritage issues.</p> <p>SDF findings: A large portion of the airport site has been allocated for future economic opportunities</p>
Ground truth findings	<p>Grassland: degraded grassland as a result of shallow soils, over-grazing and frequent unplanned burning</p> <p>Wetland/Riparian zone: relatively high functioning riparian zone, some rehabilitation work will need to be undertaken if site is developed.</p> <p>Other findings from site visit: illegal refuse dumping, recreational activities by residents, cattle on site, illegal fill dumping</p>
Scenario Outline	<p>The airport site provides excellent opportunities to meet the needs of economic and social growth for the municipality and will be developed upon. However, how will the Municipalities actions of allowing development on the airport site impact on the EGS provided by the current status quo and what EGS will be lost?</p>

5.1.2 Phase two: Priority ecosystem goods and services (PEGS)

Phase two was to identify the priority EGS for the airport site based on the scenario determined in phase one. Priority EGS are determined by the dependence the Municipality has and the impact that their actions will have on the airport site. Using the phase two question progression (Figure 4.3) on the scenario outlined in phase one (Table 5.2), the dependence and impact scores for the airport site were determined (Table 5.3) through a workshop with the Municipality. In the provisioning category, the Municipality has a *medium* dependence on grazing potential, freshwater provision and medicinal resources, with *none to low* dependence on food resources, biomass resources and genetic resources. The impact that the development will have on the EGS in this category is *negative high* impact to the medicinal resources, a *negative medium* impact on livestock and grazing, fresh water provision and genetic resources. There is a *low impact* on food resources and biomass resources.

In the regulating category the municipality has a *high* dependence on air quality, water and soil regulation; there is a *medium* dependence on climate regulation and pollution and a *low* dependence on regulation of pests, pathogens and natural hazard regulation. The Municipality's actions will have a *high negative* impact on air quality, water and soil regulation. There will be a *medium negative* impact on climate regulation, pest and pathogen regulation and natural hazard regulation.

For the cultural category there is a *high* dependence on educational and science services, a *medium* dependence on aesthetics and recreational services and a *low* dependence on spiritual, artistic ethical and religious services. The development of the airport site will have a *high negative* impact on the aesthetic qualities of the open space, and a *medium negative* impact on educational, science, recreational and spiritual services. The Municipality has a *high* dependence on all of the supporting services provided by this open space as all other EGS are functions of these services. There will be a *high negative* impact on all supporting services with the refugia, corridors and habitation service deemed as very important, whilst the remaining supporting services are important in their own right, but will not be used in the following phase.

Table 5.3: Dependence and impact scores for the Msunduzi Municipality on the EGS found at the airport study site

Landscape functions - Airport				Municipality delivering these EGS to Customers (inhabitants of the city)			
Service	Sub-Service	Description	Examples	Dependence (none, low, med or high)	Impact (+and/or - none, low, med, high)	Notes	
Provisioning	Food	Cultivated lands (extensive and intensive) for human or animal consumption	Fruits, vegetables, grains	None	None		
		Livestock raised for domestic (subsistence) or commercial purposes and provision of grazing potential for livestock	Cattle, pigs, chickens, goats	Med	(-) Med	Informal grazing, grass is cut for bailing	
		Commercial fishery installations that use freshwater enclosures for the production of aquatic produce	Freshwater fish, shrimps	None	None		
		Wild game or edible plants species captured or harvested in their natural environment	Fruits, seeds, fish, bush meat	None	None		
	Freshwater	Fresh water provision	Retention of usable water for domestic, industrial, commercial or agricultural purposes or the availability of potable springs or streams	Drinking water, industrial processes, springs, cleaning, electricity generation, transport	Med	(-) Med	
	Biomass resources	Fuel source	Biological material that serves as a source of energy that can be derived from living or former living organisms	Fire wood, charcoal, dung, waste products from agriculture (crops) processes, peat, fodder	None	None	
		Timber fibre	Products derived from plantations or natural forest systems such as craftwork materials and building materials	Logs, building material, pulpwood, paper, industrial processes	None	None	
Other fibre		Nonwood and nonfuel sources of fibre that can be used for numerous purposes	Rope, clothing, household items, twine, leather	None	None		

Landscape functions - Airport					Municipality delivering these EGS to Customers (inhabitants of the city)		
Service	Sub-Service	Description	Examples	Dependence (none, low, med or high)	Impact (+and/or – none, low, med, high)	Notes	
Genetic resources	Genetic materials	Genes used for plant improvements, biotechnology, biomimicry and animal breeding	Increase plant resistance to intolerable conditions, genetic structure or evolutionary traits to be adapted into man-made objects	Low	(-) Med	Potential habitat for <i>Hypoxis</i> , no record of presence, no in-depth study has been undertaken	
	Medicinal, biochemical and pharmaceutical	Biological medicinal characteristics and value	Extraction of medicines from biological matter, use of tradition medicinal plants, biocides, food additives	Tree extracts, natural pesticides, medicinal plants, traditional medicinal practises using biological matter.	Med	(-) High	Potential habitat for <i>Hypoxis</i> , no record of presence, no in-depth study has been undertaken, other traditional medicine species
Regulating	Climate	Global	The effect ecosystems have on global climate through the release or absorption of greenhouse gases and aerosols	Forests and grasslands sequester certain greenhouse gases, livestock and certain agricultural practises emit greenhouse gases.	Med	(-) Med	Grasslands are important sequesters and although the site is small this service is not easily replaceable
		Regional and local	The effect ecosystems have on the local or regional micro-climates, regional temperatures, precipitation and other climatic factors	Green spaces such as parks and forests can reduce the urban heat island effect,	Med	(-) Med	The presence of nearby open spaces can ease the loss of this service
	Air	Air Quality regulation	The effect ecosystems have on air quality by either being a source (emitting) or sink (extraction) of pollutants, chemicals and particulates	Forests and lakes can act as sinks for industrial emissions, vegetation fires emit particulates	High	(-) High	There is a high demand for this service as the area separates industry from residential, it also could reduce impact from the airport operations, this service also forms part of the municipal mandate, grassland could act as a source through controlled burning and arson

Landscape functions - Airport				Municipality delivering these EGS to Customers (inhabitants of the city)		
Service	Sub-Service	Description	Examples	Dependence (none, low, med or high)	Impact (+and/or – none, low, med, high)	Notes
Water	Water regulation	The effect ecosystems have on ground water recharge/dischage and surface run-off and the reduction of velocity and amplitude of flood water discharge	Wetlands, flood plains and riparian zones retain water which regulates runoff and water flow during peak flow stages	High	(-) High	Wetlands and grasslands providing this function that can has positive benefits for the airport and surrounding residential and industrial areas
	Water purification and waste treatment	Retention, filtration and breaking down of waste, detoxifying pollution and the dilution, detoxification, assimilation and transport of pollutants.	Wetlands trap and remove harmful pollutants, metals and organic materials	High	(-) High	Wetlands and grasslands providing this function that can have a positive benefits for the airport and surrounding residential and industrial areas
Soil	Erosion regulation	The function vegetation plays in the retention of soils and sediments	Grass and tress prevents soil loss and helps reduce siltation in water bodies, vegetation holds soil in place therefore reducing the risk of erosion	High	(-) High	
Regulation of pest and pathogens	Disease and pest control	The effect ecosystems have on the regulation and abundances of malaria, bilharzia, black fly, invasive alien species, etc.	Forests provide a habitat for predators that feed on crop pests such as bats, snakes and frogs, wetlands, riparian zones and rivers control waterborne diseases	Low	(-) Med	
Pollination		Ecosystems provide habitat for pollinators	Bees and other insects are essential for crop pollination	Med	(-) Med	Habitat lost for pollinators, could affect research station adjacent to airport site, however there is no surrounding agriculture processes
Natural hazard regulation	Disturbance protection	The capacity for ecosystems to reduce the impacts of natural disasters	Natural flood barriers, decomposition reduces fire fuel load	Low	(-) Med	Grasslands and wetlands could be lost reducing water regulation potential, reduced fire risk

		Landscape functions - Airport				Municipality delivering these EGS to Customers (inhabitants of the city)		
		Service	Sub-Service	Description	Examples	Dependence (none, low, med or high)	Impact (+and/or – none, low, med, high)	Notes
Cultural	Aesthetic			Beauty or attractive landscape features provide an opportunity for tourism ventures	The enjoyment from the scenery on site	Med	(-) High	The airport has a great scenic outlook on to grasslands and Thornveld forests, which provided passengers and people waiting with and enjoyable
	Educational and science			Ecosystems provide learning, training and research opportunities	Habitat for school excursions and the use of nature for scientific study	High	(-) Med	Airport provides a case study for research, grasslands have produced research output, research facility adjacent to the airport
	Recreational			Opportunity for recreational activities	Bird watching, hiking, mountain biking and trail running	Med	(-) Med	Area is used by residents for recreational use
	Spiritual, artistic, ethical and religious			Many belief or sources of spirituality or creative inspiration can arise from these ecosystems	Spiritual fulfilment, intrinsic value, art and photography	Low	(-) Med	Known photography location, area has been used for religious and spiritual rituals
Supporting	Soil formation			Weathering of rock and the accumulation of organic matter	Maintenance of arable land, maintain healthy and productive soils	High	(-) High	
	Nutrient cycling			The role ecosystems have in the storage, processing, re-cycling and collection of nutrients	Decomposing organic matter increases the fertility of the soil, promotion of healthy soils and productive ecosystems	High	(-) High	
	Water Cycling			The flow of water in its three different states through abiotic entities, biota and ecosystems	Transfer of water from soil to plants to air then to rain	High	(-) High	
	Refugia, corridors and habitation			Providing habitat for wild flora and fauna maintaining biological and genetic diversity, forming the basis for other functions, serving as a corridor	Conservation areas and untransformed land	High	(-) High	Provides a link between two conservation areas and therefore has strong corridor dependence

Due to the scope of this research, and in consultation with the managers of the Municipal Department of Environment, Conservation and Forestry, two PEGS were chosen to be piloted in phase three of the ESR tool (Table 5.4). As this research is focused on piloting the tool, only two PEGS will be used in the next phase, but in an operational context the tool would require five to seven PEGS to be used in phase three depending on available experts or specialist studies needed. The two selected PEGS to be used in the next phases are (i) air quality and (ii) refugia, corridors and habitation. These two PEGS were chosen based on the importance that was placed on them by the Department.

Table 5.4: Priority EGS that will be used in the phase three for the airport study site

Landscape functions - Airport					Municipality delivering these EGS to Customers (inhabitants of the city)		
	Service	Sub-Service	Description	Examples	Dependence (none, low, med or high)	Impact (none, low, med, high) & (+or-)	Notes
Regulating	Air	Air Quality regulation	The effect ecosystems have on air quality by either being a source (emitting) or sink (extraction) of pollutants, chemicals and particulates	Forests and lakes can act as sinks for industrial emissions, vegetation fires emit particulates	High	(-) High	There is a high demand for this service as the area separates industry from residential, it also could reduce impact from the airport operations, this service also forms part of the municipal mandate, grassland could act as a source through controlled burning and arson
Supporting	Refugia, corridors and habitation		Providing habitat for wild flora and fauna maintaining biological and genetic diversity, forming the basis for many other functions, serving as a corridor area for other conservation zones	Conservation areas and untransformed land	High	(-) High	Provides a link between two conservation areas and therefore has strong corridor dependence

5.1.3 Phase three: Trends and drivers of ecosystem change

Through the workshop process and site visits with the Municipality's Environmental Department the following trends and drivers were established for air quality and refugia corridors and habitation zones at the airport site. As this research is focused on piloting the ESR adapted tool certain

assumptions are made in this phase that is based on the discussions in the workshops. A high level summary is provided for air quality (Figure 5.8) and corridor zones (Figure 5.9) with the following sub-headings providing a breakdown for each PEGS.

5.1.3.1 Conditions and trends impacting on air quality

Emissions in the city area have increased over the last five years and although there have been no new major stack emission industrial developments, there has been an increase in small to medium scale developments, a large warehouse has been constructed and vehicle traffic has increased on the roads within the city. This means that the Municipality has an increased need to control air pollution levels. The valley topography of the Municipality makes the need for air quality regulation crucial and grasslands such as the one found in and surrounding the airport site are pivotal in providing air quality regulation EGS.

5.1.3.2 Direct drivers impacting on air quality

The land use will change from an open space to a developed landscape with the majority of the development being industrial based. There are likely to be increases in air and ground traffic as a result of the airport area development, which will contribute to increasing emission levels and increases in the sources of pollution. Development at this site will result in the fragmentation of the grassland and wetland reducing their functionality and increasing the potential 'edge effect'.

5.1.3.3 Municipality's activities influencing on air quality

The Municipality has a mandate to promote job creation and economic growth which will encourage development. There is also an environmental mandate for the Municipality to maintain healthy air quality standards. The Municipality is undertaking an EIA to identify and understand the air quality issues arising from developing the airport site.

5.1.3.4 Activities of others influencing air quality

There is regular unplanned burning as a result of arson or accidental circumstances. Illegal dumping was evident, which becomes an air pollution source if the area is burnt. There will be an increase in secondary industries that are not directly related to the airport functions, but that will move onto the newly developed industrial park, as a result of the airport precinct development.

5.1.3.5 Indirect drivers impacting air quality

The SDF has highlighted the area as a site for future economic opportunities and development. There is a national demand for development to occur that creates jobs and promotes economic development. There are mandates and targets from other states, provincial and municipal departments such as emissions standards, health regulations or labour laws that could impact on these drivers.

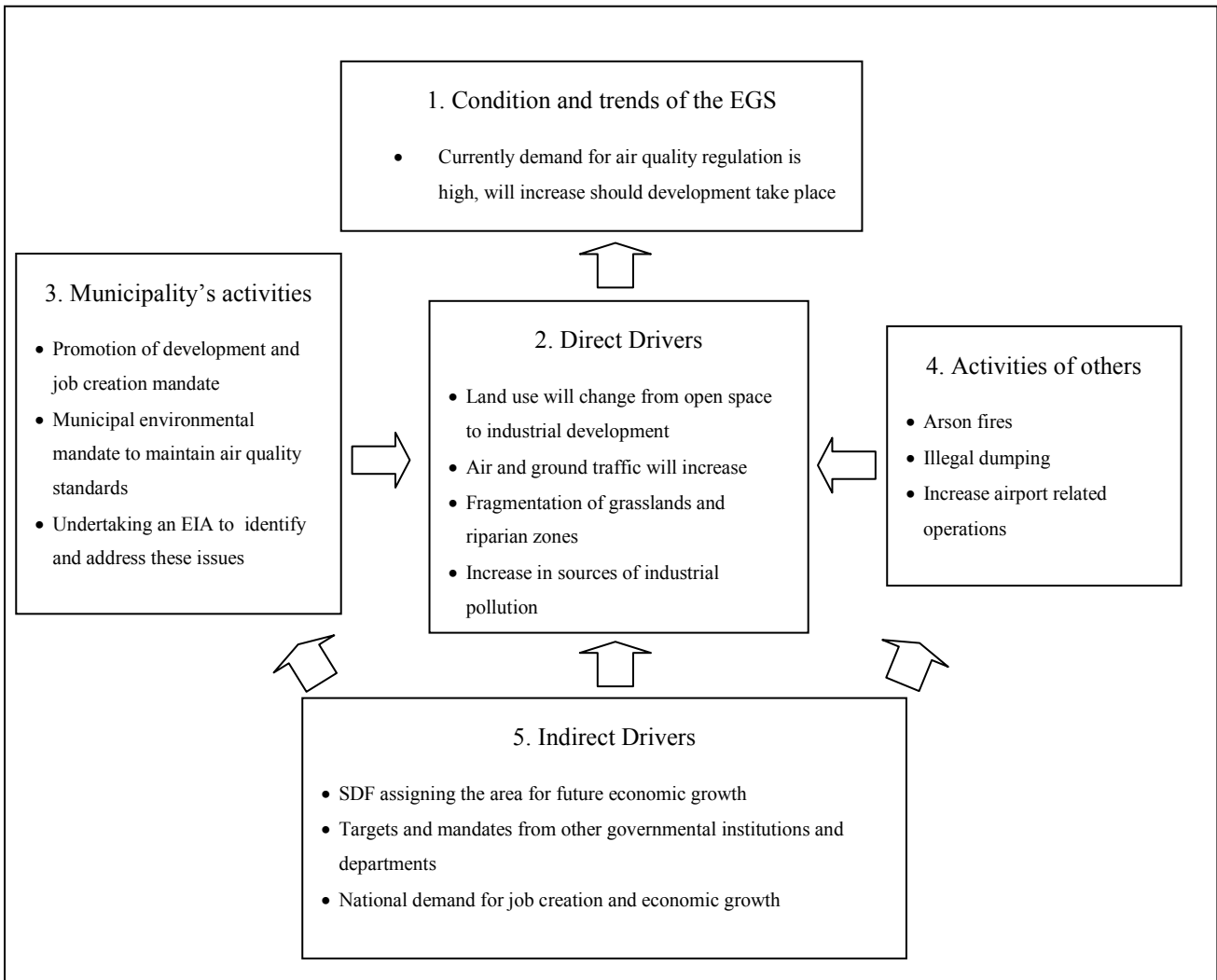


Figure 5.8: Summary of key trends and drivers of air quality regulation for the airport site

5.1.3.6 Conditions and trends impacting on refugia, corridors and habitation zones

Corridor areas have been lost or fragmented due to development encroachment and the construction of barriers such as roads. Previous city planning and zoning has neglected environmental needs such as sufficient corridor zones.

5.1.3.7 Direct drivers impacting on refugia, corridors and habitation zones

The riparian and grassland corridor area will be impacted upon due to the planned industrial development for the airport site that will occur as a result of its zoning. The planned road network expansion will create barriers for fauna species movement reducing the effectiveness of the habitat corridor. Airport regulations result in certain buffer zones that need to be maintained and while no development will occur on these buffer zones the modified landscape will impact on the corridor zone. Other habitat modification activities and incidents that will further reduce the functionality of the corridor zone include illegal developments, illegal dumping, arson fires and an increase in the potential for alien invasive species.

5.1.3.8 Municipality's activities influencing on refugia, corridors and habitation zones

The Municipality has implemented strategic studies such as the EMF and the ESP to identify and highlight these corridor zones and undertake an EIA of the airport site to pre-empt potential corridor issues. The Municipality aims to increase the amount of conservation area from 1% to over 20%, and to enforce a no net loss of certain veld types and wetland areas in an attempt to reduce the impact of development in environmentally sensitive areas. The Municipality will need, in terms of NEMA, to instruct developers to rehabilitate the riparian corridor to minimise the impact of development on the airport site and would like to encourage development designs to have a large portion of their frontage facing the riparian zones to improve working aesthetics.

5.1.3.9 Activities of others influencing refugia, corridors and habitation zones

Illegal fill dumping from infrastructure upgrading has reduced functionality of the riparian corridor. Other governmental departments such as the Department of Water Affairs are enforcing their own targets and objectives which limit the impact to riparian and wetland corridors. Increased industrial activity will result in increased noise pollution which may discourage species movement in the corridor zone. Based on the Municipality's experience, environmental lobby groups will support as much open space as possible and are likely to be opposed to any development plans.

5.1.3.10 Indirect drivers impacting refugia, corridors and habitation zones

The SDF has highlighted the area for future economic growth and therefore the Municipality is obliged to focus development initiatives at this site, however the national and provincial conservation targets that need to be met for certain veld and habitat types and the lack of institutional knowledge and capacity to better understand corridor zones within the Municipality

has to be considered. The introduction of carbon taxes, carbon trading, tax rebates and other market and tax based incentives can make keeping corridor spaces profitable.

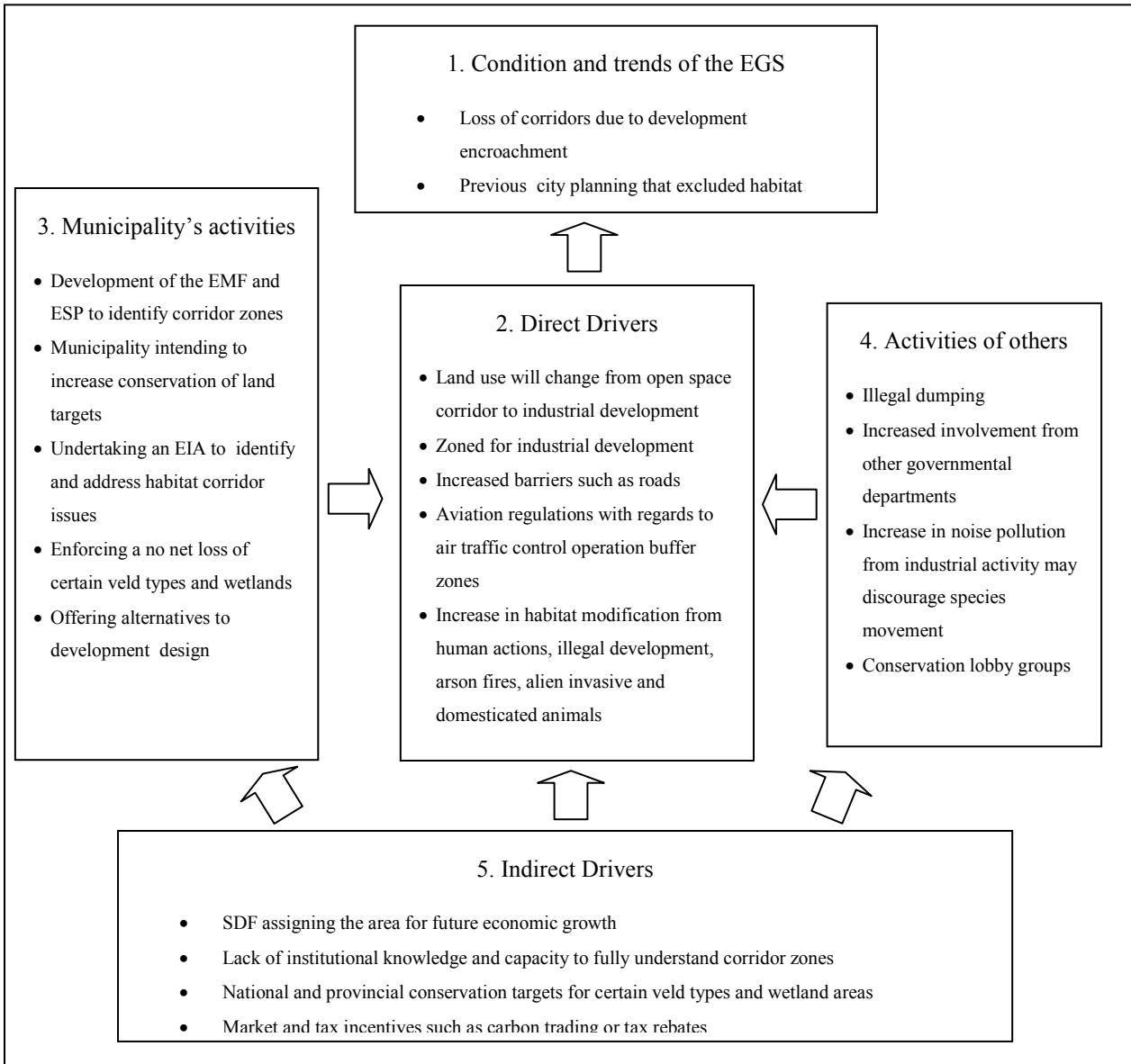


Figure 5.9: Summary of the trends and drivers for refugia, corridor and habitation EGS for the airport site

5.1.3.11 Potential future scenarios for the supply of the different PEGS

Identifying trends and drivers is needed to develop future scenarios for the PEGS. These three scenarios outline what is expected to occur to this EGS based on the previous phases and is used to test the sustainability criteria in phase four and to identify risks and opportunities for the Municipality. The predicted future scenario for air quality regulation based on the trends and drivers is that the provision of this EGS will decline for the airport site. This scenario is based on the current zoning, the planned development and the planned activities once the development has

been completed. The future scenarios used for refugia, corridors and habitation EGS test two different outcomes; the first predicts that the refugia, corridors and habitation EGS provision will decline as a result of the planned development. The grassland will be lost and the wetlands could be drained as a worst case scenario. However, the second possible scenario used is that the riparian and wetland corridor EGS provision may improve if the correct management and rehabilitation actions are undertaken and development that occurs will not have a negative impact on these corridors. These scenarios (Table 5.5) are taken into phase four to determine risks and opportunities.

Table 5.5: Summary of potential scenarios for the provision of the PEGS as identified from the trends and drivers for the airport site

Scenario No.	PEGS affected	Potential scenario for the provision of this EGS
1	Air quality regulation	Provision of this EGS will most likely decline if the grasslands and wetlands are lost to development
2	Refugia, corridors and habitation	Provision of this EGS is likely to decline if the wetland, riparian zones and grasslands are lost to development
3	Refugia, corridors and habitation	Provision of this EGS is likely to be stable or increase as a result of rehabilitation and management of the wetland and riparian zones and correct management of airport facilities buffer zones while still developing the site and for future operations on site

5.1.4 Phase four: Risks and opportunity identification

The first part of this phase requires the user to test the different scenarios identified at the end of phase three (Table 5.5) against the sustainability criteria established in the SEA (Table 3.1). Each scenario (indicated as S1 for scenario 1, S2 for scenario 2 and S3 for scenario in Table 5.5) were tested against the adapted sustainability criteria to determine either the positive or negative impacts (Table 5.6). S1 has no impact on seven sustainability criteria, with indirect negative impacts on four and a direct negative impact on two of the sustainability criteria. S2 has an indirect negative impact on six criteria and a direct negative impact on five criteria and has no impact on two sustainability criteria. S3 has no impact on one criterion with an indirect positive impact on seven and a direct positive impact on five of the sustainability criteria. A summary of these results (Table 5.7) shows how many times the scenarios fit the different impacts on the sustainability criteria. S3 has the most positive impact and S2 the highest negative impact on the sustainability criteria.

Table 5.6: The sustainability criteria checklist (SCC) showing each PEGS scenario for the airport site

Adapted sustainability criteria	No. ref of SEA sustainability criteria	Direct positive impact	Indirect positive impact	No Impact	Indirect negative impact	Direct negative impact
Preservation of biodiversity to minimise loss of species, maintain areas of high biological diversity	1.2.1; 1.3.1	S3		S1		S2
Preservation, maintaining and/or rehabilitating ecological functionality of wetlands, streams and rivers to produce; ensure aquatic ecosystem remain in a health state to ensure the quality of water is suitable for human wellbeing and within legal limits;	1.2.4; 1.3.2; 1.3.5; 2.2.1; 2.3.1;	S3		S1		S2
Minimising risk to flood prone areas; reduce vulnerabilities to communities exposed to environmental risk; manage the adverse impacts of man-made or natural disasters	1.3.6; 2.2.3; 4.3.6	S3		S1		S2
Maintaining air quality standards to reduce threat to human wellbeing	1.2.3; 1.3.10		S3		S2	S1
Provision of an effective and efficient liquid waste management system;	2.2.2; 2.3.5		S3	S1	S2	
Rehabilitate or maintain areas prone to soil erosion	1.3.1;		S3		S1, S2	
Promote sustainable agricultural production (if land is used for agriculture) in areas with high agricultural potential; provision of daily food needs through sustainable urban and rural schemes	1.3.8; 3.3.5			S1, S2, S3		
Control and management of invasive and alien species and the promotion and conservation of indigenous species	1.2.2; 1.3.4		S3	S1, S2		

Adapted sustainability criteria	No. ref of SEA sustainability criteria	Direct positive impact	Indirect positive impact	No Impact	Indirect negative impact	Direct negative impact
Protection of landscape, cityscape; maintenance of sense of place; preservation of cultural and natural heritage resources	2.2.3; 2.2.5; 2.3.10		S3		S1, S2	
Provision of clean open spaces or community parks that improve quality of life and promote human wellbeing	2.3.2; 2.3.7;		S3		S1, S2	
Provision of educational opportunities; development and preservation of indigenous ecological and cultural knowledge; promotion of access to environmental information	2.3.8; 2.3.9; 4.3.7	S3		S1		S2
Access to income generation opportunities; emphasis on linkage between poverty reduction and the environment, promotion of alternative sustainable livelihoods	2.3.3; 3. 2.2; 3. 3.2; 3.3.3;		S3		S1, S2	
Greenhouse gas emission reductions, carbon-offsetting schemes; reduction in dependence on non-renewable energy sources; reduction in fossil fuel dependence;	1.3.11; . 1.3.12; 3.3.7	S3				S1, S2

Table 5.7: Summary of how many times each scenario impacts on the different sustainability criteria for the airport site

Scenario No.	No. of times it has a direct positive impact	No. of times it has an indirect positive impact	No. of times it has no impact	No. of times it has an indirect negative impact	No. of times it has a direct negative impact
1	0	0	7	4	2
2	0	0	2	6	5
3	5	7	1	0	0

This step in phase four (Table 5.6) provides the basis for identifying the sustainability risks and opportunities for each scenario (Table 5.8). This stage in phase four provides the most important information at a glance for the Municipality and could quickly inform decision-makers regarding the changes of ecosystems services, as a result of development, could have on sustainability within the Municipality. Here, each scenario is explored in terms of risks and opportunities for meeting the sustainability criteria as established in the SEA. These risks and opportunities relate to the operational, legal and regulatory, reputational, market and product and financial functions of the Municipality. In the airport site, scenarios S1 and S2 pose more sustainability risks than opportunities while S3 provides more opportunities than risks. Each risk or opportunity is linked to a risk type that identifies where the municipality needs to consider risk or opportunities.

Table 5.8: Risk and opportunities matrix that provides a summary of the sustainability risks and opportunities identified for each scenario for the airport site (indicates type of risk or opportunity)

Scenario	Risk	Opportunity
1 – Reduction in air quality regulation as a result of the loss of grasslands, wetlands and riparian zones on the site	<ul style="list-style-type: none"> • Reduced air quality has human health and wellbeing implications (<i>operational, legal and regulatory, reputational</i>) • Loss of sense of place, natural or cultural heritage (<i>reputational, market and product</i>) • Loss of community open spaces or parks (<i>reputational</i>) • Loss of potential to access alternative sustainable livelihood opportunities (<i>market and product</i>) • Loss of potential carbon-offsetting schemes and a carbon sink (<i>regulatory and legal, market and product, financing</i>) 	<ul style="list-style-type: none"> • Promote the establishment of green/clean industries (<i>operational, reputational, market and product</i>)
2 – Reduction of the provision of refugia, corridors and habitation zones supporting EGS as a result of the loss in grasslands, wetlands and riparian zones	<ul style="list-style-type: none"> • Loss of biodiversity (<i>operational, legal and regulatory, reputational</i>) • Loss of ecological functionality of wetlands and riparian corridors, risking water quality and human wellbeing (<i>operational, legal and regulatory, reputational</i>) • Increased risk in flood prone areas (<i>operational, reputational, financing</i>) • Reduced air quality standards (<i>operational, legal and regulatory, reputational</i>) 	

Scenario	Risk	Opportunity
	<ul style="list-style-type: none"> • Reduced efficiency and effectiveness on a liquid waste management system (<i>operational, reputational</i>) <ul style="list-style-type: none"> • Loss of sense of place, natural or cultural heritage (<i>reputational, market and product</i>) • Loss of community open spaces or parks (<i>reputational</i>) • Reduced future education and knowledge generation opportunities (<i>operational, market and product</i>) • Loss of potential to access alternative sustainable livelihood opportunities (<i>market and product</i>) • Loss of potential carbon-offsetting schemes and a carbon sink (<i>regulatory and legal, market and product, financing</i>) 	
<p>3- Increased provision of refugia, corridors and habitation zones supporting EGS as a result of rehabilitation and management of the wetland and riparian zones and correct management of airport facilities buffer zones while still developing site</p>	<ul style="list-style-type: none"> • Reduced grassland biodiversity (<i>operational, legal and regulatory, reputational</i>) • Loss of potential carbon-offsetting schemes and a carbon sink (<i>regulatory and legal, market and product, financing</i>) 	<ul style="list-style-type: none"> • Preservation of biodiversity and promotion of indigenous species (<i>operational, legal and regulatory, reputational</i>) • Increased ecological functionality of wetlands and riparian corridors, improving water quality and human wellbeing (<i>operational, legal and regulatory, reputational</i>) • Decreased risk in flood prone areas (<i>operational, reputational, financing</i>) • Improved air quality standards (<i>operational, legal and regulatory, reputational</i>) • Increased efficiency and effectiveness on a liquid waste management system (<i>operational, reputational</i>) • Possible future education and knowledge generation opportunities (<i>operational, market and product</i>) • Potential to access alternative sustainable livelihood opportunities (<i>market and product</i>)

The next section provides results for piloting the adapted ESR tool on the second case study, Albany Park, this is an example of how the tool can be used in a proactive sense. Albany Park is not a site demarcated for development but rather a site that is planned for rehabilitation and conservation.

5.2 Case Study Two: Albany Park

Albany Park is situated on a steep topographic slope on the boundary of the Municipality. It forms part of the city's green and mist belt. The park is bordered by a middleclass suburb on one side and on the other by low income housing. The site currently zoned as parkland and therefore requires the Municipality to maintain the area. The Park is mainly used as a through fare connecting the two suburbs and often has cattle grazing on site. The Park also borders on part of a disused railway which forms part of a popular route used by mountain bikers and runners in the area.

5.2.1 Phase one: Study scope spatial findings

As with the first study site, the airport, the substantial amount of Msunduzi specific spatial data available is utilized for the first phase of the tool. The ESP, CEAM, EMF specialist studies and the SDF provide a spatial overview of potential constraints that can be found in the Albany Park area (Table 5.9). The ESP study identified the Albany Park site as an important area to providing key environmental services. The ESP findings (Figure 5.10) provide a mix of key untransformed public open space for the grassland area and transformed public space for the commercial timber plantations. The EMF CEAM layer (Figure 5.11), indicates that the Albany Park has biodiversity and geotechnical flood zone constraints to development. The specialist biodiversity study (Figure 5.12) shows that the grassland areas have high irreplaceability values and provide a corridor to the surrounding open spaces. The wetlands study (Figure 5.13) indicates that there are no wetlands present on the site and the air quality study (Figure 5.14) shows that the area is not sensitive to air quality issues. The SDF findings (Figure 5.15) show that the Albany Park site is allocated as a 'restricted use in the future' site, as the area has environmental or geotechnical constraints that result in it not being suited for development. However, a portion of the park has been assigned as future residential. The SDF findings show that the surrounding communities to the west and south of Albany Park have been targeted for improvements to their urban-rural living conditions.

Table 5.9: Summary of spatial findings from available spatial data for the Albany Park site

Source of data and information used	Findings from data	Maps created from data
Greater EMF Environmental Services Plan (ESP) - Draft Municipal Open Space System	<ul style="list-style-type: none"> • Key untransformed public open space • Transformed public space 	Figure 5.1 Figure 5.10
Greater EMF Consolidated Environmental Attributes Map (CEAM) - The EMF Spatial Decision Support Tool (SDST)	<ul style="list-style-type: none"> • Biodiversity constraints • Geotechnical flood zone constraints 	Figure 5.11

<p>Greater EMF Specialist Reports:</p> <ul style="list-style-type: none"> - Biodiversity study Wetland study - Air Quality study 	<ul style="list-style-type: none"> • High biodiversity irreplaceability • No wetlands present • No air quality constraints 	<p>Figure 5.12</p> <p>Figure 5.13</p> <p>Figure 5.14</p>
<p>Spatial Development Framework</p>	<ul style="list-style-type: none"> • Restricted future use • Small portion assigned as future residential • Adjacent communities earmarked for rural living condition improvements 	<p>Figure 5.15</p>

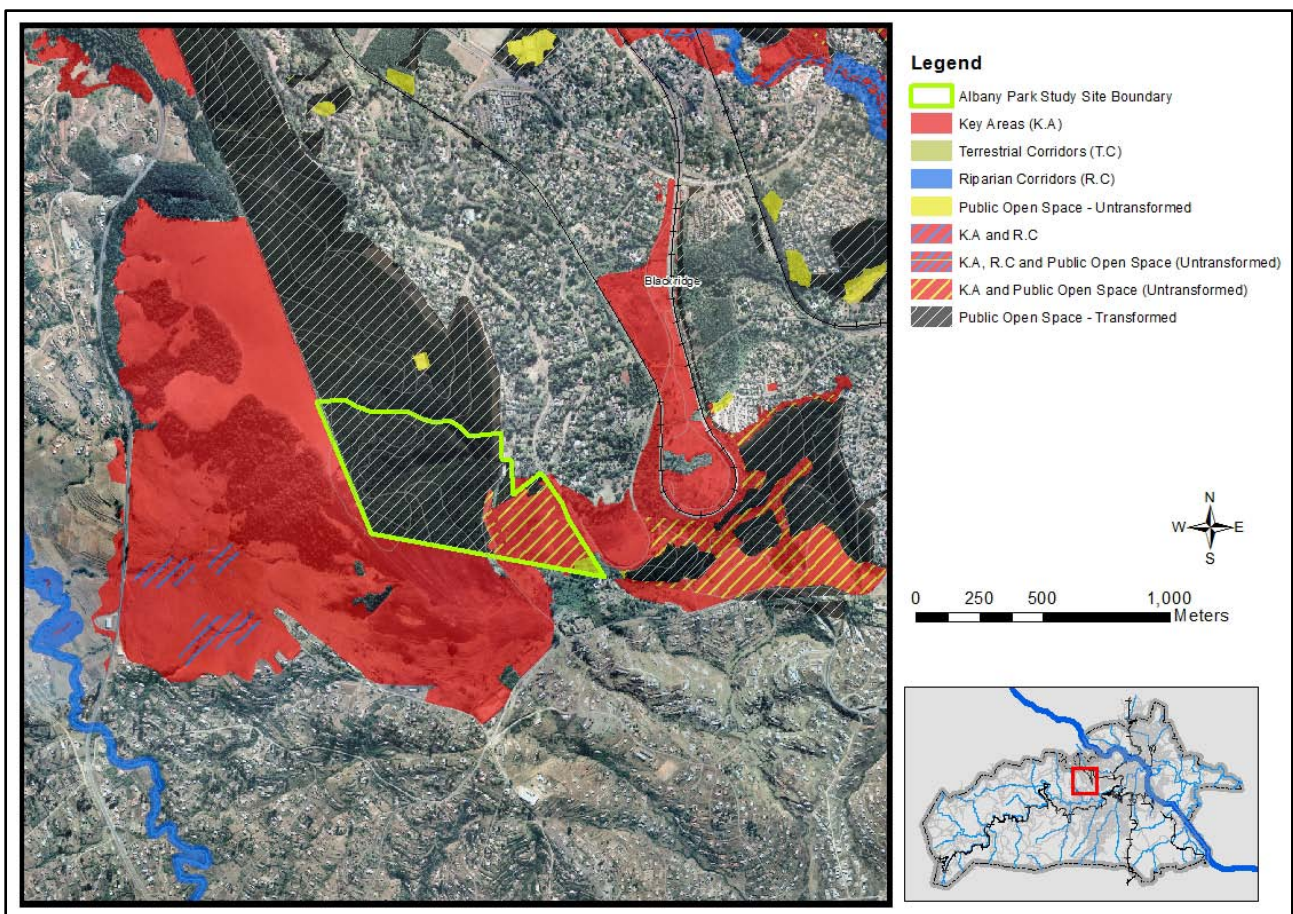


Figure 5.10: The ESP spatial findings for the Albany Park site (adapted from Msunduzi Municipality, 2010)

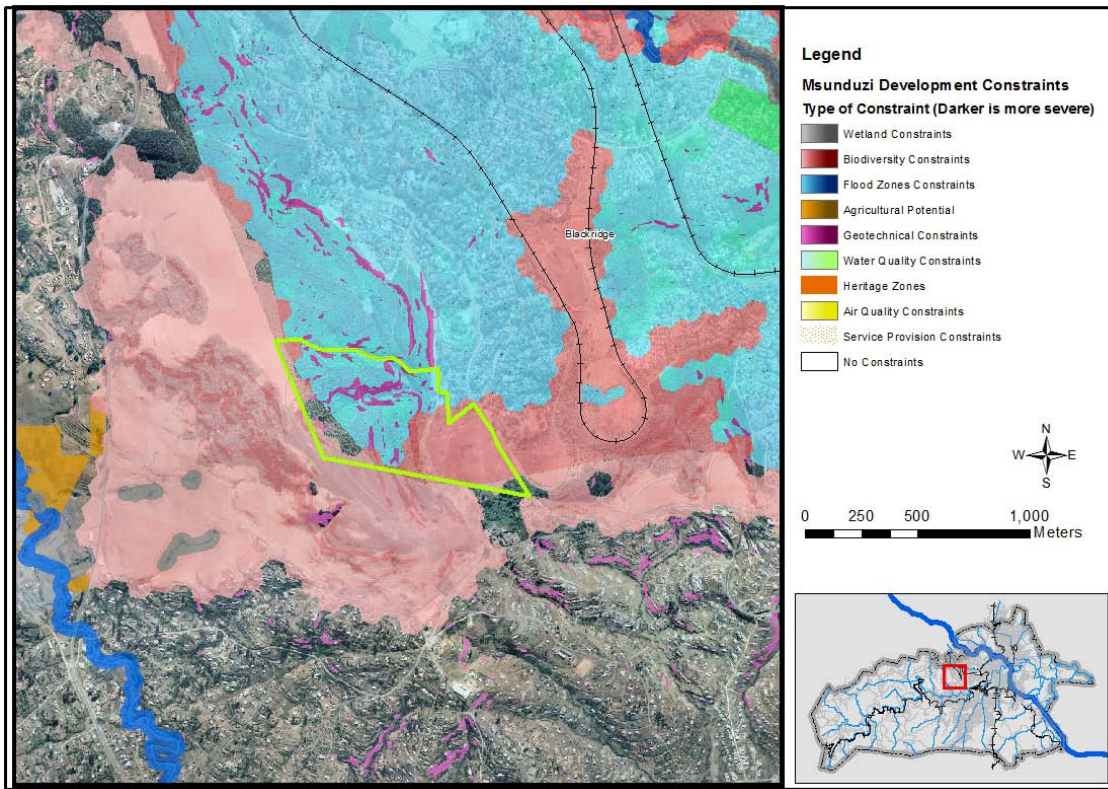


Figure 5.11: The Msunduzi EMF's CEAM layer for the Albany Park site (adapted from Msunduzi Municipality, 2010)

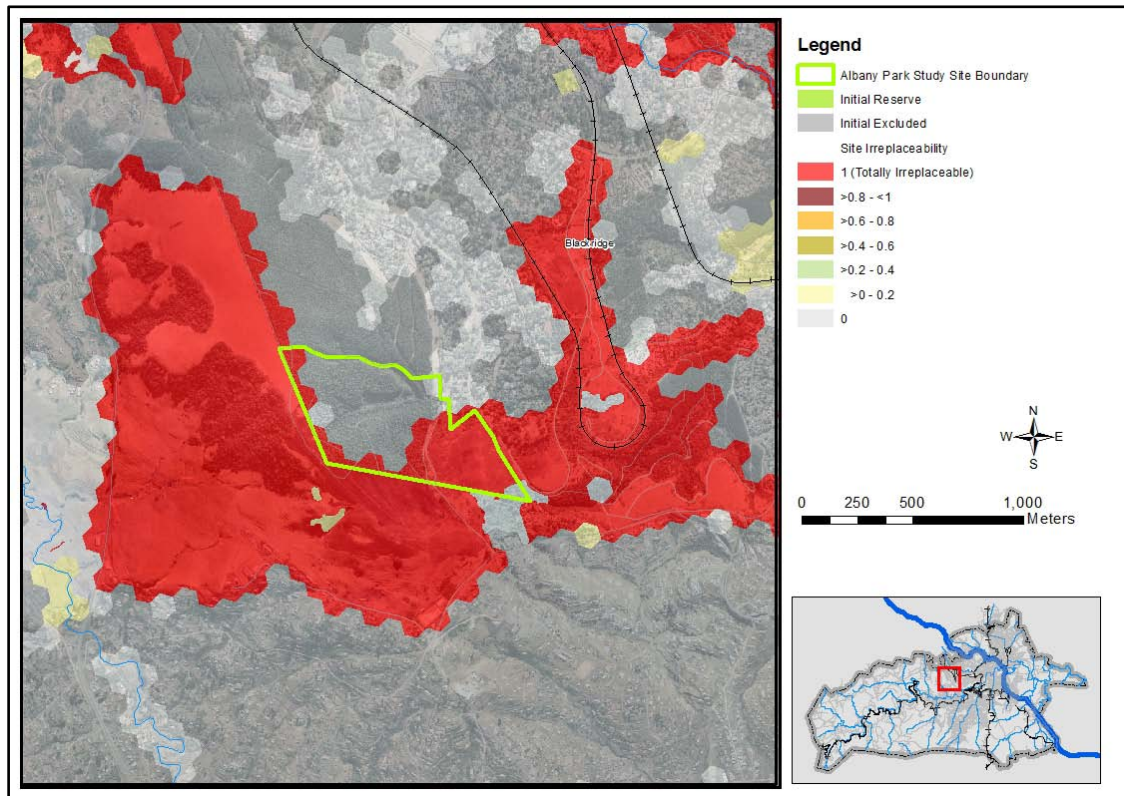


Figure 5.12: Biodiversity irreplaceability scoring for the Albany Park site (adapted from Msunduzi Municipality, 2010)

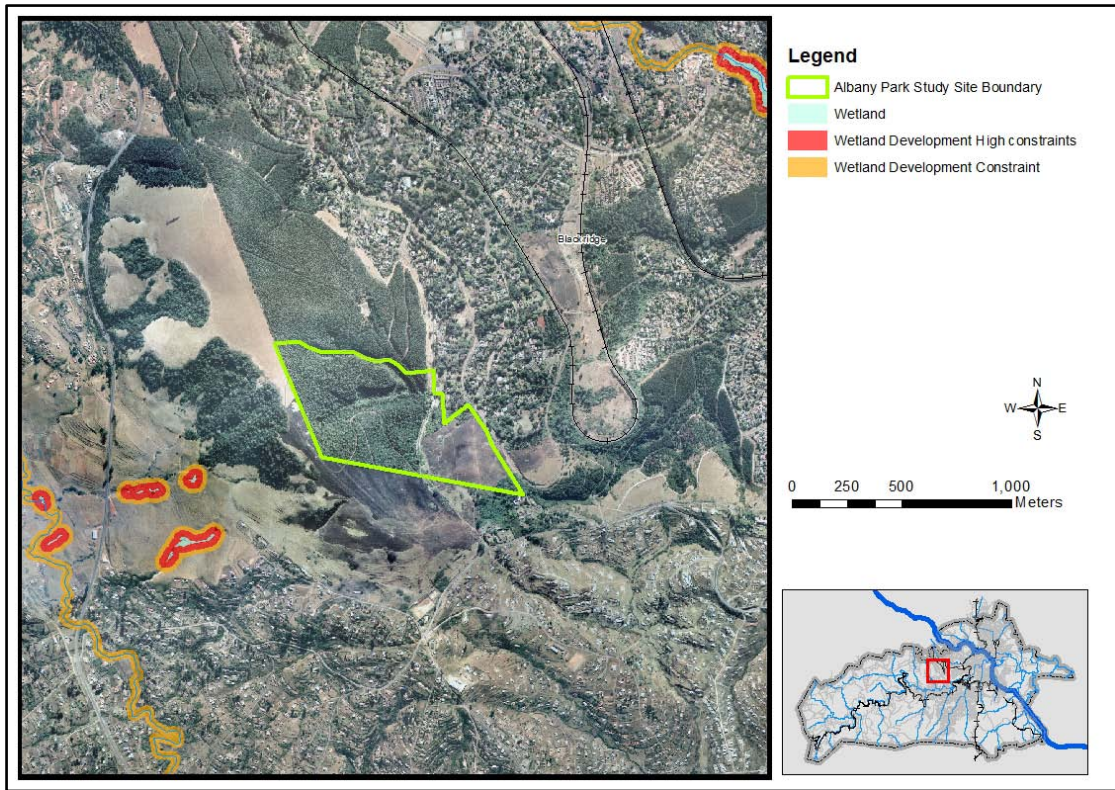


Figure 5.13: Wetland identification and constraints map for the Albany Park site (adapted from Msunduzi Municipality, 2010)

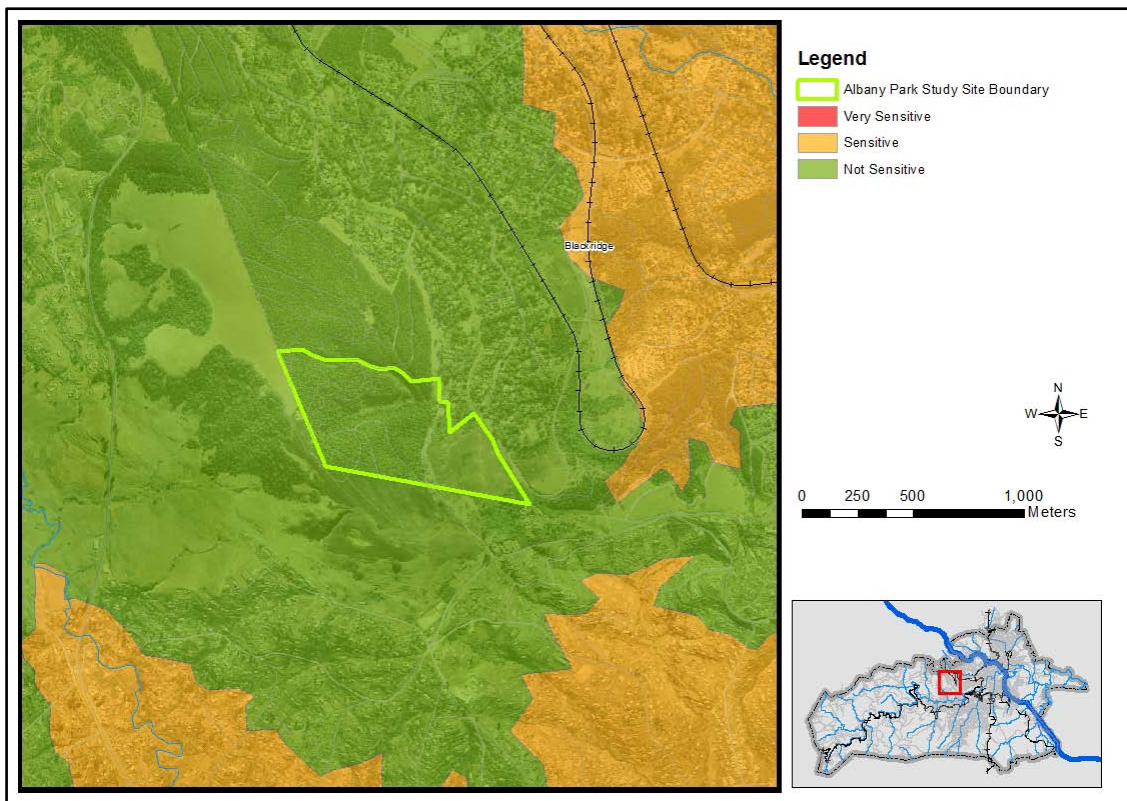


Figure 5.14: Air quality constraints identified for the Albany Park site (adapted from Msunduzi Municipality, 2010)

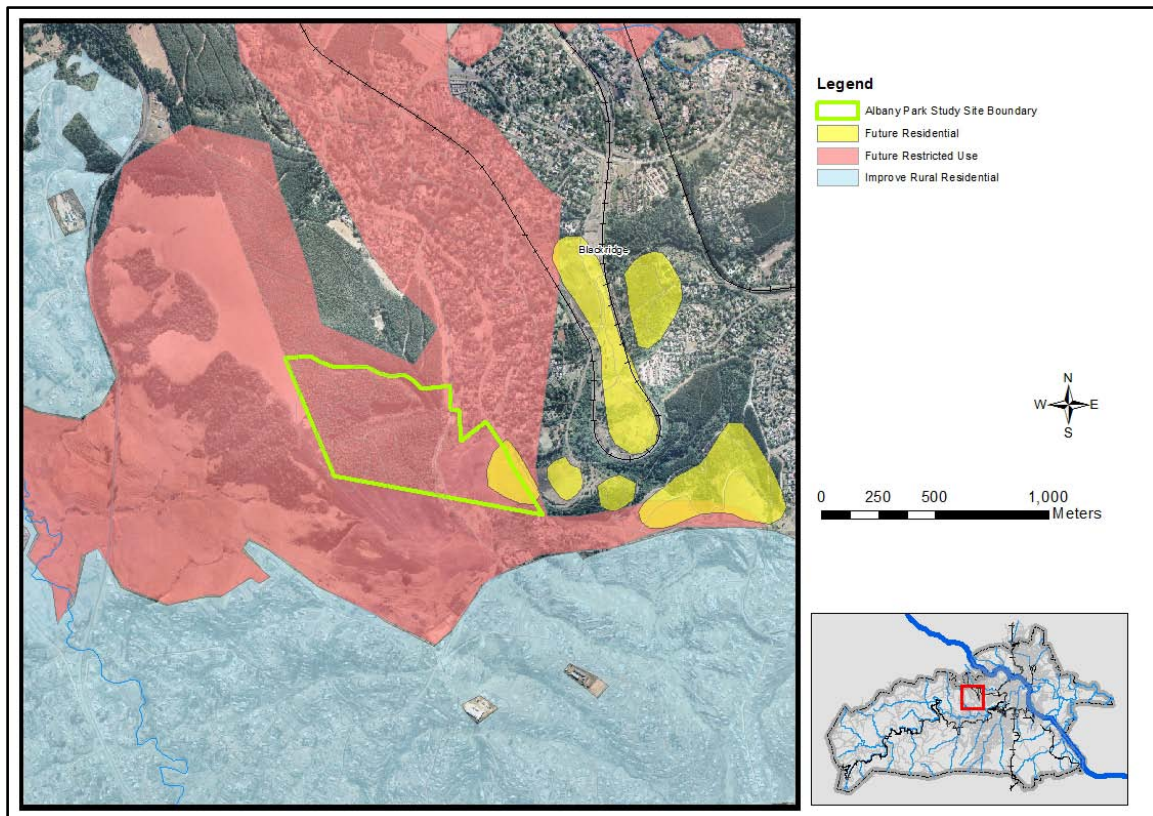


Figure 5.15: Spatial findings from the Msunduzi SDF for the Albany Park site (adapted from Msunduzi Municipality, 2010)

Site visits with the Municipal Environment Conservation and Forestry Department allowed for initial observations to be undertaken and to ground truth the results from the spatial data. These visits showed the extent of the commercial timber operations and the steep topography of the land (Plate 5.3 and Plate 5.4). The condition of the grassland, from a visual assessment, indicates that the grassland is not in pristine condition due to over-grazing, frequent unplanned and planned burning, grass cutting and high foot traffic through the park (Plate 5.4). A commercial timber plantation of *Eucalyptus*, covers the steepest and most undulating part of the slopes. Alien invasive species such as Bugweed (*Solanum mauritianum*), are present in the plantation stands and drainage lines which appear to be poorly maintained. There was evidence of root or bulb harvesting in the grassland area of the park. There were large stands of Bugweed (*Solanum mauritianum*) surrounding the park boundary. There is also high foot traffic through the park as the site connects a residential suburb with an informal settlement (Plate 5.4)



Plate 5.3: Ground image of the Albany Park site looking South West towards the commercial timber stands with the grassland in the foreground



Plate 5.4: Public use of the footpath through the Park to carry firewood to the informal settlement on the other side of the hill with cattle grazing in the far ground

The ‘desired’ land use scenario was built by the researcher for the current study from assessing the spatial and ground truth findings. This scenario, based on the current zoning of the land, is important as it is used in the next phase to determine the priority EGS. This open space was only recently identified as being zoned a park when land invasions occurred on the open space, indicating a need for housing in the area. More than half of the open space has been placed under commercial timber plantations and it is envisaged that these plantations will slowly be reduced in size. It is not a well-known recreational facility for the Municipality and is predominately used by the surrounding residents as a place to ride bikes. The scenario that was used for this study site in phase two is the following: how will the actions of the Municipality to maintain and rehabilitate the area as park land with the removal of some commercial timber sections affect the EGS provided? The summary of the spatial analysis, ground truthing exercise and the scenario (Table 5.10) forms the first phase of the adapted ESR model for the Albany Park site.

Table 5.10: Summary of the findings from the spatial analysis, ground truth exercise and scenario development for the Albany Park study site

	Overview of findings
Spatial findings	<p>Size of site: Approx. 40ha, key ecosystem types identified: Grasslands (approx. 8ha, 20% of the study site area) and commercial timber plantations (approx. 27ha, 68% of the study site area), natural forest (approx. 1ha, 2% of the study site area)</p> <p>ESP findings: ESP layer identified the Albany Park site as having transformed public open spaces and also a key untransformed public open space.</p> <p>EMF findings: the EMF identified the Albany Park site as having biodiversity, geotechnical and flood zone constraints. The specialist biodiversity study shows that the grassland area as irreplaceable. The wetland study indicates that there are no wetlands on the site. The air quality study shows that the area is not sensitive to state of the air.</p> <p>SDF findings: the SDF identifies that the Albany Park site will in future be for restricted use. However there is a section of the park that has been earmarked as future residential. The SDF also highlights the communities to the west and south in need of rural residential improvements.</p>
Ground truth findings	<p>Grassland: degraded grassland as a result of over-grazing and frequent unplanned burning</p> <p>Commercial timber: eucalyptus stand recently planted, poorly maintained drainage lines, presence of alien invasive in plantation stand</p> <p>Other findings from site visit: high foot traffic linking the residential suburb with the informal settlement, evidence of root or bulb harvesting, indication of cattle on site, large stands of alien invasive species surrounding the site</p>

Scenario Outline	<p>The current open space is currently zoned as parkland. This was only recently discovered when there was a land invasion and illegal dwellings were erected. Therefore there is a low awareness of the general public of this open space, and currently has low recreational usage. More than half the Albany Park is under commercial timber and there are plans to rehabilitate the drainage lines and remove the timber from these areas thus hopefully increasing the naturally occurring ecosystems.</p> <p>The scenario used to test the impact in phase two: how will the actions of the municipality to maintain and rehabilitate the area as parkland with the removal of some commercial timber sections, affect the EGS provided</p>
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5.2.2 Phase two: Priority ecosystem goods and services (PEGS)

Phase two was to identify the priority EGS for Albany Park based on the scenario determined in phase one. Using the phase two question progression (Figure 4.3) on the scenario outlined in phase one (Table 5.10), the dependence and impact scores for Albany Park were determined (Table 5.11) through a workshop process with the Municipality. In the provisioning category the Municipality has a *high* dependence on delivery to its inhabitants in the biomass resources of fuel and timber, genetic resources and medicinal uses. There is a *medium* dependence on grazing potential and fresh water provision and a *low to no* dependence for crops, aquaculture, wild foods and other fibre. Based on the scenario in phase one, the impact of rehabilitating and maintaining the area as a parkland showed a *positive medium* impact on fresh water provision and medicinal uses, a *low positive* impact on livestock and grazing, wild foods and genetic resources, there is little impact on food, aquaculture and other fibre. There is a *medium negative* impact fuel and timber biomass resources.

The regulating category shows a *high* dependence on local and regional climate regulation, air quality regulation, water regulation and pollination. There is a *medium* dependence for global climate regulation, water purification, soil regulation and natural hazard regulation. There is a *low* dependence on the regulation of pests and pathogens. The potential impact of the Municipality's actions shows *positive medium* impact for global climate regulation and soil regulation. There is *positive low* impact on the regulation of local and regional climate, air quality, water regulation and purification, pathogen and pest control and pollination. There is both a *positive* and *negative low* impact for natural hazard regulation.

The cultural category supports that the Municipality has a *high* dependence on the aesthetic characteristic of the park with a *medium* dependence on education and science, recreational and spiritual characteristics. There is a *positive medium* impact on education, science and recreation, and a *positive low* impact on the aesthetic, spiritual, artistic, ethical and religious services from the park. The municipality has a *high* dependence on all of the supporting services provided by this open space as all other EGS are a function of these services. There will be a *positive medium* impact on refugia, corridors and habitation, where the other supporting services will be have a *positive low* impact.

Table 5.11: Dependence and impact scores for Municipality on the EGS found at the Albany Park study site

Landscape functions – Albany Park				Municipality delivering these EGS to Customers (inhabitants of the city)			
Service	Sub-Service	Description	Examples	Dependence (none, low, med or high)	Impact (+and/or – none, low, med, high)	Notes	
Provisioning	Food	Crops	Cultivated lands (extensive and intensive) for human or animal consumption	Fruits, vegetables, grains	None	None	
		Livestock and grazing	Livestock raised for domestic (subsistence) or commercial purposes and provision of grazing potential for livestock	Cattle, pigs, chickens, goats	Med	(+) Low	Infrequent grazing from cattle from the surrounding community, conversion back to grasslands may increase grazing potential
		Aquaculture	Commercial fishery installations that use freshwater enclosures for the production of aquatic produce	Freshwater fish, shrimps	None	None	
		Wild foods	Wild game or edible plants species captured or harvested in their natural environment	Fruits, seeds, fish, bush meat	Low	(+) Low	
	Freshwater	Fresh water provision	Retention of usable water for domestic, industrial, commercial or agricultural purposes or the availability of potable springs or streams	Drinking water, industrial processes, springs, cleaning, electricity generation, transport	Med	(+) Med	Headland catchment area
	Biomass resources	Fuel source	Biological material that serves as a source of energy that can be derived from	Fire wood, charcoal, dung, waste products from agriculture	High	(-) Med	Reduction in the availability of timber

Landscape functions – Albany Park				Municipality delivering these EGS to Customers (inhabitants of the city)			
Service	Sub-Service	Description	Examples	Dependence (none, low, med or high)	Impact (+and/or – none, low, med, high)	Notes	
		living or former living organisms	(crops) processes, peat, fodder				
	Timber fibre	Products derived from plantations or natural forest systems such as craftwork materials and building materials	Logs, building material, pulpwood, paper, industrial processes	High	(-) Med	More controlled access and reduced timber production therefore a reduction in available fibre	
	Other fibre	Nonwood and nonfuel sources of fibre that can be used for numerous purposes	Rope, clothing, household items, twine, leather	None	None		
	Genetic resources	Genes used for plant improvements, biotechnology, biomimicry and animal breeding	Increase plant resistance to intolerable conditions, genetic structure or evolutionary traits to be adapted into man-made objects	High	(+) Low	Nesting site for ground birds (potential to increase genetic pool)	
	Medicinal, biochemical and pharmaceutical	Biological medicinal characteristics and value	Extraction of medicines from biological matter, use of tradition medicinal plants, biocides, food additives	Tree extracts, natural pesticides, medicinal plants, traditional medicinal practises using biological matter.	High	(+) Med	Area has been used for traditional plant harvesting, potential for a community project, high demand for traditional medicines
Regulating	Climate	Global	The effect ecosystems have on global climate through the release or absorption of greenhouse gases and aerosols	Forests and grasslands sequester certain greenhouse gases, livestock and certain agricultural practises emit greenhouse gases.	Med	(+) Med	Sequestering from grasslands and timber plantations
		Regional and local	The effect ecosystems have on the local or regional micro-climates, regional temperatures, precipitation and other climatic factors	Green spaces such as parks and forests can reduce the urban heat island effect,	High	(+) Low	Forms part of the Municipality's green belt
	Air	Air Quality regulation	The effect ecosystems have on air quality by either being a source (emitting) or sink (extraction) of pollutants, chemicals and particulates	Forests and lakes can act as sinks for industrial emissions, vegetation fires emit particulates	High	(+) Low	Municipal mandate

Landscape functions – Albany Park				Municipality delivering these EGS to Customers (inhabitants of the city)			
Service	Sub-Service	Description	Examples	Dependence (none, low, med or high)	Impact (+and/or – none, low, med, high)	Notes	
Water	Water regulation	The effect ecosystems have on ground water recharge/discharge and surface run-off and the reduction of velocity and amplitude of flood water discharge	Wetlands, flood plains and riparian zones retain water which regulates runoff and water flow during peak flow stages	High	(+) Low	Reduction in timber increases the provision of this EGS	
	Water purification and waste treatment	Retention, filtration and breaking down of waste, detoxifying pollution and the dilution, detoxification, assimilation and transport of pollutants.	Wetlands trap and remove harmful pollutants, metals and organic materials	Med	(+) Low		
	Soil	Erosion regulation	The function vegetation plays in the retention of soils and sediments	Grass and tress prevents soil loss and helps reduce siltation in water bodies, vegetation holds soil in place therefore reducing the chance of a landslide	Med	(+) Med	Grassland size is increased (due to timber reduction and grassland rehabilitation)
		Disease and pest control	The effect ecosystems have on the regulation and abundances of malaria, bilharzia, black fly, invasive alien species, etc.	Forests provide a habitat for predators that feed on crop pests such as bats, snakes and frogs, wetlands, riparian zones and rivers control waterborne diseases	Low	(+) Low	
	Pollination		Ecosystems provide habitat for pollinators	Bees and other insects are essential for crop pollination	High	(+) Low	
	Natural hazard regulation	Disturbance protection	The capacity for ecosystems to reduce the impacts of natural disasters	Natural flood barriers, decomposition reduces fire fuel load	Med	(+/-) Low	
Cultural	Aesthetic	Beauty or attractive landscape features provide an opportunity for tourism ventures	Mountains, rivers and lakes are attractive destinations for tourists because they derive enjoyment from the scenery	High	(+) Low	Visible from large parts of the municipality due to its altitude	

Landscape functions – Albany Park				Municipality delivering these EGS to Customers (inhabitants of the city)		
Service	Sub-Service	Description	Examples	Dependence (none, low, med or high)	Impact (+and/or – none, low, med, high)	Notes
	Educational and science	Ecosystems provide learning, training and research opportunities	Habitat for school excursions and the use of nature for scientific study	Med	(+) Med	Research case study potential, field trip opportunities
	Recreation	Opportunity for recreational activities	Bird watching, hiking, mountain biking and trail running	Med	(+) Med	Increase awareness may lead to more usage
	Spiritual, artistic, ethical and religious	Many belief or sources of spirituality or creative inspiration can arise from these ecosystems	Spiritual fulfilment, intrinsic value, art and photography	Med	(+) Low	
Supporting	Soil formation	Weathering of rock and the accumulation of organic matter	Maintenance of arable land, maintain healthy and productive soils	High	(+) Low	
	Nutrient cycling	The role ecosystems have in the storage, processing, re-cycling and collection of nutrients	Decomposing organic matter increases the fertility of the soil, promotion of healthy soils and productive ecosystems	High	(+) Low	
	Water Cycling	The flow of water in its three different states through abiotic entities, biota and ecosystems	Transfer of water from soil to plants to air then to rain	High	(+) Low	
	Refugia, corridors and habitation	Providing habitat for wild flora and fauna maintaining biological and genetic diversity, forming the basis for many other functions, serving as a corridor area for other conservation zones	Conservation areas and untransformed land	High	(+) Med	Important corridor zone to other open spaces

All EGS that have a high dependence and high impact were considered as priority EGS (PEGS) (Table 5.11). In this case the highest impact was at a medium scale, therefore those EGS were considered as PEGS (Table 5.12). The provisioning EGS of biomass resources (including fuel and fibre sources) and medicinal, biochemical and pharmaceutical resources (with a focus on traditional medicine products) were selected to be tested in phase three.

Table 5.12: Priority EGS that will be used in the next phase for the Albany Park study site

Landscape functions – Albany Park				Municipality delivering these EGS to Customers (inhabitants of the city)			
Service	Sub-Service	Description	Examples	Dependence (none, low, med or high)	Impact (none, low, med, high) & (+or-)	Notes	
Provisioning	Biomass resources	Fuel source	Biological material that serves as a source of energy that can be derived from living or former living organisms	Fire wood, charcoal, dung, waste products from agriculture (crops) processes, peat, fodder	High	(-) Med	Reduction in the availability of timber
		Timber fibre	Products derived from plantations or natural forest systems such as craftwork materials and building materials	Logs, building material, pulpwood, paper, industrial processes	High	(-) Med	More controlled access and reduced timber production therefore a reduction in available fibre
	Medicinal, biochemical and pharmaceutical	Biological medicinal characteristics and value	Extraction of medicines from biological matter, use of tradition medicinal plants, biocides, food additives	Tree extracts, natural pesticides, medicinal plants, traditional medicinal practises using biological matter.	High	(+) Med	Area has been used for traditional plant harvesting, potential for a community project, high demand for traditional medicines
Supporting	Refugia, corridors and habitation		Providing habitat for wild flora and fauna maintaining biological and genetic diversity, forming the basis for many other functions, serving as a corridor area for other conservation zones	Conservation areas and untransformed land	High	(+) Med	Important corridor zone to other open spaces

5.2.3 Phase three: Trends and drivers of ecosystem change

A similar process as the airport case study was used to determine the trends and drivers for Albany Park. This included workshops and site visits with the Municipality’s Environmental Department which resulted in establishing the trends and drivers for biomass resources and medicinal plants. As this research is focused on piloting the ESR adapted tool certain assumptions are made in this phase that is based on discussions in the workshops. These assumptions include; an active rehabilitation program that was carried out on the site, the surrounding community utilize the plantations as a

timber and fibre resource and the plantation size will be reduced in the parkland. A summary of the trends and drivers of the biomass resource EGS (Figure 5.16) and traditional medicinal products (Figure 5.17) are provided.

5.2.3.1 Conditions and trends impacting on biomass resources

Many plantations within the municipality are found on the steep valley slopes or in areas that were previously deemed as not suitable for development and form an extensive green belt, which Albany Park is a part of. Recently there is a trend to reassess these areas to see if they may be viable to be developed especially the plantations found in suburban areas. The Municipality is enforcing a 30 meter cut back on all drainage lines that are located within the plantations to aid in reducing the impact on the subcatchments and water flow.

5.2.3.2 Direct drivers impacting biomass resources

The close proximity of Albany Park to an urban/rural fringe settlement results in a high demand for building and fuel materials from the nearby plantation and there is a dependence on the provision of this EGS. Therefore the municipality's decision to cut back timber plantations along the drainage lines will result in a short-term increase in supply of material, as a result of increased felling, before a permanent loss in available timber materials.

5.2.3.3 Municipality's activities influencing on biomass resources

The Municipality will manage this open space as parkland and will not allow the plantation stands to be replanted once harvested. This will impact on the future supply of this resource for the surrounding community. Rehabilitating the drainage lines on the site will result in temporary work opportunities for the community and an increase in supply of timber materials that could be distributed to the community in the short-term. In the long-term there will be an increase in water supply as a result of the removal of the plantation.

5.2.3.4 Activities of others influencing biomass resources

The felling process of the plantations provides an increase in timber available to local communities, while the left-over trees can be utilized as a source of fuel or as building materials.

5.2.3.5 Indirect drivers impacting biomass resources

The SDF has allocated this space as *future restricted use* therefore this space is unlikely to be considered as developable open land and will be restored back to its natural state or left as is. There are targets and mandates from other governmental departments, such as the Department of Water Affairs, that will assess the plantation's impact to stream flow reductions and on water allocation rights. There is a local demand for housing and therefore those that cannot afford conventional or modern building materials will look at the availability of timber from nearby plantations.

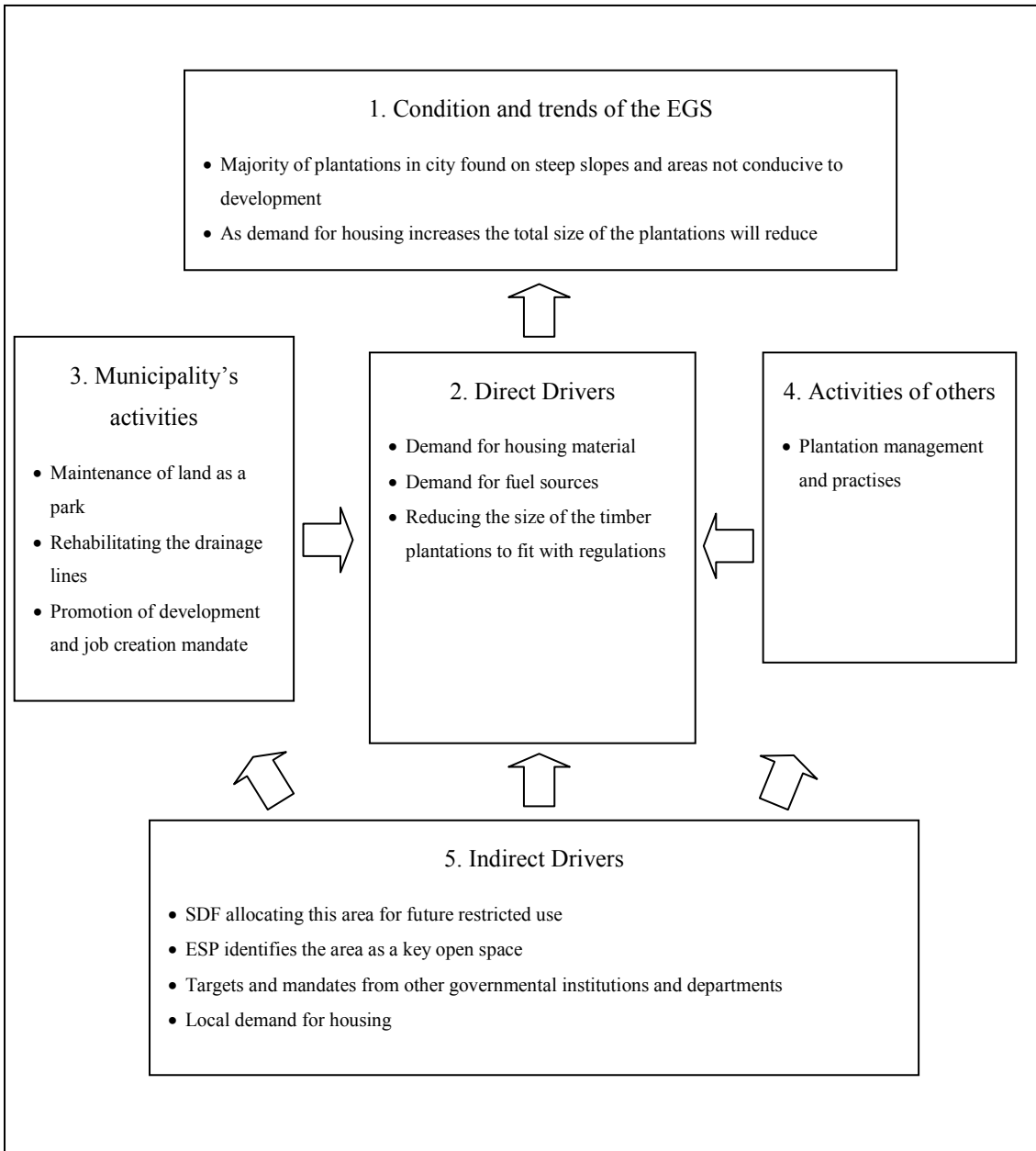


Figure 5.16: Summary of key trends and drivers for the provision of biomass resources for the Albany Park site.

5.2.3.6 *Conditions and trends impacting on traditional medicinal products*

Traditional medicine is used in conjunction with modern methods, however, as the population increases within the Municipality the demand for traditional medicines could potentially rise. According to the Municipality, historically the area in and surrounding Albany Park has been used as a site for traditional medicine, however, accurate research into the usage has not been undertaken by the Municipality and is difficult to quantify.

5.2.3.7 *Direct drivers impacting on traditional medicinal products*

Albany Park will be maintained as parkland and will not be rehabilitated for recreational purposes, therefore with the removal of alien species and the clearing of the drainage lines there is potential for encouraging indigenous species thus increasing the supply of medicinal plants. Increasing urban migration has resulted in increased population growth rates which could mean the demand for traditional medicinal plants could potentially rise. Depending on the changing demographics of the Municipality, the demand for traditional healers or the demand for people to become traditional healers may increase. The techniques used and rate of harvesting also drives change in this EGS. If harvesting is unsustainable and poor techniques are used then this could reduce supply of the EGS.

5.2.3.8 *Municipality's activities influencing on traditional medicinal products*

The Municipality intends to manage the park back to a relatively natural state and therefore, with a selective proactive planting scheme, their actions could result in an increase in the presence of medicinal plants. A previous program was established by the Municipality and medicinal plant harvesters in a different area of the Municipality that encouraged the sustainable planting and harvesting of medicinal plants (pers com. Bartholomew, 2011). The project was initially successful but later collapsed, however potential for a similar project could be established in the Albany Park area.

5.2.3.9 *Activities of others influencing on traditional medicinal products*

Policies and programmes by other governmental departments or NGOs could change demand for this EGS. The Department of Health may encourage the use of traditional medicine and therefore support policies and programmes aimed to encourage sustainable harvesting in conjunction with western medicines.

5.2.3.10 Indirect drivers impacting on traditional medicinal products

The SDF has allocated the area for *future restricted use* which is a result of environmental and/or geotechnical constraints and the ESP identifies the area as a key open space. Therefore, the land is likely to remain an open space increasing the supply of this EGS. The SDF has demarcated the area adjacent to the park as in need of rural residential improvements.

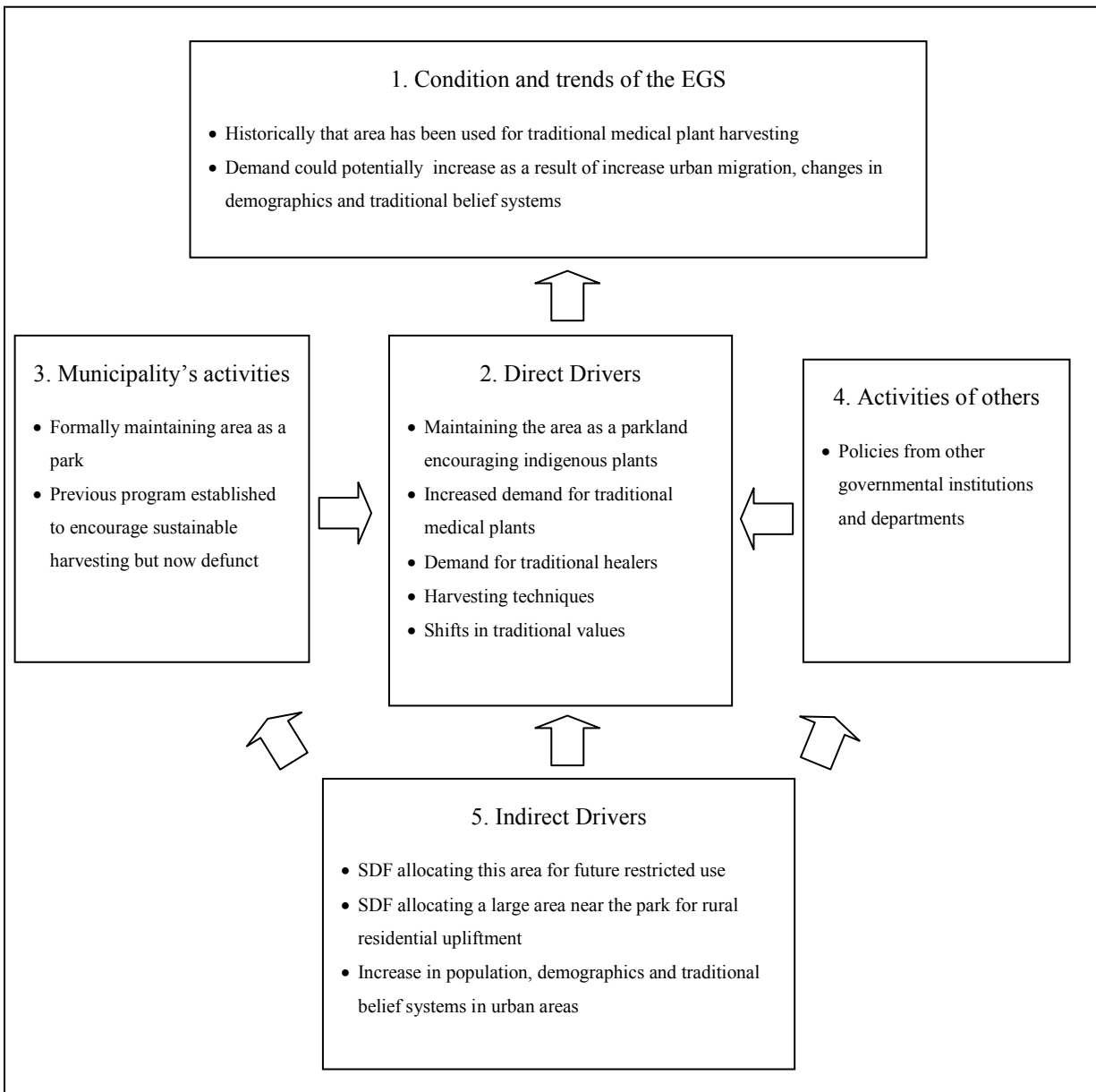


Figure 5.17: Summary of key trends and drivers for the provision of traditional medicinal products for the Albany Park site.

5.2.3.11 Potential future scenarios for the supply of the different PEGS

The nature of the Albany Park site lends itself to future scenarios that are more strategic, as there are no planned developments for the area, therefore the Municipality can be more proactive. As a result there is only one scenario per PEGS to test against the sustainability criteria. The scenario used for the biomass resources EGS is based on the future intentions by the Municipality for that site. This includes reducing the plantation size along the drainage lines and in the long-term not replanting the site after it is cleared. Therefore in the short-term supply would slowly decrease and in the long-term supply would likely cease if the timber stand is not replanted and returned to its natural state of grassland. As a result there will be a reduction in the supply of this EGS. The second PEGS scenario for traditional medicinal products is based on the potential to establish a sustainable harvesting program to promote alternative income generation opportunities and to provide increased access to sustainable traditional medicines. This would be more of a strategic scenario as there are no plans or mandates to establish such a program and is designed to be more of a ‘what if’ scenario. These two scenarios (summarised in Table 5.13) are used in phase four to determine the potential risks and opportunities of these scenarios to sustainability.

Table 5.13: Summary of potential scenarios for the provision of the PEGS as identified from the trends and drivers for the Albany Park site.

Scenario No.	PEGS affected	Potential scenario for the provision of this EGS
1	Biomass resources	In the short and medium term there will be a reduction in the supply of this EGS with a sharp decrease in the long-term as plantation will not be replanted once felled, returning back to its natural state
2	Traditional medicinal products	Potentially an increase in supply if a formalised relationship can be established between traditional healers and the Municipality whereby the grassland is rehabilitated and a sustainable planting and harvesting system can developed

5.2.4 Phase four: Risks and opportunity identification

This phase requires the user to test the scenarios developed in phase three (Table 5.13) against the sustainability criteria checklist (SCC) to show the relation of the scenario to its impact on the sustainability criteria established in the SEA (Table 5.14). S1 refers to the scenario for the biomass resource PEGS and S2 refers to the scenario for traditional medicine products PEGS. A summary of the scenario impacts on the different sustainability criteria is provided (Table 5.15) S1 has more

positive impacts on the sustainability criteria with three direct positive impacts, five indirect positive impacts and no impact on four of the sustainability criteria with one direct negative impact. S2 has five direct positive impacts, three indirect positive impacts and no impact on five of the criteria. S1 and S2 both have positive impacts towards sustainability targets established in the SEA and therefore have a strategic significance towards sustainability objectives for the Municipality.

Table 5.14: The sustainability criteria checklist (SCC) showing each PEGS scenario for the Albany Park site

Adapted sustainability criteria	No. ref to SEA sustainability criteria	Direct positive impact	Indirect positive impact	No Impact	Indirect negative impact	Direct negative impact
Preservation of biodiversity to minimise loss of species, maintain areas of high biological diversity	1.2.1; 1.3.1	S1, S2				
Preservation, maintaining and/or rehabilitating ecological functionality of wetlands, streams and rivers to produce; ensure aquatic ecosystem remain in a health state to ensure the quality of water is suitable for human wellbeing and within legal limits;	1.2.4; 1.3.2; 1.3.5; 2.2.1; 2.3.1;		S1	S2		
Minimising risk to flood prone areas; reduce vulnerabilities to communities exposed to environmental risk; manage the adverse impacts of man-made or natural disasters	1.3.6; 2.2.3; 4.3.6			S1, S2		
Maintaining air quality standards to reduce threat to human wellbeing	1.2.3; 1.3.10		S1	S2		
Provision of an effective and efficient liquid waste management system	2.2.2; 2.3.5			S1, S2		
Rehabilitate or maintain areas prone to soil erosion	1.3.1;		S1, S2			

Promote sustainable agricultural production (if land is used for agriculture) in areas with high agricultural potential; provision of daily food needs through sustainable urban and rural schemes	1.3.8; 3.3.5			S1, S2		
Control and management of invasive and alien species and the promotion and conservation of indigenous species	1.2.2; 1.3.4	S2	S1			
Protection of landscape, cityscape; maintenance of sense of place; preservation of cultural and natural heritage resources	2.2.3; 2.2.5; 2.3.10	S1, S2				
Provision of clean open spaces or community parks that improve quality of life and promote human wellbeing	2.3.2; 2.3.7;	S1	S2			
Provision of educational opportunities; development and preservation of indigenous ecological and cultural knowledge; promotion of access to environmental information	2.3.8; 2.3.9; 4.3.7	S2		S1		
Access to income generation opportunities; emphasis on linkage between poverty reduction and the environment, promotion of alternative sustainable livelihoods	2.3.3; 3.2.2; 3.3.2; 3.3.3;	S2				S1
Greenhouse gas emission reductions, carbon-offsetting schemes; reduction in dependence on non-renewable energy sources; reduction in fossil fuel dependence	1.3.11; 1.3.12; 3.3.7		S1, S2			

Table 5.15: Summary of the frequency of each scenario impacts on the different sustainability criteria for the Albany Park site.

Scenario No.	No. of times it has a direct positive impact	No. of times it has an indirect positive impact	No. of times it has no impact	No. of times it has an indirect negative impact	No. of times it has a direct negative impact
1	3	5	4	0	1
2	5	3	5	0	0

This step in phase four (Table 5.14) provides the basis for identifying the sustainability risks and opportunities for each scenario (Table 5.16). Both scenarios provide substantial opportunities for the municipality. Each risk and opportunity is categorised to the different types of risk and are found in brackets next to each entry.

Table 5.16: Risk and opportunities matrix that provides a summary of the sustainability risks and opportunities identified for each scenario for the Albany Park site (indicates type of risk or opportunity).

Scenario	Risk	Opportunity
1 – Reduction in the supply of this EGS in the short-term, supply will cease in the long-term as the stand will not be replanted returning back to its natural state of grasslands	<ul style="list-style-type: none"> Reduced possibility of access to income generation opportunities and alternative sustainable livelihoods 	<ul style="list-style-type: none"> Preservation of biodiversity and promotion of indigenous species (<i>operational, legal and regulatory, reputational</i>) Increased ecological functionality of wetlands and riparian corridors, improving water quality and human wellbeing (<i>operational, legal and regulatory, reputational</i>) Maintaining or rehabilitating areas prone to soil erosion (<i>operational</i>) Control and management of alien species and the promotion and conservation of indigenous species (<i>operational, reputational</i>) Protection of the cityscape (<i>reputational</i>) Provision of clean open space that promote human wellbeing (<i>operational, reputational</i>) Reduction in the dependence of fossil fuels (<i>regulatory</i>)

<p>2 - Potentially an increase in supply if a sustainable planting and harvesting program can developed through a formalised relationship between traditional healers and the municipality</p>		<ul style="list-style-type: none"> • Preservation of biodiversity and promotion of indigenous species (<i>operational, legal and regulatory, reputational</i>) • Maintaining or rehabilitating areas prone to soil erosion (<i>operational</i>) • Control and management of alien species and the promotion and conservation of indigenous species (<i>operational, reputational</i>) • Preservation of cultural and natural heritage resources (<i>operational, reputational, market and product</i>) • Possible future education and knowledge generation opportunities (<i>operational, market and product</i>) • Potential to access alternative sustainable livelihood opportunities (<i>market and product</i>)
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5.3 Feedback from the Municipal Environment, Conservation and Forestry Department

Feedback gathered from discussions at the workshops, meetings and sight visits with the municipal officials are provided in a summary (Table 5.17) where the strengths, weakness and applicability of the adapted ESR tool were discussed. Strengths refers to the positive aspects of the tool in environmental decision-making, the weaknesses are the perceived shortfalls of the model and applicability refers to where the model is most likely to be used by the municipality and for what purpose.

Table 5.17: Summary of the strength, weaknesses and applicability of the ESR tool based on the feedback sessions.

Strengths	<p>Focussed systematic approach, standardised layout providing flexibility in application, highlights often overseen environmental aspects, identifies priority constraints, adds value to the environmental decision-making process</p>
Weaknesses	<p>Does not provided strong quantitative data, comparisons between different sites could be difficult, element of bias when undertaking the various phases, poor understanding by non-environmental focused assessors, lack of site specific data could result in skewed analysis</p>
Applicability	<p>Most useful at inception phase, helps identify/inform specialist studies, assist in focusing attention on relevant priorities, useful when considering development applications or reviewing strategic documents</p>

Based on the feedback provided by the Municipal Department that would utilize this tool it seems that the tool is most useful in the inception phase of projects and developments that the Department would be involved in. The tool can guide the Municipality as to what specialist studies need to be conducted and assists in focusing attention on the relevant issues first. The tool can be of use to the Department when used in considering or reviewing development applications or strategic environmental management actions. The focused systematic approach allows for a standardised layout that can be used for all development reviews and applications and can highlight overseen environmental, social and economic impacts. The tool adds value to the environmental decision-making process in the municipality by identifying priority environmental, social and economic constraints and links these issues to other strategic environmental and planning documents such as the EMF, SEMP, SEA, ESP and SDF that are utilized by the Municipality. While the tool provides numerous benefits if applied in the decision-making process, there are still limitations.

Finding the best site (or potential alternative sites) for a certain development in the Municipality using this tool is compromised as comparisons between different sites cannot be made quickly based on a score or value. This is because the tool is not a standard scoring system that allows all sites to be compared equally. The tool will treat each site separately and therefore will highlight different constraints at different sites, therefore if the decision-maker wants to compare sites they would have to undertake this assessment for each site and then base their decision on the results that the tool will present. The tool does not provide strong quantitative data as it relies on the use of existing data and highlights what data is missing that needs to be generated through specialist studies. This can be further hampered where there is a lack of site specific data and therefore the data needs to be generated to remove potentially skewed results. As the tool asks the user to prescribe high, medium and low dependence and impact scores there is an element of user bias and therefore needs to be considered when applying the tool and the decisions taken. There will also be a need to train non-environmental assessors if using this tool as some of the terminology used relies on a basic understanding of environmental terms. Therefore effective implementation of this tool is reduced if undertaken by assessors without some form of environmental knowledge. There may be human capital constraints as the tool requires input from experts, resulting in a non-expert-driven approach that could restrict other municipalities from implementing the tool.

5.4 Conclusion

The focus of this chapter is to pilot the tool on different scenarios that could occur within the Municipality using two case studies. By piloting this tool it draws attention to the advantages and limitations of each phase of the tool, and highlights where the tool is most applicable and where it lacks strength and usability. This chapter also meets the third objective of this research in that the adapted ESR tool was tested to assess how the tool would function if being implemented. While this chapter may not provide ‘real-world’ results, it does serve the purpose of showing the user of the tool how each phase can be applied and set-out based on the methodology in Chapter Four. These case studies provide examples of applying an adapted ESR tool for a local government context. Case study site one demonstrates how this tool can be used in a ‘reactionary’ sense for future planned development and what the issues surrounding EGS and sustainability will be should the development take place based on the scenario presented in the chapter. The second case study site provides a more ‘proactive’ and strategic application of the tool and illustrates how the tool can be used to highlight positive intervention to strategic environmental decisions. Under the scenarios presented, changes to EGS provisions and the impacts on sustainability are shown. The tool displays, in both cases, how linking it to existing environmental management and planning tools such as the EMF, SEA and the SDF, that changes to EGS will impact on sustainability issues for the Municipality and emphasise the resultant risks and opportunities. Through utilizing this adapted ESR tool, environmental, social and economic information and their links to sustainability risks and opportunities can become apparent for the Municipality and assists in decision-making. The next chapter discusses these case studies by considering how the tool has been applied to each scenario and then assesses strengths, weaknesses and applicability of the adapted ESR framework, with a link back to the theoretical framework, for local level environmental decision-making.

Chapter Six Discussion

This chapter discusses the findings from piloting the ESR tool (Chapter Five) in two parts. First, each phase of the tool is discussed and assessed based on piloting the tool on the two study sites, with a focus on the trends and issues associated with each phase. Thereafter, the chapter discusses the strengths, weaknesses and applicability of the tool to be used at a local government level with reference to relevant literature. While the actual results from the tool may be of interest as they represent plausible ‘real-world’ findings, they are based on hypothetical scenarios developed with the municipality and therefore do not form a key part of the main discussion. These findings from piloting the tool rather serve as a means to highlight the strengths and limitations of using such a tool to better inform environmental decision-making. The strengths, weaknesses and applicability of each phase (Table 6.1) were generated through completing each phase with staff of the Environment, Conservation and Forestry Department within the Msunduzi Municipality as they are the intended users of this tool.

Table 6.1: Summary of the strengths, weaknesses and applications of each phase of the ESR tool after piloting the tool on two case study sites

Phase	Strengths	Weaknesses	Applications
One	<ul style="list-style-type: none"> • Establishes the baseline for information that user has or needs • Identifies data gaps • Provides snapshot overview of potential issues on site • Development of scenarios allows for a more strategic approach to development trade-offs 	<ul style="list-style-type: none"> • Limited by data availability • Requires expert knowledge for ground truthing • Financial constraints could hamper the ability to gather information or conduct ground truth data 	<ul style="list-style-type: none"> • Informing phase two • Could inform or be informed by a basic scoping report
Two	<ul style="list-style-type: none"> • Identification of priority EGS for that site • Using different scenarios in phase one allows for different management strategies to be compared • Can highlight previously overseen environmental, social and economic impacts 	<ul style="list-style-type: none"> • User bias can occur when placing dependence and impact scores • Need for a transdisciplinary team to reduce bias can be costly and time consuming • Poor understanding of EGS by non-environmental users of the tool can skew dependence and impact scores 	<ul style="list-style-type: none"> • Informing phase three • Identify priority EGS can then lead to informing specialist studies • Can be used as a quick guide to see if priority issues have been covered in EIA applications or basic assessments

	<ul style="list-style-type: none"> Allows for a holistic approach to be taken with regards to impact and dependence of development as environmental, social and economic considerations need to be included 		
Three	<ul style="list-style-type: none"> Flexibility, as different scenarios can be created representing drivers of EGS change based either on actual drivers or strategic interventions User of the tool can create best and worst case scenarios to be used in the next phase of the tool 	<ul style="list-style-type: none"> Availability of accurate data to determine trends and drivers may not easily be accessible Understanding what drives change of EGS will be difficult for non-environmental users of the tool 	<ul style="list-style-type: none"> Informing phase four Can be used to compare different drivers of change based on different environmental management interventions
Four	<ul style="list-style-type: none"> Links into other environmental management and landuse planning tools such as EMF, SEA and SDF Provides the link to sustainability for the Municipality Identifies risk and opportunities for the Municipality based on sustainability criteria Risks and opportunities table provides an easy to read snapshot overview for municipal managers that can inform decision-making 	<ul style="list-style-type: none"> In municipalities that do not have supportive environmental management and landuse planning tools, sustainability criteria needs to be developed for the checklist 	<ul style="list-style-type: none"> Informing phase five Risks and opportunities for sustainability allow for more informed decision-making
Five	<ul style="list-style-type: none"> Strategies and recommendations are created based on sustainability implications that incorporate the triple bottom line 		

Phase one of the tool predominately focuses on attempting to establish a baseline for the area that is being studied. This phase allows the user to gather a snapshot understanding of what the potential issues may be or linked to the site under assessment. To establish this baseline the user has to gather all a vailable spatial data and c onduct a ba sic ground t ruthing e xercise to assist in f ormulating scenarios for that study site.

The spatial data analysis in the airport case study shows that there will be conflict between the conservation (derived from the EMF and ESP data, Figure 5.1 to Figure 5.6) and economic (as indicated by the SDF, Figure 5.7) agendas within the municipality, therefore trade-offs and compromises will need to be considered if development is to occur on this site. In the case of the Albany Park site these trade-offs become less apparent as the SDF (Figure 5.15) and the EMF (Figure 5.10 to Figure 5.14) data do not highlight any potential future conflicts, however the spatial analysis shows that the relationship between the open space and the surrounding communities needs to be explored further in the following phases. The recognition of these trade-offs by the Municipality at this early stage in the tool's use highlights the viewpoint of Seppelt *et al.* (2011), that the comprehensive inclusion of all stakeholders, or at the very least identifying the different stakeholders, will allow for a more holistic and consistent approach to EGS assessment. With the airport site, there is clear conflict between the objectives of economic growth and conservation with the likelihood that development will occur. This makes the airport site application of the tool more reactionary in approach as it assesses the impacts of the development on the EGS provided by that open space. The spatial findings for the Albany Park site indicate that application of the adapted ESR tool will provide a more strategic and proactive approach as the user can create varying scenarios to assess the impact on the EGS under different management and policy options. This provides a more all-inclusive, user-inspired and user-useful form of assessment that will allow the decision-maker to select more practical choices as advocated by Fish (2011) and Salles (2011). However, a ground truthing exercise is still crucial as it can expand on the spatial findings by providing 'on the ground' insight into the ecosystems and their functionality on site, such as illegal dumping, over-grazing or riparian disturbance. Ground truthing aids in formulating the different reactionary or strategic scenarios for a site being assessed with the ESR tool.

The combination of using the spatial information (GIS layers) and the ground truth findings is essential in developing the potential land use scenarios, which is a desired output from this first phase in the tool (Table 5.2 and Table 5.10). If the ground truth exercise is ignored and scenarios are based only on the results of the spatial analysis then there is the potential risk of scenarios being based on inaccurate spatial data or a data resolution (scale) that is too broad. The Msunduzi Municipality is fortunate in having extensive and relatively good datasets as a result of the Greater EMF Process. This allows for an easier application of the tool, as a result of the spatial data availability, compared to other municipalities where this data may be missing. For the Msunduzi Municipality, the availability of the EMF, ESP and SDF datasets are a major advantage as it can

provide large amounts of spatial data for the study area. However, these data still need to be ground truthed to make certain that the data on the ‘screen’ are the same as on-the-ground. Analysing and ground truthing these data will assist the user in understanding what potential issues and constraints may be on site and will aid in the formulation of development/landuse scenarios and strategies for that site.

While the Msunduzi Municipality is in a fortunate position with regards to data availability, many municipalities do not have such a luxury. For many, this type of data does not exist or is out of date. This obviously makes phase one more difficult to conduct and may require extensive finances, often not available, to generate data through private consultant studies. This results in the ground truthing exercise becoming a key component in formulating scenarios as on-the-ground assessment can provide sufficient information to move on to the next phase of the tool.

Phase two provides the link between the land-use scenarios for the site and assessing the impacts and dependence on EGS provided by that open space. It is supposed to provide a snapshot view of what may be occurring on that site. However, it is easy for the user to be slowed by this process as there are a multitude of variables that could change the score given to the dependence and impact of that particular EGS. Therefore the use of a simple ‘*low, medium or high*’ impact or dependence allows the user to quickly determine what are the priority EGS for that site to inform Phase Three. Identifying priority EGS can inform the Municipality of what further specialist assessments need to be prioritised before conducting other specialist studies that may be of little value for that site. Ideally this process would be undertaken in a workshop type format with a trans-disciplinary group that could include experts, NGOs, other government departments and users of that open space. This phase should provide a more holistic outcome as numerous points of view would need to be considered and different aspects of dependence would need to be investigated. This could help reduce the bias that may occur if the tool was carried out by an individual or a small focus group (Babbie and Mouton, 2001).

The classification of EGS should be flexible and relate to the context in which it is being implemented. The set of EGS used in this research (Table 4.7) can be adapted to the context of the area being assessed, for example coastal environments will have a different set of EGS compared to

upland areas. This can become a problem for non-environmental users of the tool, as their knowledge on this matter may be poor and will therefore rely on a generic set. The classification of EGS in this tool was based on the Millennium Ecosystems Assessment's (MA) four categories (MA, 2005b), but the user could develop a EGS base list that is classified according to clusters, such as food, water and energy. However, if a different list is generated it is important to consider the links to human wellbeing that the new categories will have (Figure 2.2) and ensure that they are clear. A further challenge to using the MA classification is trying to determine a dependency and impacts core for the supporting services. The Municipality will always be dependent on the supporting services to deliver EGS to its inhabitants, therefore scoring these supporting services for impact and dependency will skew the overall priority EGS identification process. However, there is a strong case to classify corridor and refugia zones in a different category as for some open spaces this will be a major priority EGS (White *et al.*, 2000). Ultimately the main outcome of this phase is to understand and determine what the major pressing issues are on site, that have influence for the users and recipients of the EGS provide by that open space.

If a more strategic approach is taken in phase one where two or more land-use scenarios are established for that open space, phase two will allow the user to compare the different impacts on the EGS provided on that site. This approach may assist the Municipality in making more informed decisions and may help in identifying alternative land-use outcomes. By being able to compare what will happen to that open space under different circumstances, the tool can be utilized more strategically to determine what the most sustainable option could be for that open space. This allows for decision-makers to interpret and understand the linkages, as expressed by Daily *et al.* (2009), Perrings *et al.* (2011) and Salles (2011) that a healthy environment (ie productive ecosystems) results in healthy people and a healthy economy and consequently a more productive society. An outcome of this phase is that the user of the tool will have a clearer picture of the priority issues on that site and what will require further research and assessment. Furthermore the user will have a list of priority EGS to use in phase three. The tool requires all of the priority EGS or grouping of priority EGS to be assessed in phase three, however for this research, only two were assessed for each study site to pilot the tool.

Phase three provides an overview of the trends and drivers of that priority EGS. Each priority EGS needs to be assessed to determine what the trends are influencing the condition of the EGS, what is

driving change in that EGS and what the impacts are of activities by the Municipality and others on that EGS. Assessing the trends and drivers of each EGS allows the user to create scenarios based on the expected change to that EGS. These scenarios differ from those in phase one as they are focused specifically on the change of each priority EGS not on the overall land-use change as outlined by the scenarios in phase one. The availability of reliable and usable data will impact on the formulation of these scenarios as in some cases this data will not exist and expert knowledge of the region assessed will have to be used. In such cases, understanding what drives EGS change could be difficult for non-environmental users of the tool and therefore may have to pay for these scenarios to be developed which could become costly.

For the two case studies (Figure 5.8, Figure 5.9, Figure 5.16 and Figure 5.17), the likely change in the regulation of air quality at the airport site is negative as the wetlands and grasslands will be lost to development. For the refugia corridor and habitation EGS, there are two potential scenarios, one based on the loss of these EGS as a result of development, the other based on the implementation of a management plan that will rehabilitate and manage the wetland and riparian zones. For the Albany Park site there is one potential scenario for each EGS, biomass resources are likely to decrease as a result of reduction in size of the timber stand and no replanting once the timber is felled. In the case of traditional medicinal plants the scenario formulated is based on the potential to establish a formal relationship between the harvesters and the municipality. However, while these scenarios may not be a reality they have been created to illustrate the flexibility of the tool to show that this phase can be used for both actual changes to the EGS and changes based on strategic intervention or programmes. These scenarios need to be informed by the drivers and trends but can, however, represent a strategic action or rather an ideal for that EGS. It can allow the user of the tool to compare the best and worst case scenarios for that EGS and its implications for sustainability in the next phase. The scenarios developed in this phase are tested against sustainability criteria in phase four after which the risks and opportunities to sustainability can be identified.

Phase four links the scenarios determined in phase three to the sustainability criteria developed from the SEA. It is in this phase that the EMF, SEA and the ESP are integrated to determine the risks and opportunities to the sustainability of that open space based on the findings of the previous phases. It allows the user of the tool to assess how changes in the EGS provided by that open space will impact on the sustainability criteria developed from national, provincial and local sustainability

objectives. These impacts are materialised as risks and opportunities for the Municipality to meet its sustainability criteria and fundamentally become useful information, which in its summarised form, provides an overview that informs decision-making. For the airport site the first scenario (Table 5.8) of a loss of air quality regulation as a result of a loss of the grassland area will result in negative impacts to sustainability with risks to human health being a primary concern for the Municipality. This is not only a risk to sustainability but also to the Municipality's mandate of maintaining air quality standards within the city. However if the site is to be developed, then it is an opportunity for the Municipality to promote the establishment of clean industry to attempt to reduce the risks to sustainability. The second scenario for the airport site has sustainability risks when assessed against the sustainability criteria. These risks include the loss of biodiversity, reduction in the ecological functionality of wetland and riparian zones, increased risk of flooding and the loss of potential access to alternative livelihoods. Therefore the loss of the wetland and riparian zones does not seem a sustainable option for the Municipality. The third scenario provides a compromise situation which recognises the need to develop but also the need to ensure no net loss to the functioning of wetlands and riparian zones. While there will be risks to sustainability with the reduced grassland biodiversity and the loss of potential carbon offsetting schemes there are more opportunities that could be utilized. These opportunities include the access to potential alternative livelihoods opportunities, through the process of rehabilitating the riparian corridor and wetland. There is also the possibility that future education and knowledge generation can be achieved through researching the links between industrial and commercial zone planning development, the airport activities and the rehabilitation and conservation of corridor zones. There are sustainability opportunities through promoting an increase in the ecological functioning of the wetland and riparian corridors as this will decrease the risk of flooding and increase the efficiency and effectiveness of the ecosystem to purify pollutants (MA, 2005c). The third scenario provides the most sustainable solution to the Municipality.

The scenarios developed for the Albany park site have a positive impact to sustainability. This is as a result of both scenarios being pro-conservation through the reduction in timber production and the reintroduction and maintaining traditional medicinal plants. These scenarios were based on realistic future plans for that site and focused around a developmental aspect. While development will occur around Albany Park, it is unlikely that development will occur on the site itself. Under scenario one, which considers the reduction in timber resources, there are more opportunities than risks. Cutting back alien vegetation from the drainage lines coupled with rehabilitation work, will

assist in the establishment of indigenous vegetation and promote biodiversity. This will support increased ecological functionality of the riparian zones and therefore, as this area is in the head of the sub-catchment and in the mistbelt region of the Municipality, there could be decreased water stress further downstream in the catchment. However, these opportunities are only achievable if an effective management strategy is in place and is carried out accordingly. However, due to the financial situation experienced by the Municipality in 2011, the likelihood of funds being directed to this cause will be limited.

The second scenario places a ‘what if’ situation for the Albany park site by studying the risks and opportunities to sustainability should a medicinal plant scheme be established. There are more opportunities than risks associated with this scenario as it can provide increased alternative livelihood opportunities, promote indigenous biodiversity, preserve cultural heritage, and possible education and knowledge transfer opportunities. However, this scenario could potentially be resource and labour intensive in its initial phase and requires the local community to take ownership of the initiative to promote its sustainability. This may be the biggest challenge for this scenario to be an effective scenario to promote the sustainability criteria of the Municipality.

By assessing the risks and opportunities of each scenario for this phase, the Municipality is in a better position to make a more informed decision with regards to the impacts to EGS and sustainability. The outcomes from this phase could be seen as the most important from the Municipality’s point of view as it provides user-friendly information that, at a glance, will allow for local government and those implementing the adapted tool to make better informed decisions. Assessing each scenario in terms of its impact to sustainability potentially allows for the Municipality to create recommendations and strategies and allow for sustainability to be incorporated into the decisions that are made. The information presented in this phase should be taken into phase five where recommendations, actions, research needs, assessment needs, strategies and decisions that have been raised and determined from all previous phases are documented and implemented.

As this tool has been adapted from a corporate-based assessment, each phase of the tool has strengths and weaknesses in assessing EGS for local level government decision-making. However,

it is important to understand the applicability of this tool in a broader sense as the incorporation of EGS into local level decision-making is still a relatively new concept. Therefore it is essential to understand the applicability, strengths and weaknesses of this tool and to place the tool in the broader scope of IEM in informed decision-making. The next section of this chapter forms the second part of the discussion and links the findings from applying the tool back to the literature.

The National Framework for Sustainable Development (NFSD) (DEAT, 2008) provides South Africa's position towards sustainability and identifies five pathways to achieving sustainability. This tool provides the Municipality with the opportunity to implement the ideals of the NFSD in that: (i) it develops a new system in which EGS can be incorporated into integrated environmental and land use planning and implementation; (ii) the tool promotes the sustainable utilization of ecosystems and efficient use of our natural resources; (iii) it highlights the opportunities to promote green infrastructure and alternative livelihood strategies to drive economic; (iv) through consideration of EGS and the links to sustainability included in the tool the result will be the development of sustainable human communities and settlements and; (v) provides a relatively easy to use response for local government to develop strategies to meet the emerging challenges that face human development, economic growth and the environment. However, while this tool can provide these pathways, the current *status quo* in decision-making is the implementation of development strategies and plans often at the expense of the environment in an attempt to deliver basic services (Muller, 2009). Rather than achieving the ideals outlined in the NFSD, the continued disregard for the environmental sphere and in particular ecosystem services will have detrimental and long lasting effects. Decision-makers need to be able to realise the potential advantages of assessing development against effects to the triple bottom line (DEAT, 2006; Sowman and Brown, 2006; DEAT, 2008; Nel and Kotze, 2009).

Daily *et al.* (2009) and De Groot *et al.* (2010) concur that adopting an ecosystems services approach could result in policy and decision-makers realising the win-win trade-offs that can exist between development and the triple bottom line. However, the lack of case studies of this approach in local-level decision-making in a South African context provide little reference. This could be as a result of EGS not being fully understood or explained to local level decision-makers. Municipalities in the most part have not adequately addressed the issues around EGS and decision-making and in the past decision-making often took place without consideration of EGS. This could be as a result of

limited human and financial capital to do so. Nel and Kotze (2009) suggest the reactionary focus of EIAs in South Africa has resulted in the evolution of new tools such as EMSs, EMFs and SEAs with some EMFs, such as the Msunduzi EMF starting to incorporate EGS approaches. Since the approval and adoption of the Msunduzi Municipality's EMF, the municipality has started to consider EGS in the development application process, however there is no formalised method to do this, with the EMF failing to deliver a practical EGS solution. Therefore this tool is applicable for the Msunduzi Municipality as it assists in integrating EGS thinking into the decision-making process in a systematic way. The Municipality perceives this tool as being used in the inception phase of projects or development applications and can help to identify what specialist input is needed or should be prioritised when considering specific development applications. This can be useful as it can reduce the resources needed to conduct an assessment of an application which can increase capacity elsewhere and inevitably save the Municipality money. This tool's applicability is apparent when considering the strengths of addressing EGS issues in the decision-making process.

The ESP report (Institute of Natural Resources, 2009) suggested several 'ways forward' to ensure that EGS based approach becomes apparent in environmental decision-making within the Msunduzi Municipality. This tool provides potential solutions to achieve some of these recommendations: (i) including stakeholders and government departments while assessing the priority EGS in phase two of the tool, will result in increased support from decision-makers and Municipal manager. A stronger approach to quantifying EGS to managers can result in better management plans for integrating EGS into policy; (ii) the tool can highlight potential partnerships that can be created with local communities so that the incentives and benefits are fairly distributed, at the same time this will encourage better understanding of EGS; (iii) this tool requires the user in phase one to assess all information and data that is available from existing environmental and planning tools and take into consideration broader conservation programmes and initiatives. This includes better integration across municipal, district and provincial boundaries as the functioning EGS will have trans-boundary implications (Nel and Du Plessis, 2004; du Plessis, 2008). These recommendations are enhanced through the tool's utilisation of the SEA document.

The Msunduzi Municipality's SEA (SRK Consulting, 2010b) identifies limits of acceptable change to sustainability targets and indicators and provides strategies to attain these sustainability criteria. One of the key recommendations in the SEA is to implement a program to identify and rehabilitate

degraded ecosystems to increase EGS productivity. The SEA provides recommendations to consider socio-economic factors such as identifying communities that are at risk from environmental factors and to develop market and incentive based strategies to promote sustainability. This tool provides the link between development applications, EGS and sustainability as it includes the SEA's criteria in phase four. This is a pivotal step in the EGS assessment process as it allows for the Municipality to connect drivers of EGS productivity change as a result of development, to risks and opportunities to meeting the sustainability criteria as outlined in the SEA. This tool allows for the breaking down of environmental and land use decisions support tools by integrating input from the EMF, ESP, SDF and SEA at various phases in the tool (Cowling *et al.*, 2008). Therefore, the final outcome of using this tool will result in strategies for the municipality that take into account EGS, the greater EMF project and the triple bottom line. The tool, if applied, will result in the Municipality implementing practical IEM solutions as it provides an integrated and cooperative approach to environmental governance, while trying to achieve sustainable development in a holistic manner (Kotzé, 2006; Malan, 2009; Nel and Kotze, 2009).

The greater EMF project resulted in the development of a Strategic Environmental Management Plan (SEMP). One of the action plan recommendations in the SEMP is that the Municipality develops strategic objectives to ensure that EGS assessment is included in development planning as to ensure that the economic cost of EGS loss can be accounted for. This is needed to ensure the efficient and sustainable use of the Municipality's natural resources and to highlight the interconnectedness of the environment, economic growth and social progress. To achieve this, the SEMP identifies tasks in the action plan so that EGS can be incorporated in the development decision-making process. These tasks include: (i) the identification of EGS within the Municipality; (ii) the identification of priority EGS as identified in the ESP; (iii) identify methods for valuation of EGS and which method should be preferred; (iv) the collection of information that relates to EGS such as spatial, function and monetary data; (v) undertake a valuation of EGS within the Municipality; and (vi) the development of a scorecard that will rate the impacts to EGS based on individual development projects. There is scope to include a seventh task which includes evaluating and monitoring of these tasks. The adapted tool presented in this research provides the solution for four of the six tasks that are required. The tool identifies EGS that are present within the Municipality, identifies priority EGS based not only on the ESP but also the EMF and SDF, requires the user of the tool to collect information that relates to EGS and allows for impacts to

EGS based on individual development projects to be assessed and compared. The use of this adapted tool allows the Municipality to be more strategic and incorporate EGS into development planning. Due to the fact that local governments are the most pivotal in providing services to communities, applying this tool will improve the relationships and contact with these communities. It can enhance the Municipality's capacity to implement, execute and perform core functions and responsibilities such as basic service provision, waste and sanitation services, infrastructure maintenance and development, and parks and recreation provisions, ultimately resulting in effective environmental governance (Sowman and Brown, 2006; du Plessis, 2009; Muller, 2009).

Using this tool can add value to the decision-making procedure as it allows for EGS to be considered as an issue in the development assessment process (Audouin and Hattingh, 2008). It can identify issues that may be found on-site and is a mechanism that requires the user to think in a more holistic manner. The tool can help with comprehension of EGS by requiring the user to think of the bigger picture when looking at site issues and assists in focusing attention on relevant priorities. This can aid in determining priority constraints that may not have featured if an EGS approach was not taken. By highlighting a wide range of potential EGS attributes non-traditional constraints to development and often overseen environmental aspects such as medicinal plant harvesting or informal cattle grazing can be considered. A focused and systematic approach to addressing EGS issues and a standardised layout allows for the tool to be applied equally through differing sites and development scenarios. This can reduce potential bias in assessments for when assessment would only focus on the assessor's strengths such as water quality, but neglect their shortfalls or fields that they are not as strong in, such as social issues. Another aspect of this tool is that each phase's outputs can be used as stand-alone outcomes, for example phase two of the tool highlights what specialist studies need to be undertaken while providing input into phase three. While there are numerous strengths of this tool, there are, however, shortfalls and weaknesses that need to be identified and discussed.

While the TEEB study (2010a) has resulted in increased awareness and exposure to incorporating EGS into decision-making this is still a relatively new concept in South Africa. This tool attempts to bridge that gap of policy implementation as highlighted by Daily *et al.* (2009) and Fish (2011). However, the operational application of this tool in the Msunduzi Municipality will be in a qualitative sense, until capacity is increased to allow for modelling, ground truthing and economic

calculations. This can result in the findings from the tool being undermined and lack credibility. While this tool does try to incorporate previous quantitative research it is still not an exact science, as it is reliant on user experience if there is no scientific data, however the alternative of not taking EGS into consideration should not be an option when reviewing development applications or making strategic decisions regarding open spaces. Another weakness as pointed out by Daily and Matson (2008) is that this tool can provide problems due to the lack of understanding of EGS by users or assessors which can result in skewed results. This can be further exacerbated if training of the tool is not undertaken by users or experts are not consulted. There is an element of personal bias as each user will have their own reasons for placing a higher value on different aspects of EGS which relates to the problems identified by Turpie (2009) when quantifying EGS. This bias can result in the situation stressed by Turner *et al.* (2003), Salles (2011) and Seppelt *et al.* (2011) where an ecosystem is undervalued and lost due to the poor understanding of the intrinsic or social value of EGS. Consulting experts in a trans-disciplinary manner is an important aspect when applying this tool as it attempts to reduce these potential biases. Input from different spheres of interest and influence will allow for the user of the tool to identify issues that may otherwise be overlooked.

The quality and the quantity of spatial data can become a hindrance if it is not accurate and easily available. Daily and Matson (2008) suggest that spatial data that only provides broad strategic level outputs or has not been ground truthed will distort results and may increase bias. Therefore site specific data is a requirement if the tool is to provide useful input into the decision-making process. The Msunduzi Municipality is fortunate as it has access to municipal level spatial data, however, site level data still needs to be developed to properly inform the tool. This can be achieved by conducting ground truthing exercises that can provide a baseline from which the tool can utilize. The tool does not attempt to provide a quantitative output such as a score, figure, value, ranking or rating and therefore does not provide a 'bottom line' value that will allow one site to be compared to another. However, the tool can be used in a strategic sense by applying different development or conservation scenarios in the first phase of the tool. This allows different site specific scenarios to be compared to one another and assists in more strategic decision-making. While the tool cannot integrate all aspects of sustainability and the links between the environment, society and the economy, the user has to identify these links when assessing the priority EGS, in the context of the NFSD (Figure 2.1) (DEAT, 2008)

The application of this tool will allow the Municipality to take a sustainability science driven approach to decision-making. It promotes the co-production of knowledge ideal of sustainability science as promoted by Komiyama and Takeuchi (2006) by providing a trans-disciplinary approach, where the gaps between the knowledge makers (researchers and consultants) and knowledge takers (decision-makers and general public) can be broken down and a more holistic decision can be made, something which is stressed in the MA framework (2005b). This tool allows for knowledge to be created for end-user utilization and establishes a dialogue between the knowledge makers and knowledge takers. Requirements that were recommended by Lawrence and Depres (2004) are met by the implementation of this tool in decision-making, in that complexity is acknowledged, fragmentation and isolation of knowledge is avoided and the knowledge is exchanged between researchers, decision-makers and society. This promotes more informed decision-making that is been due to the trans-disciplinary nature of this tool and by incorporating sustainability principles and work that has been undertaken in the Municipality, can improve the effectiveness of knowledge generation and sharing.

This adapted tool promotes Audouin and Hattingh's (2008) principles of enhancing environmental assessment and decision-making by adopting a trans-disciplinary approach. The tool redefines developmental impacts by going beyond the norm of understanding the needs and welfare of society through an ecosystem services perspective. By using the tool in an environmental decision-making process the findings can aid in addressing the unique relationships that exist in South Africa, especially a local government arguably has the closest relationship and contact with communities and therefore has an essential role in implementing policies that are aimed at social and economic upliftment (Kotzé, 2006). Opportunities and risks to increasing welfare, wellbeing and quality of life can be identified through the consideration of the interlinked ecological-societal relationships. If the Msunduzi Municipality were to use this tool, then the six benefits of an EGS approach for municipalities as identified by Robrecht and Lorena (2010a) in the TEEB study could be realised: (i) there would be improved quality of life and wellbeing for communities as development would take into consideration ecosystem services; (ii) there would be a reduction in public spending on environmental assessments as a clearer terms of reference could be generated or previously hidden specialist studies could be identified at an early stage; (iii) a reduction in the potential investment needed into man-made water purification systems would occur as a result of

improved functionality of local water catchment; (iv) the city could create a competitive edge over other municipalities by attracting alternative investment or green economy focused investment and differentiating themselves from other municipalities by being recognised for their green initiatives; (v) the promotion of alternative livelihoods identified by using the tool can result in the reduction of poverty levels; (vi) by taking a pro-ecosystem services approach to development planning, protection from natural disasters can be achieved at lower costs than man-made interventions.

The ESR tool utilizes two solutions as suggested in the TEEB study for Local and Regional Policy Makers (TEEB, 2010a) to assist local governments and policy makers to effectively utilize ecosystem services for local development; (i) the tool uses existing environmental instruments; environmental assessment and public management tools such as strategic environmental assessments (SEA), environmental management frameworks (EMF) and spatial development frameworks (SDF) and can be used to inform local tax incentives and alternative livelihood strategies that have a direct impact on ecosystem services; and (ii) the tool is developed from local solutions through the implementation of new instruments such as the greater EMF project that can help to address biodiversity issues (TEEB, 2010a). This further enhances the application of IEM within the Municipality and results in more effective environmental governance (Nel and Kotze, 2009).

De Groot *et al.* (2010) note that local government managers are beginning to recognise that biodiversity conservation and development do not result in trade-offs but in fact can lead to economic, social and environmental benefits as a result of investments made into the sustainable use and restoration of ecosystems. As this tool requires input from a range of stakeholders, particularly in other local government departments, it can echo De Groot's sentiments. This will reaffirm Burns *et al.* (2006) trans-disciplinary model to advance sustainability in South Africa, that through successful cooperative governance, where there is involvement from political, corporate, research spheres, and the general public, sustainable development through sustainability will successfully transpire. This multi-dimensional and highly cooperative government is viewed as essential by Malan (2009) so that environmental management promotes sustainability and further enhances the ideals and principles of NEMA and the Constitution of South Africa.

This tool provides part of the solution for local government to move towards a developmental paradigm shift as suggested by Folke *et al.* (2002), Kates *et al.* (2005) and Dasgupta (2007) where meeting the needs of expanding economies, cities and populations can be achieved in a sustainable manner through the promotion of resource restoration and conservation. The tool replicates sustainability science's attempts to make the connection between the knowledge makers, takers and users to achieve growth and development in a sustainable method. Through using this tool it is possible for local government to understand the primary characteristics of the relationship between the natural environment, the economy and society. Kates *et al.* (2001) and Clark (2007) suggest that this will allow for more informed environmental decision-making that will play a key role in achieving the goals of sustainable development.

Chapter Seven Conclusions

The aim of this research was to develop a tool that would assist local level environmental decision-making to include ecosystem goods and services (EGS). This was achieved by adapting an existing tool that links changes in EGS to risk, opportunity and sustainability. This adapted tool, based on a corporate EGS assessment methodology, provides local level decision-makers with increased EGS awareness by understanding their dependence on EGS to provide life supporting services to the municipality's inhabitants. This tool links the impact of a loss or gain of EGS to risks and opportunities to meet sustainability criteria.

The review of past and current EGS research and approaches demonstrates the need to bridge the gap between EGS assessments and local level decision-making. It is through the adaptation of certain EGS assessment tools that EGS and their links to sustainability can be better understood and addressed in the decision-making process, particularly at a local level. It is evident, through studies such as The Economics of Ecosystems and Biodiversity (TEEB), that there is a growing trend in the incorporation of EGS assessments in the corporate and governance sectors, where big businesses are starting to take note of the research being undertaken by the World Economic Forum and the World Business Council for Sustainable Development on the dependence that companies have on EGS. This is evident in the number of global corporations undertaking EGS impact and dependency assessments to understand how changes in ecosystems can result in changes to their bottom line of business growth. This approach is reflected in the way in which governments view their dependence on EGS. However, at a local level there still needs to be a more direct way in which EGS assessments can be incorporated into local-level decision-making.

Bridging the gap between local level decision-making and EGS focused assessments provides more informed decision-making. The corporate response to the EGS dependence has developed various tools to assess their dependence, however, the tool developed by the World Research Institute, entitled the corporate Ecosystems Services Review (ESR) (Hanson *et al.*, 2008), provides an adaptable methodology framework to be utilized by local governments. For this research this tool was adapted to assist the Msunduzi Municipality to facilitate informed environmental decisions based on an improved understanding of the relationship between EGS dependence and impact.

Through the generation of a base-level list of EGS found within the Msunduzi Municipality, the local authority is able to assess how developments or land-use change will impact on these EGS.

This tool was adapted for and tested on two study sites within the Msunduzi Municipality case study to determine whether the tool could add value to the environmental decision-making process. Through incorporating existing IEM tools that exist for the Msunduzi Municipality such as the Environmental Management Framework (EMF) and the Environmental Services Plan (ESP), and spatial decision support tools such as the Spatial Development Framework (SDF), the tool highlighted site specific EGS issues that could arise as a result of land use change. The tool includes links to the sustainability criteria for the Municipality, developed through the Strategic Environment Assessment (SEA), thus identifying the implications for the sustainability objectives within the Municipality. These sustainability issues will link EGS to potential risks and opportunities that the Municipality may encounter as a result of land use change. Applying this tool to two study sites allowed the user, in this case the researcher, to determine how this tool would function if it were to be used by the assessor or decision-maker. This provided insights into the applicability, strengths and weaknesses of the tool.

The tool has the potential to assist the Municipality in the inception phase of development projects, when reviewing development applications or making strategic decisions. Applying the tool can point the Municipality towards specialist studies that need to be undertaken by identifying priority EGS issues. The tool allows assessors and decision-makers to follow a systematic approach through a standardised layout that will raise often unseen environmental and socio-economic aspects. While there are some weaknesses with this tool, such as bias by the assessors or the lack of site specific data, the tool will ultimately add value to the current environmental decision-making process.

The tool presented in this research allows Msunduzi Municipality to assess their dependence and impact to EGS provision to its inhabitants. The systematic approach when utilizing the tool allows for more interaction between the knowledge makers and knowledge takers that can result in decision-makers being presented with a more holistic approach to EGS assessment. This can allow decision-makers to make more informed decisions as they will be aware of the risks and opportunities to achieve sustainable development as a result of EGS change. This will ensure that

the needs and wants of society will be met through a new form of economic growth, one which encourages the productivity of our ecosystems and incorporates the conservation, preservation and restoration of our natural resources.

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Appendices

Appendix 1

This is the questionnaire used to understand the strengths, weaknesses and applicability of the adapted ESR model for the Mtsiwe Municipality. These five questions formed the guiding questions that were used in a snowball style interview with the Municipal Environmental Department. The final three questions were unpacked in more detail during the interview with the aim of comprehensively understanding the Department's views on the tool.

- 1) How do you feel Ecosystems Goods and Service (EGS) assessments have been utilized in past environmental decision-making?
- 2) Have you used EGS based assessments before to help with environmental decision-making? If so, how was it used?
- 3) Do you feel that this adapted Environmental Services Review (ESR) tool will add value to your decision-making process? If so where/when do you feel it will be most applicable?
- 4) What do you feel are the strengths of this tool?
- 5) What do you feel are the weaknesses of this tool?

Appendix 2

These set of questions were used as base questions to generate discussion when conducting interviews with non-municipal stakeholders and experts. These interviews were conducted in a semi-structured snowball interview style where at any stage of the interview other questions were asked as a result of the discussion generated.

- 1) What is your opinion of role of EGS can play in local government decision-making. How has EGS been incorporated in the past and where do you see it being used in the future?
- 2) What EGS tools have you used before and what were the positives and negatives of using a tool for EGS assessment?
- 3) What other approaches have you taken for EGS assessment? Why did you find that these approaches worked better than a tool?
- 4) Do you feel the adapted ESR tool has scope to become a useful resource for local governments to be more inclusive of EGS in decision-making?
- 5) How do you perceive environmental considerations are taken into account when economic and social policy is being discussed?
- 6) Do you see EGS informing economic policy, if so how?
- 7) Can an EGS based approach provide solutions to South Africa's challenges of job creation, poverty alleviation, and economic growth? How and where best should EGS assessments be utilized to assist in addressing these challenges?