

UNIVERSITY OF CAPE TOWN

A Natural Resource and Landscape Management Framework for the Bergrivier Municipality

Master of City and Regional Planning Dissertation

By: Aa-ishah Petersen, October 2013

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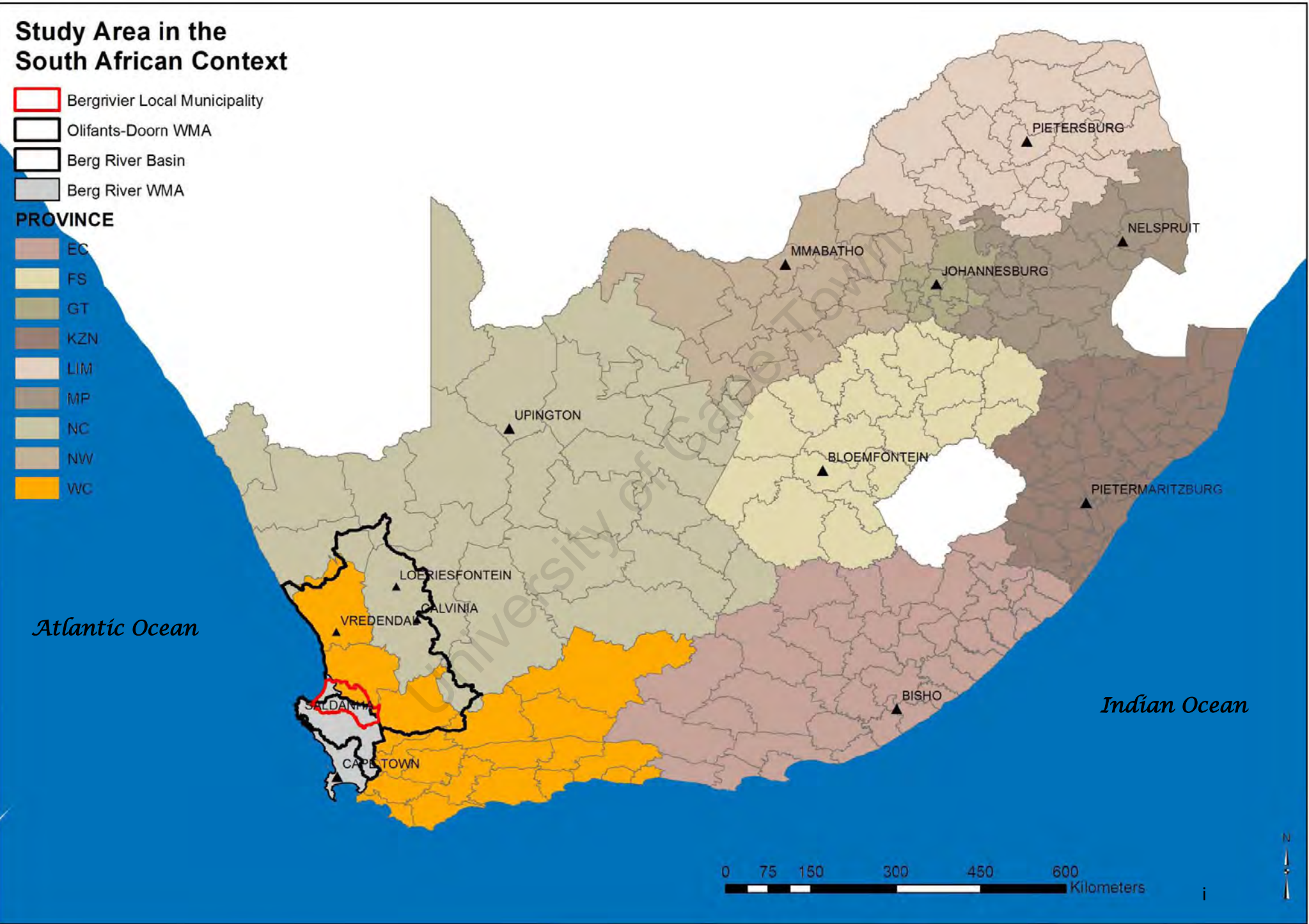
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Study Area in the South African Context

-  Bergrivier Local Municipality
-  Olifants-Doorn WMA
-  Berg River Basin
-  Berg River WMA

PROVINCE

-  EC
-  FS
-  GT
-  KZN
-  LIM
-  MP
-  NC
-  NW
-  WC



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A Natural Resource and Landscape Management Framework for the Bergrivier Municipality

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Abstract

Natural resource management formed out of a century long process within regional planning. Early authors such as Mumford, Geddes and Leopold have contributed to this evolution. These early proponents of sustainable natural resource management promoted the relationship between the natural world and human beings. They believed that people were on a negative development path; one that would cause great difficulties in future.

Today we see the great negative impacts on the natural environment. Human beings have caused large scale destruction of ecological infrastructure and degradation of land, soils, water and the relationship between people and the natural world. Drawing on past regional theory, this Natural Resource and Landscape Management Framework investigates ways in which to improve the relationship between people and the environment. It does this by employing a Bioregional Framework to investigate the Bergrivier Municipality in the Western Cape, South Africa. This framework investigates the region within its natural context and finds several negative anthropogenic impacts such as low water quality, institutional problems such as low municipal capacity and several positive points to arise, such as the various culturally significant sites and artefacts.

The outcomes informed the framework development, a set of spatialised strategies that aim to improve the natural setting of the Bergrivier Municipality and its functioning within the region. The Bioregional Approach provided a holistic framework from which to analyse the study region and sets the stage for well-rounded, considerate policy production.

Definitions

Catchment Synonymous to basin or watershed, Catchment in relation to watercourse or watercourses or part of a watercourse, means the area from which any rainfall will drain into the watercourses or part of a watercourse through surface flow to a common point or points.[Source: National Water Act (Act No. 36 of 1998)] (www.dwaf.gov.za, 2011)

Ecological planning The “wise and sustained use of the landscape in accommodating human needs” (Ndubisi, 2002: 4).

Landscape Landscape in this project is defined as the natural (above and below the surface) and cultural elements on earth (Ndubisi, 2002).

Fynbos Biome The Fynbos and Renosterveld vegetation types (Low and Rebelo, 1996).

Cape Floristic Region or Cape Floral Kingdom

The geographic location of the fynbos biome, this region includes other plant species such as forest, thicket, Nama Karoo and Succulent Karoo (Low and Rebelo, 1996).

Abbreviations

BM Bergrivier Municipality

CBA Critical Biodiversity Area

CSAG Climate Change Analysis Group

DWA Department of Water Affairs, formerly called the Department of Water Affairs and Forestry (DWAF)

EIA Environmental Impact Assessment

GIS Geographical Information Systems

IDP Integrated Development Plan

NGI National Geospatial Information, Department of Rural Development and Land Reform

NPAT South African Environmental Potential Atlas

NRLMF Natural Resource and Landscape Management Framework

NWRS National Water Resources Strategy
PSDF Provincial Spatial Development Framework
SANBI South African Biodiversity Institute
SDF Spatial Development Framework
SWOT Strengths Weaknesses Opportunities and Threats
TMG Table Mountain Group
WMA Water Management Area

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Chapter 1

Introduction

Today human beings suffer impacts of vast environmental degradation and have ironically placed themselves in it. The Earth's natural resources, processes and products are the essential inputs to the various processes that have greatly contributed to the massive economic and technological advances. Ironically the vast majority of these "human-made" products are in fact contributing to the destruction of its raw materials- the Earth's natural processes and products. Currently the Earth suffers enormous pressures, to its detriment, to sustain human life. The effects can be seen at a global and local scale.

During the last century many authors of various disciplines have written about the many facets to the natural environment, resulting in increased awareness of environmental issues today. Authors such as Leopold, Mumford, Geddes and MacKaye wrote about the relationships between people and the natural surroundings indicating the need for the natural world. The relationship between people and the natural environment has changed over time, from conqueror to reliant inhabitant (Leopold, 1966). People were unable to see how "conquering" the world has never benefited humans, as this thinking is firmly grounded in the subjectivity of people (Leopold, 1966).

The conquering way of man can potentially be attributed to two "cultural foundations" which currently hamper the potential success of planning and environmental management. Leopold (1966) describes that the current Judeo-Christian religions of the world convey human beings as being superior to nature, allowing people to use the natural environment to their desires as they feel entitled to it (Jepson, 2004). The second cultural foundation is that of "empiricist tradition," this allows people to view the natural world as a machine, allowing people to feel entitled to manipulating and changing it (Jepson, 2004). These cultural foundations are still evident in the way people use nature (as capital and objects). The vast impacts of this view of the natural world is due to anthropogenic lack of restraints and reverence for the natural environment causing massive environmental degradation and the lack of consideration for the natural world, we witness today. This negative relationship

results in the “under-valuing” of the natural environment which in itself leads to the destruction and lack of consideration of nature. In 1966, Leopold spoke about the lack of human ethics toward the natural environment, this still exists in varying forms today and is making way for unrestricted freedom to weaken the chance of the existence of the natural environment.

Since 1960 the global use of natural resources has increased dramatically and presents a doubling in natural resource demand since then (WWF, 2010). The incredible amount of pressure on the Earth as the life support system today has resulted in large tracts of land required for food production and settlement development, resulting in loss of natural habitat for plants and animals and loss of biodiversity. Major technological advancements in transportation have resulted in large scale air pollution and large scale resource extraction, threatening future energy sources. These are but a few global issues faced today. Through the many debates that have taken place about the current global environmental problem, the verdict remains, current environmental issues are as a result of anthropogenic action (Le Maitre, 2007). Le Maitre et al (2007) describes how humans are directly and indirectly contributing to a decline in the quantity and quality of these resources,” originating within society (Le Maitre, 2007: 367).

With the current negative environmental state there have been positive social and economic outcomes such as economic growth, global movements of people and resources (Kinzig et al., 2000). Unfortunately even these positive outcomes have only benefited a portion of the world’s population; others have suffered great losses and continue to struggle for survival. It is without a doubt that social and economic success depends on the well-being of the natural environment. The relationship between people and the natural world should therefore change in order to accommodate for a better future.

Many attempts in recent history have looked to mitigating the anthropogenic impacts on the natural world. Authors of the past wrote from a variety of disciplines: ecology, anthropology, sociology, geography and planning, contributing to planning theories. Over time these writings moved from a holistic natural resource management perspective to a more economic perspective. Until approximately the 1960’s in which books such as *Silent Spring* by Rachel Carsons contributed to the awakening of the world to the decreasing

environmental integrity, globally. The inequitable distribution of resources was noted as a great tragedy to natural resource management and new attempts such as neo-regionalism were made to aid both the natural environment and social inequalities. Frameworks and policies were devised in attempts to best plan for the natural resources globally, plans were inspired by the older writers such as Geddes, Mackaye and Mumford. Upon focussing on saving the integrity of the natural environment the integrity of future resources and populations will also survive, this was an idea identified many years earlier, but only took the needed form after the 1960's.

Globally, the need for environmental planning is clearly understood, almost all countries have environmental policies in place to guide and manage the relationship between people and the natural environment. South Africa has strong environmental legislation in the form of the National Environmental Management Act (No. 107 of 1998) and the associated Coastal Management, Biodiversity and Waste Acts.

Project Description

This dissertation aims to broadly investigate various natural resource management methods over the last century in an attempt to develop a natural resources and landscape management framework. The focus is on sustainable natural resource use but in order to attain a holistic approach the management of the landscape is also investigated. The study area is the Bergrivier Municipality in the West Coast Municipality, Western Cape, South Africa. The project uses the Bioregional Approach, developed in the neo-regionalist period as a holistic framework to sustainable, regional planning. The goal is to base the entire functioning of the Municipality on maintaining ecological integrity. It attempts to do this by re-focussing attention from socio-economic prosperity to environmental protection, enhancement and restoration. The Municipality is a coastal region characterised by agriculture and low socio-economic profiles which emphasises the importance of the natural environment and its resources to this region. (Bergrivier Municipality, 2008; 2012). It also boasts a number of significant environmental resources such as the Berg River Estuary, a coastal zone, vibrant wetlands and a rich array of endemic biodiversity (Bergrivier Municipality, 2011/2012).

The analysis of this region will incorporate an investigation into the river basins that falls within the Municipality's boundaries, this will be dealt with as the Berg River Basin and the Olifants-Doorn Water Management Area. The analysis will attempt to extract the various environmental concerns in the Municipality and examine these within the context of the surrounding water basins. Issues such as climate change will also be studied as this can have a profound impact on the region. Climate change impacts are often felt more directly by regions whose socio-economic prosperity involves primary economic activities, the Municipality is therefore specifically vulnerable. Its dependence on primary economic activities and the high economic and social vulnerability of its people makes for potentially serious social and economic problems in the future. (Bergrivier Municipality, 2008; 2012).

The context of the Municipality provides an interesting base for a project of this nature. It contains a number of risks that can be solved, in the long term, by a focus on environmental issues. The region also provides an ideal setting for attempting to change the nature of the relationship between people and the natural environment as the dependence of people on the natural environment is clear.

The result of this Natural Resource and Landscape Management Framework is a spatialised, strategic, policy document that could help the Municipality guide management of natural systems and improve the connection between the social, economic and natural systems. A natural resource and landscape management framework guides the use of natural resources and the anthropogenic actions between the natural environment and people. It can thus potentially serve as an enhancement to the municipal Spatial Development Framework. This framework can serve as an environmental management plan for all the natural resources in the Municipality. This Framework is informed by a Bioregional Planning approach and incorporates a landscape character assessment and basic material flow analysis in order to form an holistic approach to environmental and resource management.

Guiding Values

Environmental

Triple Bottom Line

The relationship between humans and the natural world has developed into an almost purely economic relationship (Leopold, 1966). People take what they want and further themselves socially and economically. Since approximately the late 1960's current environmental issues have risen to the fore (Elkington, 2004). Three main "waves of public pressure" influenced the present day environmental agenda, according to Elkington (2004: 7)¹. Sustainable development has thus come in to the arena of environmental protection and has become an imperative for humanity. Sustainable development is ensuring natural resources for future generation by efficiently managing the current natural resource base (United Nations, 1987). Sustainable development principles influenced the development of the "triple bottom line" approach (Elkington, 2004). This approach aims to include the importance of social and economic systems in an integrated means to attaining the goals of sustainable development (Elkington, 2004).

In a country like South Africa, the "triple bottom line" approach is the underlying theme of environment management; it calls for the sustainable management of the environment, social and economic systems, in all developments (NEMA, No, 107 of 1998). This approach has been adapted and places the environmental system at the root of all development, prioritising the natural world over the social and economic, producing a concentric (nested) triple bottom line approach (Department of Environmental Affairs and Tourism, 2006) (see Figure 1.1).

¹ The first is a wave of protective environmental legislation. The second was the recognition of the need for sustainable development, causing many businesses to partake in sustainable development practices. The third wave recognised the need for change in global business processes and corporate governance (Elkington, 2004).



Interlocking circles model



Concentric circles model

Figure 1.1: A conceptual representation of sustainable development (Source: Department of Environmental Affairs and Tourism, 2006). The diagram on the left is the older version of the triple bottom line approach and the one on the right is the concentric triple bottom line which bases action on the environmental sustainability.

The Land Ethic

For the global environmental issues to be resolved, the process needs to start at a very individual level. People need to value the natural environment and in order for this to happen they need to see themselves as part of the natural environment, they need to have a land ethic.

A land ethic is based on the human consideration of the natural environment, but goes further than just an “ecological conscience” (Leopold, 1966). The land ethic speaks to the relationship between people and the natural environment; it denounces the “conquering” way of people and promotes the idea of the land community (Leopold, 1966). The land community is the idea that human beings, animal, soils, water and vegetation (as well as all other natural elements) are from one community (Leopold, 1966).

Planning

Spatial planning provides an adequate arena for tackling environmental issues. Spatial planning “entails the deliberate organisation of society and space,” with the intention of providing an outcome better than what already exists” (Winkler, 2012). It also incorporates the role of the markets, the state and society (Winkler, 2012). The strategic nature of spatial planning allows one to plan high level interventions in various settlement aspects. In recent years it has been acknowledged as an ideal setting for implementing ideals of natural resource and environmental management (Eggenberger and Partidario, 2000). Its interdisciplinary nature also allows for the accurate implementation of the nested triple bottom line approach which considers the social and economic systems within the context of the natural (environmental) system.

The field of regional planning has played a significant role in terms of natural resource management, regional planning has evolved out of holistic approach to understanding the role of the natural environment and the reliance of people in the natural world. Doctrines such as the Comprehensive River Basin Development, Polarized Development and Neo-regionalism are examples of the roots of natural resources management in regional planning. In using planning and environmental values, the links between planning and environmental management can be further enhanced. Spatial planning also presents environmental planning with an established policy and legislative platform to base environmental concerns within. This at times is what is required in order for government to consider environmental goals

Research Objectives

The end goal of this dissertation is to produce a spatialised framework that is based on the key environmental issues of the Bergvriër Municipality. The spatial plan allocates certain roles to land pockets as a means of ensuring ecological integrity and thus environmental

sustainability of the region. These land pockets are assimilated based on their biophysical characteristics. The analysis of the region is based on six systems analyses that examine the biophysical features, the climatic features, the landscape character and the metabolic structure of the Municipality and the surrounding environments. The context in which the Municipality exists is important in terms of maintaining a healthy environmental flow throughout the larger region. It also enhances the understanding of the complex, large scale relationships between people and the natural environment.

The dissertation aims to highlight the key environmental issues in the Municipality and the linkages these have with the surrounding regions. It also aims to highlight the issue of administrative and natural borders, which proves to be quite complex in the case of the Bergrivier Municipality. Overall the dissertation hopes to highlight the linkages between the various biophysical systems and the way in which these link to form complex ecosystems on which humans depend. The framework hopes to protect the natural systems of the region by managing the anthropogenic impact and uses of the natural environment.

This dissertation asks:

How can we better structure the natural resources and landscapes of the Bergrivier Municipality in order to better manage the negative human impacts thereon and improve long term ecological security?

Research Method

Selecting a Guiding Theory

Devising a method for this project was guided by the researcher's values of maintaining or restoring a land ethic, through managing environmental integrity. The overall guiding theory was motivated by the inter-disciplinary, holistic nature of (regional) spatial planning as a holistic plan ensures ecological security (Brunckhorst, 2000). In providing a necessary theoretical base for this Municipal Natural Resource and Landscape Management Framework, a brief look to into recent regional planning doctrines is investigated. This brief investigation provided the researcher with an understanding of past efforts to implement

natural resource and landscape management. These relevant theories are further discussed in the literature review with the aim of guiding this project.

When searching for an appropriate theory to base this project in, prominent concerns such as the triple bottom line sustainability, climate change, climate change mitigation and adaptation, regional metabolisms were all factors that would need to be covered. The Bioregional Approach was chosen as it includes a complete assessment of the characteristics of a landscape. This includes the interaction between people and the landscape.

Brunckhorst (2000: 126) provides six tasks that are required to form a bioregional framework:

1. The first is the collection of multidisciplinary data and information, the data and information should cover a large range of topics from biophysical attributes to institutional, law, history, social and economic. This information should be spatialised in order to integrate them, neither should be prioritised to ensure the frameworks use in large range of resource issues. If there is data missing, an indicator may be used to replace it.
2. Secondly, gathering information based on social data and mapping this data. Investigating the way people view themselves in the region and how they feel about certain sites within the region is essential. It helps to provide the planner with an idea of what is important to the community and what they hope to achieve in the region. It also provides the planner with an idea of what needs to change and what needs to be improved.
3. A list of relevant institutional private and government stakeholders should be made. A list of institutions that impact the framework should be kept. These bodies will be able to provide vital information about the area and a project of this nature. They will also be partners in the implementation and management of the framework, they will be able to guide the project and clarify jurisdictional and institutional issues.
4. Throughout the project and the framework development, one should be cognisant of the fact that the framework is multidisciplinary, and that the information and data collected will be used for a range of different kinds of issues. Attempt different

methods of data and information analysis and try different approaches to trans-disciplinary and multi-disciplinary approaches.

5. Assess the possibility and ability of the relevant institutions to integrate processes and institutions. This should result in a more coherent management team and a more efficient and productive project.
6. Promote changes to the relevant social and institutional systems in order for the framework to be successful.

The idea is to create an inventory of data and information and then analyse it and understand the role of the entire bioregion and the various important natural and cultural sites and services within it. In this framework, the inventory is based on six systems analyses: water systems, land systems, climate systems, biodiversity, landscape character and material flow analysis. It is used to identify cross-cutting issues that impact the region both positively and negatively. The six analyses sections are further enhanced by a landscape character assessment and a basic material flow analysis (see Chapter 3).

The Case Study Research Method

In devising the structure of this project, a case study research strategy was deemed most appropriate as it works well with individual unit analyses (Flyvbjerg, 2011). An individual unit is the unit being investigated, it could be spatial, temporal, a community or an event. Case study research also allows detailed contextual analysis of the relationships between systems within the individual and is adequate in investigating change, relations, processes and performance (Yin, 2009). This project is an explanatory case study as it asks how and why certain issues and patterns exist within the study region (Yin, 2009). It also asks how the situation can be better managed and prompts the researcher to investigate why this has to be done.

A case study method is sufficient for the investigation of the Municipality, as it is ideal in investigating current issues. A strength of case study research is that it includes a variety of data sources such as a variety of documents, interviews and observations (Yin, 2009). Some weaknesses of case study research lie in the lack of rigour of the research (Yin, 2009). It does not have many procedures to follow in order for research to qualify as case study research;

it therefore leaves gaps open for the researcher's bias to crop in or "sloppiness" (Yin, 2009: 18). This bias can be overcome, to some extent, by basing the strategies and plans on the outcomes of the analysis phase. This will ensure that the real problems are acknowledged, not just the issues identified as important by the researcher. However, this bias cannot be completely overcome as this project's outcomes will be (partly) based on the researcher's values.²

A second critique of case study research is that it cannot be used to generalize from (Yin, 2009). The same can be said for scientific experiments, experiments are only generalized from a large number of the same experiment which produce the same result (Yin, 2009). This can be done with multiple case study research, however single case study research such as this project, is not performed with the aim of generalization. It is performed to add to current theories and understandings. Single case study research, like experiments are "generalizable" to theoretical proposals and not to populations or universes (Yin, 2009). A third critique of case study is that it produces large documents that remain unread (Yin, 2009). This can be attributed to more specific techniques used in many case studies, such as ethnography and narratives; these techniques are not necessary in all case studies and are not used in this project (Yin, 2009).

The technical characteristics of the case study research strategy will play an important role in guiding this project. It allows for contextual analysis of the unit in study (avoiding the isolation of the unit), a task not encompassed by many other research methods. It also makes use of a large array of information which aids in triangulating the researcher's findings (Yin, 2009). And lastly it acknowledges previous theory and allows it to guide the researcher (Yin, 2009). All these characteristics will be incorporated in this project. The contextual analysis of the Municipality's natural environment will be analysed in the context of the river basins present. The large variety of information types will allow checking information accuracy. And lastly, the literature review allows relevant theories to guide this project and ensure it remains relevant to the realm of current knowledge.

² The key issues are based on the researcher's values, the analysis of the six systems and the literature review.

Project Outcomes



Figure: 1.2 The project process, the method is based in the case study research strategy and follows the guides of Bioregional Planning (source: author's own).

This project aims to produce a spatial plan that guides the objectives and strategies for the Natural Resource and Land Management Framework of the Bergvriër Municipality. It will be informed by three main components: the researcher's values, the literature review, and the analysis of issues in the region. This will incorporate relevant precedent and standards to aid the framework.

The analysis of the region will be based on six main investigation themes: biodiversity systems (fauna and flora), climate and local weather systems, land systems (soils, vegetation and geology), water systems, material flow assessment and landscape character assessment (heritage and cultural impacts). The context of the Municipality is deeply considered in this

project, the six themes above will be analysed at two scales, at the catchment scale and at the Municipal scale. These six themes will together form a holistic picture of the state of the Bergrivier Municipality's natural environment. A synthesis phase will take place in which the issues and opportunities in the region are identified, these will inform the spatial framework. The spatial plan aims to achieve specific objectives and strategies which are based on the key problem and potential areas.

The framework informs the implementation plan which comprises projects and project stakeholders. It must be remembered that most of the issues will be environmental as this is the focus of the project. However the selection of strategies form a starting point for future social and economic sustainable development. If ecological integrity is managed and maintained, it forms an efficient and strong basis for the economic and social development as the basis of social and economic functioning (the natural environment) is protected.

Document Structure

The structure of this dissertation aims to systematically build onto the understanding of natural resources management. It starts with a brief contextual analysis of resource management in regional planning theory (Chapter 2). It goes on to analyse the Bergrivier Municipality in the context of its constituent river basins (Chapter 3). The key environmental issues are then drawn out and spatialised for the Municipality (Chapter 3). The framework development phase then produces objectives and strategies for the future sustainable use of the Municipality's land. This is done according to a zoning systems devised by the researcher which is spatialised for ease of use (Chapter 4).

Conclusion

By use of the case study method, this dissertation looks to contextualise the environmental issues of the Bergrivier Municipality within the broader region. It also aims to assess the local, natural environmental and attempts to advise for a more sustainable region, environmentally and more subtly socially and economically. It attempts to do this by using the multi-disciplinary approach of Bioregional Planning and making use of relevant literary fields such as natural resource management, sustainable development and climate change

and adaptation. The outcome of this dissertation is a spatial plan that guides a set of objectives and strategies. With an in depth assessment of the region as this dissertation hopes to complete, the goal is that the intricate, dependent relationships between social and economic systems on environmental systems are acknowledged, understood and related to planning and that an ethic toward the natural environment becomes an inherent part of the region.

Image Source: Author's own



Chapter 2

Literature Review

Regional planning is a broad field encompassing a range of “region-related” topics such as natural resource management, ecological planning and regional economics. With the developments of regional planning in the last, approximate century, the cognisance of planners to natural resource (or environmental) issues has increased significantly. This chapter describes the major trends in regional planning that relate to the natural environment. It discusses the developments of various natural resource thinking and the associated methods, plans and programmes that sought to integrate the natural environment into the realm of regional planning. With this, it also aims to better understand the linkages between natural resources to regional development and planning as well as explore the ideas around the management of natural resources. The goal of this chapter is to produce a thought basis for this project, as well as an understanding of the various approaches to natural resource and landscape planning. The outcome of this chapter is a critical examination of Bioregional Planning as an appropriate approach to developing a Natural Resources and Landscape Management Framework.

From Holistic to Economic Planning

Just after the turn of the century, planning was viewed as a holistic practice, one that would promote closer relationships between people and the natural world (Friedmann and Weaver, 1979). Authors such as Mumford and Odum recognised the needed limits to human intervention on natural systems, they recognised the disconnect that cities brought and called for limits to the “cancerous growth of cities” (Friedmann and Weaver, 1979). Planning was promoted as a field that understands and recognises the intrinsic value of the ecological and aesthetic value of nature and using this to better the landscape for “human use and enjoyment” (Ndubisi, 2002). This era brought about an understanding of the need to understand the complex relationships between people and their surroundings. This was done by various authors from a plethora of academic fields such as philosophy,

anthropology, geography, sociology and ecology. The mix of interested academics provided an integrated starting point to natural resource thinking

Patrick Geddes, one of the prominent writers of this era, used a systems approach in his assessments and evaluations of the landscape (Ndubisi, 2002). He recognised the complexities of the natural world and the complex relationship between people and the environment, incorporating this view into planning would improve the ability to plan settlements. Another author of this era, Benton Mackaye presented planning in an ecological light, he described (regional) planning as “applied human ecology” (Ndubisi, 2002: 19). However, Geddes was the first to suggest a regional scale of analysis for large-scale planning, before this, much of the planning field concentrated on city or urban scale planning. With this scale he also suggested an integrated analysis method which involved “folk, work, place” (Ndubisi, 2002: 14). A critique of this planning method was the loss of context. Mumford criticized the regional planning during this time, he went onto suggest planning as a field in which a place is analysed in its context (using Geddes’ “folk, work, place”), and that in this place and time, planning should “co-ordinate human activities” (Ndubisi, 2002).

The regional scale in this era was important; it showed the recognition of larger scale environments and recognition of the linkages of local environments to seemingly external environments. Regionalism started to ask more refining questions around what actually constitutes a region, a watershed, a catchment, or political boundaries. The questions around what constituted the external and internal was however still unclear as the defined boundaries for regions had not been resolved (Ndubisi, 2002). As regional planning changed, deeper understandings of ecology was warranted and the focus of regional planning changed from the need to understand the value of nature to wanting to know how to adequately deal with it in order to better guide human landscape and natural resource use (Ndubisi, 2002). This kind of holistic thinking would soon be lost to a more economic development related thinking but returns in time.

River Basin Development

This era is marked by the Tennessee River Valley project which posed as an ideal example of the Doctrine of River Basin Development. This was an era in which regional balance was sought. The era is marked by attempts by Mumford, Geddes and Mackaye to develop a sense of balance within regions and to highlight the diversity among regions (regionalism) (Katzschner, 2013).

Mumford describes how the greed of people has undermined their relationship with nature; they did not place limitations to their assumed needs (Mumford, 1938). Mumford (1938: 306) then went on to base regionalism on three elements characterising regionalism as the following:

- Recognising that a region is a “basic configuration in human life”
- Accepting natural diversities, associations and uniformities
- Recognises the region as an important point of culture, economic activity and geography

Regionalism thus aimed for a more balanced development of local resources, the natural way of people is to be cultural and human, and due to mechanisation people have lost this in some form and have to therefore re introduce social order (Mumford, 1938). The social order should be based on the links humans have with its surroundings, the various systems that people fall within. He goes further to say that in order to recognise the people and the linked systems, people will have to accept the “disappearance of the boundary wall between the inner and the outer, internal and external environments” (Mumford, 1938: 303). Unfortunately the supporters of this goal of balanced, context specific regionalism went unheard and the idea was labelled as utopianism (Friedmann and Weaver, 1979). These ideas would however form the basis of Bioregionalism in years to come. At this time the USA, a country leading in regional thought and theory, was in an economic crisis and required an initiative to pull its people out of poverty.

The Tennessee Valley was the pivotal project which jolted the Comprehensive River Basin into popularity. This doctrine came as a means to deal with the vast social and economic crises due to the great depression (Friedmann and Weaver, 1979). This project, in its attempts to improve the socio-economic issues in the USA, was an example of Mumford’s “territorial vision” in that it used a natural area as a basis in which to ground people and link

people with the natural environment in terms of social and economic dependence. It however strayed from Mumford's vision as this project only became an economic means to a better economic end. It used the natural resource base of the Tennessee River Valley to improve the economic state of the country (Friedmann and Weaver, 1979).

The project aimed to use the river basin as a means to integrate natural resource development for the use of surrounding populations (Friedmann and Weaver, 1979). It was a territorial plan but unfortunately viewed this resource as a purely economic means to the development of the USA.

The Tennessee Valley project failed to successfully implement the regional component to the plan. The Tennessee River Valley project thus succeeded in being a model on how to use natural resources to stimulate economic development and expansion (Friedmann and Weaver, 1979). It also highlighted the future need for cultural, natural, economic and social resources (Ndubisi, 2002). This project, which influenced a thirty year period of similar, economic development project, focused on functional regionalism. Meaning the focus of the project was toward the role of the project and less on the context of the space within which the project is took place (not context specific, can take place anywhere).

The Second World War marks the approximate end of this era, after which many countries but the USA in particular looked for more sustainable means of maintaining their new found power and wealth. This means was found to be in large scale industrialization (Friedmann and Weaver, 1979).

Doctrine of Polarized, Unequal Development

Influenced by the period in regional planning in which planning focussed on balanced development, it rose out of the need to development economies and industry in the post war period, despite regional planning previously aiming toward reducing inequalities and poverty, this period focussed on economic, capitalist development (Katzschner, 2013 and Friedmann and Weaver, 1979). Influenced by the comprehensive river basin development doctrine, it attempted to integrate regional planning with economic development. It thus focussed less on needs and resource use and more on growing the economy (by industrialization). During this era regionalism adopted the modernization goals; regionalism

developed only certain areas, these areas received investment as they showed the greatest potential (Katzschner, 2013). Cities and urban areas were the main focus of this “polarized development” and thus rural areas were left lacking investment and development (Katzschner, 2013). The idea in terms of economic development was that the focus on core areas and the success thereof would trickle down to the surrounding less developed, rural areas (Watson, 2013).

The focus on industrialisation to increased wealth requires government who was moving toward an “all powerful national government” to shift the territorial focus to a national territorial integration (Friedmann and Weaver, 1979: 6). A significance of this doctrine is that development was geared toward increasing goods and service and not based on need (Friedmann and Weaver,, 1979). This could only negatively impact the natural environment as this would be the requirements for the increase in goods and services and the capitalist system.

The “trickle down” did not take place, poverty and inequality remained and “backward region” did not benefit from the investment in core regions (Friedmann and Weaver, 1979: 6).

Toward Bioregionalism

Doctrine of Neo-regionalism

This doctrine comprises major critiques of the polarised development doctrine, the results of the modernist era in planning and the inequalities and poverty these aided (Katzschner, 2013). After the Doctrine of Polarized Development Friedmann and Weaver (1979) provided a somewhat utopian development theory called Agropolitan development. This centred on a basic needs approach, it was initially proposed as a social movement aiming for self-reliance, which is perhaps an early form of sustainability thinking and even Bioregionalism. It was a holistic approach and set the stage for the current thinking in development planning. It was territorially based which meant it was context specific; also focussing on an imbalanced approach to planning, it aimed to improve issues of inequality and poverty (Friedmann and Weaver, 1979). It came about in response to the failure of polarized development. Regional planning started orientating itself around the redistribution of

resources and therefore looked to older, more holistic ideas to combat the inequitable distribution of resources and the unhealthy state of environmental affairs.

This doctrinal era started to look back to Geddes, MacKaye and Mumford for inspiration and closely aligned with many of their approaches. Propelled by books such as Rachel Carson's *Silent Spring* this doctrine brought great environmental awareness to the lay person, This "environmental awakening" spread into planning with planners now looking into issues of over population, inappropriate use of technology, landscape degradation and finite resources (Ndubisi, 2002); highlighting the importance of government and management in the development planning arena.

The influence of Multiple Use and the Ecosystems Approach

In an attempt to use natural resources more sustainably and decrease the "human abuse of the land" the Multiple Use and Sustainable Yield Act of 1960 was promulgated in the USA (Ndubisi, 2002). This was one of the first pieces of environmental legislation that promoted the protection of the natural environment and recreational use thereof (Multiple Use and Sustainable Yield Act of 1960). The various interpretations of multiple use brought a new understanding to conservation and natural resource management. These ideas of conservation and natural resource management closely aligned with definitions produced earlier in the twentieth century. These described conservation as the "the multiple and sustained use of natural resources" (Ndubisi, 2002: 13). The multiple uses were interpreted in a number of ways. The first involved detailed biophysical, social and economic aspects of the land in order to make appropriated and informed decisions. The second involved the marking of links and relationships between resources to understand resource capabilities (Ndubisi, 2002). McHarg, one of the most prolific ecological planning writers devised a land suitability method which detailed the various systems within a landscape and included the multiple use approach. McHarg's approach remained widely used as the method to decrease human abused landscapes (Ndubisi, 2002). The suitability approach however did not ask the question of how the impacts had occurred, for this a more holistic approach was called for, especially with the increasing inequitable distribution of the world's resources (Ndubisi, 2002).

The understanding of ecosystems brought in the systems analysis, in which systems and their linkages were analysed. With various new issues such as inequitable resource distribution, climate change and human-induced land degradation, various other frameworks were developed (Ndubisi, 2002). Newer frameworks included the dynamic nature of landscapes and ecosystems and considered the socio-cultural and economic aspects, such as The Applied Ecosystems Approach and The Applied Landscape-Ecology Approach and Landscape Ecology (Ndubisi, 2002). These frameworks proved to be more holistic, aiming for multiple use but also considering the root of the environmental problems. Ecosystem studies forces the researcher to view a system in its component parts and as a whole and the linkages in and between the systems (Ndubisi, 2002) it also forces people to identify themselves in the system, leading to the identification that people are part of nature and the environment. This then leads to the development of an environmental ethic and valuing of nature (Golley cited in Ndubisi, 2002).

The above doctrines paved the way for increased awareness of understanding the role of the natural environment in regional planning. It also caused interest and thus investigation into the relationship between people and the environment, it produced and contributes to the production of methodologies and techniques around environmental and development planning (Ndubisi, 2002). It also acknowledged older techniques such as the land-unit analysis or inventory, theories around Human Ecology (MacKaye), Human Ecological Planning (McHarg) influenced by Folk, Work, Place (Geddes). The theories around natural resources management evolved from philosophical writings to acquiring a physical space (regional) and an academic arena in which it is practiced (planning). Natural resource management thus has two important components to it, the desired human outcome (what is needed or wanted) and the limitations to what is required (understanding the limits and opportunities) (MacKaye cited in Ndubisi, 2002). It is essentially understanding the context of the natural environment and finding a balanced approach to pleasing the human desires and maintaining ecological integrity. Planning exists at this interface between people and their use of the Earth's resources and processes (Ndubisi, 2002). It is the link between knowledge (technical and scientific) and action (Friedmann, cited in Ndubisi, 2000); thus allowing the field of planning to be actively involved in decisions about the future, (in this

case, decisions about natural resource management and its links to human survival) (Ndubisi, 2002).

The above, brief history of regional, ecological planning describes a number of imperatives in choosing an ecological planning technique. Factors such as holism, multiple-nested systems, socio-cultural inclusions, and context and linkages between factors are all needed in for developing an ecological framework. Major themes such as the influence of people on the environment and the environment on the people should always be considered as well as the linkages between the bio-physical and bio-climatic elements in the landscape. These theories provided a base for bioregional planning, bioregional planning has many of the important, needed elements brought out of the past theories.

The Bioregional Approach

“We have a responsibility to each other and or descendants to ensure ecological security, now and in the future,” (Brunckhorst, 2000: 5).

Bioregionalism is not a recent idea, it has its base in a century of attempts to define socially-just and ecologically sustainable human cultures and traditions (Sale, 1985 cited in Aberley, 1999). It is holistic, with roots in ecosystems approach and can be traced to the earlier works of Mumford (Aberley, 1985 cited in Carr, 2004 and Bridgewater, 2002). The goal of bioregionalism is to produce a self-sustaining region, one in which the region produces all its basic needs (Carr, 2004). This idea is in direct opposition to the current capitalist and neo-liberalist system that the world is under, in which natural resources are exploited to serve transnational corporations and promote the capitalist agenda (Carr, 2004). Bioregionalism supports the relative comparative advantage of regions, in which regions produce and sell what it indigenous or ecologically healthy to produce (Carr, 2004). It acknowledges the differences among landscapes and the links between systems and links the local to the global (Carr, 2004). Bioregionalism thus supports a holistic understanding of a landscape and acknowledges the value of whole systems and its constituent systems (Carr, 2004).

Bioregionalism “evolved from a social critique to an alternative lifestyle” (Frenkel, 2002: 291) and has been adapted to serve development and spatial planning too. Bioregional planning is related to regional planning traditions (Aberley, 1999: 28). It contains the

elements of previous regional planning and natural resource ideals such as identifying the relationship between the natural environment and people, the links between the landscape and human ecology and incorporates the suitability approach. Bioregional planning, due to its basic principles, incorporated institutional integration, as well as, collaborative and multi-disciplinary approaches (Brunckhorst, 2000: 8). Bioregional planning can greatly add to the integration attempts in and among government institutions. This is needed in natural resource management.

Bioregionalism is a holistic approach to regional environmental management. It aims to provide ecological security by maintaining ecological integrity; natural capital and biodiversity (Brunckhorst, 2000: 5) (see Figure 2.1). Ecological integrity is “the health and resilience of natural life-support systems, including their capacity to assimilate wastes and endure pressure such as climate change and ozone depletion” (Brunckhorst, 2000: 5). Natural capital is “sustaining the store of renewable natural resources such as productive soil, fresh water, forests, clean air, ocean—that underpin the survival, health and prosperity of human society. Biodiversity is the maintenance of “the variety of genes, species, populations, habitats and ecosystems” (Brunckhorst, 2000: 5).

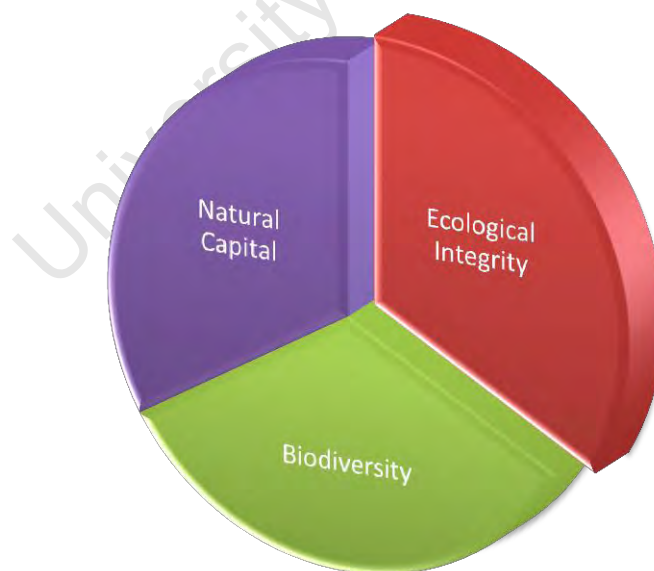


Figure 2.1: The three requirements for ecological security, using a Bioregional Approach (Brunckhorst, 2000: 5). These are: ecological integrity, natural capital and biodiversity (Brunckhorst, 2000).

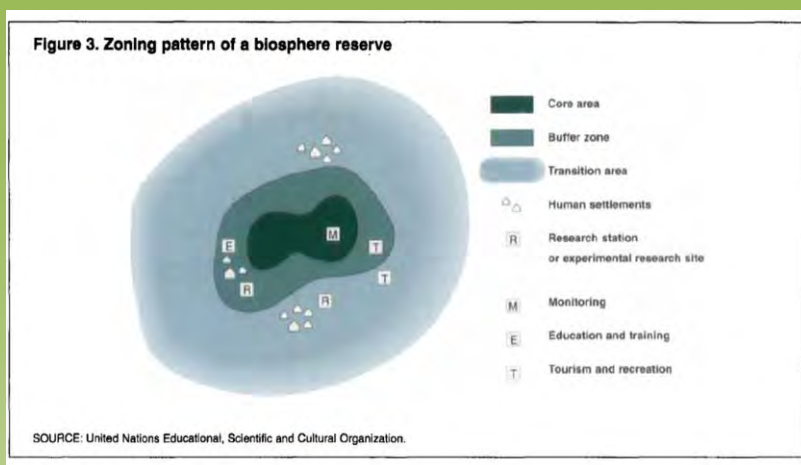
The Bioregional approach incorporated strong ideals such participatory planning, community involvement, systems analysis, socio-cultural analysis and biophysical analysis, it also contains a monitoring and evaluation components. This makes it open for adaptation to its plan as it monitors the changes in biodiversity, human population, settlement patters, rivers, to name a few, and accommodates for any changes (Brunckhorst, 2000). Bioregional Planning accepts human beings as part of the “landscape scale” and provides a practical, holistic approach to planning while considering the social and environmental systems (Brunckhorst, 2000 and Carr, 2004).

UNESCO Biosphere Reserve Programme

This programme forms part of the Man and the Biosphere programme (MAB). It is form of ecological planning based on three principles (Batisse, 1997):

- To reintroduce the importance of conserving biological diversity through a system of global protected d areas.
- To maintain the link of inter dependence between rural communities on natural resources.
- To provide researchers with a systems of site to study.

Today there are 621 biosphere reserves in 117 countries, including 12 transboundary sites. (www.unesco.org)



The basic unit of assessment in this approach is the bioregion, a “bio-cultural landscape” which refers to “a regional landscape scale of matching social and ecological functions as a unit of governance for future sustainability that can be flexible and congruent still with various forms of governance found around the world” (Brunckhorst, 2000: 8). Bioregions are a form of zoning the natural, cultural and heritage significant environment according to value and the potential for human use. This allows for an increase in natural resource capital and thus better sustainable development prospects for a region (Brunckhorst, 2001).

Critique of Bioregionalism

Devall and Session (1985, cited in Pepper, 1993) mentions that in cities

Figure 2.2: The UNESCO Biosphere Reserve Programme zonation

for example, the ability to find a sense of place within the natural, physical environment is not practical or realistic. Bioregionalism developed out of regional theory, in many reviews the concept is not discussed in consideration of the city scale. In aiming for a self-sufficient bioregion, it is probably unlikely for a dense, highly populated city to reach a self-sufficient state. Bioregionalism seems to work better in regions with a variety of smaller communities. Pepper (1993) critiques bioregionalism for its unrealistic stance regarding cities, however bioregionalism was produced from regional planning, which deals with dispersed settlements with low population numbers. The gap is still there though; bioregionalism does not adequately deal with cities. What should cities aim for in terms of Bioregionalism? There is always the option of dividing a city up into small scale “regions” in which the principles of bioregionalism can be practised; where people can produce resources that maintain the ecological integrity of their natural surrounding and that obey the limits of their specific natural context.

In terms of the sense of place within the city, Cayley (1986 cited in Carr, 2004) speaks of the advised perception of place within the context of bioregionalism. Place is described as an area one finds themselves in, and no matter how long you remain there, there is an obligation or responsibility to recognise the sustenance the place gives you and ask yourself what you can do in return (Carr, 2004: 73). In re-looking at Pepper’s (1993) point, one can understand that the bioregional approach in cities will still promote the link between human beings and their natural environment. Upon understanding or investigating the city, people will be able to find links with the built environment and eventually this will lead them to the links between that environment and the natural environment. The concept of re-inhabitation (Berg, 1978 cited in Carr, 2004) can prove strong in a city which identifies with bioregionalism. Re-inhabitation reminds people of their responsibility of “learning to live in place” and “becoming fully alive” in a place. This involves investigating place and fading out what would truly enhance it socially, environmentally and physically (Berg, 1978 cited in Carr, 2004).

Bioregionalism promotes self-reliant settlements or communities and thus indirectly promotes smaller communities as opposed to large populous settlements such as cities. Within smaller communities the goals of bioregionalism can be met with greater ease. The natural world is conserved and protected, in bioregionalism, in order for this to happen

appropriately, human processes need to obey natural time thus resulting in slow “organic” change. Pepper’s (1993) critique of this is that change and progress in communities will be slow, the slow rates will have great impacts on modernism meaning solutions to problems in the communities will be attained slowly. It does however allow enough time for social improvements (Pepper, 1993).

During the development of bioregionalism, proponents of bioregionalism looked to the past for inspiration on how to demarcate borders. Snyder (1970 cited in Aberley 1999) looked to historical indigenous American maps, demarcating natural boundaries, different tribes (and culture) and biodiversity. He overlaid these maps to understand the relationships between various physical aspects (such as flora, fauna, climate and hydrology) and culture and tribal locations (Aberley, 1999). Today Bioregionalism advocates for the use of natural boundaries to allow for adequate movement of natural processes and biota. The lack of anthropogenic boundaries could foster a closer relationship between people and the environment as people a larger sense of responsibility to the landscape. The opposite might also be true as people might not concern themselves with anything but their own.

Pepper (1993) draws from bioregionalism that is an anarchist position, it denounces state boundaries, administration and politics. Bioregionalism today has evolved and been developed into state plans, perhaps not obeying all the strong philosophical underpinnings of the original bioregionalism, but maintaining the core component, acknowledging the natural environmental and aiming for maintain ecological integrity. In working towards a landscape which hosts small communities of self-reliant people, unless the global economic market does not change from capitalist to something more accommodating, the goals of bioregionalism cannot be met as the global market will contribute to be operated and managed by a select few (Pepper, 1993).

The Vermont example of the Biosphere Reserve is an example of how small communities of people across an area of 10 million acres of land spreading across four states. It is a prime example of how people banded together and after approximately ten years succeeded in producing a bioregion (McGinnis, 1999). The Champlain-Adirondack Reserve forms one of the largest reserves under The Man and the Biosphere Reserve Programme, it is a good example of bioregional approach making way for human habitation in “wild lands”

(McGinnis, 1999). There were issues post the biosphere designation, regarding funding for future initiative, the people of the region however have managed to continue the bioregional work in their capacities.

Environmental Determinism within Bioregionalism

Frenkel (2002) discusses the contradictions within bioregionalism, specifically regarding environmental determinism. Environmental determinism was a period in geographical history in which the environmental was seen as limiting and determining people's paths in terms of economic and social development (Frenkel, 2002). The problem with this was that it provided a morally unjust hierarchy in which certain areas were preferred over others due to their comfortable natural state. A simple example such as air conditioners is provided by Frenkel (2002). Tropical regions were less favourable to their high humidity and temperature; the air conditioner resulted in making this region very popular, particularly in the USA. In staying within the limits of the land, as bioregionalism promotes, certain regions and climates would become unfavourable producing some sort of environmental deterministic issue. These kinds of impacts will affect social and economic systems, negatively in some areas and positively in other. One way of averting this problem is simply to look into alternative sources of energy; this is if one were to focus on the issue of energy production to increase people's comforts. Other environmentally deterministic factors such as food production could also impact bioregional thinking negatively. Certain areas have large amounts of people and might not have the resources to feed these people. In case such as this very specific one, the linkages and "give and take" in and amongst regions becomes important. Bioregionalism will however come with its limits, migrations of people might occur as people look to better prospects, but what is important is that ecological integrity of the natural landscape is maintained as this is the main form of protection and sustenance to people.

In thinking about bioregionalism perhaps in its deterministic fashion, it might result in strains of natural environments (due to increased population) that are most favourable also resulting causing a contradiction in bioregionalism which promotes decentralisation and egalitarianism (Frenkel, 2002).

Bioregional Planning

Brunckhorst (2000) suggests six characteristics that Bioregional plan should maintain in order to succeed. These six points paint a good, practical understanding of what a bioregional plan should aim for.

- The plan should be equally focussed on the **process and the product**,
- it should be motivated by the concerns and values of the **local community**,
- it should be understood by the local community and **promote communication** between the managers and the local people,
- it should be “**action-oriented**” and offer **long term** direction,
- it should also link with **higher level policies and laws**
- and finally it should include **continuous evaluation and feedback** (Brunckhorst, 2000: 133).

Bioregionalism aims for sustainability and ecosystem management by focussing on ecological integrity, biodiversity and natural capital. Sustainability comprises three parts, ecological, social and economic (Brunckhorst, 2000). Brunckhorst (2000) defines it as something that “does not challenge ecological thresholds in neither temporal nor spatial scales that will negatively affect resilience or adaptive capacities of social and ecological systems” (Brunckhorst, 1998 cited in Brunckhorst, 2000). This definition of sustainability ensures the endurance of the economic and social systems by prioritising the ecological system. Sustainable development forms part of the bioregional agenda as it maintains ecological security, a main principle of bioregional planning. Ecosystem management is a holistic, interdisciplinary study of the restoration and sustainable use of natural resources (Brunckhorst, 2000 118). It considers regions (large areas) and includes human relationships with natural systems

Bahia de Caraquez, Ecuador

A small coastal town of approximately 500 000 people proceeded to employing bioregional practices in their city, in order to maintain the ecological integrity of the coastal town.

The plan was simply a garbage recycling initiatives that turned organic waste into compost for private gardens, public gardens, parks and fruit trees. The plan would expand to include plastic, paper, metals and glass. The town bioregional initiatives were further improved after major debris slides destroyed certain areas of the town. After which the town's people replanted only indigenous vegetation and turned it into an education and tourist attraction promoting the biodiversity and thus a bioregional approach.

(Berg, 2007)

(Brunckhorst, 2000). Ecosystem management promotes “connectivity, avoidance of fragmentation, protection of catchments and identification and protection of critical habitat components” (Brunckhorst, 2000: 118). It also identifies the need to understand the connectivity of natural systems and the interaction and relationships that are within and between ecosystems, this contributed to its use as a tool for sustainability, biodiversity protection and sustainable natural resource use (Brunckhorst, 2000: 118).

Adaptive Management

Bioregional planning accommodates for a dynamic world in its consideration of adaptive planning. Adaptive management is required in future planning as it allows for consideration of unknowns and enables a plan to be easily changed and still continue to fulfil its initial goals. Adaptive management is also a form of risk planning; it accommodates a lack of information, uncertainty or surprises (Gunderson. Et al, 1995 cited in Brunckhorst, 2000). In today’s uncertain times especially regarding climate change impacts, risk management is an imperative. The Bioregional Approach is thus well suited to climate change adaptation and associated impacts as it leaves room for changes to the plan. It also thus provides an element of risk management (Brunckhorst, 2000).

Scale

The unit of analysis in the Bioregional Approach is a bioregion, Bioregions should generally cross political and administrative boundaries as they constitute a variety of land cover types, resources and ecosystems (Brunckhorst, 2000). This will result in the inter-sectoral, cross disciplinary, cross boundary and cross administrative management of a bioregion (Brunckhorst, 2000), ensuing a focus on nothing else but natural boundaries. The local community should be included, the identity and local understanding of the citizens must be acknowledged and incorporated into the plan (Brunckhorst, 2000). In using the bioregional approach, a number of synthesis and analyses of the study area needs to be made, this includes investigations of the physical, biological and social aspects of the “ecological systems” and processes at landscape scales” (Brunckhorst, 2000:25).

Brunckhorst (2000) presents the Hierarchical framework for ecological units, within this framework the bioregion as the regional scale. This framework works through various scales, from continental down to local (Brunckhorst, 2000). The continental and local scales have proven to be too large and too small respectively and the regional scale perfect for the

kinds of social and ecological relationships to be assessed. “The bioregional scale also works well for integrated management, has good temporal scales for change and adaptation and flexibility in the framework for social and institutional change” (Brunckhorst, 2000: 30).

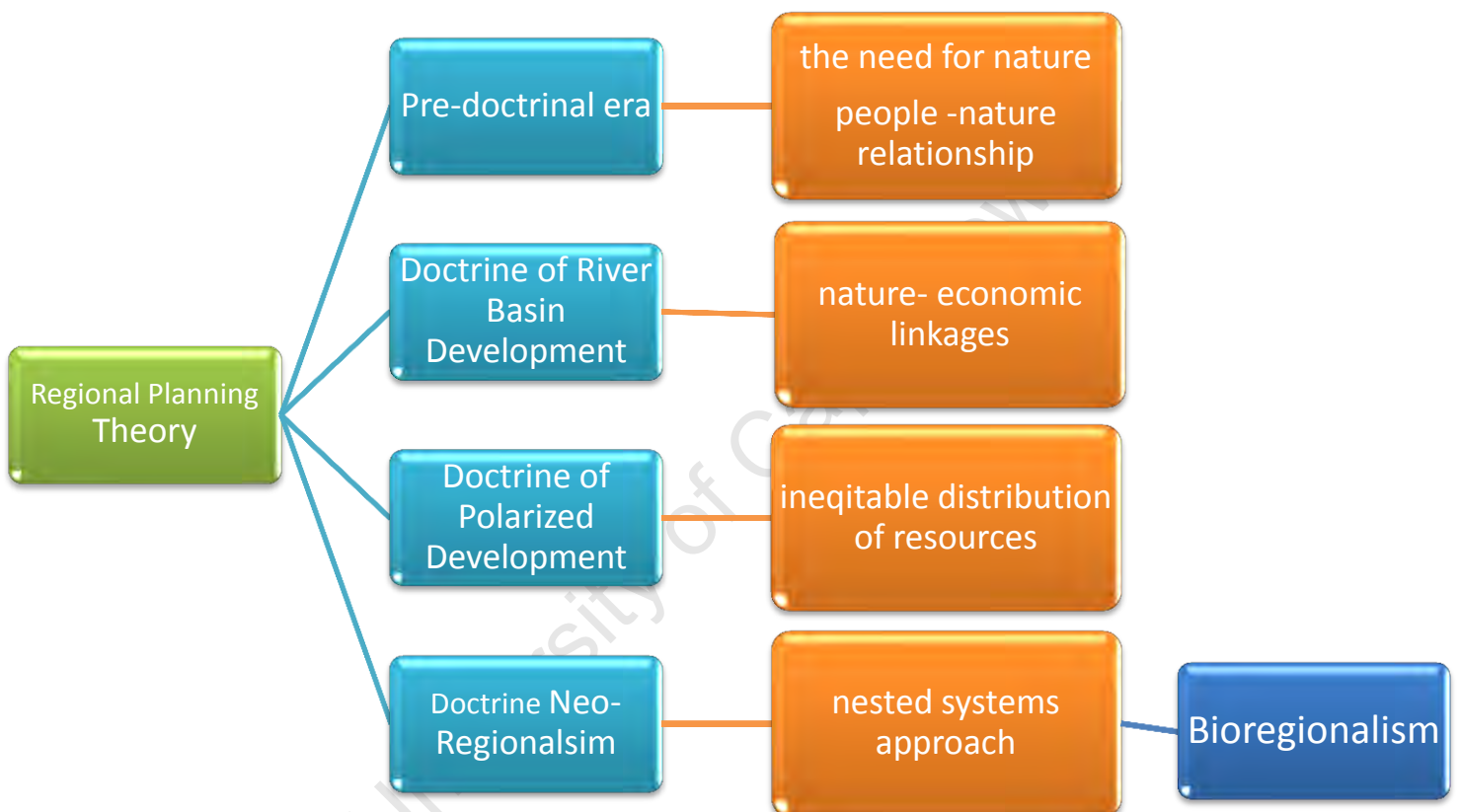
Bioregions can be based on a number of characteristics, Bioregional authors such as Carr (2004) and Brunckhorst (2000) promote the level of scale at which to work with bioregions, mentioning watersheds, climatology, natural history and biodiversity. In South Africa the most prominent proponent of Bioregional Planning is SANBI, who base their bioregional plans on biodiversity but within the administrative boundaries, still however acknowledging the (eco) system links to larger regional and national scales.

Bioregional plans should link to higher level and integrated projects, as in South Africa, bioregional plans are considered at the Local and District Level Municipalities. They are also encouraged at all other government departments at all levels (SANBI, 2009). It is important for bioregional plans to inform spatial planning policy and frameworks, to ensure the maintenance of ecological integrity in future.

How does the Bioregional approach work in a regional planning setting?

The regional scale contains a number of smaller scales (nested spatial contexts/ hierarchies), scales that host a variety of important ecosystem functions (Brunckhorst, 2000). These nested hierarchies provide enough context and understanding at different scales, needed for a holistic plan (Brunckhorst, 2000). It also provides the best scale for social and environmental planning (Brunckhorst, 2000). Referring to the regional scale, Brunckhorst (2000) says: “It is often at this regional landscape level that assessment of the integration of the social and ecological elements can be achieved” (Brunckhorst, 2000: 21). A nested hierarchy of ecosystem units is required in order to plan appropriately for sustainable resource use by humans (Brunckhorst, 2000). The regional scale also generally hosts a range of different activities required for development, it is therefore a good scale to work with when working in transitioning societies, a society moving toward a more “mature industrial economy” (Friedmann, 1964: 59). In defining a more developed region as an area that is more industrially focussed is not the focus or aim of a project of this nature, for this reason Friedmann’s (1964) statement is interpreted as a more socially and economically developed region, changing the focus from industrialization to a broader socially and environmentally just understanding of development.

Figure 2.3: A summary of the influence of regional planning history on Bioregionalism (source: author's own).



Chapter 3

Regional Analysis

The Bergrivier Municipality is situated along the west coast, in the West Coast District Municipality in the Western Cape. It is approximately 4407.04 km² in area and includes 40km of coastline (Bergrivier Municipality, 2011/2012). The Municipality boasts nine main towns of which Piketberg is the administrative town. The Bergrivier Municipality is very diverse geographically; it hosts a vibrant coast, several rivers, agricultural farm land and a mountainous expanse toward the eastern portions of the Municipality.

This chapter aims to explore and understand issues, challenges and opportunities in the Bergrivier Municipality; it will be done by analysing the surrounding environments, specifically the water catchments in which the Municipality falls into. The analysis methods used are the land-unit analysis, material flow analysis and landscape character analysis. The analysis details will be used to paint a picture of the environmental opportunities and constraints of the Bergrivier Municipality while considering its broader context. This broader analysis is important for a number of reasons. The first is that the Municipality does not exist independently of its surroundings, people move in and out of the boundaries and goods and services are transferred across the boundaries. The reliance on surrounding regions and distant regions is undeniable and is important for the socio-economic well-being of the Municipality. Secondly and most importantly this context is important as the natural environment does not adhere to these anthropocentric boundaries. Biological systems do not conform to political or administrative boundaries, and are often demarcated without the consideration of the natural environment. The catchments, natural vegetation, soils and geology for example, do not suddenly change at the Municipal edge. The natural environment has its own boundaries in the form of catchments, geological substructure and coastal zones, to name a few.

The chapter will go on to draw out the key issues faced in the region and go on to explore the institutional arrangements involved in the region. In analysing the institutional issues, the researcher hopes to draw out the various initiatives and problems involved in the administrative management of the region.

The Defined Borders for this Study

In assessing the broader context of the Municipality, the river basins were chosen as a scale of departure. This was done as water is the basis of life; the supply of water is thus an imperative in daily life and upon basing the analysis on water basins and the acknowledgment thereof, one can almost ensure long term sustainable water resources. With this in mind the surrounding river basins were analysed. The Berg River basin was analysed to cover the southern regions of the Municipality, in order to analyse the northern section of the Bergrivier Municipality, the Olifants-Doorn WMA was used. The reason for this scale difference is due to a lack of access to relevant information for the smaller river catchments directly to the northern edge of the Municipality (the Verlorevlei River catchment, Langvlei and Jakkalsvlei catchments- See Figure 3.1). These smaller catchments are however already incorporated in the Olifants-Doorn WMA and are included in Olifants-Doorn WMA studies. For a deeper understanding of the water catchments and the water boundary delineations, see Appendix A.

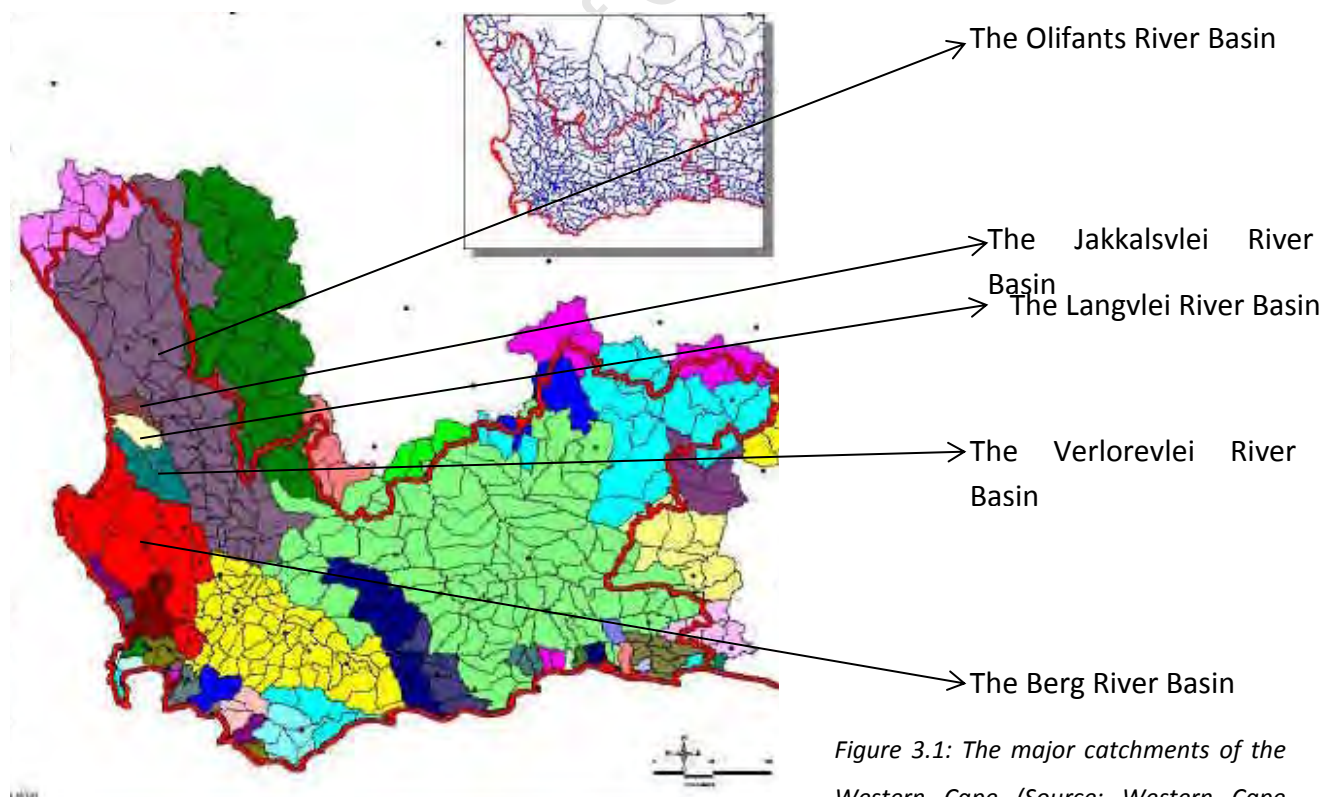


Figure 3.1: The major catchments of the Western Cape (Source: Western Cape Bioregional Plan, Western Cape Government, 2000). The Bergrivier Municipality incorporates the Berg, Verlorevlei and Olifants River basins.

Methods

This analysis incorporated three kinds of analysis methods: land unit analysis, land character analysis and material flow analysis. It is a spatial assessment of an area, considering its context and biophysical features. Land character is qualitative assessment of an area, understanding an area's cultural assets, heritage, genius loci and the relationship of the locals with the area. Material flow analysis is a quantitative analysis of an area's resource inputs and outputs. The Bioregional approach does not incorporate material flow analysis, however this project will, to some degree. Material flow is a valuable method, especially regarding sustainability. It measures the amount of natural resources used in an area, this also describes the energy use of an area and the kinds of energy used. This kind of approach therefore helps in determining whether places should move to more sustainable energy sources and how waste is produced (to incorporate recycling initiatives for example). Land capability assessment such as "The County of London Plan" the production of the suitability plans opened the doors for many more ecological planning techniques and methodologies (Ndubisi, 2002).

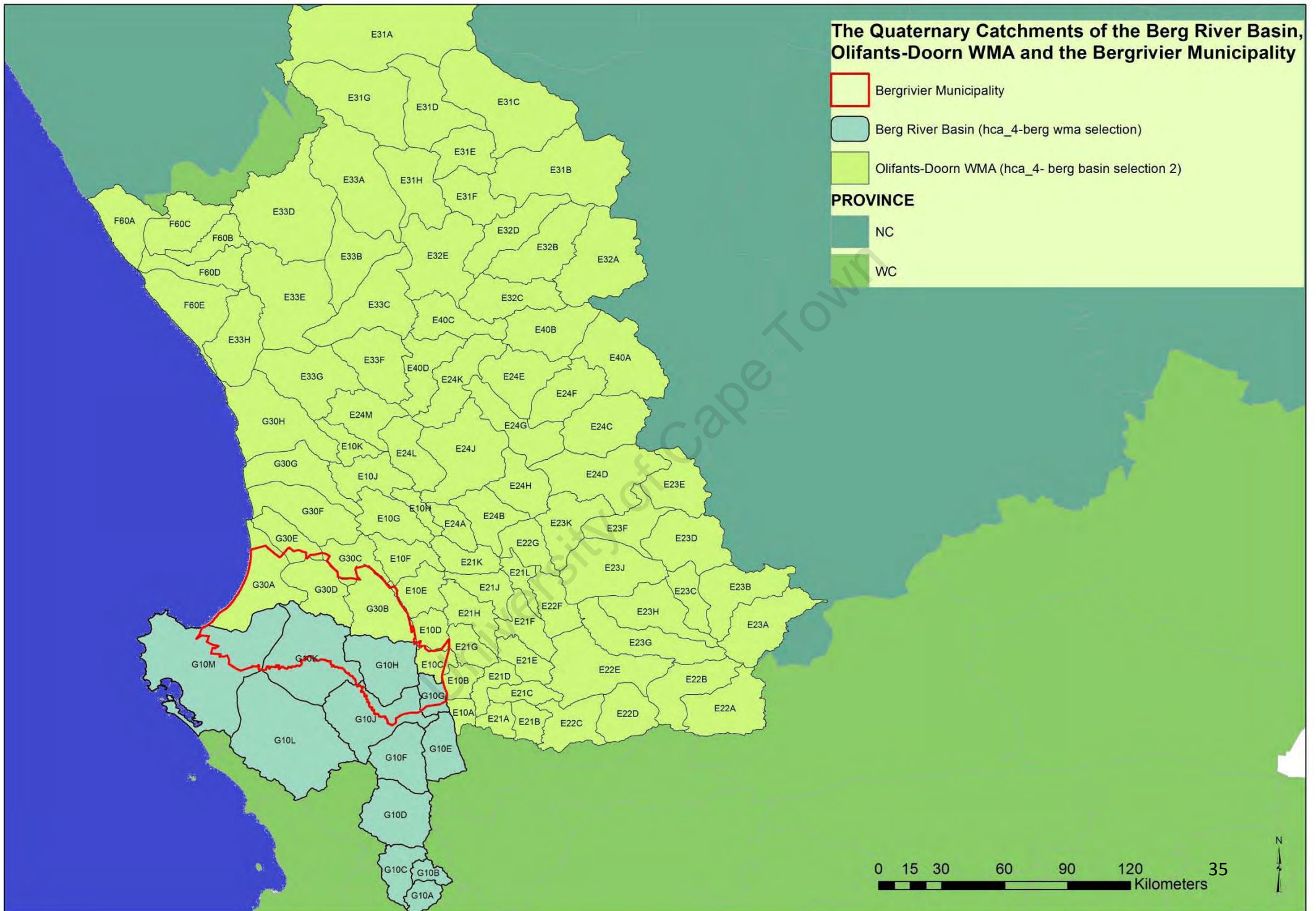


Figure 3.2: The quaternary catchment of the Berg River Basin and the Olifants-Doorn WMA (Data Source: Department of Water Affairs, 2007).

River Basin Context

The study area under analysis consists of the Berg River Basin to the south of the Bergrivier Municipality and the Olifants-Doorn WMA to the north. The Berg River catchment is approximately 9000km² and is the largest river catchment in the Western Cape (Department of Water and Forestry, 2007) (see Figure 3.2). The Berg River is the main river in the catchment; it starts in the Franschhoek Mountains and flows in a North Westerly direction to exit at Velddrif, into the Atlantic Ocean. The basin contains three major dams, Wemmershoek Dam to the North-West of Franschhoek, Voelvie Dam West of Tulbagh, and recently Berg Rive Dam. Major Tributaries of the river are: the Franschhoek, Wemmershoek, Dwars, Kompagnies, Klein Berg and Twenty-Four Rivers (Department of Water and Forestry, 2007).

The primary function of the basin is agriculture, with grape and deciduous fruit farming most prominent (River Health Programme, 2004). Associated industries are also commonly found in the basin. The majority of these industries are involved in preparing the primary produce for commercial sale.

The Olifants-Doorn WMA is situated on the West Coast of the Western Cape, it falls into the northern half of the Bergrivier Municipality. The WMA gets its name from the Olifants River as the main river in the WMA, and the Doring River which flows into the Olifants River just South of Klawer. The Doring River is the Olifants River's main tributary (DWAf, 2005). This name was given to distinguish the WMA from the Olifants River Basin in Limpopo Province, South Africa.

The Olifants River starts in the mountains to the South East of the WMA in the Agter Witzenberg Mountains, North of Ceres (River Health Programme, 2005). It flows in a north westerly direction to exit into the Atlantic Ocean, near Papendorp (River health programme, 2006). This WMA also lies across two provinces, to the North East is falls into the Northern

Population Estimates

The combined population of both the Berg River basin and the WMA is approximately 500 000. The majority of people in these regions live in the urban settlements. The Olifants-Doorn WMA has the lowest population in South Africa- 104 000. 65% of the population lives in the South Western portions of the WMA.

The Olifants-Doorn WMA suffers major population loss due to lack of opportunity. The Berg River basin however is a growing region in which the population is at 3.2% (River Health Programme, 2004).

Socio-Economic Profile

In terms of socio-economic profile, these regions suffer inequality according to racial and urban rural divides– this means that those who live in urban areas are generally of a higher socio-economic status than those of a rural setting (Department of Water Affairs and Forestry, 2005 and Bergrivier Municipality, 2004). In terms of racial divides the region still suffers the impact of racial oppression from the apartheid era, this is evident in the “white farmer” still being the predominant farmer (Department of Water Affairs and Forestry, 2005). This has long term impacts on the ability of non-white farmers to generate productive farms; issues with water are one of the main hindrances to this (Department of Water Affairs and Forestry, 2005).

Cape Province (DWAF, 2005). The total area covered by the WMA is 56 446km² (DWAF, 2005).

Water Systems

The study area comprises three main rivers, the Berg River, Olifants River and Doring River. These three rivers along with estuaries, wetlands, aquifers and rainfall form the basis of the water system.

Water Quality

Both the Berg and Olifants Rivers are heavily relied upon by surrounding areas in the basin. It is a source of irrigation, storage and supply (Department of Water and Forestry, 2007). The Berg River also forms part of a number of water transfer initiatives, the most prominent involving the Theewaterskloof Dam in which water is supplied to Cape Town. Both the Olifants and the Berg Rivers receive water from the Breede River Basin to supplement yields (NWRS, 2004).

The main concerns within the water system are water quality and quantity of the rivers. The water quality of the Berg River system generally decreases as it moves downstream. The upper sections have high water quality due to near pristine mountain conditions. The middle to lower sections are impacted by alien vegetation, development, abstraction (which causes decreased flow) and river modification causing altered flow and quality (River Health Programme, 2004). Issues of low water quality can have significant impacts on the water supplied to Cape Town, the decreased water flow (quantity) negatively impacts water quality. Therefore the export of water needs to be balanced, providing an opportunity to investigate potential water returns from areas that receive water from the Berg River Basin. Water flow also impacts the quality of estuaries and wetlands.

Water quality in the tributaries and the middle reaches are low due to agricultural run-off, alien fish and bad farming practices in the lower reaches are contributing to low water

The Berg Water Project

With the growing water demand in the Western Cape, the Berg River Water Project was initiated and constructed the Berg River Dam, this dam also stores water for use throughout the year (Department of Water Affairs and Forestry, 2007). The Berg River Dam was officially opened in 2009 and operated concurrently with the Theewaterskloof inter-basin water transfer scheme (Department of Water Affairs and Forestry, 2007). The Berg River Dam captures winter rainfall to increase the water supply to the City of Cape Town during summer months (Berg Water Project, unknown).

quality (River Health Programme, 2004). Other contributing factors are the removal of riparian plant species and thus the destruction of riparian zones as well as dam water releases which cause a change in flow (Department of Water and Forestry, 2007). There is an added problem of sub-minimum wastewater effluent discharged into the river, this kind of pollution could have detrimental impacts on human health, especially considering the potable water transfer schemes in the region.

The study area has a number of important fauna and flora species that require healthy environments suited to them. River flow reduction decreases water quality, impacts the underwater profile and habitat-impacting the aquatic biodiversity negatively (Anchor Environmental, 2009).

The water quality of the Olifant-Doorn WMA is variable, the section above Clanwilliam is of “ideal quality” and perfect for any use (DEADP, 2011). The lower sections are influenced strongly by underlying geology and water flow. During the warmer months the water quality deteriorates due to high evaporation rates and decreased quantity. The section along the coast is of low water quality due the high density of farming activity and run-off. This section is.

Estuaries

The estuaries in the study area are two of four permanently open estuaries along the west coast, both have high conservation value and serve a great economic purpose in local peri-urban settlements (Anchor Environmental, 2009). The Olifants River estuary is the highest rated estuary in terms of botanical significance, in South Africa (Department of Water Affairs and Forestry, 2005). This significance is dependent on the condition of the estuary, the water quality, river flow and the condition of the salt marshes (Department of Water

Affairs and Forestry, 2005). The Olifants riverine system is in a much healthier ecological state than the Berg River system. There is opportunity to maintain this health and improve the Berg River system significantly.

Wetlands

In terms of wetlands, the most popular wetland in the WMA is the Verlorenvlei wetland along the coast which enjoys Ramsar³ status (Department of Water Affairs and Forestry, 2005). This means that this wetland is internationally recognized as an important ecological site. The wetlands face destruction due to decreased groundwater levels and surface and groundwater pollution (Department of Water Affairs and Forestry, 2005). The Verlorenvlei wetland is especially important as it hosts thousands of birds from over 75 different species, throughout the year. The wetland serves as a resting, feeding and nesting site for these bird varieties (Department of Water Affairs and Forestry, 2005). The survival of the wetlands depends on good quality and adequate groundwater. Wetlands are an important regulatory service in riverine systems and the water cycle. They moderate water flow during wet seasons by acting as buffers (or sponges). They also regulate water quality by slowing water flow and allowing wetland plants to absorb any nutrients or suspended material (River Health Programme, unknown).

Groundwater

The Olifants-Doorn WMA groundwater yield is highest in the Sandveld regions (to the south west of the WMA)-shown in Figure 3.3. This area is just north of the Bergrivier Municipality. This area has a high number of farming towns, probably due to excellent water availability. This area also has high rainfall and good groundwater quality, to the north and north western part of the WMA there are risks of salt water intrusion as the groundwater is already more saline (DEADP, 2011). There are a high number of people making use of groundwater, the salt water intrusion in these areas can therefore have a significantly negative impact. The groundwater levels are generally adequate for summer and winter months but used more during summer. The areas of Calvinia and Niewoudtville are particularly dependent on groundwater as well as the drier areas between Elands Bay and Doring Bay (Department of Water Affairs and Forestry, 2005). Groundwater as a source of

³ RAMSAR sites are wetlands of great ecological importance recognised under the Ramsar convention (www.naturalengland.org.uk).

water supply has not been adequately monitored or investigated. “The TMG fractured-rock aquifers should be the main groundwater exploration targets in this region,” (Department of Water Affairs and Forestry, 2005), as can be seen in. The upper Olifants-Doorn catchment experiences good recharge rates and yields and is therefore a favoured site for groundwater as a source of bulk water supply (Department of Water Affairs and Forestry, 2005).

Precipitation

In terms of precipitation the Olifants-Doorn WMA has a mean annual rainfall of 1108 million m³ per annum, of which the ecological reserves use 156 million m³ per annum (DWA, 2004). The Berg River basin experiences 1429 million m³ of which the ecological reserve uses 217 million m³ per annum. (Further details regarding the precipitation are provided in the climate section). The natural environment uses a significantly small proportion of the rainfall, this leaves a large amount of rainfall for anthropogenic uses. Despite the high rainfall rates, the area still experiences low water availability in several areas.

The need and availability of water are mostly balanced across the region, there are certain water stressed areas-immediately north of the Clanwilliam Dam and certain areas in the Sandveld region (in which the groundwater is stressed). Due to the various changes in rainfall, the salinity of the rivers in the WMA change often, these changes impact the salinity and quality of the rivers. According to the National Water Resources Strategy (2004) the salinity plays a major role in the aquatic ecosystems of the area and should be carefully considered. There is great potential for groundwater use in the Table Mountain Aquifers-these should be further investigate and could aid the Sandveld region as water resources there are under stress.

Coastal Areas

The coastline, is one of the biggest resources to the District Municipality and the Bergrivier Municipality, it falls into both the District and the Local Municipality’s responsibility according to NEMA (107 of 1998). The District is currently devising a roster of responsibilities regarding the responsibilities of the coastal area, as advised by NEMA (107 of 1998). The coastline of the region is laden with significant cultural and historical artefacts. The jurisdiction of the coastal area falls onto the District and Local Municipality

and should be directed by the District Municipality according to the Integrated Coastal Management Act (Bergrivier Municipality, 2013/2014).

Pollution

There is a lack of water availability due to the inefficient use of water and pollution, especially north of the Olifants River. There are issues of water scarcity in some areas and over-consumption in others. Pollution is adding to the lack of water, and added to this is the below standard wastewater effluent. The Municipality's wastewater is only of acceptable standards, the Municipality has therefore not been awarded any Greendrop status (BM, 2012). The lack of up to standard wastewater is due to ageing infrastructure which inefficiently discharges low quality wastewater into the Berg River.

There are also inadequate sewage facilities in the rural areas which contribute to groundwater pollution and eventually river pollution. Dumping is also a problem due to the centralization of the waste dumping sites, the lack of accessible dumping sites has resulted in many illegal dumps across the region. Privately owned dump sites have since sprung up but are also inadequate (WCDM, 2007).

Land Systems

Land-use and Land Cover

The majority of the study area is covered by cultivated land; there is a predominance of farming land, to the north (in the Olifants-Doorn WMA). Livestock farming, followed by fruit farming and potatoe farming in the south-west, are the most common farming types (River Health Programme, 2006). The Olifants-Doorn WMA is also home to key conservation areas namely, the greater Cederberg Biodiversity Corridor and the Knersvlakte Centre of Succulent Karoo (River Health Programme, 2006). Other conservation areas include the West Coast National Park near Langebaan, the Cederberg Nature Reserve (which form forms part of the Cederberg Biodiversity Corridor), the Groot Winterhoek State Forest, the Verlorevlei Wetland and to the far north the Tankwa Karoo National Park. Only 31km² of the Olifants-Doorn WMA is covered by urban settlement, the rest of the settlements are rural and very small scale. The region host a number of mining activities, such as diamond dredging, heavy mineral and granite quarrying-to the north of the WMA (Department of Water Affairs and Forestry, 2005). (see Figure 3.8).

The southern part of the study area (the Berg River Basin) too comprises farming land, agricultural (dryland) farming is which is the predominant land-use. Most of the basin comprises unnatural land, 24% of the basin is urban land and 60% is agricultural (Department of Water and Forestry, 2007). The Berg River Basin hosts a range of activities these include: agriculture, livestock farming, plantation forestry, commercial industry,

The Greater Cederberg Biodiversity Corridor

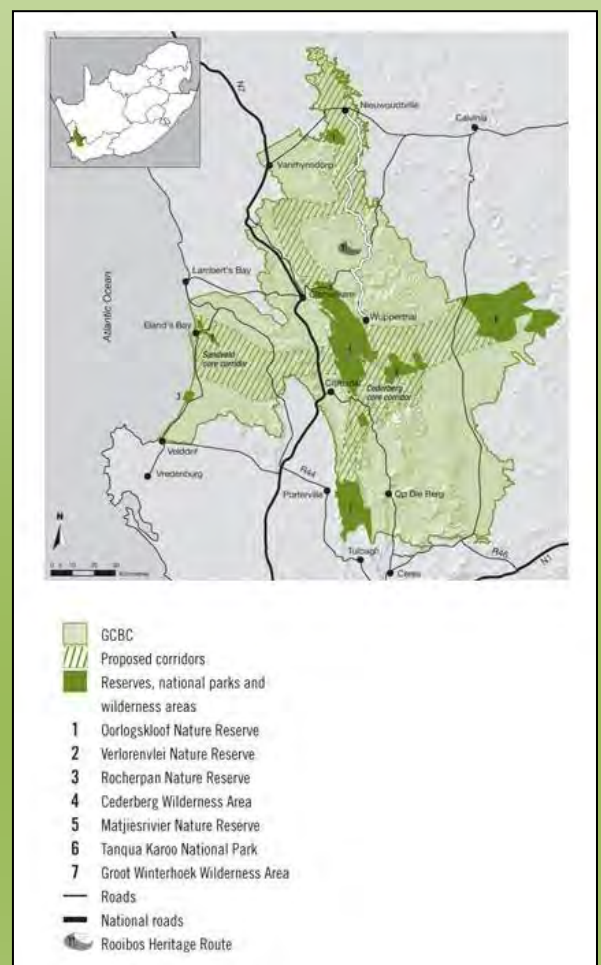


Figure 3.4: The Greater Cederberg Corridor

The Greater Cederberg Biodiversity Corridor is a project aimed at integrating the human and natural environment. It is managed by the Cape Action for People and the Environment and implemented by CapeNature. The project promotes the protection of local biodiversity as a basis to improving the economic, ecological and social sustainability (CapeNature, 2007). The area is also part of the Western Cape Bioregional network. (Figure Source: CapeNature, 2007).

fruit farming, residential areas and nature conservation. Major industries include: grapes and deciduous fruits (including wineries, canneries and other food processing factories (Department of Water and Forestry, 2007). These industries that serve as secondary industries to the primary farming activities are examples of multiplier industries, creating job opportunities for the local people and increasing economic activity. Low air quality in the District Municipality is a problem due to the many industrial areas. This applies specifically to Saldanha and Vredenberg, these areas also host the largest number of industrial employment.

Toward the source of the Berg River, vineyards dominate, this is associated with the large amounts of water and fertile soils available in this part of the basin. The areas north of Wellington are predominantly used for dryland farming (Department of Water and Forestry, 2007), this type of farming is usually practiced in water scarce regions, crops that require little to no irrigation are planted (www.britannica.com). To the east of the basin there are some forestry plantations, these are very few (Department of Water and Forestry, 2007). The riparian zones of the rivers also host fertile, good quality soils, these are however very sensitive areas and have been covered by agricultural land more so in the southern part of the study area (around the Berg River and its tributaries) than in the Olifants River and its tributaries (see Figure 3.7, below).

Pollution

The Municipality has identified pollution as a problem of the area; they have also planned for the rehabilitation of the closed waste sites. The current Municipal waste is being removed and dumped in

The Function of Reserves

Reserves play a major role with regard to rehabilitation of indigenous flora and fauna, an example of this is the Limietberg Nature Reserve, which extends from Du Toitskloof to the Voelvllei Dam, extending for 117 000 Ha. The reserve is important for water capture for the surrounding dams. It has a number of alien fish and vegetation problems; these are however under the management of CapeNature. The reserve is also important as it maintains the scarce Renosterveld Fynbos of which there are dependent animal species, such as the endangered geometric tortoise (River Health Programme, 2004).



Figure 3.5: The Limietberg Nature reserve (source: www.capenature.co.za)

Swartland Municipality's waste site (Bergrivier Municipality, 2012). The Municipality is also currently preparing recycling initiatives in an effort to curb pollution and waste. The Bergrivier Municipality does not have pollution control unit. These issues are dealt with in other departments. Pollution issues are dealt with in the water and waste plans. This capacity issue is found to occur across the Municipality and District Municipality. It has significantly negative results in terms of service implementation and natural resource protection.

Spatial Planning issues in the Bergrivier Municipality

The Municipality does not envisage its resource capacity being able to host any more developments and settlements similar to those that currently exist in the Municipality. It states that the resource base will not be able to maintain this. They do however have the resources to maintain "a regional significance" (Bergrivier Municipality, 2008). One of the major set-backs is the lack of capacity in the local municipality, this results in a lack of

<p>Provincial Spatial Development Framework</p> <p>The PSDF is a strategic Provincial Government policy aimed at guiding the spatial development of District Municipality and Local Municipality. It was developed in adherence to the Conformity Principle in which it does not create no remove land use rights, it should however be abided by (PSDF, 2005).</p> <p>The Western Cape has a bioregional plan that is based on the UNESCO Man and the Biosphere delimitations (Western Cape Government, 2000). These biospheres were selected from a nominations process, in which countries nominated regions according to conservation role, logistical role and development role (Western Cape Government, 2000).</p>	<p>This means that the area must have cultural and social significance, educational value and conservation value. Once a biosphere zone is demarcated, it is assigned a land use and conservation status. The Man and the Biosphere programme has provided great impetus for bioregional planning (Western Cape Government, 2005). The Western Cape Bioregional plan however bases its bioregional demarcations on ecosystems and primary biomes, the plan uses vegetation as the basic unit of ecosystems, and the plan is therefore based on vegetation.</p> <p>Basically, the plan uses the various vegetation types of the Cape Floral Kingdom as the basic unit of representation for biomes and ecosystems. It very briefly acknowledges the catchment of the Western Cape but then retreats back to basing the Bioregional Plan on the vegetation of the Cape Floral Kingdom.</p>	<p>This project uses the river basins as the basis for bioregional delimitations, as I felt that water, as the basis of life, would be the most appropriate boundary. Water boundaries are also easier to promote to government institutions in terms of administrative boundaries on a large scale such as national or provincial. Perhaps vegetation biomes are easier to use on a smaller scale such as within a province. The Western Cape Bioregional Plan however uses the vegetation biomes as a national basis for bioregional delimitations. The Western Cape Bioregional Plan is based on linking biospheres with spatial planning land-use categories. These together form six spatial planning categories that include the biosphere regions.</p>
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planning implementation, management and monitoring of “on the ground” problems.

The problem of different boundaries is also highlighted by the Municipality. In the Municipality’s local SDF, they realise that holistic planning cannot take place within the administrative boundaries of the Local Municipality. This is due to the fact that the majority of the other functional areas such as water, agriculture and mineral resources do not fall within this boundary. This is one of the issues this project tries to highlight and explore.

These kinds of issues result in “skewed investment” and inadequate and ineffective planning (Bergrivier Municipality 2008). The bioregional approach was thus seen as a possible intervention for this problem.

There was an identified “lack of rationalisation between the zoning schemes and bioregional planning categories,” the Municipality has thus attempted to use the Western Cape Bioregional Framework as a basis for its spatial planning categories, especially in certain sensitive areas (Bergrivier Municipality, 2008). With the Bioregional Plan of the Western Cape, the Bergrivier Municipality covers three bioregional zones.

The Bergrivier Municipality is looking at renewing the urban edge. An urban edge is generally understood as a land-use management mechanism that controls the spread of urban development. The problem with the urban edge is the ease with which it can be changed by authorities. Perhaps the urban edge should be removed as an idea and in place the bioregional approach is used within which bioregions for urban development are identified.

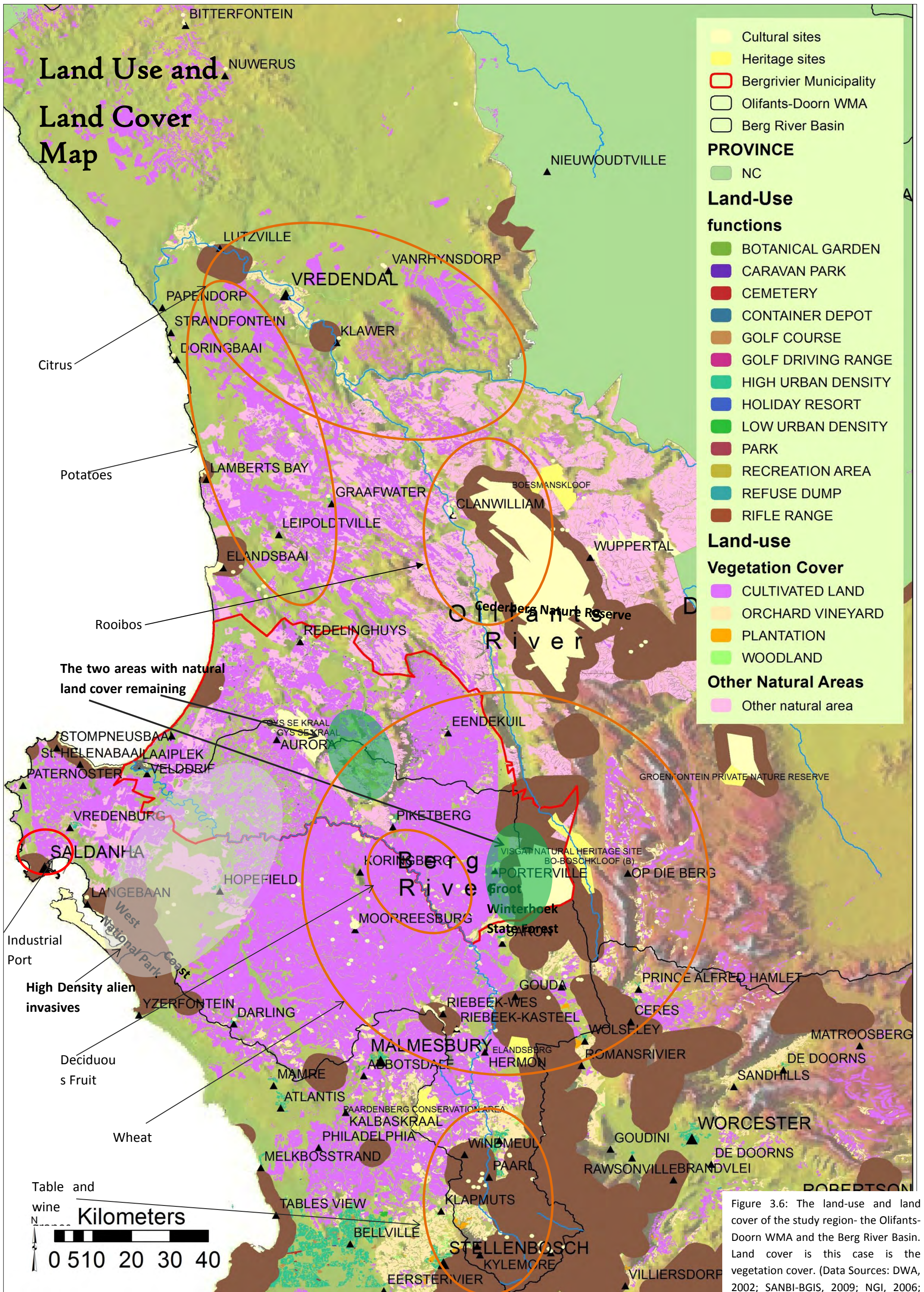


Figure 3.6: The land-use and land cover of the study region- the Olifants-Doorn WMA and the Berg River Basin. Land cover in this case is the vegetation cover. (Data Sources: DWA, 2002; SANBI-BGIS, 2009; NGI, 2006; and NPAT, 2001).

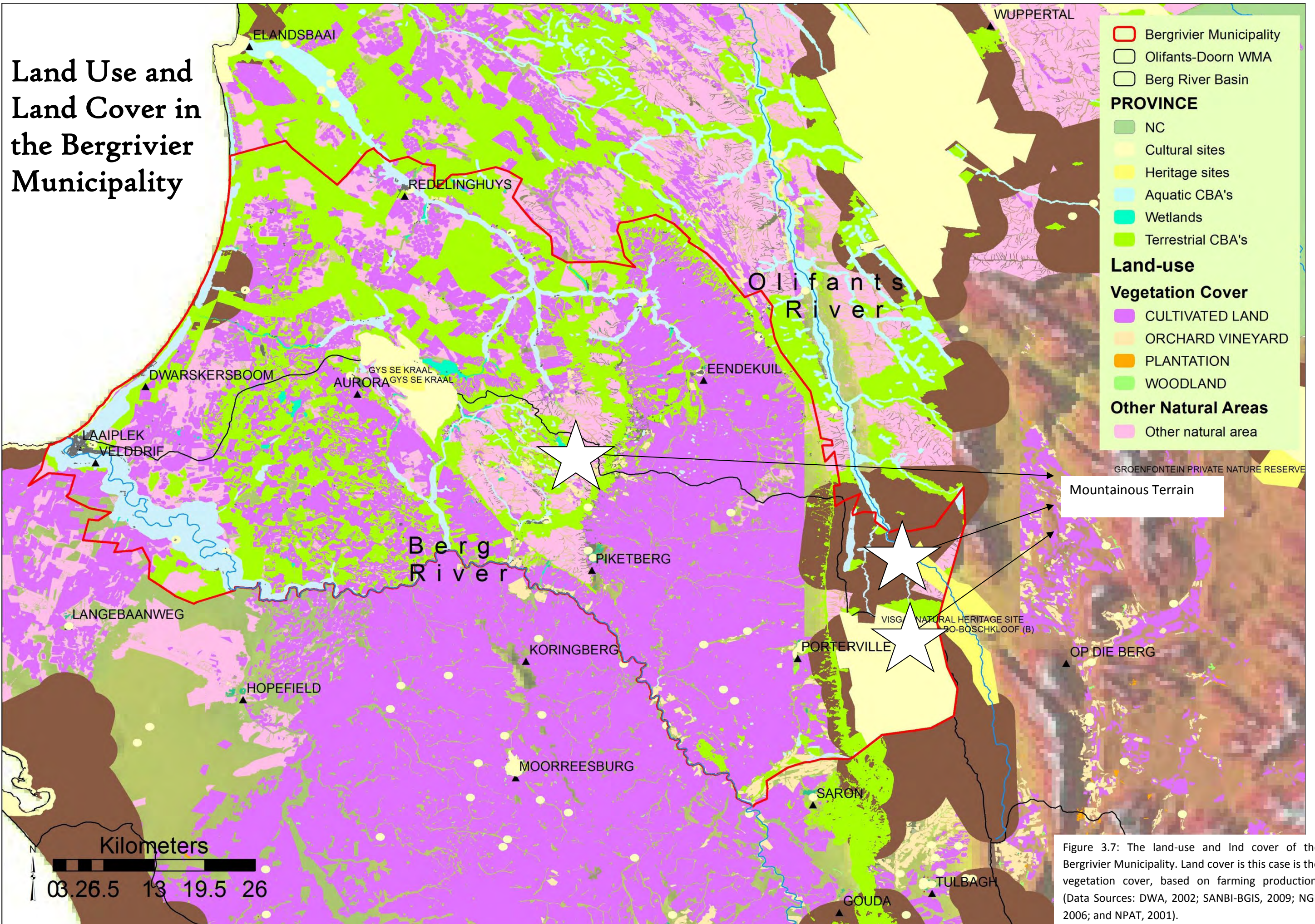


Figure 3.7: The land-use and land cover of the Bergrivier Municipality. Land cover in this case is the vegetation cover, based on farming production. (Data Sources: DWA, 2002; SANBI-BGIS, 2009; NGI, 2006; and NPAT, 2001).

Mineral Endowments

The mineral resources of the study area are quite limited; the area has most of its richness in its geology, vegetation and coastal environments. There are however several mineral deposits found in both the Olifants-Doorn WMA and the Berg River Basin and some metal deposits in the Olifants-Doorn WMA. (see Figure 3.8 and Appendix B)

The mineral deposits that are commonly found are limestone in the Langebaan region as well as near Moorreesburg; Moorreesburg also has dolomite deposits (Council of Geoscience, 2002). The basin also contains some phosphate deposits along the coast, specifically near Vredenburg, Saldanha and Langebaan. Quartzitic Sandstone is the only dimension stone found in the region. There are currently eleven quarries producing limestone and dolomite in the Western Cape, one of these occur in the Berg River basin, specifically in Saldanha. Salt extractions take place in Velddrif, many salt pans occur along the West Coast and the Berg and Olifants estuaries.

In terms of unexploited resources, Riviera, North of Piketberg contains a large amount phosphates along the coastal zone and West Coast from about 35 km north of Cape Town to 40km north of Lambert's Bay. There has been mining interest recently despite the minerals being of "sub-economic" value (Council for Geoscience, 2012). Hopefield has great potential for glass sand, the current glass sand produce come mainly from Phillipi (in Cape Town) and Atlantis. The Hopefield glass sand must be further investigated.

In the Olifants-Doorn WMA, Vredendal is known for dolomite and agricultural lime production. Vanrhynsdorp had a granite quarry which lays in a north-westerly direction but this has closed. There are however low grade diamond deposits and iron deposits in the North West. There are two diamond mines in the North of the WMA, as well as at least one iron and one copper mine. Vanrhynsdorp and Yzerfontein also host gypsum deposits, gypsum is generally used in the construction industry (Council for Geoscience, 2012). Gypsum mining taking place in Knersvlakte (Western Cape Government, 2000).

The WMA hosts three kinds of dimensional stone quarrying: quartzitic sandstone, marble and granite. South West of Clanwilliam there are TMG sandstone quarries and bed sandstone quarries. These types of sandstone are used as building materials as dry walling

and slasto. Further north of the WMA, along the Vredendal coast, diamonds are mined; this diamond rich area extends all the way to Namaqualand.

North of the Olifants River, beach and Aeolian sand is mined for their mineral content (Namaqua sands), of these minerals, illment is used in the paint industry.

University of Cape Town

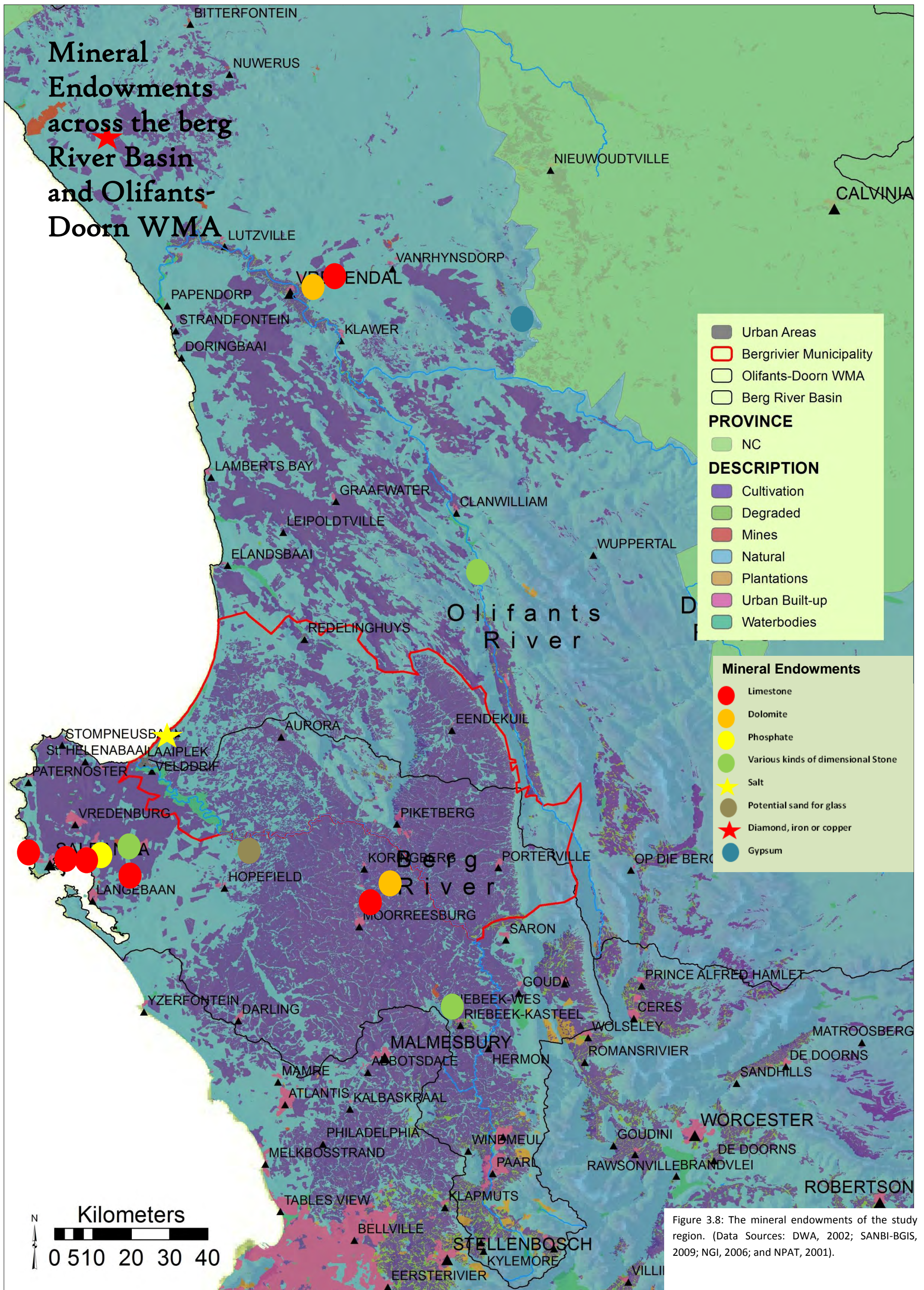


Figure 3.8: The mineral endowments of the study region. (Data Sources: DWA, 2002; SANBI-BGIS, 2009; NGI, 2006; and NPAT, 2001).

Biodiversity

Very few areas in the Berg River Basin and the Olifants-Doorn WMA have remaining natural land. From Figure 3.6 one can see the majority of the land has been overrun by agriculture, with a few sections of "other natural" land. Two specific sections of land in the Bergrivier Municipality have been left in its natural state, this is the mountainous region to the East of the Municipality and the Piketberg Mountains. These have been largely put into conservation areas or incorporated into the Terrestrial CBA's.

The original vegetation cover of the area can be seen in Figure 3.11 the Bergrivier Municipality was once covered by Coastal Renosterveld, to the east and middle sections of the Municipality, Coastal Macchia to the west and Central Lower Karoo to the north. The Olifants-Doorn section of the study area is covered predominantly by Knysna Forest and Central Lower Karoo up until the Olifants River. North of the Olifants River the vegetative character of the WMA changes to a drier climate and thus drier plant types such as Succulent Karoo (ENPAT, 2001 and Department of Water Affairs and Forestry, 2005). Very few sections of indigenous vegetation still remain in the Bergrivier Municipality.

There are great issues with alien vegetation in the north of the study area, they stretch across approximately 122km² of the WMA with the majority of the alien invasive occurring in the sensitive, riparian zones (Department of Water Affairs and Forestry, 2005). Alien invasive clearing has been taking place under the Working for Water Programme. The most dominant and water threatening alien species are: Acacias, Pines, Syringa, Eucalyptus and Prosopis, these species use 80% of the water used by alien invasive (Department of Water Affairs and Forestry, 2005).

One of the largest terrestrial alien invasive problems can be found near Langebaan, in and around the West Coast National Park (see figure below) (Department of Water Affairs and Forestry, 2007). This however conflicts with data from the River Health Programme (2004) in which this area is shown to constitute natural vegetation (see Figure 3.10, below and 3.6, above).

The fauna of the region ranges from various endangered, indigenous aquatic species to larger, terrestrial animal species. The Berg River particularly has major problems with alien

fish species killing off the indigenous fish within the river (River Health Programme, 2004). Much of the Olifants River is still unspoiled and therefore of great ecological value, the river and its tributaries also hosts a number of endangered, endemic fish species (Department of Water Affairs and Forestry, 2005). The Olifants River and its tributaries are generally in a much better condition than the Berg River and its tributaries which rates predominantly poorly according to the River Health Programme (2004).

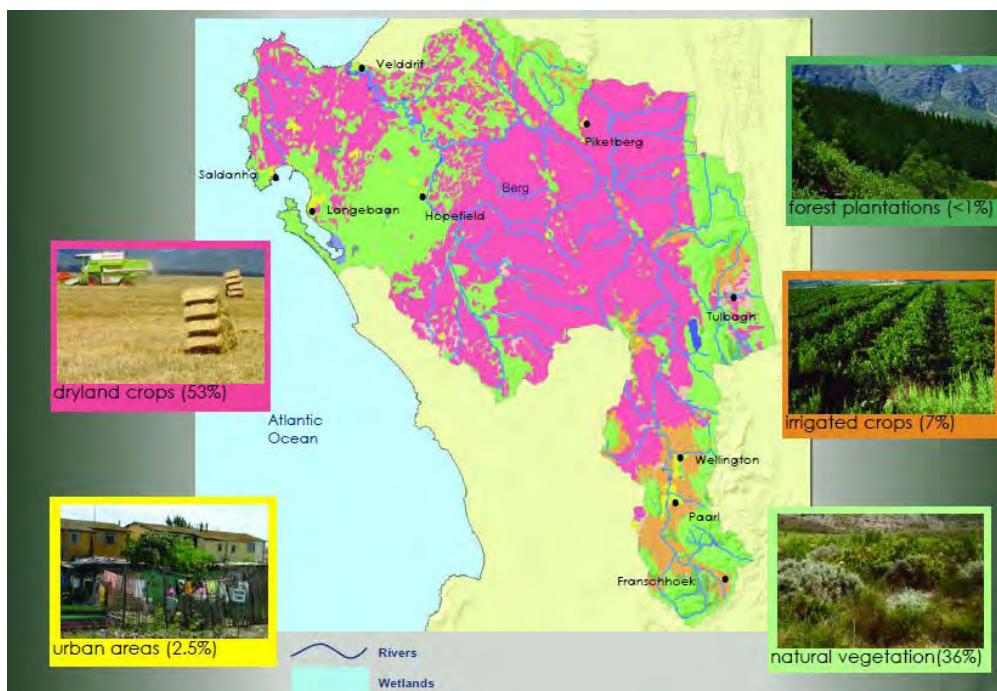


Figure 3.9: The farming land-use within the Berg River Basin (River Health Programme, 2004). Note the dryland crops coincide with the category “cultivated land” in figures 3.6 and 3.7.

The alien fish species along with alien vegetation has detrimental impacts on the riverine system resulting in weakened banks causing increased sedimentation and disturbed aquatic faunal ecosystems. The middle-lower reaches of the river has issues of alien plant species, specifically river gum and black wattle, these alien species in the riparian zone, destabilizes the river bank causing vital soils to wash away and increase sediment load of the river. Pesticide run-off from surrounding farms have also caused a loss in aquatic fauna.

The lower reaches of the river is dominated by alien fish, the riparian zone is also inundated by alien vegetation which clog the river surface and used large amounts of the water. There are a number of important fresh water and salt water fish species in the Berg River basin system. It goes without saying that these species are important to the system and should be cared for and protected.

The floodplain of the Berg River is a vital process that needs to be protected (River Health programme, 2004). The flooding of the flood plain release fresh water into the area, this brings in nutrients for the land and vegetation and also bird sanctuary. The floodplain is the site of high biological activity and should be maintained; threats to the floodplain are reduced river flow and increased demand for agricultural land and developments.

There are various conservation sites for conserving Fynbos species along the West Coast. The conservation of Renosterveld is however very poor with less than 1% of Renosterveld being conserved along the West Coast (Western Cape Government, 2000). Less than 3% of the West Coast Renosterveld still exist, the fertile soils on which Renosterveld thrive has been largely removed due to agricultural potential (Western Cape Government, 2000). It is safe to assume Renosterveld falls into the CBA category, and will therefore form part of the proposed protection network.

The alien fauna and flora issues are directly linked to issues of water quality in the Berg River system. In solving this issue the water quality and flow will increase. The quality will increase for two main reasons, increased water flow due to decreased water abstraction by alien plants. And it will increase due to a reduction in fish species which feed off the indigenous fish and plant species which have a very significant role in maintain the river's health.

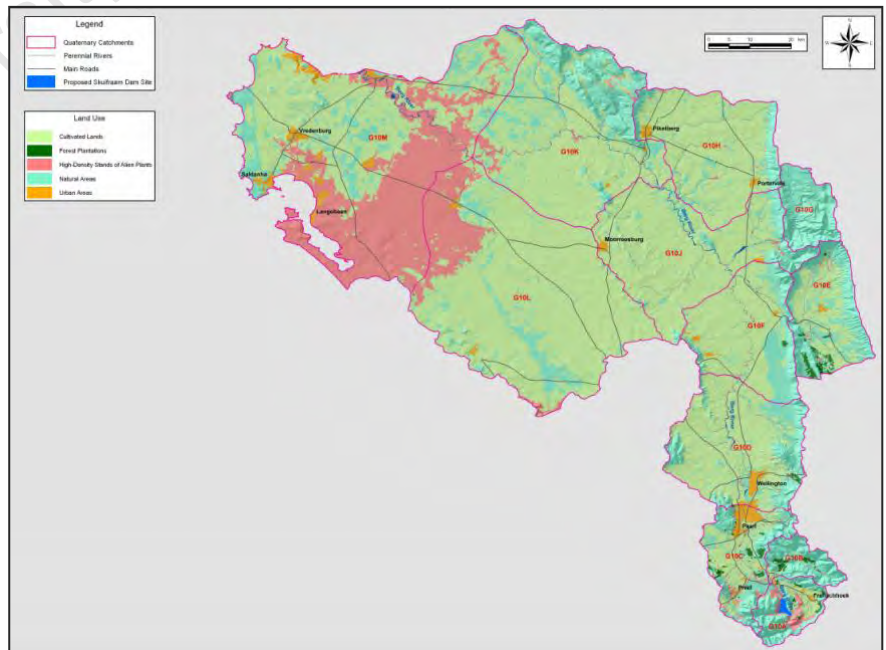


Figure 3.10: The SANBI CBA's (terrestrial and aquatic) these are areas in urgent threat. These areas form a connected network of endangered areas and will form the basis of the proposed protected areas network in this project (Source: Department of Water Affairs, 2007).

Soil Potential

Within the entire study area (the Oifants-Doorn WMA and the Berg River Basin) the large majority of the land has low soil potential for agriculture, possibly due to the fact that the

land is already mainly covered by agriculture (ENPAT, 2001). Soil potential is measured in potential for agricultural production. The soil potential does however help in that it provides a layout for areas for potential rehabilitation, protection or conservation as it shows areas with good soil quality (these will be the soils that are best suited for agricultural use). The only area with good quality soil according to Figure 3.12, is the area south of Eendekuil. This area is currently used for agricultural production. Other areas known to have high quality soils is the riparian zone, most of these have been overrun by agriculture. The mountainous regions are suitable for conservation, recreation and grazing. There is potential for soil rehabilitation.

Biodiversity management in the Bergrivier Municipality

The following are current foci of the local biodiversity strategic and action plan:

- The closure and rehabilitation of waste disposal sites and the implementation of recycling
- The development of a botanical garden in Piketberg
- The revision of the Spatial Development Framework
- Participation in the Berg Estuary Management Forum (BEMF)

The main issue to come out of the Bergrivier Municipality Biodiversity Strategy and Action Plan (2011) is the need to integrate the issues of biodiversity into government plans and policies. The conservation of terrestrial and aquatic biodiversity is also lacking. Other issues include the more generic, reduction of waste and pollution impacts on biodiversity and how to integrate biodiversity into economic development (Bergrivier Municipality, 2011). It seems the issues of biodiversity are being lost along the way and are only considered if it contributes to economic development (either directly or indirectly such as in tourism).

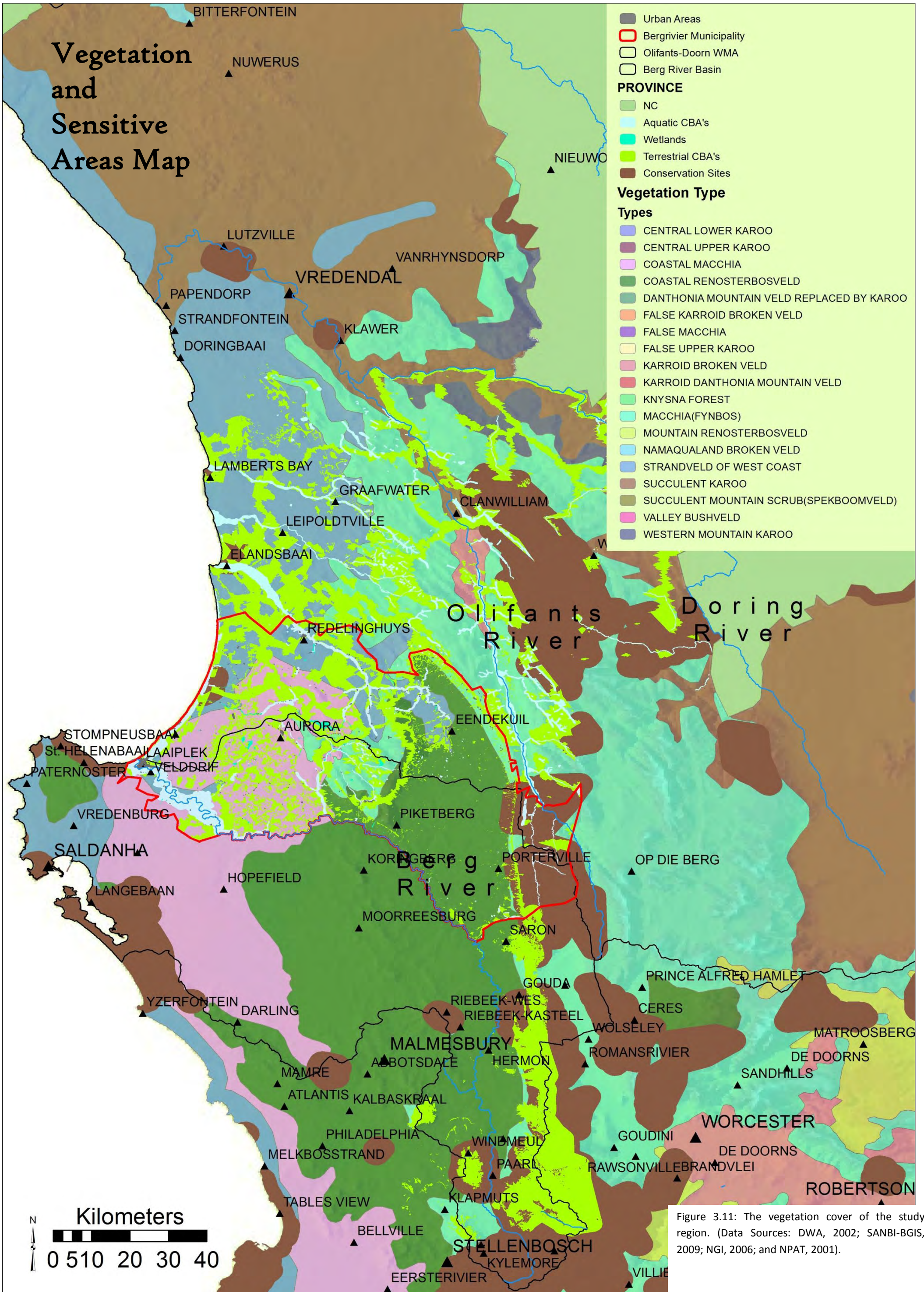


Figure 3.11: The vegetation cover of the study region. (Data Sources: DWA, 2002; SANBI-BGIS, 2009; NGI, 2006; and NPAT, 2001).

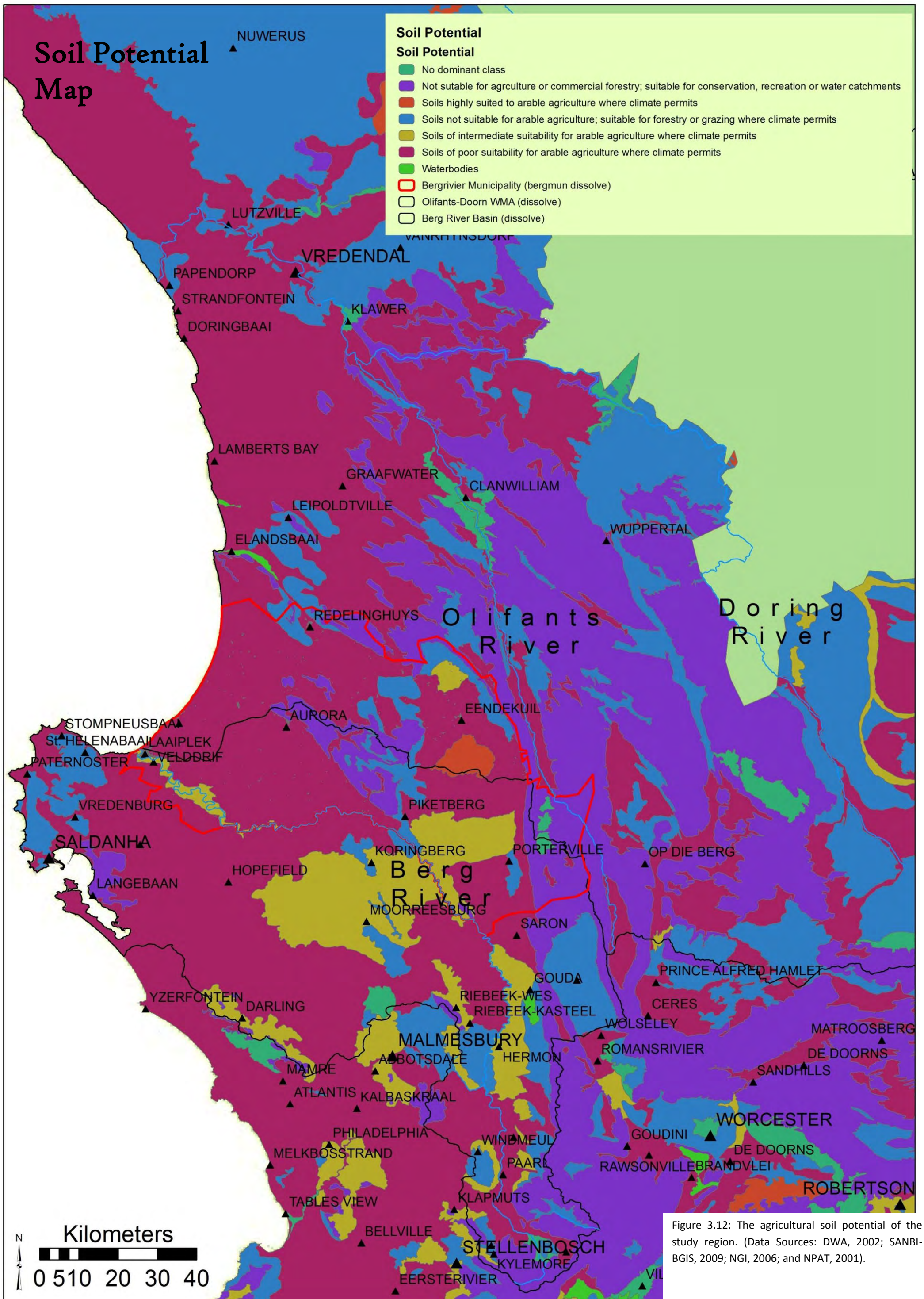


Figure 3.12: The agricultural soil potential of the study region. (Data Sources: DWA, 2002; SANBI-BGIS, 2009; NGI, 2006; and NPAT, 2001).

Climate Systems

The Berg River catchment experiences a Mediterranean climate, this means warm, dry summers and cold, wet winters (Department of Water and Forestry, 2007). The rainfall is associated with low pressure systems (cold fronts), experiencing warm period's between these north western cold fronts. The rainy season lasts from approximately April to October and mean annual precipitation ranges between 300 and 1000 millimetres per year, depending on the section of the catchment (Department of Water and Forestry, 2007). The rainfall increases in a general trend from the West to the East, making the Western portions of the catchment significantly drier (see Figure 3.6).

The mountains play an important role in capturing moisture as air is pushed up alongside the mountains causing rainfall during drier seasons. This is in addition to the frontal rains (Department of Water and Forestry, 2007). This orographic rain causes the massive difference in precipitation across the basin, making the Eastern side wetter than the West (Department of Water and Forestry, 2007). The average temperature for the basin is 16°C (18°C in the West and 16°C in the East) (Department of Water and Forestry, 2007).

The climate of the Olifants-Doorn WMA is very similar to that of the Berg River basin, especially to the southern sections. The WMA experiences extremes in summer and winter temperatures due to the local topographical variations. Average winter temperatures range between -3°C and 3°C, average summer temperature range between 39°C and 44°C (Department of Water Affairs and Forestry, 2005). The area typically receives winter rainfall and experiences a Mediterranean climate. The rainfall for the area also varies with topography, certain areas in the south receive 1500 mm per year and other areas to the north east receive up to 2200 mm per year (Department of Water Affairs and Forestry, 2005). With the impacts of climate change, it is predicted that these areas can receive 15% less rainfall than currently (Department of Water Affairs and Forestry, 2005). This is significant for dryland crops which are predominantly farmed in the study region (both the WMA and the basin).

The more northern sections of the Olifants-Doorn WMA experiences much drier conditions, evident in the change in crop type and average temperatures. The rainfall to the southern

sections of the Olifants-Doorn WMA is about 100 mm to 200 mm and 1500 mm in the south, closer to the Berg River Basin (DEADP, 2011). The northern land is thus not suitable for dryland farming as it best used to accommodate livestock farming (IWRMP).

Physiographic and Climate Hazards

The study region has very little physiographic risks with the exception of a high fire risk. The region has two striking faults systems; these occur in a North to North Westerly direction- the Franschoek-Saldanha (Colenso) fault and the Wellington-Piketberg fault (Visser, 1989 cited in Department of Water and Forestry, 2007). The earthquake risk is however very low. The region has not experienced any earthquakes, there has been one reports of a slight tremor in Porterville in 1963, this is however negligible (Council for Geoscience, 2012). The closest town with the most significant tremors or earthquakes is Ceres.

The risk of fires and floods are shown below, for the Western Cape. The Olifants-Doorn WMA and the Berg River Basin have a high fire warning due to vegetation, these are highly vulnerable to fires due to their dryness. The flood risk for the Berg River basin is predominant along the lower sections of the Berg River, the Verlorevlei River and the Olifants River (see Figure 3.14 -circled in black). The most recent floods to occur in this area were in August 2013, in which residents along the river in Paarl, were washed out of their homes and certain parts of the town (www.news24.com, 2013). With the increase in erratic rainfall, due to climate change, the potential for floods will increase. The rivers and their associated buffer zones should be maintained or increased.

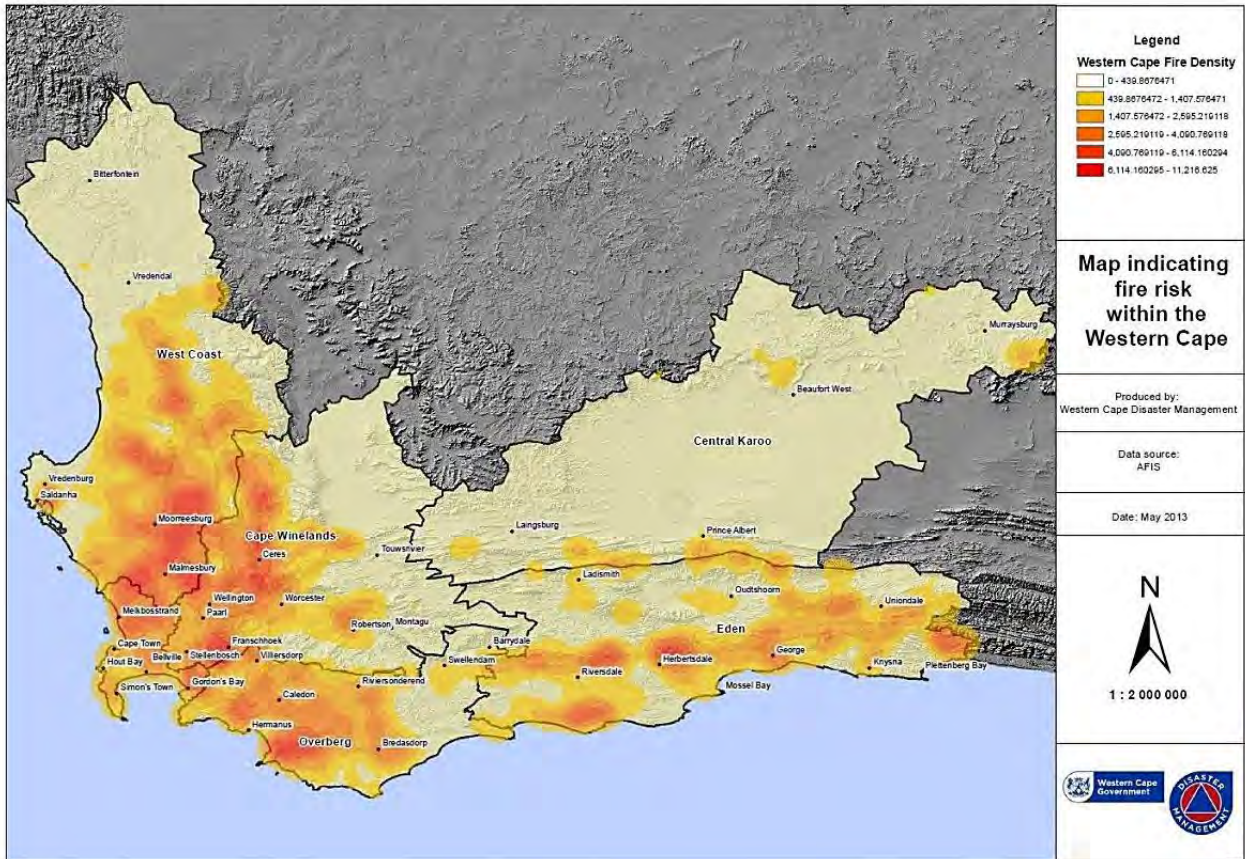


Figure 3.13: Fire risk for the Western Cape (Source: www.news24.com).

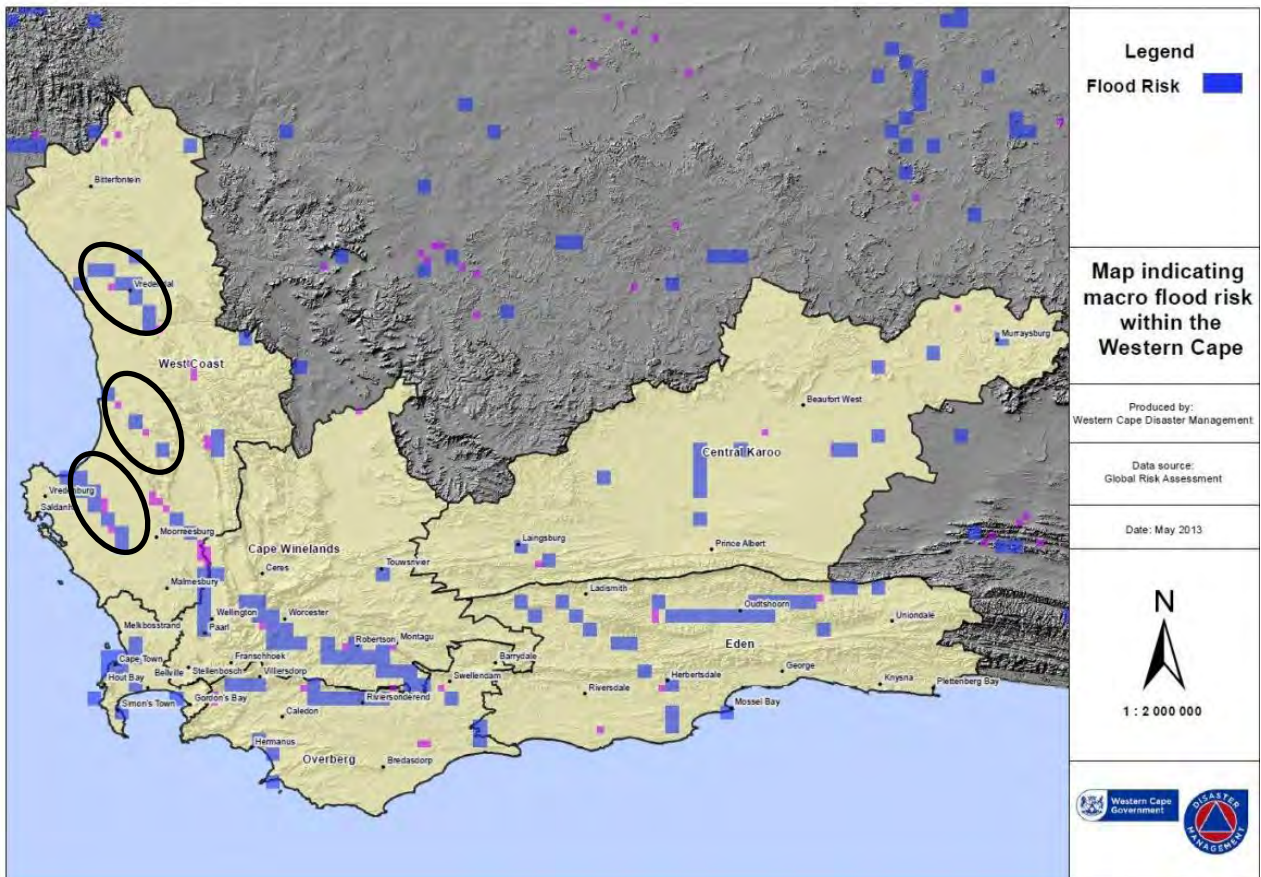


Figure 3.14: Flood risk for the Western Cape (Source: www.news24.com).

Climate Change Impacts

The Western Cape is predicted to become drier and warmer with the impacts of climate change, with increased frequency of storm surges and erratic rains (DEADP, 2013). Within a region such as the West Coast which is mainly concerned with agriculture these impacts could prove detrimental. In the study region, the main farming type is dryland crop farming of potatoes, deciduous fruits and forest plantations. The estimated lack of water in future will negatively impact the crop, even more than the increase in temperature, according to a case study in China (Zhao et al., 2013). This case study, in the Wuchuan County, China, examined the impacts of a drier, warmer climate of the dryland crops (potatoes, wheat and naked oats) and found that the lack of water affected the crop production more severely than the increased or accumulated temperature (Zhao et al., 2013). In an effort to preserve their farmland they have proposed adaptation techniques that include introducing the drought resistant crops and drought resistant cultivation techniques (Zhao et al., 2013).

Climate changes will also impact livestock farming, increasing heat exhaustion among animals (Thomas et al., 2007). It will also impact water quality by decreasing water flow and thus increasing the densities of suspended materials, wetlands, floodplains and estuaries will be impacted. Other climate change impacts include changes to the coastline due to sea level rise and increased frequency and severity of storm surges. These impacts have not been identified as particularly occurring within the study region, it should however be further investigated.

Bergvliet Municipality's' response to climate change

The Municipality has recently prepared a draft climate change adaptation plan which identified the following as the major concerns for the Municipality:

1. Poor infrastructure and limited services
2. High dependency on grants
3. Degraded environment due to development
4. Poor water quality (river)
5. Limited employment opportunities

6. Migration and seasonal work (leading to HIV and competition for jobs)

These issues are social in essence and all of them are not necessarily direct implications of climate change. Climate change issues should be investigated and mapped. Mukheibir and Ziervogel (2007) provide a Municipal Adaptation Framework for local Municipalities. This proves helpful and practical in terms of planning for Municipal level.

The Bergrivier Municipality is currently experiencing climate change impacts, the Municipality draft climate change adaptation plan describes that the region has experienced ten warmest years, all after 1997. There is evidence of changing rain fall patterns, the precipitation has become more infrequent but increased at the same time. The rain season has also slightly changed (Bergrivier Municipality, 2013). The following were identified as the elements most vulnerable to climate change impacts in the Municipality:

- Low income housing
- Stormwater infrastructure
- Natural resources – veld/soil/land
- Agriculture – wheat

The Municipality identified that a need for political buy in and funding is now needed to carry out the climate change adaption plans. It has a drastic shortage of environmental personnel, with the addition of climate change issues, this shortage is much more urgent. The Municipality has come up with strategies to combat climate change impacts, these include increasing awareness and building climate resistant low cost housing, improving the use of stormwater run-off and improving stormwater infrastructure. There is no material plan in combatting the impacts on agriculture, this perhaps the most important climate change impact as it impacts the main economic and socio-economic function of the area.

Basic Material Flow Analysis of the Bergrivier Municipality

In analysing the material flow of a Municipality, an audit of used, produced and lost natural resources are measured. This section on material flow analysis is not a full analysis as it does not analyse all the relevant resources used in this region due to lack of available information to the researcher at the needed time. It does however aim to paint a picture of the regions

natural resource use and highlight areas in which the Municipality could potentially be saving and substituting. A proxy is used, the Breede River Basin and Langeberg Municipality is used as a proxy as it consists of similar social, economic and environmental characteristics. Due to lack of available information this material flow only focuses on the Bergriver Municipality (and not the river basin context).

In this section I will focus on two specific resources, water and electricity, but also maps the important industries in the region. A more detailed study of the Municipality is suggested, this will aid the Municipality in detailing their resource losses and identifying gains.

Electricity

The main inputs into regional functioning are local extracts, imports and domestic material inputs (Fischer-Kowalski, 2010). This produces a domestic processed output, emigrants and exports. The main inputs in today's industrial societies are: carbon containing biomass and fossil fuels, construction mineral and industrial minerals (Fischer-Kowalski, 2010). The inputs accumulate to 17 tonnes per person per year (Fischer-Kowalski, 2010). The outputs consist in large majority of carbon dioxide, in much smaller quantities there is domestic output to water sources, land and air. The outputs accumulate to approximately 16 tonnes per person. Resource use and abstraction has increased exponentially over the last 100 years. The main driver of this being, population, income increases, human settlement patterns and the change from agrarian societies to industrial societies (Fischer-Kowalski, 2010).

South Africa is a high intensity industrial nation due to its large coal exports, the main energy source in South Africa is from coal oil, natural gas and biomass this accumulates to 96.6% of South Africa's energy being based on natural resources and at least 80% of this are non-renewable resources (Swilling, 2011). South Africa produces its own coal but imports oil, the use of these fuels is vast across South Africa with the main mode of transportation reliant on fossil fuels, there is opportunity for new energy resource. Regions like the West Coast District are important in this regard as there is ample opportunity for wind, sea and solar energy production. The Bergrivier Municipality as a typical rural-industrial South African Municipality, relies heavily on oil and petrol for imports and exports into the region for the sustainability of its economy. The Municipality employs no alternative source of

electricity and are therefore either supplied with nuclear or coal fired power (Bergrivier Municipality, 2011-2012).

In terms of energy, there is an interest in wind energy production in the District, there is also a planned gas and oil energy farm planned at Saldanha due to discovered resources (West Coast District Municipality, 2007). Further to the north of the District Municipality, to the middle of Olifants-Doorn WMA there are applications for a wind farm and mining activities, just north of the Olifants River.

Water

The Bergrivier Municipality gets water from three sources: abstraction from surfaces within the water service area, groundwater abstraction in the water services area and purchasing from the external sources (for example the water board) (Bergrivier Municipality, 2009-2010). The total water usage for the Bergrivier Municipality for the 2008, 2009 period was 2563.8megalitres, this is projected to increase to 3000.7 in 2014 (Bergrivier Municipality, 2009-2010). Water availability is a vital issue in this region and Municipality, potential for diversified water sources is available. However the potential for water reuse or recycling is still a gap. There are a number of towns that require more water; options for water re-use should be investigated. With approximately 2126 Megalitres of treated effluent being discharged into the Berg River with an additional 400 Megalitres increase request, there is opportunity for the Municipality to develop ways to reuse this water as irrigation or potable water. According to the Municipality's annual report (2011-2012) the problem of water waste (through infrastructure leakages) has decreased significantly.

Towns such as Piketberg and Porterville get their water from within the water use area (the Municipality) and require at least 700 Megalitres additional water, each. These increasing water needs trends are not uncommon in the Municipality. Due to increased water demand there has been an increase in groundwater stress. A number of town depend on groundwater for potable water, however there has been an increased demand on groundwater in recent years. The groundwater in the area is not regularly monitored; this could cause problems in times of urgent water need where the groundwater could serve as ideal water sources. Another option for the Municipality is to use the several aquifers in the region as underground dams as there is a reduced evaporation rate.

The Berg River is heavily relied upon by surrounding areas in the basin. It is a source of irrigation, storage and supply (Department of Water and Forestry, 2007). It also forms part of a number of water transfer initiatives, the most prominent one being the Theewaterskloof Dam. The Theewaterskloof Dam is situated in the Breede River Basin, it is used to supplement the Berg River in order for it to maintain supplying the surrounding areas and Cape Town metro.

The current transfer volumes are as follows (Department of Water Affairs, 2004):

- 162 million m³/a from the Riviersonderend catchment.
- 22.5 million m³/a on average from the Palmiet River
- Smaller transfers from the Breede WMA accumulate to 9 million m³/a

The tables below describe the water use in the study area. The volume of water used in the Bergriver Municipality is not accurate and should be somewhat lower than what it is in Table_. The calculation is an approximation as it is based on the entire Olifants-Doorn WMA, of which only a portion falls into the Municipality. Only the “lower berg” volumes were used to represents the section of the Municipality that falls within the Berg River Basin.

Theewaterskloof Water Transfer Initiative

The water is taken from the Riviersonderend River and held in the Theewaterskloof dam until it is released into the Berg River, some of this water is used in the catchment for irrigation and the rest is used to supply Cape Town with potable water.

The kinds of water released have been known to cause changes to the quality and flow of the Berg River (Department of Water and Forestry, 2007). With the growing water demand in the Western Cape, the Berg River Water Project was initiated and constructed the Berg River Dam, this dam also stores water for use throughout the year (Department of Water Affairs and Forestry, 2007). The Berg River Dam was officially opened in 2009 and operated concurrently with the Theewaterskloof inter-basin water transfer scheme (Department of Water Affairs and Forestry, 2007). The Berg River Dam captures winter rainfall to increase the water supply to the City of Cape Town during summer months (Berg Water Project, unknown).

Table 3.1: The water inputs and outputs of the Olifants-Doorn WMA (Table Source: Department of Water Affairs, 2004).

Component/	Local yield	Transfers in²	Local requirement	Transfers out²	Balance¹
Koue Bokkeveld	67	0	66	0	1
Sandveld	32	0	38	0	(6)
Olifants	221	0	247	3	(29)
Knersvlakte	4	3	7	0	0
Doring	11	3	15	0	(1)
	335	3	373	0	(35)

Table 3.2: The water inputs and outputs of the Berg WMA (Table Source: Department of Water Affairs, 2004).

The Upper Berg represents the south of the study area- the Berg River Basin.

Component/	Local yield	Transfers in²	Local requirement	Transfers out²	Balance¹
Greater Cape	108	269	394	0	(17)
Upper Berg	322	32	229	125	0
Lower Berg	52	18	81	0	(11)
	482	194	704	0	(28)

Table 3.3: The total inputs and outputs of the Bergrivier Municipality and the wider study area- the Berg River Basin and the Olifants-Doorn WMA (Table Source: Authors own, data from the National Water Resources Strategy, 2004 and the Bergrivier Municipality, 2009-2010).

	LOCAL YIELD	TRANSFERS IN	LOCAL REQ	TRANSFERS OUT
Olifants Doorn WMA	335	3	373	0
Berg River Basin	52	32	229	125
TOTAL WATER USE IN THE BERGRIVIER MUNICIPALITY	387	35	602	125

**The Breede WMA transfers water to the Olifants-Doorn WMA (2.5 million m³/a to the Inverdoorn Canal, mainly for irrigation).

Landscape Character Analysis

The Berg River basin is largely rural, with peri-urban settlements. The basin area constitutes a majority of large agricultural land and very few remaining natural areas (areas with indigenous land cover). The region displays a rich range of holiday places in which many people from nearby cities enjoy, evident in the large variety of farmsteads hosting holiday makers. It also boasts a range of heritage and culturally significant sites (see Figure 3.15).

The River Health Programme (2004) describes a brief history of the Berg River Basin. The rich social history regarding the indigenous tribes of the area, the San and Khoekhoe has provided a range of rock paintings within the study region. These artefacts form a very significant part of South African national history and placed in the hands of the current population in order to be preserved for future generations. Franschhoek, Paarl and Tulbagh form part of this cultural heritage as these towns housed several groups of settlers in the past. Franschhoek housed the French Huguenots who brought new knowledge, of wine farming, presenting the region with an intellectual property that it would one day become world renowned for (River Health Programme, 2004). The towns of the region grew as settlers moved further north, livestock and grain farmers developed their farms toward Moorreesburg, Porterville and Piketberg. Several of the towns have great heritage value and cultural significance such as Goedverwacht, Piketberg, Porterville and Wittewater in the Bergrivier Municipality. In the study region the list of towns extends to include: Riebeeck Kasteel, Doringbaai, Paternoster, Dwarskersbos, Clanwilliam, Wupperthal and Riebeeck Wes (West Coast District Municipality, 2007). The rich cultural and historical significance of the region can be harmed with drastic changes in land-use and functioning of the area. Recent interest in developments in the region should be strongly considered in terms of posing a threat to local heritage and history.



Synthesis of Analysis for the Bergrivier Municipality

This section looks to summarize the major issues identified in the Bergrivier Municipality and then goes on to examine the initiatives of the Bergrivier Municipality is undertaking to mitigate these problems. Many of the issues are linked and impact each other, especially those from within the same systems, such as the water system. This summary however also attempts to find further integrative links between the systems.

Water Quality and Quantity

The predominant water supply is river water, thus water quality refers to river water. Water quantity is impacted by a number of elements; alien vegetation generally uses much more water than indigenous vegetation, adding to the problem of reduced river flow, contributing to increased salinity and thus lower water quality. Alien vegetation is a problem in the study area, particularly in the middle to low reaches of the Berg River. There are five species that use 80% of the water used by alien vegetation which should be removed first to help secure water quantity and quality.

Anthropogenic activity increases as the river moves from source to mouth, with the increase of settlements and anthropogenic activity, the quality of river water decreases. This is due to major issues, pollution through wastewater treatment works and agricultural run-off. The influence of anthropogenic activity also impacts groundwater. The study region does not contain many adequate aquifers, there is only one area in the Bergrivier Municipality that has a good source of groundwater. The use of groundwater is un-monitored, leaving opportunity for groundwater abuse, pollution and exhaustion. In an area such as the study area, the sources of groundwater are imperative in cases of drought. Just as there are quantity issues with groundwater, the region exercises a number of river water abstractions. The region has water transfers in place with the Breede River Basin, but there are opportunities to return this water to the Breede River Basin or recycle the region's water in order to supplement the need.

The problem of alien vegetation is twofold; it reduces water and increases fire risk. The Municipality have suggested using the Expanded Public Works Programme (EPWP) as a

means of clearing the alien vegetation and providing employment for local communities (Bergrivier Municipality, 2013). This could foster closer ties with other government departments and other spheres of government. The integration of the Municipality is important, integration into Water Affairs and Environmental Affairs is important for the links the Municipality will need to succeed in their water related plans, this has been identified by the Municipality as a current gap (Bergrivier Municipality, 2013). The health of the local biodiversity is vital to the Municipality as tourism depends greatly on it. Tourism is a large economic sector in the region and continues to grow. To fulfil the goal of tourism, the Municipality aims to maintain ecological integrity and natural land-cover.

In addressing the water need in the Municipality, the Municipal Water Services Development Plan focuses on providing well-functioning infrastructure to other rural and urban settlements. This focus is service delivery focused and looks to the end of the water cycle to make a change. Perhaps the change should be made earlier in the cycle. The Municipality identified ample financial support available for infrastructural projects. This can be taken advantage of by devising infrastructural projects for water re-use or recycling projects. In this way the funding can be granted to a more sustainable use.

Pollution is another hindrance to water quality, issues with pesticides, substandard wastewater effluent and waste sites in Municipality contributing. There is sufficient opportunity to develop recycling efforts, specifically water and household waste. There is an integrated waste management plan in a second round of updates; this plan has been put forward by the Local Municipality to guide waste reduction. The Municipality is currently working toward a 30% reduction in waste in an attempt to reduce travel costs for waste (Bergrivier Municipality, 2013). The Municipality has also rolled out a number of monitoring and measuring air quality controls, the District Municipality currently controls this.

High Value Areas

The study region contains a variety of conservation corridors and areas including wetlands and biodiversity hotspots. These areas are important in terms of tourism and thus economic functioning but also rely on the quality and quantity of water. The estuaries provide an excellent ground for biodiversity but the Berg River estuary is overrun by

anthropogenic activity. The estuary management plan speaks rehabilitation of estuary which has been approved since 2010. An estuary zonation plan was put in place as a means of regulating the rehabilitation of the estuary and managing the anthropogenic uses and functions. There are processes currently in place to put part of the estuary under Marine Protection status, this will place 50% of the biodiversity into protected status (Bergrivier Municipality, 2010). The problem of alien fish is still a problem thought; this strategy does not specifically focus on alien fish but focuses on protecting the indigenous fish and vegetation. The Municipality is also strongly motivating for the Berg River to become a RAMSAR site and be incorporated as a core area in the West Coast Biosphere Reserve framework. Due to the position of an estuary, sitting on the border of fresh and sea water, there are many government departments at all spheres that take an interest. For this reason a Berg River Estuary Management forum was established, to help the integrated management of the estuary.

Riparian zones along the Berg River in particular are in a negative state. Riparian zones are vital for river health and form a protective buffer around rivers. They are also areas of high quality soils and in the Berg River basin have been largely used for agricultural production. This could be contributing to the unhealthy state of the Berg River and should be cleared and rehabilitated. The West Coast District is currently producing a coastal management plan that will be used defining roles and responsibilities in the Municipalities (Bergrivier Municipality, 2013/2014).

The Bergrivier Municipality consists of a number of highly valuable natural resources, the broader context too. Opportunities exist to form a continuous ecological or “green” corridor, along the West Coast.

Potential Resources

With the need for more water in the region, groundwater is a possible solution. A number of towns currently make use of groundwater but groundwater goes un-monitored in the region. There is a definite opportunity for larger scale groundwater abstraction, but feasibility studies will need to investigate this first. Groundwater sources require finer monitoring and evaluation especially since it is in threat in certain areas.

There is a number of building materials present in the region, but not in the Bergrivier Municipality. The Municipality does however produce salt on a fairly large scale. In terms of potential resources the Municipality's ideal potential lay in adapting their agricultural activities with climate change and producing a wider variety of drought resistant crops.

The carbon heavy nature of the Municipalities functioning will lead it into difficult times with the current fossil fuel depletion. There is thus a more urgent need to find other sources of energy and the location of the Municipality provides it with several opportunities for renewable energy. In introducing a new market, such as renewable energy, the Municipality can increase job opportunities.

Risks

The Municipal IDP has identified the issues of drought and water quality and suggest the option of desalination in times of drought as well as the monitoring current groundwater in order to secure this resource, which is currently running low (Bergrivier Municipality, 2013). The issue of drought is said to occur due to climate change impacts. There is opportunity for crop changes in order to maintain economic, social and environmental security. In terms of the fire hazard of the area, the Municipality in conjunction with the District Municipality have established a fully functional fire station. Public awareness regarding fires will be the next step. The study region has a risk of flooding especially in areas alongside the Berg River. These areas however do not fall into the Municipality. The Municipality have identified this and are looking to establish flood line barriers. The Municipality has a disaster management team, which works closely with the West Coast District Municipality

Institutional Problems

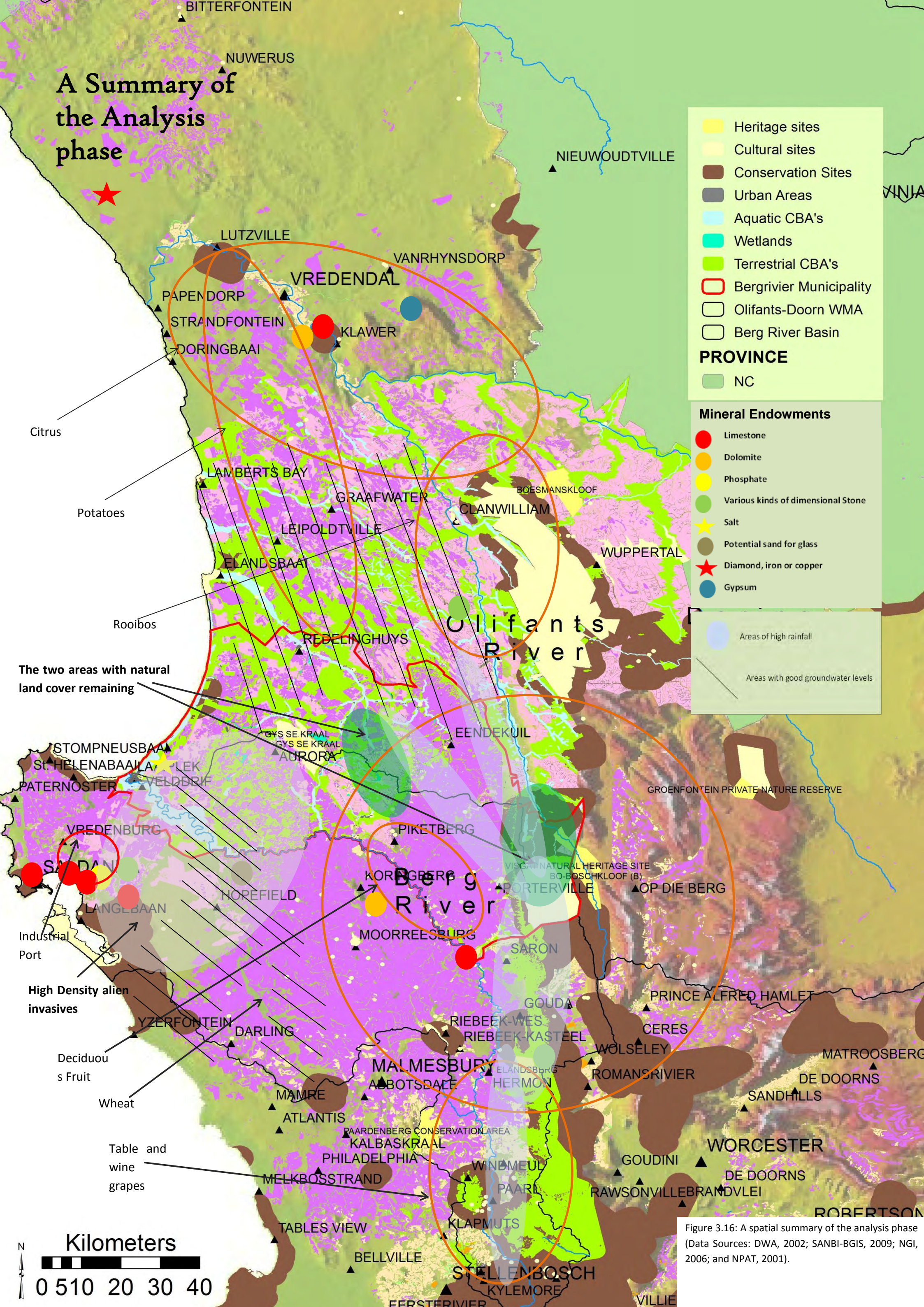
There are a number of jurisdictional grey areas when working with the natural environment, estuaries and coasts seem to be the major victims thereof. The Bergrivier Municipality is a small Municipality with a very limited capacity base; it does however use the national and provincial arm in positive ways in order to aid them. The capacity issue however still remains a vital gap and needs urgent attention. With the increase in capacity the Municipality will be able to carry out a lot more detailed plans and programmes. They will also be able to

investigate and understand their surrounding environment in a much healthier detail. This environment is their shaping factor to their settlements and functioning (Bergrivier Municipality, 2008).

Table 3.4: A summary of the analysis phase using the SWOT Analysis.

	Strengths	Weaknesses	Opportunities	Threats
Physiographic	<ul style="list-style-type: none"> • Good soil in riparian zones • Mineral deposits 	<ul style="list-style-type: none"> • Lack of vast natural land • Low soil potential • Predominantly agriculture • Agriculture in riparian zones • Settlement in sensitive areas 	<ul style="list-style-type: none"> • Potential for rehabilitation of land • Some natural areas remaining 	<ul style="list-style-type: none"> • Lack of good quality soils
Hydrological	<ul style="list-style-type: none"> • Adequate quantity of water produced in the region, for the region • Groundwater 	<ul style="list-style-type: none"> • Many water exports to Cape Town • Low quality river water • Groundwater stress 	<ul style="list-style-type: none"> • Potential groundwater resources • Potential to increase surface water by alien removal 	<ul style="list-style-type: none"> • Alien vegetation and fish • Pollution • Unhealthy estuaries and wetlands
Biotic	<ul style="list-style-type: none"> • Significant biodiversity 	<ul style="list-style-type: none"> • Alien invasive fauna and flora 	<ul style="list-style-type: none"> • Rehabilitation of habitats 	<ul style="list-style-type: none"> • Urban settlement • Increased agricultural land • Alien vegetation
Landscape Character	Many culturally and heritage significant places		Potential for increased tourism	
Institutional	<ul style="list-style-type: none"> • Integrated thinking and operations • Coverage of a diverse range of environmental problems • Diverse range of environmental management plans 	Lack of capacity	Potential for more projects	Lack of capacity
Hazard and climate change	<ul style="list-style-type: none"> • Disaster management plans in 	<ul style="list-style-type: none"> • Uncertain future impacts 	<ul style="list-style-type: none"> • Adaptation • Mitigation methods 	<ul style="list-style-type: none"> • uncertainty
Material Flow	<ul style="list-style-type: none"> • water sources are diversified. 	Linear metabolism	Potential for a more circular loop	Linear processes, lack of re-use and recycling

A Summary of the Analysis phase



- Heritage sites
- Cultural sites
- Conservation Sites
- Urban Areas
- Aquatic CBA's
- Wetlands
- Terrestrial CBA's
- Bergrivier Municipality
- Olifants-Doorn WMA
- Berg River Basin

PROVINCE

- NC

Mineral Endowments

- Limestone
- Dolomite
- Phosphate
- Various kinds of dimensional Stone
- Salt
- Potential sand for glass
- Diamond, iron or copper
- Gypsum

- Areas of high rainfall
- Areas with good groundwater levels

The two areas with natural land cover remaining

High Density alien invasives

Figure 3.16: A spatial summary of the analysis phase (Data Sources: DWA, 2002; SANBI-BGIS, 2009; NGI, 2006; and NPAT, 2001).

Chapter 4

This chapter describes the intervention needed to carry out this framework. It comprises five sections: protection policy, production policy, rehabilitation policy, a metabolic restructuring policy and a hazard avoidance policy (Barrie Gasson, 2013). It also contextualizes this framework in terms of its influence on South African policy and legislation. This chapter is based on the analysis chapter, specifically the key issues that came out of the analysis.

Positioning this Natural Resources and Landscape Management Framework

Divergent paths of planning and environmental management related fields

Environmental management and planning have developed separately, out of different processes and yet they are required to integrate under the banner of planning (Todes, 2005). This integration saw its first phases in the 1970's (in South Africa) but lead to too many overlaps in structure and legislation (Todes, 2005). Thereafter the Environmental Conservation Act (No. 73 of 1989) was promulgated, this separated the environmental system from planning but unfortunately focused on management and control (in the form of conservation areas) (Todes, 2005). This still maintained the separation between the environmental system and spatial planning. According to Todes (2005) the South African government has not yet decided on an adequate definition of sustainability, causing a number of priority issues between the social, economic and environmental systems (Patel, 2004 cited in Todes, 2005). This impacts the plans on the ground as the environmental systems are often neglected due to "more powerful policy and legislation" usually concerning economic development (Bond, 2002 cited in Todes, 2005). This is ironic in that development in South Africa has been strongly underpinned by the 1987 Brundtland Report's definition of sustainable development (Todes, 2005). This definition made an important contribution to environmental legislation in South Africa as it directly underpins NEMA (Todes, 2005).

According to the National Framework for Sustainable Development in South Africa it is "the integration of social, economic and environmental factors into planning, implementation and

decision-making so as to ensure that development serves present and future generations,” (Todes, 2005: 14). It provides a holistic base for not only environmental management but to all kinds of development in South Africa (Todes, 2005).⁴

There are a number of functional areas that show evidence of the gap between sustainability (environmental management) and planning. Allowing a number of important development components to “fall through the cracks” (Todes, 2005: 5). Social concerns and a narrow focus on environmental issues are problems despite the many overlaps in mandate between the planning (which requires a sustainability focus) and environmental management (Todes, 2005). National plans in South Africa prioritise economic development, through infrastructure related job creation, and they do not consider the environment as strongly (Todes, 2005). Local level governments attempt to implement sustainability into their strategies and policies but lack the appropriate focus on environmental issues, in many cases, as the socio-economic needs are more prominent (Todes, 2005 and Bergrivier Municipality, 2012).

Another misalignment between spatial planning and sustainability (environmental management) exists in that the former takes place at a strategic (higher) level and the latter at the lower, local level (Todes, 2005). This allows for a number of gaps in planning and implementation phases to attaining sustainability.

Jepson (2004) explores a much broader disjuncture between environmental management and spatial planning. He ascribes it to the lack of a resource based economic model. Two dominant world views of natural resources currently exist, expansionist and the ecologist. The expansionist perspective is the view that people will continue to grow and develop in a mechanistic manner due their ability to control and adapt prices (Jepson, 2004). He goes on to describe the advent of the ecological perspective, which describes how the natural world has limits in its ability to sustain people (Jepson, 2004). There are two associated economic models,

⁴ Evident in the NEMA principle 2(1)e “guide the interpretation. administration and implementation of this Act, and any other law concerned with the protection or management of the environment.” With this statement, NEMA is the most relevant piece of guiding legislation to a document such as this proposed framework. In acknowledging this, this framework has been prepared in light of NEMA and aims to adhere to all the NEMA principles.

the neoclassical model which is based on expansionist perspective, believes that the economy operates in isolation to nature and society and operates in a circular model based on mathematical models. It believes that the market is the best mechanism for allocating resources and that development will be the antidote to poverty (Jepson, 2004). The other economic model is the steady state model, associated with the ecological perspective; it is based on the foresight to see that unlimited resource use by people will lead to a “tragedy of the commons” (Hardin, 1968 cited in Jepson, 2004) and social chaos (Ruckelshaus, 1989 cited in Jepson, 2004).

The current predominant model in the world is the neoclassical model, this is based on a price based economic model whereas the steady state model is based on a resource based model (Jepson, 2004). The lack of a resource based model is an inherent problem in attempting to merge sustainable development into the spatial planning field (Jepson, 2004). The current policies and strategies are based on neoclassical economics and can therefore not accommodate a resource based economic model.

If one were to change from the price based model to the resource based model, economic development would cease to exist as the answer to poverty reduction; public policy would therefore need to focus on equitable distribution of resources and efficient production to combat poverty (Jepson, 2004). Jepson (2004) mentions that in order for planners to be able to implement sustainable development into their plans, they need to truly understand these two world views and the vast impacts they have on the current world functioning. Secondly planners need to have a clear understanding of their method and role under the various circumstances they might come across (Jepson, 2004). In this way planners will be able to play a better facilitative role in developments and the integration of these oppositional world views can take place (Jepson, 2004).

This expansionist versus ecologist perspective reminds one of Leopold’s (1966) discussions about man as the conqueror. He describes how man has never learnt that being the conqueror has never ended well for human beings due to the fact that people are unable to objectively assign values to natural world. In attempting to introduce the land ethic into communities, the

problem of natural resource management can be successfully managed from both a local and global level. Frameworks such as this work well on the ground, toward implementation of a land ethic. Natural resource and landscape management can improve greatly, leading people successfully toward once again improving their land ethic.

The Role of Bioregional Planning in South Africa

Sustainability is one of the components of Bioregional Planning. This inherently brings the context of South African planning into contact with Bioregional Planning and makes Bioregional Planning a worthy option for South African environmental planning. In South Africa, Bioregional plans are produced by SANBI, these are the most prominent endorsers of bioregionalism in South Africa. Bioregions according to the SANBI guidelines (2009) do not cross administrative boundaries, something in which this framework does not adhere to. Bioregions in this framework fit into the Municipal boundary but encourage crossing administrative boundaries to promote stakeholder integration and exchange of information and ideas. Older writings on bioregionalism endorse the removal of administrative boundaries and promote the use of natural boundaries (Pepper, 1993).

In terms of Municipal functioning, bioregional plans are predominantly, but not exclusively produced by SANBI. These plans inform Municipal IDP's, SDF's, as well as, EIA's and other planning and environmental sector plans (SANBI, 2009). There are four compulsory users of South African bioregional plans. These are the local and district level municipalities, any person compiling plans under NEMA section three and any person required to make decisions under NEMA section 2(1)(c) (SANBI, 2009).

The Influence of South African Policy and Legislation on Bioregional Frameworks

As mentioned before, the local and district level policies and frameworks have to consider bioregional plans, this is due to the fact that the Western Cape uses bioregional planning and due to the Consistency Principle. In South African development planning, there is a consistency hierarchy of development policies and projects, amongst all levels of government -this is based

on the Consistency Principle⁵. The Local Municipality (LM) has plans that should align with higher levels strategic plans such the District Municipality (DM) and the Provincial Government (West Coast District Municipality, 2007). However at times, the Consistency Principle can force limitations on Municipalities.

The PSDF for example describes that development should be for social and economic benefits and should make use of “mixed use integration” by using “urban management mechanisms” such as densification, urban edges, nodes and corridors.” This does not leave room for Municipalities to devise their own holistic method for spatial planning at their scale; it might work well in metros and urban settlements but corridors, urban edges and nodes do not always relate well to spread settlements as would be found in rural and semi-urban areas. It also leaves very little room for the bioregional approach or any other environmental approach to be used.

The Bergrivier, Municipal IDP on the other hand focuses very narrowly on only two environmental issues, biodiversity and climate change. The issues of biodiversity are clear perhaps due to the Municipality being part of the Local Action for Biodiversity Programme (LAB). This is operated by the local governments for sustainability’s global biodiversity centre and the international union for conservation of nature (IUCN) (ICLEI) (Bergrivier Municipality, 2011/2012). The drive for biodiversity issues are of high significance in the region, but are perhaps highlighted more prominently due to the large focus by external projects and programmes.

The Bergrivier Municipal SDF considers the environmental issues that occur in the region, it has however in some way, missed the connection between the environmental issues and planning. Planning is a field that can ideally integrate with environmental planning. In basing the region’s functioning on the environment, many spatial, economic and social issues will firstly automatically become sustainable and secondly can be accommodated into long term sustainable endeavours. The attempt to integrate planning with the natural environment is

⁵ The Consistency Principle is defined in the PSDF as the alignment of provincial government policies with national and the alignment of DM and LM policies and frameworks with the Provincial policies and frameworks (PSDF, 2005).

made in the Municipal zoning scheme, which finds its base in the Western Cape Bioregional Plan.

South African legislation currently lacks a formal definition of a natural resource, even the National Environmental Management Act 107 of 1998 (NEMA), holds no definition of natural resources, despite using it numerous times. In comparing the definitions of heritage resources (by SAHRA 25 of 1999) or the understanding of water as a national resource (NWA 36 of 1998), it is then easy to assume that a natural resource implies those elements produced without human intervention (by the natural world in natural processes). There is no evidence of the legislation making reference to natural resources as economic inputs yet, despite South Africa having a strong economic development agenda (evident in a variety of national strategies and policies).

In the Australian resource management arena it is defined as “any activity relating to the management of the use, development or conservation of either soil, water, vegetation. It is also any change relating to the use, development or conservation of soil water or vegetation.” (Zammit et al., 2000). Australia has been very active in their use of Bioregional Planning, specifically using it for conservation and the maintenance of biodiversity (Craig, 1996).

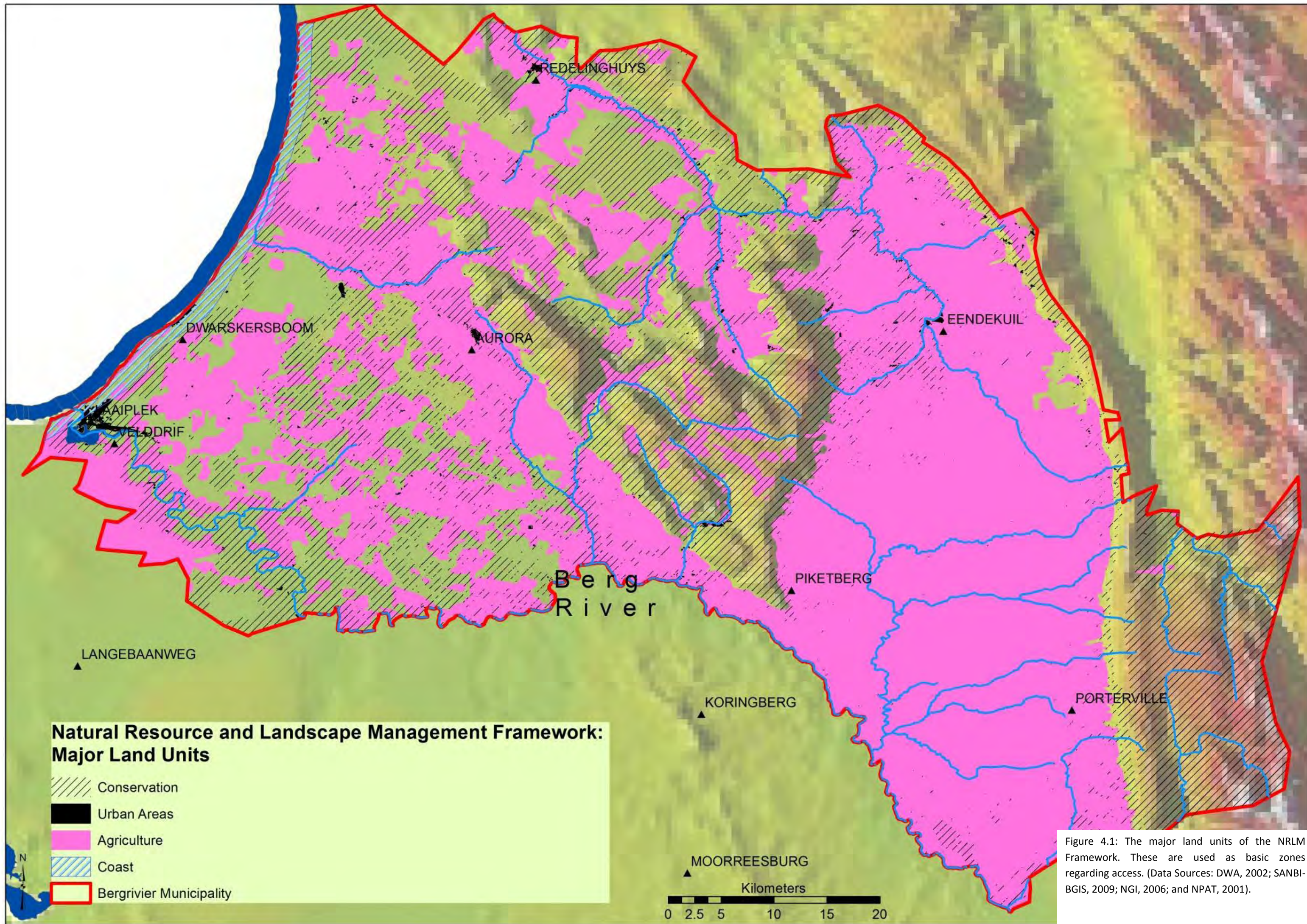
The lack of a natural resource definition can lead to issues pertaining to natural resource management not being taken seriously and not adequately implemented. In South Africa the current focus is too heavily on socio-economic development through infrastructure development and should perhaps focus more on socio-economic development through ecological infrastructure development.

Natural Resource and Landscape Management framework

*A Municipality in which all could find
a semi-urban based home, surrounded
by the rich display of indigenous,
natural features.*

The overarching goal of this NRLM Framework is to attempt to add value to the Municipal SDF by guiding the Municipality toward self-sustenance. The Framework is composed of five policies: Protection, Production, Rehabilitation, Hazard Avoidance and Metabolic Restructuring. These five policies consist of strategies that aim to manage the ecological integrity, biodiversity and natural capital of the area (the components of Bioregional Planning). The goal of this bioregional framework is to maintain ecological security for the region, in order for the Municipality to attain a self-sustaining state. The five policies thus discuss strategies that would aid the mitigation of the key issues identified during the analysis phase as well as mitigate the complex impacts of climate change and make optimal, sustainable use of the natural resources.

The framework is based on four basic land units (see Table 4.1). These basic land units are based on the interaction between humans and the natural element, and the degree to which it defines the region. The land units represent four most prominent, defining characteristics for the area: Conservation, Urban, Agriculture and Coast (see Figure 4.1). The region is defined by its coast and agricultural activities. The urban represents the fact that although the area is rural, there are agglomerations of urban settlements. The conservation represents the variety of ecologically and culturally significant features that form part of the regional landscape. Within every policy, there are land management units that are focused on, these land management units are based on the land units and encompass more detail within the policies. The frameworks work hand in hand, some issues are covered across different frameworks and sometimes the management areas will fall into more than once framework.



**Natural Resource and Landscape Management Framework:
Major Land Units**

-  Conservation
-  Urban Areas
-  Agriculture
-  Coast
-  Bergrivier Municipality

Figure 4.1: The major land units of the NRLM Framework. These are used as basic zones regarding access. (Data Sources: DWA, 2002; SANBI-BGIS, 2009; NGI, 2006; and NPAT, 2001).

Table 4.1: Basic Land Units of the Natural Resources and Landscape Management Framework for the Bergrivier Municipality.

Basic Land Units			
Conservation	C1	Temporary	use mountainous terrain
	C2	Use only in restricted area	
	C3	No use for a period of time-rehabilitated land	
Urban	U1	Town exceeding	natural capacity
	U2	Towns within	natural capacity
Agricultural	A1	permanently cultivated	
	A2	subsistence farming	
	A3	fallow land	
	A4	Other natural areas-	
Coastal	Coastal Protection Zone		

The policies are geared toward specific key issues, the issue of lack of Municipal capacity is however a general problem in the Municipality and District Municipality. This has been identified as a major setback in municipal functioning. The Municipality currently employs one environmental practitioner; this person is situated at the District level and therefore also oversees the entire West Coast District. With the magnifying implications of climate change, the municipality and the District municipality will require additional professional environmental capacity in order to maintain a good level of environmental or ecological integrity. This kind of capacity need also link to monitoring the agricultural sector and ensuring their compliance to Municipal environmental policy. Community service for students who study in the environmental sciences is an option that national government

can consider in order to increase environmental training and capacity in South Africa. This will also help the government attain true environmental sustainability according to the nested triple bottom line approach. The Local and District Municipality can consider providing students with internships to train in the region.

The above strategy is an overarching one that is perhaps too broad for focus in just one of the policies below. The policies below speak specifically to environmental issues.

Image Source: author's own



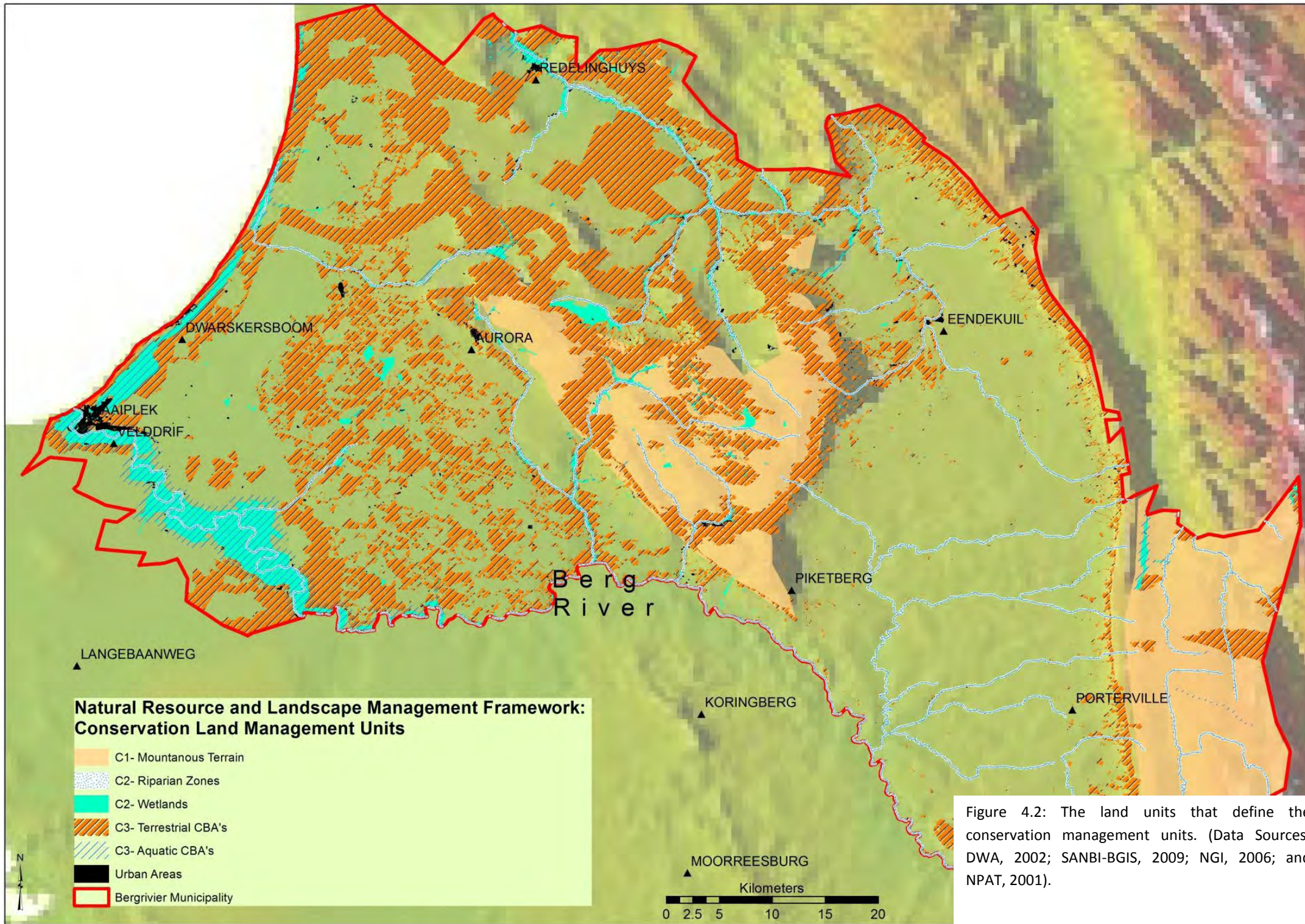


Figure 4.2: The land units that define the conservation management units. (Data Sources: DWA, 2002; SANBI-BGIS, 2009; NGI, 2006; and NPAT, 2001).

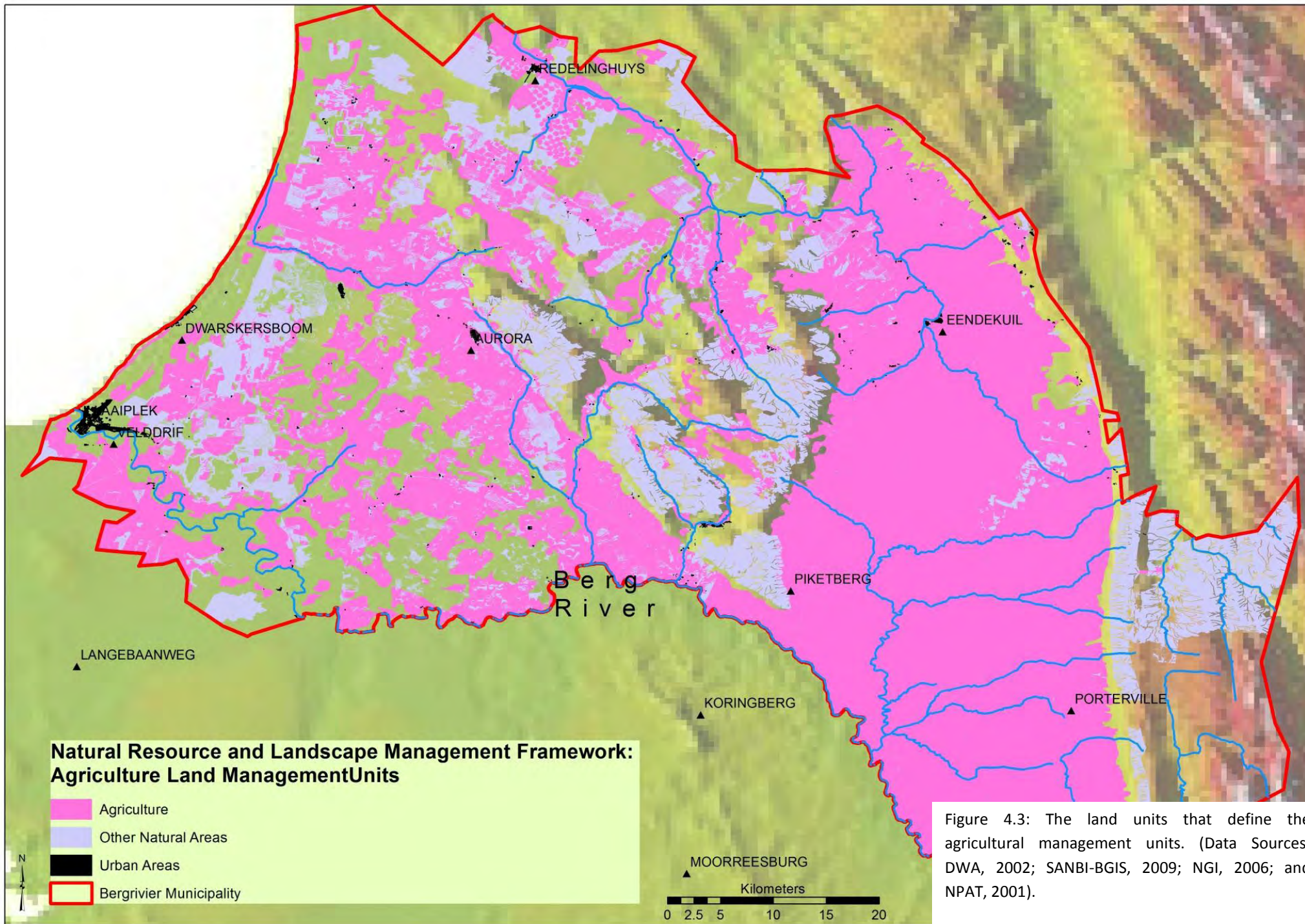


Figure 4.3: The land units that define the agricultural management units. (Data Sources: DWA, 2002; SANBI-BGIS, 2009; NGI, 2006; and NPAT, 2001).

Protection Policy

Background

The protection policy or framework speaks to the areas within the Municipality suggested to be protected from anthropogenic forces and negative impacts. Figure 4.4 shows the spatial layout of the areas that are protected under the protection policy.

The Municipality experiences problems of low water quantity and quality. This is due to the problems associated with certain ecological infrastructure such as the state of the wetlands, estuaries, river courses, riparian zones and floodplains. In order to positively impact the issues of water quantity and quality, certain ecological elements should be protected adequately. The Municipality currently protects all the sensitive ecological elements in the form of CBA's. Figure 4.4 shows the areas protected by the Municipality (the CBA's, estuary and wetlands). This policy looks to enhance the protected elements within the Municipality with the goal of protecting water quantity and quality. It also aims to increase

protection around heritage and culturally significant sites.

The systems concerned: water, land, biodiversity, climate, landscape character.

Guiding Question: What land, water or biodiversity must be protected to achieve improved water quality and quantity, and improve land-use and ecological integrity?

Policy Strategies and Action:

- Improve water quantity and quality
- Sensitive Areas Protection
- Protection of heritage and culturally significant sites

Management Areas:

- a) Water quantity
- b) Riparian Areas
- c) Estuary and floodplain
- d) Wetlands
- e) Tertiary river setback lines
- f) Heritage and culturally significant towns, building and artefacts
- g) Coastal Protection Zone

Improve water quantity and quality

The increase in water quantity and quality needed in the Municipality can come from decreasing abstraction along the river course. Most of the water in the region is used for irrigation purposes. With the added future impact of climate change, water scarcity is said to increase. The need for extra sources of water such as groundwater has been realised. However groundwater in itself is a scarce and very sensitive resource. In attempts to decrease irrigation water, the Municipality can look to new irrigation methods for farmers, such as drip irrigation and other methods that decrease surface water evaporation.

In terms of water quality, the need to address pollution issues are most urgent. Second to this, the protection of aquatic ecosystems is required.

Sensitive Areas Protection

A starting point in protecting water quantity is protecting the main rivers in the area. The most used river currently is the Berg River. It should be protected along the entire course of the river. The source of the Berg River is in the Franschhoek and Drakenstein Mountains, in the Drakenstein and Stellenbosch Municipalities. This crosses an

administrative boundary, close alignments between the Bergrivier, Stellenbosch and Drakenstein Municipalities should be formed, if none exists. The protection of the mountainous source of the Berg River should be environmental imperatives of these three Municipalities.

In the Bergrivier Municipality, secondary rivers that constitute an important component of the water supply systems should also be protected at its mountainous sources. Groundwater should be protected with specific emphasis in areas that rely on groundwater sources. Monitoring groundwater levels and limiting extraction are key to groundwater monitoring. There are no areas within the Municipal borders that are particularly dependent on groundwater. However there are areas just north of the Municipality that rely on groundwater, the Municipality should therefore maintain good groundwater standards and levels in order to aid the groundwater needs in the Cederberg Municipality.

The protection of the river water is also linked to the health of the riparian zones. The riparian zones play a vital role in

maintaining river health and river protection. In many parts of the Bergvriër Municipality, agricultural land can be found in these sensitive riparian areas. These should be removed. This can be done if the Municipality implements a river set back line or a by-law that is retrospective, meaning that the law does not concede old developments or actions, the cultivated land would need to go.

Other important features are the estuary and floodplain. These require setback lines to curb any further development. The current Municipal estuary has a zoning plan which inhibits new development. This should be extended to the flood plain and included in the Coastal Protection Zone. The Coastal protection zone extends from the high water mark to 100 metres inland, in urban areas and up to 1000 metres in rural-agricultural land. Added to this should be the implication that if property is damaged by floods or increased wave activity, that property cannot be re-built. The owners should be insured and should move or settle for a smaller plot. This policy has outlined a coastal protection zone for the Municipality to consider, the guidelines of the NEMA coastal management Act (No. 24

of 2008) were used. 100 metres set back from urban areas and 1000 metres for agricultural areas.

Wetlands should be incorporated into the river riparian and buffer area as they form an integral part of the riverine system. Wetlands are seen as watercourse according to NEMA listing notice 3, thus requiring a 10m buffer if it is within a built up area. Wetlands form an integral part of the biodiversity and riverine systems, the Municipality could consider implementing a larger setback line than 10 metres, to protect the wetland, which is highly sensitive, from impacts associated with urban spaces.

Setback lines for smaller, tertiary level rivers should be considered by the Municipality. The smaller rivers are overlooked at times, due to the lack of anthropogenic dependence on them. They are however important components of the riverine systems.

Protection of heritage and culturally significant sites

The protection of heritage and culturally significant towns, building and artefacts. These resources can be incorporated into

the protective landscapes to form a more holistic “high value areas” corridor. The surrounding Municipalities also contain several heritage significant towns and sites, these could be included to form a West Coast District Heritage and Cultural Corridor.

Implementation

The basic implementation process of this policy is to buffer the coastal protection zones, wetlands and rivers. It is based on decreasing human activity in sensitive, recovering areas. It also looks to investigate other sources of water to supplement the water need in the region.

Relevant Stakeholders

The Municipality is the first phase respondent to the region. The DEADP will be responsible for authorising the requests for buffer zones. SANBI should be informed of all environmental initiatives and plans as they oversee the biodiversity plans in the region. The Provincial Heritage Resources council should also be consulted regarding the heritage significant towns and artefacts. There stipulations should be included in any plan regarding these sites. The local Department of Water Affairs should be

consulted regarding groundwater use licences and penalties for water wastage.

As described by NEMA (No. 107 of 1998) public engagements are a legal requirement in planning and environmental management. Thus the local communities in the Municipality will need to be consulted.

Policy Linkages

NEMA Listing Notice 3 guides the buffer around the wetland areas, specifically in urban settings, this policy suggests that these buffers be widened to increase the protection area of wetlands in urban areas.

NEMA Integrated Coastal Management Act (No. 24 of 2008) guides the zonation of Coastal Protection Zones and coastal setback lines.

National Heritage Resources Act (No. 25 of 1999) will guide the preservation of the heritage and culturally significant towns and artefacts.

The National Water Act (No. 36 of 1998) guides the water use licences and the water wastage penalties that could help the Municipality in maintaining adequate water

quantity (National Water Act No. 36 of 1998
section 26(4) c).

University of Cape Town

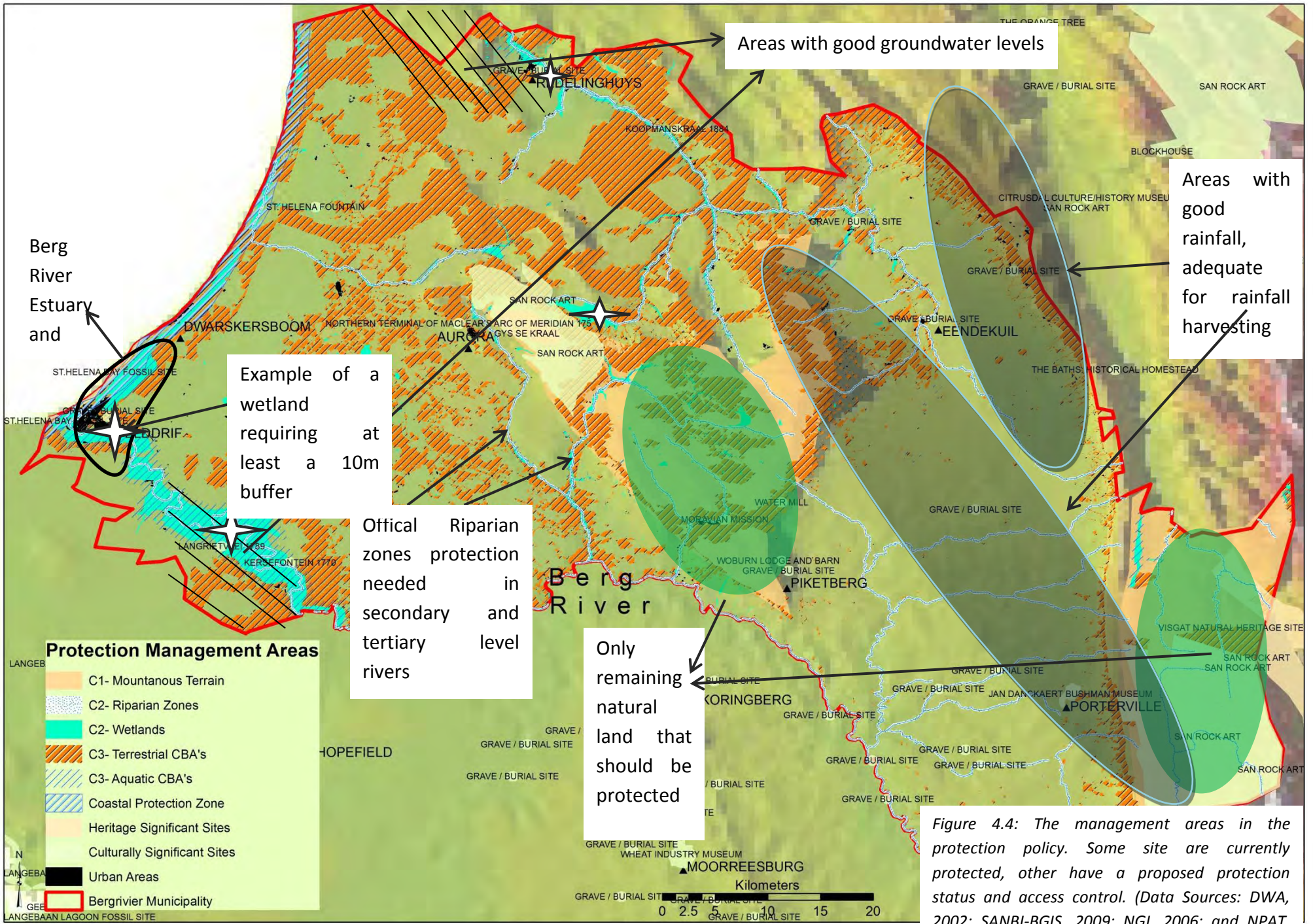


Figure 4.4: The management areas in the protection policy. Some site are currently protected, other have a proposed protection status and access control. (Data Sources: DWA, 2002; SANBI-BGIS, 2009; NGI, 2006; and NPAT, 2001).

Production Policy

The overall goal of this policy is to allocate resources for sustainable and future use. The main land-use of the Municipality will continue as agricultural. This policy however also aims to minimize the impact of this land-use.

The general soil potential of the region is low due to the removal of indigenous vegetation, and cultivation. The general basis for this policy is increased regional resilience to food and economic insecurity by improving ecological integrity. This kind of improved management will increase the future potential for the Municipality's food production and increase the potential for self-reliance. The Municipality's land is covered in a large majority by large scale commercial farms, there are very few subsistence farms. According to ENPAT GIS data, there is no subsistence farming, subsistence farming has been catered for, in the Basic Land Management units, (see Table 4.1) if subsistence farming is to arise in near future.

The systems concerned: land, material flow, biodiversity, climate and water.

Guiding Question: How can the distribution of land-uses change in order to better plan for improved ecological integrity of both aquatic and terrestrial ecosystems?

Policy Strategies and Action:

- Climate change impact and adaptation plan
- Future agricultural activity
- Promotion of indigenous vegetation cover
- Municipal off-shore mining plan

Management Areas:

- a) Coastal Areas
- b) Crop change
- c) Decrease Fertilizer and pesticide run-off
- d) Restrict mining
- e) Renewable energy potentials
- f) Re-use and recycling of water
- g) Incentives

On the coast, the Berg River estuary specifically, Velddrif are involved in salt production. This is a fairly large scale activity and can be seen across the town. According to the SDF, the saltworks in the town are very successful and there is space to grow this economy. The implications for a larger saltworks in the town should be assessed through an EIA process as the

extraction of sea salt will impact the nearby ocean ecosystems.

The estuary is also used for small scale fishing which is reportedly negatively impacting the fishing stocks within. The estuary management plan calls for a balance between conservation, development and sustainable use, this will however require a holistic approach as there are many interested parties to the estuary and it also straddles a number of administrative and statutory borders. In order to facilitate this process of including all stakeholder, a Berg River estuary management forum has been set up. The needs of the small-scale fishers are seemingly under represented. In the drive toward self-sufficiency, the Municipality could look to improving the level of small scale fishing and associated monitoring. The Municipality can and has, taken the initiative in developing an estuary management plan, this plan guides the use of the estuary and concentrates on protecting this resource.

Climate change impact and adaptation plan

Further studies should be done to investigate the exact areas which are getting increasingly drier (possibly due to climate change). A full Municipal Adaptation Plan should be devised. This should map out the drought and flood prone areas as well as the temperature and rainfall changes in the Municipality's (Mukheibir and Ziervogel, 2007). These areas should be targeted for crop changes. The new crop should be specifically more resilient to erratic and intense rainfall patterns.

The Municipalities current adaptation plan could be enhanced with a spatial layout of climate change impacts of agriculture in particular. In knowing the potential for this land-use, employment can be remedied at least somewhat. Also, in understanding which area will be receiving more and less rainfall, stormwater infrastructure can be better planned for, with areas predicted to receive more rainfall receiving upgraded stormwater infrastructure. Universities such as the Climate Systems Analysis Group at UCT could help the Municipality monitor the impacts of climate change specifically rain and temperature. They could work in with the farmers in the area as the farmers

know what their lands need in terms of water and sun.

Mukheibir and Ziervogel (2007) provide a paper describing the elements to a refined climate change adaptation plan. This could be helpful to the Municipality.

Future agricultural activity

There is potential grape farming in the north of the Municipality, in the area that experiences high rainfall. This could serve as an extension of the Franschhoek wine area serving economic good as well as diversifying crop production in the Municipality. The main farming type in the Municipality is dryland crop farming. The future impacts of climate change on these crops have been tested in other areas, with the result that dryland crops do not withstand the extended periods without water.

In an effort to preserve farmers in the Wuchuan County, China, have proposed adaptation techniques that includes introducing drought resistant crops and drought resistant cultivation techniques (Zhao et al., 2013). A similar result was found in the Kordofan region, Sudan 2012 (Drylands Co-ordination Group, www.drylands-group.org) in which the

dryland crop farming yields are in decline due to decreased rainfall and increased temperature. Suggestion for adaptation by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) included increasing climate change awareness and new technology (Drylands Co-ordination Group, www.drylands-group.org). More detailed adaptation techniques will be required in the Bergrivier Municipality. New crop types should be considered for the region, crops that are more water resistant. Farmers should be looking to provide more shelters for their grazing animals and increase the water stores.

Thomas et al (2007) describes that the key to combatting negative climate change impacts is to treasure biological surface cover such as soils, water, and nutrient exchange in soils, soil inhabitants and organic matter.

This also includes maintain genetic diversity, this Thomas et al (2007) says should be the starting point to climate change adaptation. They also suggest using the national and international “greenbanks” to aid governments in devising genetically

adapted crops to cope with new, changed environments (Thomas et al., 2007). The use of genetically modified crops is a contentious issue and should be deeply and widely considered by authorities and the public before use. The other option would be to have regions change their main agricultural commodity entirely. Also further studied need to be performed in order to understand the accurate impacts on farming in the area.

All the soils in the Municipality are of altered quality, this can be viewed as a potential for a number of functions.

Promotion of indigenous vegetation cover

Because most of the land has been altered, the land can therefore be used to replant and rehabilitate indigenous vegetation, it could be used for additional farming land and it can just be used to rehabilitate the soil for future use.

All land is available for various uses with the exception of the protected terrestrial CBA's, the land in the riparian zones and the land within the coastal setback line.

Fertilizers and pesticides contribute to the low water quality in the Municipality.

Investigations into better quality fertilizers and pesticide should be made; these should be carbon neutral and low impact to surrounding natural environments.

Municipal off-shore mining plan

Mining has not played a major role in the Municipality, in the past. The Municipality does not contain any significant mineral resources with the exception of salt. The potential for offshore mining is always there, this however falls into the jurisdiction of the national governments. The local municipality should however devise a plan to adequately detail the process to follow if offshore mining becomes a reality.

Implementation

The general implementation of this policy is to optimally use the resources of the area in order meet economic and social demands, but maintaining ecological integrity at the same time.

Relevant Stakeholders

Stakeholders will include relevant university departments to aid the climate analysis for future impacts. CSAG, UCT is a possibility. Other stakeholders will include the DEADP, Provincial Department of Agriculture and

the National Department of Minerals and Energy.

Policy Linkages

The Agriculture and Land Bank Act (No. 15 of 2002 3(1) g) guides the support of agricultural production in South Africa and provides sources of funding. In the case of crop change for climate change this Act could come in handy. National Mineral and Petroleum Resources Act (No. 28 of 2002) guides the mining or use of marine resources.

The Adaptation Research Flagship Programme is a programme co-ordinated through the National Climate Change Response, White Paper. This initiative is run by SANBI, whom is already very active on the West Coast. The Municipality can form part of this initiative in order to inform its Draft Adaptation Plan.

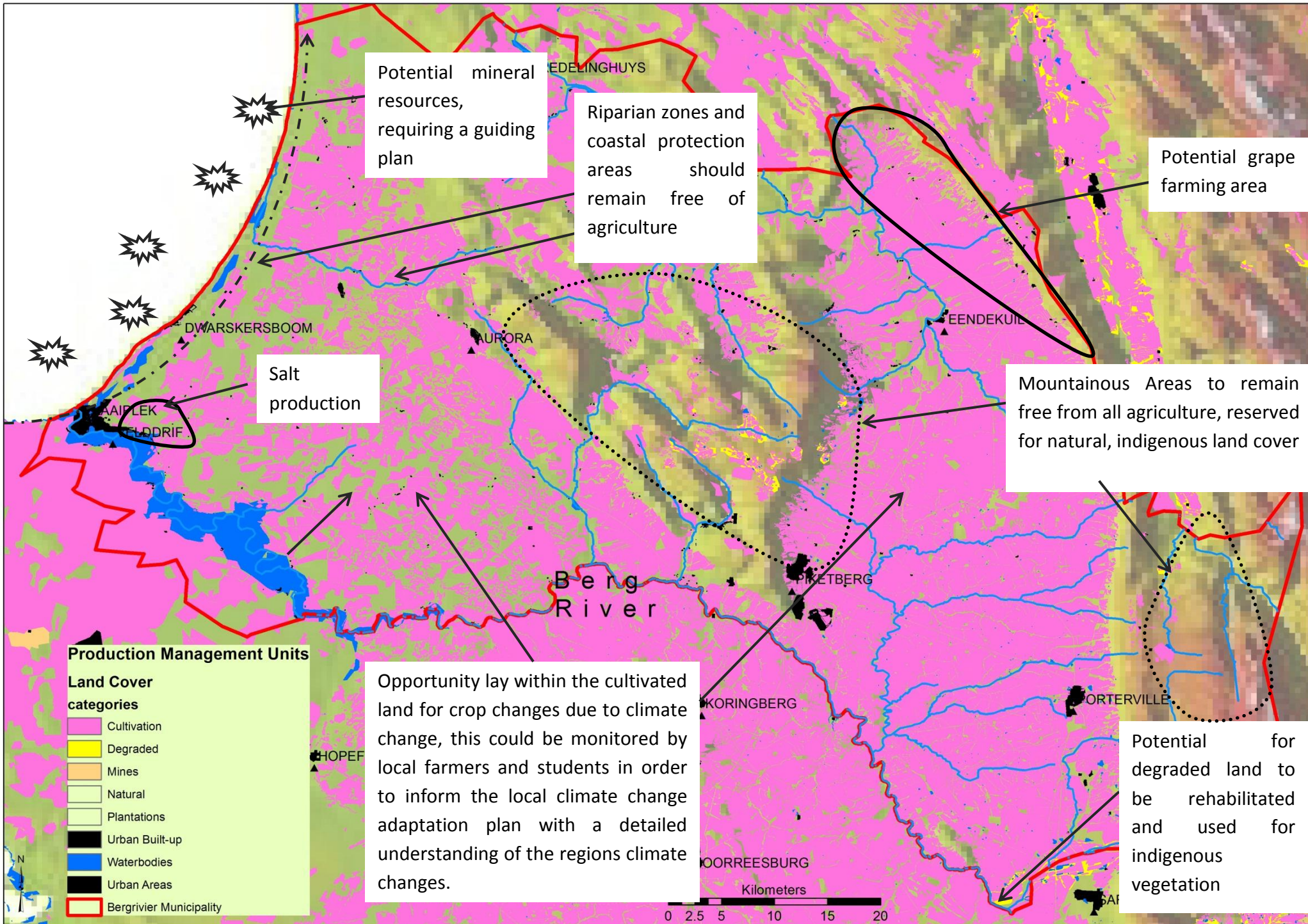


Figure 4.5: The Production Policy (Data Sources: DWA, 2002; SANBI-BGIS, 2009; NGI, 2006; and NPAT, 2001).

Rehabilitation Policy

The goal of this policy is to rehabilitate land and ecologically sensitive areas to a state of reasonable well-being, in which these elements can start generating a healthy functioning within the region. The majority of the elements in this policy are currently under some sort of restoration or rehabilitation. It is important to note that these areas are only limited to human access for a short period of time, after which they should be open for people to use to be educated and to foster a relationship between people and these ecological elements.

The Systems Concerned: water, land and biodiversity.

Guiding Question: Which areas of the Municipality require restoration or rehabilitation in order to serve an improved function?

Policy Strategies and Action:

- Improving land cover
- Water re-use
- Managing Pollution

Management Areas:

- a) Terrestrial and Aquatic CBA's
- b) Fallow land and un-used farm land
- c) Opportunity for water reuse
- d) Degraded land
- e) Recycling station
- f) Rivers
- g) Alien vegetation
- h) Water Quality
- i) Riparian Zones

Improving land cover

Terrestrial and Aquatic CBA's have been identified by SANBI and have been categorized as requiring rehabilitation. This strategy is also included in the Municipal SDF's. It is highlighted in this framework due to the importance of these areas. Several riparian zones are examples of aquatic CBA's.

Fallow land is agricultural land currently not being farmed, there was no evidence of this in the analysis phase, but provision has been made for it (see Table 4.1). The rehabilitation of fallow land and unused agricultural land is important. The Municipality can consider promoting the rehabilitation of fallow and unused farm land using indigenous vegetation. This will

increase the indigenous vegetation coverage in the region.

The riparian zones in the region are in need of rehabilitation, this has been identified in the Protection Framework. In removing the agricultural land from riparian zones and allowing for a setback line for rivers that include the riparian zones.

Water re-use

The high need for water in the region makes a good case for water re-use system. A system like this could increase water availability and make the Municipality less dependent on external links for water. This is a step toward self-sufficiency for the Municipality. George Municipality invested in a grey water recycling plant to supplement the water needs of the region- the Outeniqua Reclamation Plant (George Municipality, 2013),

The Municipality takes significant interest in clearing alien vegetation, the largest density of alien vegetation can be found in the southern section of the Municipality.

Managing Pollution

Water quality can be managed in managing the ecological infrastructure and effluent.

The Municipal wastewater treatment works add to the problem of water pollution as well as pesticide and fertilizer run-off. Figure 4.6 shows the location of the wastewater treatment works along the Berg River and its tributaries. The upgrade and improved management of local wastewater treatment works are important for maintaining water quality (see Figure 4.6). The Municipality also has no pollution control department, this is greatly needed especially due to the large scale pollution impacts on the water systems.

Implementation

This policy aims to enhance the quality of the land and water in the region by protecting certain ecological elements for a space of time and then reopening it for human interaction. It aims to improve water use in the area by proposing a water re-use plant to move the Municipality toward a more self-sufficient state and also improve the state of natural water sources by providing people with other sources of clean water.

Relevant Stakeholders

Once again various provincial departments will have a vested interest in a policy of this

nature. Authorisation by the DEADP is required in any environmental policy. SANBI will need to be further consulted regarding the protection of certain ecological infrastructure. Water Affairs and the Department of Agriculture will also need to be consulted regarding the proposed water re-use systems and the pollution issues. In improving the local wastewater treatment works, the Municipality is able to do this themselves but can employ the help of local community member using the Expanded Public Works Programme (EPWP).

Policy Linkages

The current white paper on climate change in South Africa speaks of a variety of programmes to aid local municipalities in their goals of sustainability. The Water Conservation and Demand Management Flagship Programme is one operated through the Department of Water Affairs. It looks to rainwater capture in high rainfall areas as well as rainwater capture in areas with low water infrastructure.

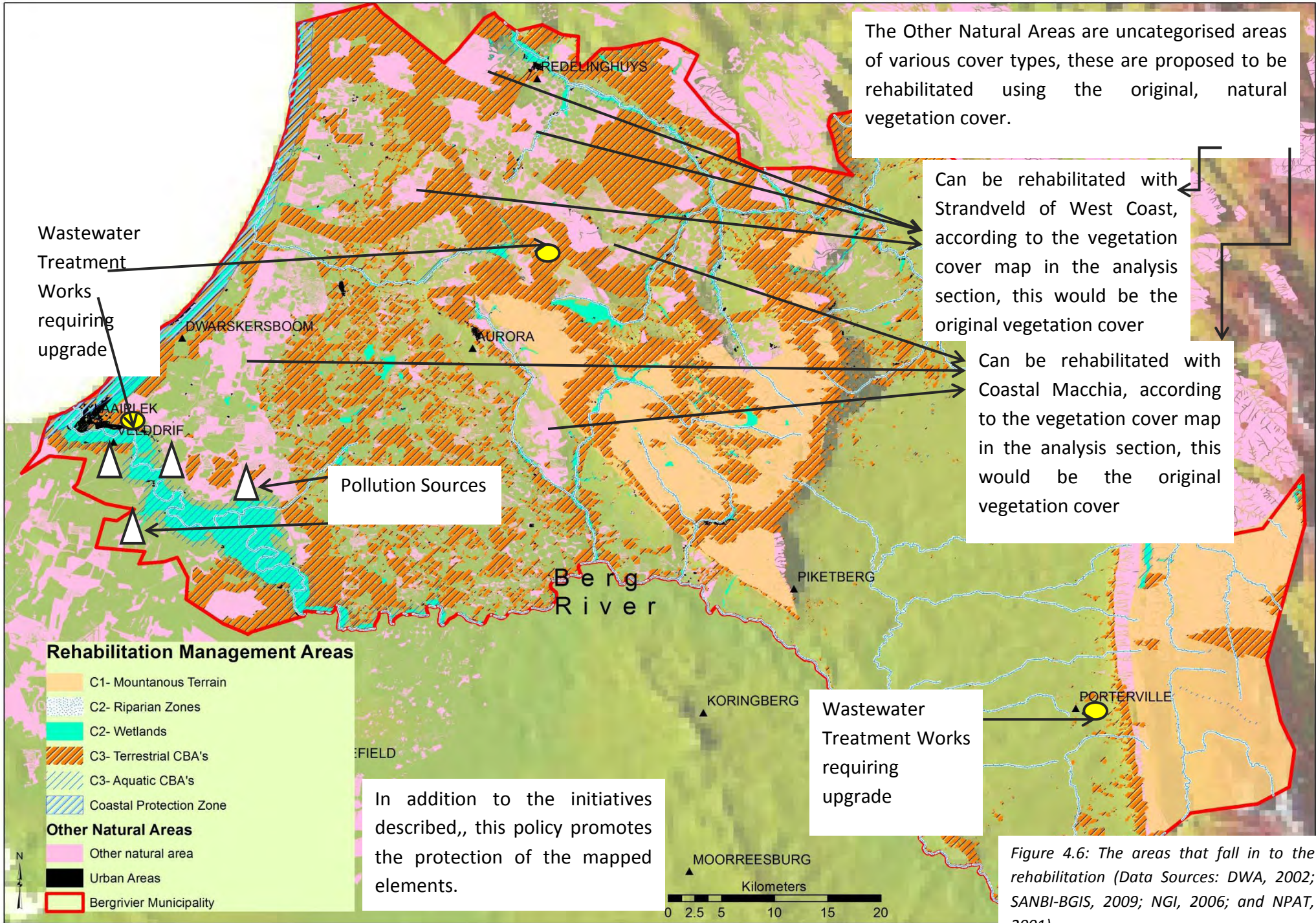


Figure 4.6: The areas that fall in to the rehabilitation (Data Sources: DWA, 2002; SANBI-BGIS, 2009; NGI, 2006; and NPAT, 2001).

Hazard Avoidance Policy

This policy speaks to areas that require special attention due to risk of flooding or fire. Floods and fire are the two biggest hazards the Municipality faces. Flooding along the Berg River has become a problem and results in the temporary movement of a large number of people, specifically in Paarl (as of recently). As described before the Municipality does face increased pollution risks but these have already been addressed in earlier policies.

Guiding Question: How can the Municipality reduce the risk of flooding and fire as the main risks in the region?

The Systems Concerned: water, land, biodiversity and climate.

Policy Strategies and Action:

- Flooding
- Fire
- Urban Expansion

Management Areas:

- a) Estuary
- b) Floodplain
- c) Riparian Zones

- d) Riverside Settlements
- e) Alien Invasives
- f) Urban Expansion

Flooding

The settlements in and along the estuary, floodplains and riparian zones are in particular danger of flooding. The Municipality could devise an education programme for emergency situations and also provide signboards and awareness infrastructure to inform the nearby communities of the procedures in flooding events. The Municipality should also look at more long term movement of certain settlements or sections within settlements. There is a possibility of increased flooding for the future as impacts of climate change could possibly bring more severe rainstorms over short periods of time. A long term flooding assessment should be carried out by the Municipality in order to assess the risk of flooding for nearby settlements.

Fire

The Municipality have already addressed the issues of fires in the Disaster Plan. The clearing of alien invasive plant species also works toward this strategy.

Urban Expansion

The Municipality have delineated an urban edge, in this Municipality however a setback line is more realistic as the towns are not estimated to grow much faster.

Implementation

The implementation of this framework is about protecting the landscape and its inhabitants from potentially dangerous situations. There are seemingly very few, possibly due to the small settlements and low populations.

Relevant Stakeholders

The Municipality and the local inhabitants are the main stakeholders in this policy. Other potential stakeholder is the Western Cape Disaster Management Department which could help the Municipality in terms of planning and in cases of emergency.

Policy Linkages

The Municipality has to plan for disaster management as the constitution states that everyone has the right to a safe environment.

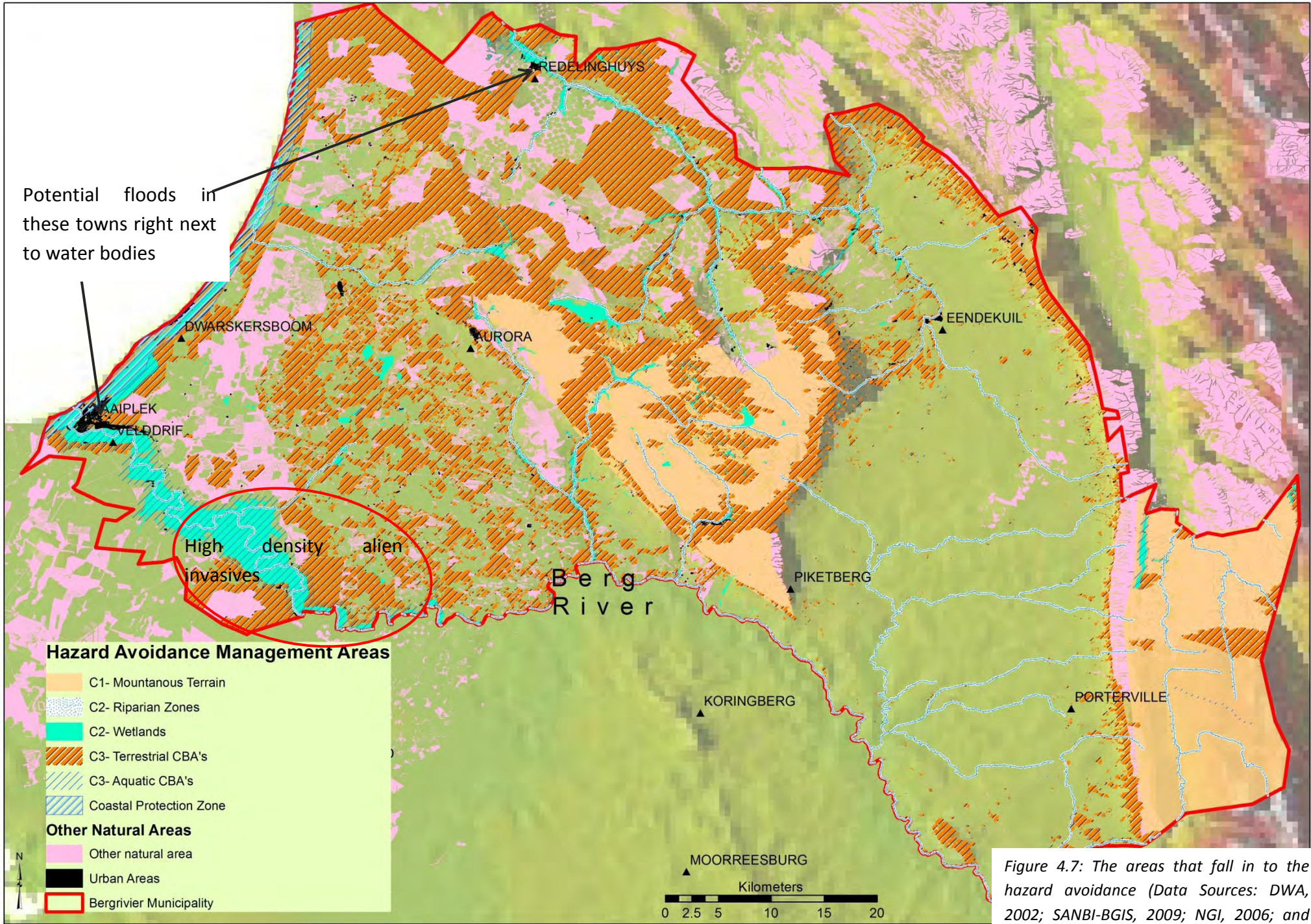


Figure 4.7: The areas that fall in to the hazard avoidance (Data Sources: DWA, 2002; SANBI-BGIS, 2009; NGI, 2006; and NPAT, 2001).

Metabolic Restructuring Policy

The overall aim of this policy is to promote a circular municipal metabolism. This entails adopting large scale re-use and recycling programmes regarding water, waste and land. It centres on ways in which the Municipality can become carbon neutral, more energy efficient and water efficient.

The Systems Concerned: water, land and material flow analysis.

Guiding Question: How can the Municipality work toward a circular metabolism?

Policy Strategies and Action:

- Alternative Energy Production
- Incentivise People

Management Areas:

- a) Renewable energy potentials
- b) Water re-use and recycling
- c) Incentivise “green developments”

Alternative Energy Production

Sections of appropriate land should be set aside for renewable within the Municipality. These could aid farms in saving energy and

money, leaving available funds for improving a number of other negative farming practices. Renewable energies are vital for a self-sustaining region. Electricity supply in South Africa is carbon intensive, in general. In order to aid the mitigation of global warming and the associated impacts, carbon and other greenhouse gas emissions need to reduce. This will also help decrease air pollution in electricity producing parts of South Africa. With the Municipality on renewable energy sources, the cost of buying electricity can be decrease, leaving available funds for improved environmental practices and increased staff.

Incentivise People

Provide incentives for people operating sustainable businesses such as recycling plants and food gardens for example. Rates incentives can be granted for people who produce their own electricity and especially those who feed back into the Municipal grid, which inevitably saves the Municipality money.

Implementation

Depending on the alternative energy source, the Municipality should investigate the most appropriate location.

Relevant Stakeholders

DEADP will need to authorise any proposed renewable energy source.

Policy Linkages

The climate change white paper has the The Energy Efficiency and Energy Demand Management Flagship Programme that can aid the Municipality in introducing energy saving methods and possibly guide the Municipality in acquiring renewable energy sources.

Policy Summary

Implementation Table

The Implementation table below should be read in conjunction with the policies as it serves as a project implementation summary. Further details of the policy implementations are provided in the detailed policy descriptions above.

The overall timeframe for the Natural Resource and Landscape Management Framework is 40 years, with reviews every 4 years to prepare for the SDF and local IDP, which could use this framework as a base. The timeframes for the implementation projects are described as short, medium and long term. Short term is a period of less than 2 years. Medium term is a period of 2 to 5 years. And long term is the period of 5 to 10 years.

Table 4.2: A summary of the policy implementation (Source: Author's own).

Project	Institutions	Timeframe	Location
Water quality and quantity reservation	SANBI, Bergrivier Municipality, West Coast District Municipality	Long	CBA's, wetlands, riparian zones, rivers, mountainous areas, estuary, floodplain
Tertiary river setback lines	DEADP, BM, SANBI, DWA	Short	Riparian zones, rivers
Protection of heritage and culturally significant towns, building and artifacts	Provincial Heritage Department	Short	Goedverwacht, Piketberg,
Establishment of the Coastal Protection Zone	DEADP, West Coast District Municipality, BM, Cederberg Municipality, Swartdland Municipality, National Environmental Affairs: coastal management department,	Medium	Porterville, Witterwater, Visgat Nature Heritage Site, Gys se Kraal
Saltworks	BM, DEADP-for the authorization of the	Short	Velddrif
Adaptation Plan should be devised	BM, West Coast District Municipality, CSAG Provincial Department of Agriculture, DWA,	Long	For the entire Bergrivier Municipality
Crop Changes	of Agriculture, DWA,	Long	Cultivated land

		SANBI		
Land rehabilitation		DEADP, SANBI, BM	Long	Other natural areas, alien infested areas,
Pollution Control		BM, DWA, DEADP- pollution management,	Long	Wastewater treatment works, waste dump sites
Aquatic Systems rehabilitation		SANBI, surrounding municipalities	Long	Aquatic CBA's, riparian zones, wetlands, estuary, floodplain
Water System	Recycling	BM, DEADP, George Municipality	Long	
General Recycling	Waste	BM	Medium	
Renewable Energies		BM, DEADP, West Coast Municipality, National Environmental Affairs	Long	
Flood education and training		BM, local community groups, local schools	Short	Velddrif, Piketberg, Porterville, oedverwacht, Witterwater
Municipal Capacity Increases		BM with the aid of South African Local Government Agency (SALGA)	Short	Piketberg, Moorreesburg

Chapter 5

Reflecting on the Dissertation Process and Outcomes

Bioregionalism has been produced out of approximately a century long process of natural resource management in the regional context. It is based on the ideals of Mumford, Geddes and McKaye and has been designed into a form that hopes not to repeat any mistakes of the past. It looks to avert the economic centred outcomes of the Tennessee Valley approach, and aims to spread resources equitably using decentralization, unlike the ideals of polarized development. The basis of Bioregionalism is to attain ecological security through maintaining ecological integrity, biodiversity and natural capital. This dissertation worked toward devising a framework which could potentially aid the Bergrivier Municipality in attaining ecological security.

The framework produced in this dissertation is based on the analysis phase the researcher's guiding values and the regional planning theory draw from in the literature review. The researchers guiding values are based in maintaining or re-establishing a land ethic among communities, globally. It is also based in spatial planning, aiming to link environmental issues and spatial planning and development arenas better. These two fields are intrinsically linked in South Africa as the basis of South African development planning is based on the triple bottom line approach to sustainability, arguably, the nested triple bottom line approach. Spatial planning also presents environmental planning with an established policy and legislative platform to base environmental concerns within. This at times is what is required in order for government to consider environmental goals.

The dissertation centres on the question: **How can we better structure the natural resources and landscapes of the Bergrivier Municipality in order to better manage the negative human impacts thereon and improve long term ecological security?**

In starting to answer this, the dissertation explores the literature behind current regional planning thinking. It explores the evolution of natural resource understanding and thinking all the way from the period before regional planning was defined up to the period of neo-

regionalism. In attempting to answer this question, the Bioregional approach was used, the analysis of the Municipality in its larger context was performed. This analysis encompassed a land unit analysis that analysed the biophysical characteristics of the Municipality and its constituent river basins. The key opportunities and constraints to come out of the analysis were issues around river water quality, water quantity, pollution, the high conservation value of the region and the mass expanse of primary, agricultural activity on which the Municipality's economy is based. There was also a highlighted need for more environmental personnel in the region as well as increased municipal capacity. This was an issue highlighted for the District and Local Municipalities.

The analysis also performed a basic material flow analysis and landscape character analysis. The material flow analysis informed the metabolic restructuring policy which aims to promote a circular metabolic structure in the municipality in an attempt for self-sufficiency. The landscape character assessment was performed to incorporate the cultural and social aspects into the assessment as the need to understand the relationship between people and their environment is needed when planning. It is also a requirement under Bioregionalism as it helps maintain or improve the relationship between people and their natural environment, which was an aim of this dissertation. The landscape character assessment was a basic one, due to the scope and time constraints of this dissertation, a full landscape character assessment and material flow analysis was not performed. In order to fulfil the complete social assessments of the region, according to Bioregionalism, a full public participation process should have taken place and the views of the local community would be strongly considered.

The analysis phase was separated into six systems analyses and integrated the issues raised; this was done to link elements to the same problem, making the understanding of the region more holistic. This also helps strategise around problem areas and provides a variety of ways to solve one problem. However, the analysis section lacks integrated themes in some areas. This was due to the lack of availability and access to some information. The material flow for the region, for examples, was never done before and due to the limited scope of this dissertation, the material flow could not be accurately performed, thus proxies were used. Other areas that

lacked detailed information was climate change impacts, this could be improved with a spatialisation of impacts. This kind of information is needed but would be best done by the Municipality who know the area well and have been there to witness longer term changes.

Information regarding the coastal area seems to be lacking, future investigations into potential resource use and associated impacts off the coast and in the coastal protection zone could be conducted in order to better prepare the Municipality when developments are proposed along the coast. Proposed developments could potentially harm the sensitive marine ecosystems and services, there are some legal gaps in the protection of these ecosystems but with the Municipality planning for potential threats, the ecological security can be improved.

Bioregional planning is based on biodiversity, ecological integrity and natural capital. It is generally a tool used for biodiversity planning; in this case it is used to define river basins as appropriate natural boundaries for Bioregional Planning. This was done as the water is the basis of life and even biodiversity is based on water patterns and availability. The use of river basins did not prove to be any less complex than using biodiversity as the natural boundary. If anything it increased complexity but it did allow appropriate integration of climate, biodiversity, physical, metabolic and socio-cultural issues.

The outcome of this dissertation is a set of spatialised strategies that could guide the Municipality, within its larger context, move toward a more sustainable region and increase ecological security. The role of this Natural Resources and Landscape Management Framework can be exercised in the public policy sector as a basis to the District and Local Municipality Spatial Development Frameworks and Integrated Development Plans. This can ensure the ecological security and thus sustainability of all development and planning initiatives. Bioregional Frameworks are accommodated in South African policy and legislative arena due to the strong role of the National Environmental Management Act (107 of 1998).

From this research, the link between human and natural environment is highlighted due to the current state of the natural environment. In maintaining or fostering this link a land ethic can be attained, a sense of responsibility and care toward the natural world can be gained. These are the starting points to implementing holistic, sustainable natural resource and landscape

management practices. Frameworks such as this aid this kind of land ethic production and forms a simple set of considerate strategies to further entrench a land ethic into communities and settlements.

Image Source: Author's own



Appendices

Appendix A:

Boundaries, Basins and WMA's



Figure A1: The WMA's in the Western Cape (Department of Water Affairs and Forestry, 2004). Note the misalignment of the provincial boundaries and the WMA's. Since 2012 there are only three WMA's in the Western Cape, the Gouritz and Breede have been joined to form the Breede-Gouritz WMA (DWA, 2012).

Water catchments in South Africa are delineated according a classification of that catchment. Primary catchments are the largest catchments to be found; these are further divided into secondary, tertiary and quaternary. These were originally delineated by grouping certain quaternary catchments together; these are 'clipped' according to an international system which tries to keep the quaternary catchments in correspondence with watersheds and river lines (Weepener et al., unknown). The quaternary catchments are the basic units of water resource management in South Africa (www.dwa.gov.za). They are delineated according to pour points by "calculating the contributing area per surface drainage exit point (pour point)" (Weepener et al., unknown). In order to delineate the Berg River and Olifants basins, certain of these

secondary catchments are grouped together. But to formulate the WMA's certain secondary and quaternary catchments are grouped together. The WMA boundaries are not purely scientific though, as they are influenced by watersheds and river flows but also by social concerns such as: the water needed in certain regions, financial viability and certain administrative capabilities (van Blerk, 2012).

The Berg River Basin is based on the secondary catchment whereas the WMA's are based on the secondary and quaternary catchment along with some non-scientific characteristics. In analysing Figure A2, one can see that the Olifants River Basin will include the E Primary catchments, but the Olifants-Doorn WMA includes the E, F and part of the G primary catchments. The Berg River Basin comprises the G10 secondary catchments. It must be noted that the Berg River WMA and Olifants-Doorn WMA area share the G30A Quaternary Catchment.

In this study I will be using the Berg River Basin and the Olifants-Doorn WMA, for this reason the G30A quaternary catchment will not be split as it does not fall into the Berg River basin at all. It will thus form part of the Olifants-Doorn WMA (for this project only). This is acceptable due to the fact that the WMA is only used as a study scale in order to obtain physical characteristics of the area (such as vegetation, soils etc.). The scale difference is of low significance as the intended bioregional framework will work closer to the natural river basin boundaries and not at all with the WMA when deciding on how to delineate the bioregions.

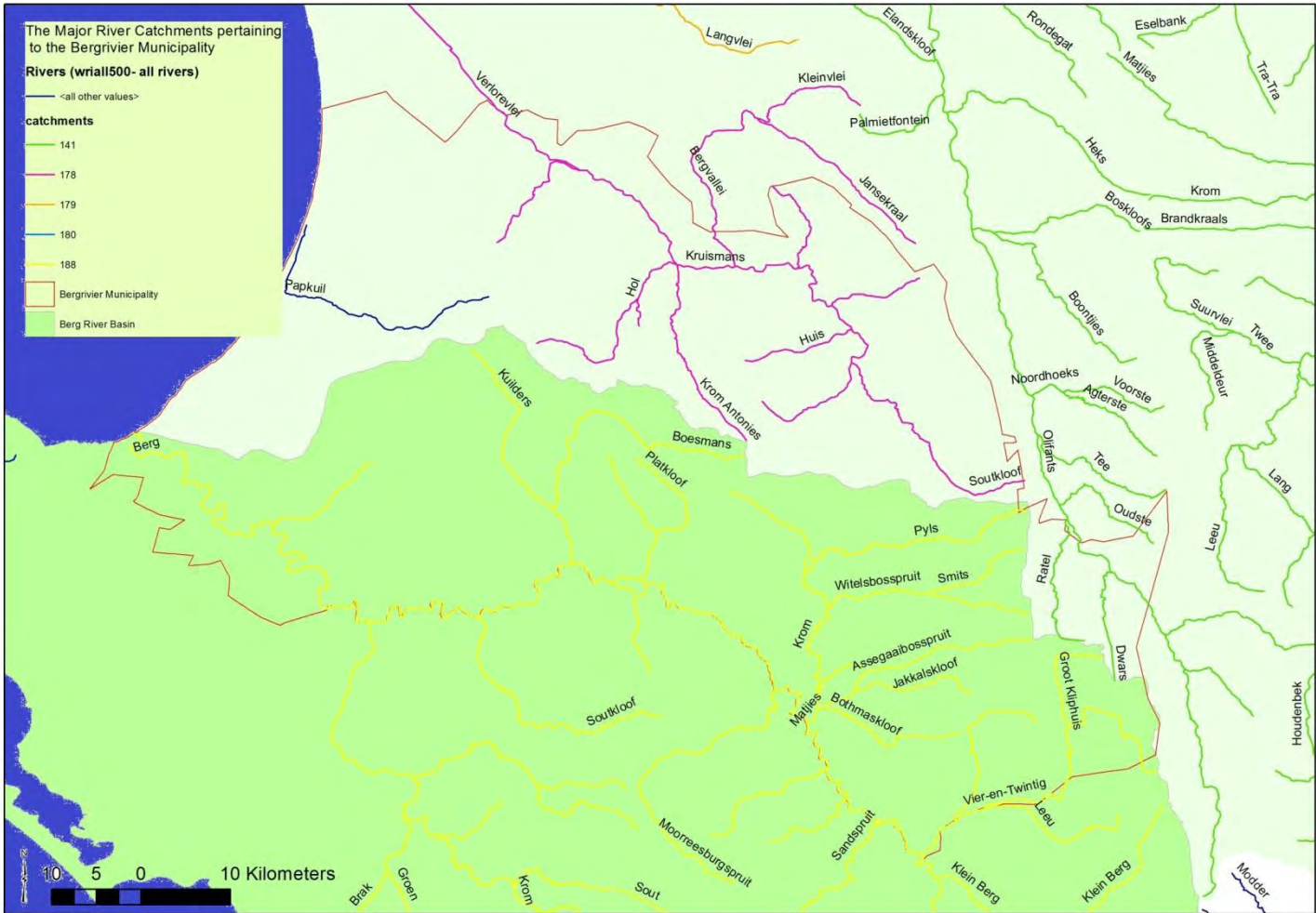


Figure A2: The various rivers within the study region and the catchments they fall within, show according to colour (Data Source: DWA, SANBI-BGIS, 2009; Author's own map).

Appendix B:

The figures below show the mineral and active mines mapped for South Africa, these maps helped inform the mineral and stone resources section (Map Source: Council of Geoscience, 2012).

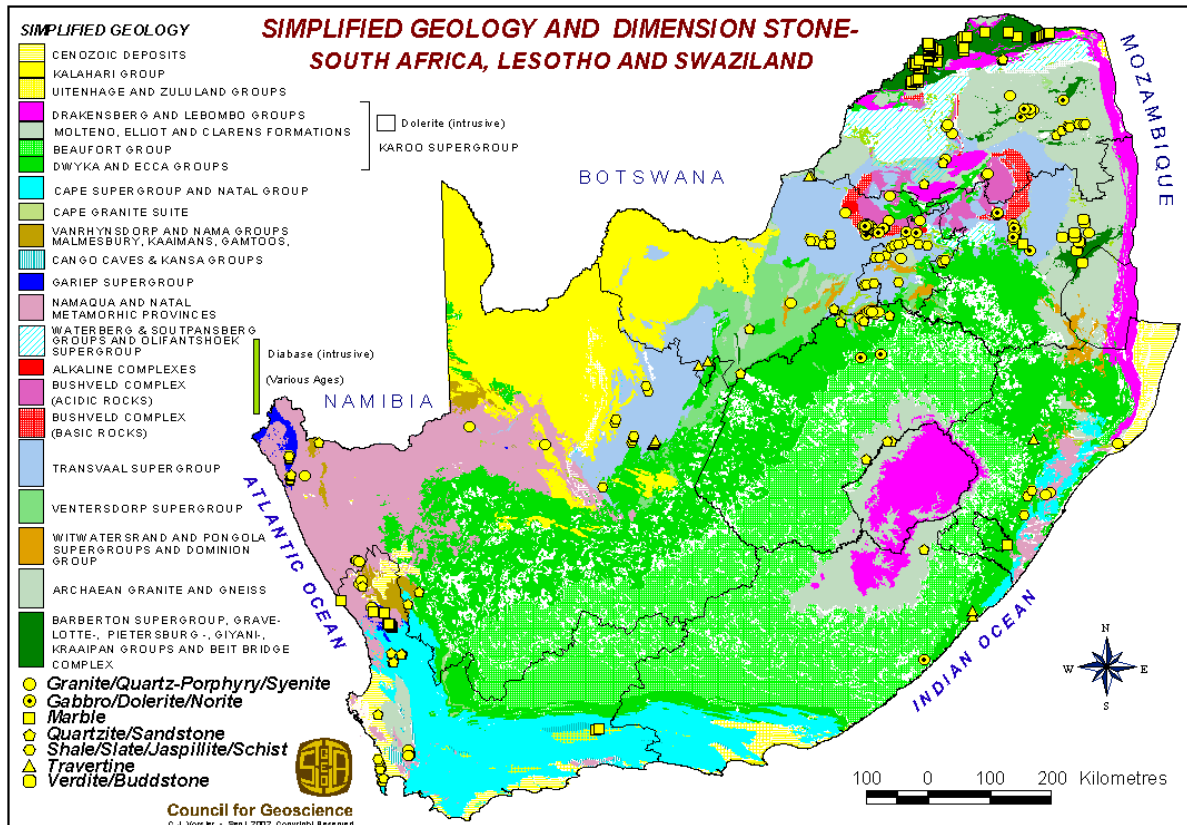


Figure A3: The distribution of building stone across South Africa (Map Source: Council of Geoscience, 2012).

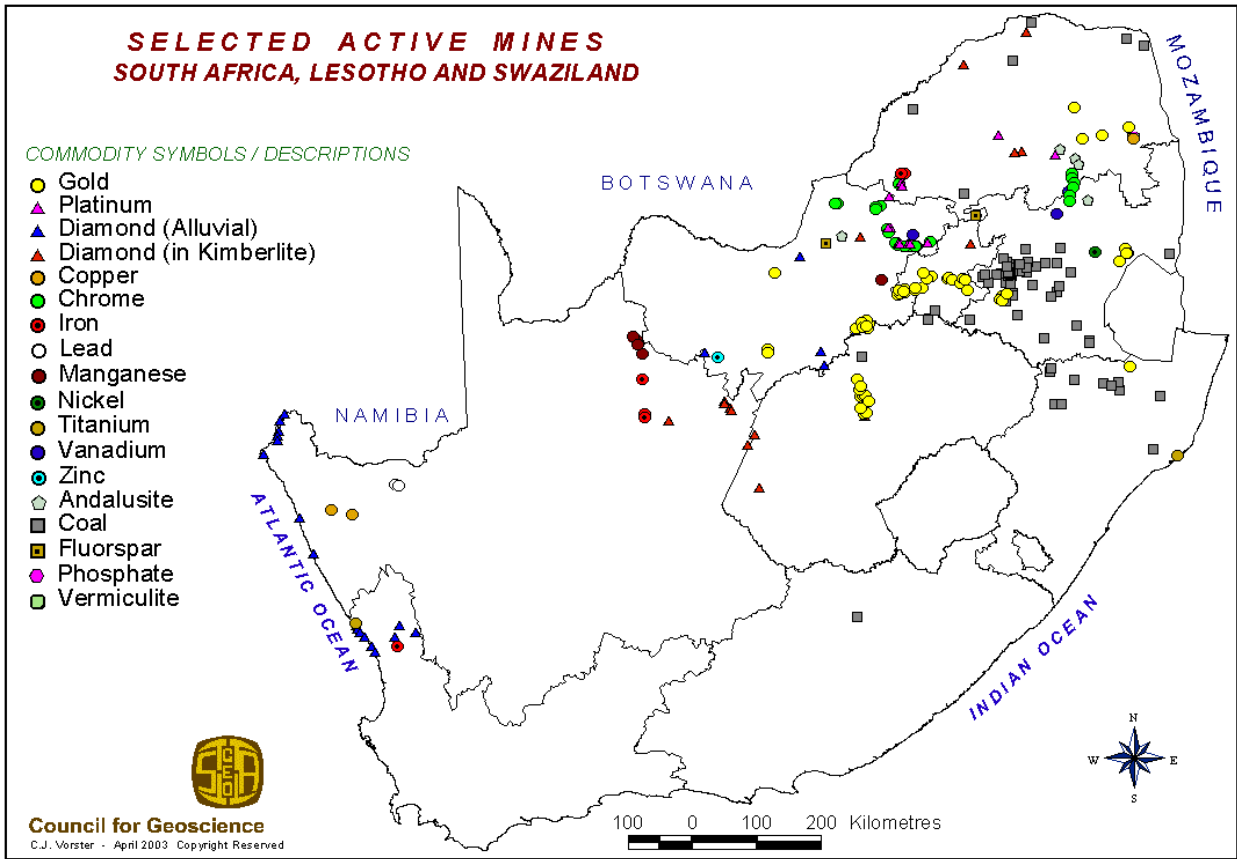


Figure A4: The distribution of building stone across South Africa (Map Source: Council of Geoscience, 2012).

Appendix C:

Ethics Approval from the Ethics Committee, Department of Engineering and Built Environment, UCT.

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