NORTH WEST PROVINCE

Environment Outlook

A report on the state of the environment

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North West Province Environment Outlook

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NORTH WEST PROVINCE Environment Outlook

A report on the state of the environment

Sponsored through

SUSTAINABLE DEVELOPMENT & ENVIRONMENT

the dace
Department:
Agriculture, Conservation and Environment
North West Provincial Government
Republic of South Africa

Foreword

The North West Province has made progressive strides in documenting the state of the environment and the advancement of sustainable development in the province. In response to its national sustainable development commitments and following on the reporting successes of the South Africa Environment Outlook, the North West Province undertook to compile the first provincial outlook in South Africa. The report provides the reader with a perspective of the pressures exerted on the environment, which define the state of environmental challenges within the province, culminating in a glimpse of the possible environmental futures to be inherited by our children.

The North West Province is alive with opportunity in various sectors of the economy, however, there are clear signs that our activities are infringing on the quality of our environmental resources, consequently impacting on the most vulnerable segments of the population. In our efforts to mine our rich mineral reserves, build socially equitable settlements or realize the overall potential of our province, it is vital that we consider the intrinsic value of our environmental resources and diverse ecosystems. Should we fail in finding creative ways to deal with environmental degradation, we will ultimately infringe on our own prosperity. The report provides mechanisms for responding to these challenges.

Against this backdrop and with the sincere hope that this report may serve to assist in decision making and uphold the principles of sustainable development in the province, I am pleased to present the North West Province Environment Outlook.

Member of the Executive Council : Mr Jan Serfontein

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Chapter 9: Environment outlook for the North West Province 2008-2025
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Chapter 10: Taking action
Compiled by Lizelle Prosch.

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Preamble – about this report

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Acronyms and abbreviations

CIDA	Canadian International Development Agency
DACE	Department of Agriculture Conservation and Environment
DDLGH	Department of Developmental Local Government and Housing
DEAT	Department of Environmental Affairs and Tourism
DPSIR	Drivers-Pressure–State–Impact-Response
DWAF	Department of Water Affairs and Forestry
EC	European Commission
EIP	Environmental Implementation Plan
IDP	Integrated Development Plan
NEMA	National Environmental Management Act (Act 107 of 1998)
NSSD	National Strategy for Sustainable Development
NW Province	North West Province
OECD	Organisation for Economic Cooperation and Development
PGDS	Provincial Growth and Development Strategy
RDP	Reconstruction and Development Programme
SESDNW	Support to Environment and Sustainable Development in the North West Province
SoER	State of the Environment Report
WCED	World Commission on Environment and Development

Photo: Mary-Ann Palmer

Photo: SA Tourism

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The North West Provincial Environment Outlook Report

The purpose of this report

The North West Provincial Environment Outlook Report 2008 is a detailed analysis of the past and present state of the environment, as well as the development of possible future scenarios for North West (NW) Province. The purpose of undertaking scenario planning is to inform decision-makers of possible alternative options relating to the environment going forward. Scenario building is structured around strategic thinking to inform strategic decision-making (Ratcliff, 2002). Scenarios are not a prediction of the future but rather 'what if' stories that portray the future in a certain context. The preferred future scenario will be that of an environmentally-sustainable state and the formulation of responses to achieving this.

The report focuses on the complex inter-relationship between the biophysical environment, human needs and activities, and the economy and aims to:

- Describe environmental issues in a provincial context;
- Build awareness and assist in the effective management of the environment;
- Provide objective, accurate scientific information about the current conditions and prospects of the NW Province's environment;
- Provide vital environmental information for authorities to make informed decisions relating to environmental management in order to support sustainable development;
- Build an understanding of environmental trends and to identify priority areas where action in respect of environmental management must be taken (including an early warning of potential environmental problems in the province);
- Report on the progress made towards the implementation of environmental management recommendations made in the NW Province State of the Environment Report (SoER), published in 2002;
- Continue the development of provincial environmental indicators and report on these indicators;
- Provide responses to environmental deterioration that has occurred within the province;
- Make recommendations for strengthening environmental policies and/or programmes;
- Inform the public of the NW Province about the environment, and
- Raise environmental awareness amongst communities within the province.

Based on the development of scenarios and through the analysis of current trends, a likely future for the province is determined, referred to as the "Outlook".

This is the third State of the Environment Report (SoER) that the NW Province has produced. The first was completed in 1995 and the second in 2002. These reports have over time assisted NW Province in setting goals and objectives as well as in developing new policies based on the awareness of trends and the underlying drivers of change. The purpose of this Outlook Report differs from that of the previous SoE reports in that it deals not only with the past and present environmental issues, but also creates scenarios for the future.

The environment

The National Environmental Management Act 107 of 1998 (NEMA), defines the environment as the surroundings within which humans exist and that are made up of -

i. The land, water and atmosphere of the earth;
ii. Micro-organisms, plant and animal life;
iii. Any part or combination of (i) and (ii) and the interrelationships among and between them, and
iv. The physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being.

The natural environment is utilized as a resource by people. This is described as follows: *"The objective of any human intervention in a natural ecosystem is to direct the natural flow of energy and matter (i.e. the system's productivity or potential productivity) into forms more readily exploitable by man. Manipulation by man converts natural ecosystems into resource systems - a set of actions that, by definition, both simplifies and destabilizes the natural system. Poorly planned and ill-advised interventions may so disrupt the natural processes and functions of an ecosystem that they bring irreversible disintegration and decline to its productivity and recovery capacity in the short and medium term"* (Ruddle and Rondinelli, 1983).

Human activities and natural events drive change in the environment. The processes of production and consumption that exert pressures[1] on the environment can be categorised as follows:

- Excessive use of environmental resources;
- Changes in land use, and
- Emissions (chemicals, waste, radiation and noise) to air, water and soil.

Understanding the nature and extent of environmental change enables the management thereof through the development of appropriate responses (Kristensen, 2004). Thus, based on an analysis of the current state of the environment within the Province, and through an understanding of the drivers and the resultant pressures, environmental issues are revealed.

Sustainable development

The World Commission on Environment and Development (WCED) defines sustainable development as the ability to *"meet the needs of the present without compromising the ability of future generations to meet their own needs"* (Brundtland Commission Report, 1987).

The European Commission (EC) defined the features of sustainability in its Fifth Action Programme on the Environment (European Commission, 1993) as being:

- To maintain the overall quality of life;
- To maintain continued access to natural resources, and
- To avoid lasting environmental damage.

The Programme further stressed that:

- Preventative action should be preferable to remedial measures;
- Environmental damage should be rectified at the source, and
- The polluter should pay the cost of corrective measures taken to protect the environment.

Though the NW Province does not have a provincial strategy for sustainable development, it relies on the National Framework developed by the Department of Environmental Affairs and Tourism (DEAT). The purpose of the National Strategy for Sustainable Development is to improve and integrate cross-sectoral policy development and implementation, to provide sufficient information for decision-making for current and future spatial development, and to improve communication between organs of state and the public.

The aim of this Environment Outlook Report is aligned with the objectives and aims of the national strategy through:

- The establishment of the current state of the environment;
- The causes of the environmental impacts in the province, and
- The provision of sufficient information to the authorities in order to facilitate informed decision-making within the broader environmental context.

Environmental governance

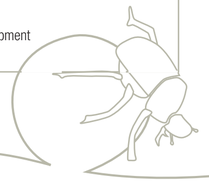
South Africa has been profoundly influenced by international law. Section 2(4)(n) of the NEMA states that *"global and international responsibilities relating to the environment must be discharged in the national interest"*. This statement acknowledges South Africa's responsibility towards its broader international obligations. The following international policies affect the development of national and provincial plans, policies and programmes.

On a national scale, DEAT is aiming to lead sustainable development in South Africa by ensuring the conservation of natural resources, the protection and improvement of the quality and safety of the environment, and through promoting a global sustainable development agenda (South African Government Information, 2008).

National legislation has been promulgated in or to support the protection, conservation and management of South Africa's natural resources[2].

Box-1: International policy which affects the development of national and provincial plans, policies and programmes

- Agenda 21 and Rio Declaration - The implementation of programmes for sustainable development into the 21st century.
- Basel Convention on the Control of Transboundary Movement of Hazardous Wastes - A convention on the control of the movement and trade in hazardous and toxic substances and the reduction of the production of such substances.
- CITES - The Convention of Trade in Endangered Species.
- Codex Alimentarius of the World Health Organisation and Food and Agricultural Organisation.
- Convention of the Conservation of Migratory Species of Wild Animals (Bonn Convention) - A convention to give protection to migratory bird and other species.
- Convention on Biological Diversity - A convention to conserve biological diversity resources.
- Convention on International Trade in Endangered Species of Wild Fauna and Flora.
- Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention)l - A convention to protect, manage and rehabilitate wetlands.
- International Convention on the Protection of New Varieties of Plants.
- International Plant Protection Convention.
- Kyoto Protocol on Climate Change.
- Lusaka Agreement on Co-Operative Enforcement Operations Directed at Illegal Trade in Wild Flora and Fauna.
- Montreal Protocol on Substances that Deplete the Ozone Layer - A treaty for the reduction of ozone depleting substances.
- Stockholm Convention on Persistent Organic Pollutants.
- The International Animal Health Code of the World Organisation for Animal Health.
- The International Code for Laboratory Diagnostic Procedure for Animal Diseases of the World Organisation for Animal Health.
- The Sanitary and Phytosanitary Agreement of the World Trade Organisation (WTO).
- United Nations Convention to Combat Desertification - A convention to reverse the land use practices causing the process of desertification.
- United Nations Framework Convention to Combat Climate Change - A convention to reduce the production and emission of green house gases.
- World Heritage Convention - A convention to give legal protection status to unique features and sites.
- World Summit on Sustainable Development - A summit focussed on the evaluation of sustainable development programmes and policies and the success achieved towards their realisation.



1 Refer to Chapter 2 for a detailed discussion regarding pressures

2 Refer to Chapter 2 for further information on environmental governance

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On a Provincial level, in terms of the NEMA, NWDACE currently has the mandate to administer the following in terms of environmental management:

- Environmental Impact Assessments (EIAs);
- Strategic Environmental Assessments (SEAs);
- Environmental Management Frameworks (EMFs), and
- Environmental Implementation Plans (EIP).

As stated in the NW Province EIP Annual Report 2006/2007 (NWDACE, 2007), working relationships between government departments, as well as between the local and provincial government spheres, are improving. NWDACE is now more involved in the review of Municipal Integrated Development Plans (IDPs), Waste Management Projects and has embarked on various initiatives such as ***Support to Environment and Sustainable Development in North West (SESDNW) Project.*** The conflicting roles and the duplication of statutory mandates and uncertainties with regard to the parameters of the powers and functions of authorities are, however, still affecting their ability to achieve cooperative governance.

The SESDNW is a bilateral development co-operation project of the governments of Finland and South Africa. The objective of this agreement is to contribute to the improvement of environmental management and sustainable development in the NW Province. As reported in the NW Province EIP, Annual Report 2006/2007 (NWDACE, 2007), the first phase of the project ended in December 2005 and the extended phase commenced in January 2006 and will end in December 2008. The components of the extended phase focussed on the following issues:

- Integrated environmental management framework legislation and management tools;
- Spatial planning and land use management;
- Biodiversity management & conservation;
- Environmental monitoring, reporting and information management systems;
- Waste management;
- Air quality management;
- Capacity building and institutional development for environmental management and sustainable development of the NWDACE, Environmental Services and the Department of Developmental Local Government and Housing (DDLGH), Spatial Planning Unit as well as district and local municipalities, and
- The North West Eco–Fund.

Initiatives such as these have assisted the NW Province in improving provincial environmental management. Plans, programmes and policies developed as a result of these projects are considered as part of this Environmental Outlook Report.

The reporting framework

As was the case in the 2002 NW Province SoER, this report is based on a modification of the Drivers-Pressure-State-Impact-Response (DPSIR) model for state of the environment reporting, developed by the Organisation for Economic Cooperation and Development (OECD) in the early 1990s, and adapted by the United Nations Commission on Sustainable Development (UNCSD) in 1995.

The DPSIR framework is a model which establishes a cause and effect relationship between human activities and the impacts exerted by such activities on the environment (Figure 1). Responses to the impacts are formulated and interventions are then made in the cause and effect relationship to enhance the positive impacts and reduce the negative impacts (Goslar *et al.* 2008).

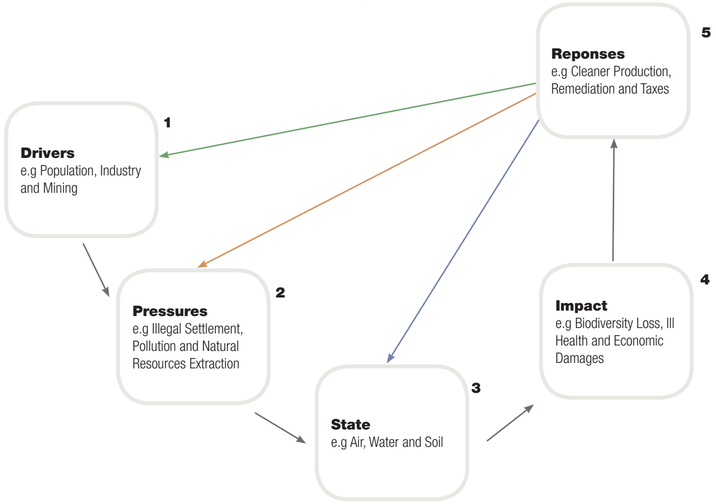

Figure 1: The DPSIR framework (Segnestam, 2002)

Report outline

- **Part I & II** (Chapters 1 and 2) introduces the NW Province, deals with the concept of sustainability and describes the context within which the Outlook is written. It also describes the challenges associated with the socio-economic needs of the Province, and outlines, in broad terms, how economic activities impact on the environment and the drivers[3] of environmental change;
- **Part III** (Chapters 3 to 8) investigates the state of each environmental component or theme, as well as how these are governed;
- **Part IV** (Chapter 9) evaluates the trends presented in the preceding chapters, and extrapolates the information in the form of scenarios. Based on the two main drivers (governance and economy), attempts are made to predict what the NW Province could reasonably be expected to look like in 2025, and
- **Part V** (Chapter 10) provides a broad discussion on the conditions and options that may require attention in order to slow, halt, or reverse social and environmental degradation in response to the identified scenarios.

The following image (Figure 2) illustrates the manner in which the report outline has been structured, in accordance with the DPSIR Model.

Indicators

Indicators are measurable features or occurrences through which, if monitored on a regular basis, changes in the pressures acting on the environment and the condition of the environment can be tracked. Indicators need to provide information on how aspects of the environment have changed both over time and spatially and should be **simple, quantifiable and communicable.**

Indicators are used to form the basis of SoE reporting and present an opportunity to not only audit the environment at a particular point in time, but to establish trends when information and data is monitored and collected. Indicators are therefore useful tools both for establishing the SoE and to provide a baseline for future monitoring (Goslar *et al.*, 2008).

3 Refer to Chapter 2 for a detailed description of the drivers.

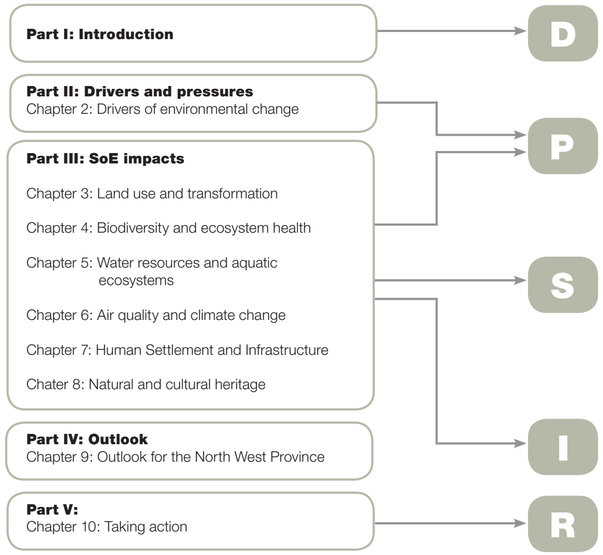

Figure 2: The DPSIR framework and report structure

Photo: NWDACE

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Box-2: Example of an indicator – surface water quality

The following table provides an example of one of the indicators that is used to determine surface water quality. One of the parameters to measure the water's fitness for recreational use is the Department of Water Affairs and Forestry (DWAF) guideline for the percentage of chlorophyll-a. The following table illustrates the relationship between issue, objective and indicator.

Issue	Objective	Indicator
Freshwater resources – Dams	Ensure fitness for use	Percentage that Chlorophyll-a for non-contact recreational use exceeds DWAF guidelines.

Through the measurement of indicators, the current state of the surface water feature and its suitability for recreational use can be determined, and the data can be used to measure change over time.

Indicators may be used for, *inter alia*, the following (NWDACE, 2008):

- Monitoring and assessing conditions and trends;
- Comparing and assessing situations;
- Assessing the effectiveness of policy-making;
- Marking progress against a stated benchmark;
- Monitoring changes in public attitude and behaviour;
- Ensure understanding, participation and transparency in information transfer between interested and affected parties;
- Forecasting and projecting trends, and
- Providing early warning information.

The North West Office of the Premier has recently completed the development of the Indicators for Sustainable Development for the Province and its District Municipalities. This initiative involved the identification of a proposed set of indicators based on sustainable development principles. As a result, the Office of the Premier launched a pilot project to calculate these indicators. The indicators identified by the province, as well as indicators[4] specifically identified for the purposes of this report, have been used to give an account on the current state of the environment in the province.

4 It should be that insufficient data exists for the complete interpretation of all identified indicators and those that have not been measured are noted in this report and proposed for future monitoring.

It is important to distinguish between *indicators of sustainability* and *environmental indicators*. Sustainable development indicators take into account economic linkages, quality of life and environmental quality. Environmental indicators deal with natural environmental issues and the influence of humans on natural systems.

Obvious linkages do exist between the two sets of indicators, particularly when environmental degradation or consumption of a resource can be related to social and economic practices. Table 1 illustrates the differences between environmental and sustainable development indicators.

In addition sustainable development indicators should reflect desirable **sustainability conditions** including:

- Having a reasonable relationship to the interpretation of 'sustainability' at both a local and national level;
- Being relevant to the concerns and responsibilities of the decision-makers, community and the ordinary citizen;
- Reflecting local circumstances;
- Being derived from easy to collect and relatively inexpensive information;
- Showing trends over reasonable time scales;
- Having a relationship to other sets of indicators;
- Being clear, easy to understand, and educate as well as inform;
- Provoking change (in policies, practices, lifestyles);
- Leading to the setting of targets or thresholds;
- Having available previous data from which the indicator can be derived, and
- Being comparative between geographic areas, either within the province or between provinces.

Traditional environmental indicators need to be tested and evaluated in order to establish whether they conform to the concept of sustainable development and other sustainability indicators.

	Environmental Indicators	SD Indicators
Themes	☐ Natural environment. ☐ Influence of natural environment on humans.	☐ Economic linkages. ☐ Social welfare. ☐ Environmental quality.
Concept	Monitoring the state of the natural environment with a focus on non-living (air, water, soil) and living (animals, plants, biodiversity) components.	SD by monitoring the social, economic and natural environment (three pillars of SD).
Linkages	Provides information on the natural environment which assists in measuring SD. The conditions of the components of the natural environment have a bearing on economic and social welfare.	Economics and social welfare are dependent upon the natural capital from the natural environment. They in turn have direct and indirect impacts on the natural environment.

Table 1: Comparison of environmental and sustainable development (SD) indicators (Goslar *et al.* 2008)

Photo: NWDACE

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Photo: SA Tourism

CHAPTER 1

Introduction to the North West Province

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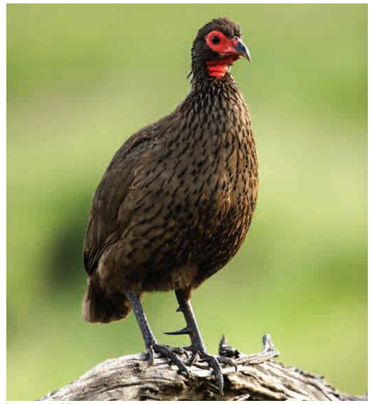

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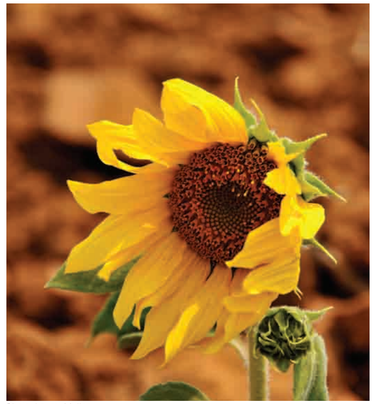

Photo: Lauret Muller

List of tables

Acronyms and abbreviations

BEE	Black Economic Empowerment
DACE	Department of Agriculture, Conservation and the Environment
DEAT	Department of Environmental Affairs and Tourism
EIP	Environmental Implementation Plan
GEAR	Growth, Employment, and Redistribution Strategy
MDB	Municipal Demarcation Board
MDG	Millennium Development Goal
NW	North West
PGDS	Provincial Growth and Development Strategy
PPP	Plans, Policies and Programmes
RDP	Reconstruction and Development Programme
SMME	Small, Medium and Micro Enterprises
SoER	State of the Environment Report
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme

SI units

°C	Degrees Celsius
km^2	Square kilometres
masl	Meters above sea level

Definition of terms

Aquifer
An underground geological layer of permeable rock from which water can be abstracted.

Biome
The world's major communities classified according to the predominant vegetation type and characterized by adaptations of organisms to that particular environment (Campbell, 1996).

District
District municipalities as demarcated by the Municipal Demarcation Board (2008).

Dolomitic eye
A spring with groundwater rising to the surface.

Endemic
An organism which is exclusively found within a particular geographic location or region.

Ramsar
A city in Iran where an intergovernmental treaty for the protection and wise use of wetlands was signed in 1971 (The Ramsar Convention on Wetlands, 2008).

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1.1. Introduction

The North West (NW) Province, one of the nine provinces of the Republic of South Africa, was established in 1994 and comprises the western portion of the former Transvaal province, and Bophuthatswana (a former homeland created by the pre-1994 government).

The province is situated at the centre of the northern border of South Africa, and shares borders with Botswana to the north and four of the other South African provinces: the Northern Cape Province to the south-west, the Free State to the south, the Gauteng Province to the south-east, and the Limpopo Province to the east and north-east.
The province covers 129,821 km^2 or approximately 11% of the total surface area of South Africa (Municipal Demarcation Board, 2008).

1.2. Administrative areas

1.2.1. Municipalities

In 1994, the NW Province was created together with five district municipalities. The municipalities were originally named after their geographic location as the Northern, Southern, Eastern, Western, and Central districts. The NW provincial and municipal boundaries were amended in 2006 resulting in the western portion of the NW Province being reallocated to the Northern Cape Province and two portions of the Gauteng Province being reallocated to the NW Province. Furthermore, the Eastern and Central districts were merged into a single municipal, the Bojanala District Municipality, and the Western district was renamed the Bophirima District Municipality. The culmination of this process was the creation of four new district municipalities within the provincial boundaries of the NW Province.

During the course of 2008, the districts were renamed to: the Ngaka Modiri Molema district; the Dr. Kenneth Kaunda district, the Dr. Ruth Segomotsi Mompati district, and Bojanala Platinum district, as indicated in Table 1-1 (Municipal Demarcation Board (MDB), 2008). The four district municipalities are divided into 21 local municipalities, which are represented in Table 1-2.

2000	2006	2008
Central	Central	Ngaka Modiri Molema
Northern	Bojanala	Bojanala Platinum
Eastern		
Southern	Southern	Dr. Kenneth Kaunda
Western	Western	Dr. Ruth Segomotsi Mompati

Table 1-1: Change in district municipalities for the NW Province (MDB, 2008)

2000	Local municipality
Ngaka Modiri Molema	Ramotshere Moiloa Ditsobotla Tswaing Ratlou Mafikeng
Dr. Kenneth Kaunda	Maquassi Hills City of Matlosana Tlokwe Merafong City Ventersdorp
Dr. Ruth Segomotsi Mompati	Molopo Kagisano Naledi Greater Taung Lekwa - Teemane Mamusa
Bojanala Platinum	Moses Kotane Kgetlengrivier Rustenburg Madibeng Moretele

Table 1-2: Local municipalities per district (from MDB, 2008)

1.2.2. Towns and cities

The City of Mafikeng serves as the provincial capital of the NW Province. Other significant towns are Brits, Klerksdorp, Lichtenburg, Potchefstroom, Rustenburg and Vryburg. The location of these towns is illustrated in Figure 1-1.
The significant towns of the NW Province were originally agricultural centres, which later evolved into mining centres. The city of Rustenburg is currently reported by the Business Day (2008) as being the fastest growing urban area in Africa due to mining activities along the western rim of the Bushveld Igneous Complex.

1.3. Physical environment

The landscape of the NW Province varies from plains in the west to mountains in the east. The altitude ranges from 1,000 masl in the plains to 2,000 masl in the mountains.
The western and north western portions of the province are dominated by plains, with scattered hills running in an arc from the Northern Cape Province. The central and southern portions of the province feature mostly plains with pans. Slightly undulating plains characterise areas to the west of Vryburg, and south of Lichtenburg. The towns of Taung and Vryburg are also located in hilly areas with a thin band of escarpment running from the Northern Cape Province up to Taung. Potchefstroom and Rustenburg are located in an area of parallel hills and lowlands. The north eastern portion of the province is characterised by plains and undulating plains with scattered occurrence of hills and lowlands, and parallel hills. The most prominent of these hills are the Magaliesberg, Pilansberg and Norite Koppies.

The Magaliesberg and the Pilanesberg mountain ranges occur in the Bojanala Platinum District. The Pilanesberg mountain range surrounds the bowl of an extinct volcano which is now a popular National Park, the Pilanesberg Game Reserve. The Magaliesberg mountain range extends for approximately 130 km from Pretoria to Rustenburg.

The province enjoys a continental climate characterised by a high variance between minimum and maximum temperatures. According to the South African Weather Services (2008), the daily maximum temperatures range from 17 to 31 °C in the summer and from 4 to 20 °C in the winter. The highest ever recorded temperature is 40° C in the months of December and January. The lowest ever recorded temperature is -6 °C in the months June and July. Annual rainfall totals approximately 539 mm, with the highest rainfall during the summer months between October and April (an average of 117 mm in January). Precipitation is very low in the winter months with an average of 3 mm falling in July. The highest recorded 24 hour rainfall is 99 mm in the month of March.

Due to the low precipitation levels, the province is considered to be an arid region. A large percentage of precipitation occurs as thunderstorms, which are associated with events such as heavy gusts of wind, lightning, hail and flash-floods. [1]

Water drains through three primary river catchment systems: The Vaal in the south, Molopo in the west and Crocodile and Marico in the east. The majority of rivers are non-perennial, flowing with seasonal rainfall.

1 Refer to Chapter 6 for further information on air quality and climate change.

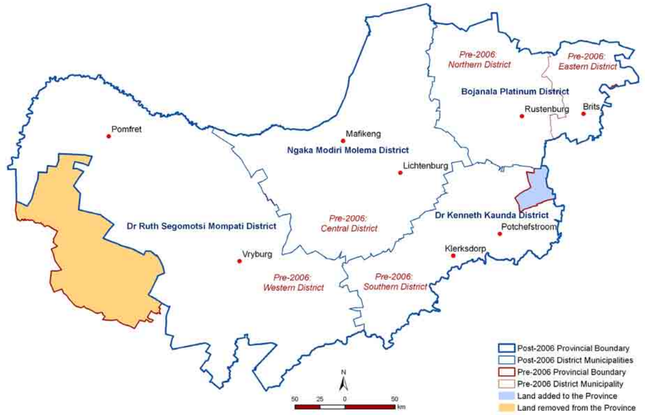

Figure 1-1: Administrative areas of the NW Province (MDB, 2008)

The main perennial rivers are the Crocodile (West), Groot Marico, Hex, Elands, Vaal, Mooi, Harts and Molopo rivers (North West Parks and Tourism Board (NWPTB), 2008). Larger rivers are concentrated in the wetter eastern and southern portions of the province, with the Crocodile, Hex, Elands, Mooi, Vaal and Harts Rivers occurring in these regions. The Molopo River is the only major river occurring in the drier north-western portion of the province. Other important surface water features are dams, pans, wetlands and dolomitic eyes fed by aquifers. The runoff as percentage of precipitation in the province on average is 6%, lower than the national average of 9% (NWPTB, 2008). This varies considerably from less than 1% in the west to 7% in the east of the province. [2]

The province has large underground water reserves in the form of fractured aquifers and dolomitic compartments (NWPTB, 2008). The general semi-arid conditions of the province have resulted in a high demand for groundwater. The aquifers are however recharged slowly at an average recharge rate of less than ten millimetres per year in the western region and 300 mm per annum in the eastern regions (NWPTB, 2008).

2 Refer to Chapter 5 for further information on water resources.

1.4. Living environment

The NW Province is primarily covered by the Savannah biome (71%) and to a lesser extent the Grassland biome. These two biomes are divided further into 41 vegetation biomes, of which twelve are endemic to the province. The vegetation in the NW Province represents approximately nine percent of the vegetation types found in South Africa (Mucina, Rutherford and Powrie, 2005). Approximately 3,025 plant species, 138 mammals, 384 birds, 27 amphibians and 59 reptile species are found within these biomes. Several of these species are endemic to the province, such as the African Wild Dog (*Lycaon pictus*) and the *Aloe peglerae* in the Magaliesberg (NWPTB, 2008). Medicinal plants (such as the devil's claw *Harpagophytum procumbens*) are harvested, traded and utilised by local communities. [3]

In order to conserve plant and animal life within the province, 2 national parks and 12 provincial reserves have been established. The two national parks, the Pilanesberg and Madikwe National Parks, are administered by the North West Parks and Tourism Board (NWPTB) (2008). The most significant cross boundary conservation area is the Magaliesberg Protected Environment which is shared with the Gauteng Province. Other significant conservation areas shared with other provinces are the Cradle of Humankind, shared with the Gauteng Province, and the Vredefort Dome shared with the Free State Province. According to the NWPTB (2008), the total size of formally protected areas, is 283,308 ha which amounts to just over 2% of the total land area of the province.

If properly managed, game farms are an important component of conservation. These farms comprise 1,171,332 ha of the province's surface area and form an important part of conservation in the province. A large source of foreign exchange in the province is generated from the trade in wildlife, as the game farms in the NW Province are well known hunting areas, both nationally and internationally (NWPTB, 2008). The species being conserved in these areas are predominantly antelope such as kudu, duiker and steenbok, as well as other animals such as sable, cape buffalo, gemsbok, eland, red hartebeest and blue wildebeest.

The most prominent wetland in the province is the Barberspan, a Ramsar site which is recognised as a wetland of international importance (NWPTB, 2008). Both the perennial and non-perennial pans and dams are important breeding sites, particularly for waterfowl, amphibians and invertebrates. Many of these species are adapted to the seasonal nature of the non-perennial water bodies (NWPTB, 2008). Some wetlands and dams are located around the numerous artesian wells (dolomitic eyes) in the province. These form habitats unique to each artesian well or the general region. Within these habitats indigenous plant and

3 Refer to Chapter 3 for further information on biodiversity and ecosystems.

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animal species of unique importance are found, particularly the aquatic invertebrates and fish (NWPTB, 2008).

Fishing in the province is undertaken mostly for recreational purposes. Fishing is however an important protein source in areas where communities are vulnerable to food shortages (NWPTB, 2008). The NW Province has been involved in the development of small-scale commercial fisheries in conjunction with communities utilising dams. Similar projects are underway by DWAF for the aquaculture of fish in the ponds of sewage works (Venter, 2008).

1.5. People, economy and culture

The NW Province has a long history leading to settlement of a variety of cultures and people within the province. Many people migrated to the province seeking land and opportunities, or due to the separate development and group areas policies of the pre-1994 South African government.

The population of the province was 3,271 million people in 2007, which constituted approximately 8% of the national population. The east of the province has the highest population density in 2007 of 55 persons per km^2, tapering off to 11 persons per km^2 in the western region (Global Insights, 2006). Sixty five percent of the people live in the rural areas and the major ethnic group are the Setswana (NWPTB, 2008), followed by the minority groups of the Afrikaans, Sesotho, and Xhosa speaking people.

During the 1950s, the majority of the population groups, except for the Afrikaans, were placed in demarcated areas as a part of a forced removals policy. This involved the relocation of urban populations of African, Asian and Coloured communities from scattered formal locations and informal settlements, to larger townships. The policy of forced removals is probably one of the most important factors that has contributed towards the destruction of cultural heritage in the province and left behind a legacy of hundreds of forgotten cemeteries and the ruins of villages and homesteads. Parallel to the forced removals was a major process of political restructuring in the reserves, through their development into "homelands" based on tribal and language lines. These homelands were created around the areas demarcated in 1913 and 1936.

In line with this, the Tswana Territorial Authority was created in 1961, and was renamed *Bophuthatswana* in 1972 when it became a "self-governing state". Bophuthatswana was declared as "independent" by the government in 1977.

After the change in government in 1994, and the introduction of the new Constitution of the Republic of South Africa in 1996, the former four provinces of South Africa were demarcated into the current 9, which assimilated the former homelands[3].

The exploitation of minerals is a common heritage of the NW Province that has been practised since the Early Iron Age. African communities mined iron, copper, tin and salt until the advent of colonialism in the 1830s, when it became more convenient to procure ready-made products. In many instances, the local knowledge about mineral deposits was transferred to white prospectors and explorers. Commercial mining took root in the province in the early 1880s, starting with the discovery of gold at Klerksdorp, Hartbeesfontein and Ottoshoop. This was preceded by the advent of alluvial diamond mining along the lower reaches of the Vaal River.

This type of mining resurfaced when diamonds were discovered during the excavation of a cattle dip in 1924 in what is known today as Bakerville, a provincial heritage site. This gave rise to some of the largest alluvial diamond diggings in South Africa.

Today the foundation of the NW economy is based on mining[5], which generates more than half of the province's revenue and provides jobs for more than 23% of its workforce (Urban-Econ, 2007). The NW Province is an important source for platinum, vanadium and a host of other minerals. Platinum mining was established after the discovery of the Merensky Reef by Dr. Hans Merensky in 1924, and today approximately 94% of the country's platinum is extracted from this reef. This is evident from the large number of mines that characterise the landscape between Brits and Rustenburg. The province produces approximately 46% of South Africa's granite, with most quarries located in the Brits area, and 25% of the country's gold from the mines in the Klerksdorp-Potchefstroom area.

Figure 1-2: The historic cattle dip that triggered the diamond rush at Bakerville in 1924. Now a provincial heritage site, it is owned by a private land owner

4 Further information on human settlements and infrastructure is provided for in Chapter 7.

5 Refer to Chapters 2 (drivers of environmental change) and 3 (land use and transformation) for further discussion on mining in the Province and its role as a driver.

The main minerals currently extracted in the province are (Anon, 2006):

- Gold which is mined in the Orkney, Klerksdorp and Carltonville areas;
- Uranium which is mined in the Klerksdorp area;
- Platinum group metals and chrome which are mined in the Rustenburg and Brits areas, and
- Diamonds which are mined in the Lichtenburg, Christiana, and Bloemhof areas. While agriculture is not the major contributor to the NW economy from a monetary perspective, it is the largest contributor to employment.

The biggest number (326) of game farms occur in the Bojanala region with the Bophirima region covering the largest area (497,365 ha) of exempted game farms, as well as the largest average size (4,110 ha) of exempted game farms within the province (Boshoff, 2007). The eastern and southern regions are cultivated producing, amongst other crops, maize, sunflowers, tobacco, cotton, and citrus fruits [6] (Anon, 2006).
Although the province is well known for its rich mineral resources, and its unique biophysical features such as the Magaliesberg, it is rich in cultural resources and has a history spanning over 2 million years[7]. The recently proclaimed protected areas within the province have helped to conserve some of the natural and cultural heritage, however many significant sites or artefacts have become degraded or lost as they have not been given the necessary protection.

1.6. Sustainable development in the North West Province

Sustainable development is a concept that aims to ensure that the progress of today is not achieved at the expense of future generations. In order to achieve this, sustainable development requires the current rate of consumption of environmental resources is sufficiently balanced to ensure that the natural capital and environment services will be available in the future.[8]

To facilitate sustainability, strategies and policies are required for all spheres of government to control the rate of consumption of non-renewable and renewable resources, as well as to ensure the health of ecosystems which provide humans with essential services. This requires a holistic approach to sustainability.

In South Africa, current national strategies on sustainable development reflect an approach which seeks to ensure that development in the social, economic and environmental sectors is equitable for all citizens, both now and in the future, as highlighted in South Africa's definition of sustainable development (NWDACE, 2008):

"Sustainable development means 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."

This concept is encapsulated in the basic rights of every South African citizen as contained in Section 24 of the Constitution. Based on the above, the Department of Environmental Affairs and Tourism (DEAT) has developed a national framework for sustainable development.

The NW Province's philosophy to sustainable development, as illustrated in Figure 1-3, is based on three core concepts: economic viability, social equity, and ecological integrity. These concepts, also known as the three pillars of sustainable development, form the foundation on which the province plans to facilitate sustainable development.
The NW Province has not developed a province-specific strategy to facilitate sustainable development, but rather relies on the national framework developed by DEAT. Based on this framework, decision making within the province is established on a cluster system comprising the following clusters:

6 Further discussion on the population and the economy is provided in Chapter 2 (drivers of environmental change) and on agriculture is provided in Chapter 3 (land use and transformation).

7 Chapter 8 (natural and cultural heritage) of this report provides further information on the cultural and natural heritage resources in the NW Province.

Box 1-1: Unique features of the NW Province

From an economic perspective, the NW Province is known for mining and agriculture. The NW dominates platinum mining in South Africa, accounting for 94% of the country's platinum reserves, and over 70% of the world's reserves. The province also contains generous resources of granite, gold and diamonds. The second largest and perhaps oldest economic activity in the province is agriculture. The NW is the country's second largest producer of sunflowers, accounting for 36% of market share (and a third of South Africa's maize (NWPTB, 2008), and also an important producer of maize, groundnuts and livestock agriculture.

Important heritage and ecological sensitive sites within the NW Province have gained international recognition. Three World Heritage Sites are fully or partially located within the province: Taung Skull Fossil Site, Vredefort Dome and the Cradle of Humankind. Barberspan has been declared a Ramsar wetland, noting it as an internationally recognised bird habitat.

Tourism is an important part of the NW Economy. The entertainment and casino complex at Sun City and Lost City are the largest single tourism contributors to the provincial economy. These are located adjacent to the Pilansberg National Park which is founded on a prominent geological feature. Other important tourism areas are the Madikwe Game Reserve located on the Border with Botswana and Hartbeespoort Dam located close to Gauteng.

Other important facilities in the province include Pelindaba, or the Nuclear Energy Research Institute of South Africa (NERSA), located adjacent to Hartbeespoort Dam. This facility was formerly the site for the production and storage of nuclear weapons by the South African government. The facility now produces radioactive isotopes for medical use.
The major university of the NW is the North West University which comprises the following campuses:

- The Mafikeng campus which founded in 1979 in Mmabatho as the University of the Bophuthatswana;
- The Potchefstroom campus which was founded in 1869 and became a constituent college of the University of South Africa in 1921. The university gained its independence in 1951 as the Potchefstroom University for Christian Higher Education, and
- The Vaal Triangle campus.

8 Refer to the preamble for information on sustainable development and indicators.

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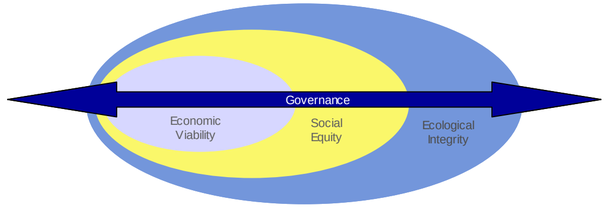

Figure 1-3: Concept of sustainable development for the NW Province (NWDACE, 2008)

- Economic Development and Infrastructure;
- Social Development, and
- Governance and Administration.

These clusters are responsible for the formulation of plans, policies and programmes (PPP) across all sectors of government within the province (NWDACE, 2008) and through this framework, sustainable development is being facilitated in a top-down approach through all sectors of government within the province.
The implementation of the 3 core concepts of sustainability across the 3 governing clusters is driven at a provincial level by the NW Province through the Provincial Growth and Development Strategy (PGDS) (NWPG, 2005).

The sustainability challenges for the province as identified through the PGDS 2014 are to achieve (Bophirima District Municipality, 2006):

- A real economic growt rate of 6.6% per annum in order to:
  - Halve unemployment, and
  - Provide sufficient momentum for integrated and sustainable growth and development in the NW.
- Provide basic services and eradicate backlogs in order to:
  - Assist poverty alleviation in accordance with the provisions of the Constitution, and
  - Provide essential services to facilitate the future growth and development of the poor.

The Executive Council in the NW Province's cabinet has subsequently defined a set of provincial priorities, including among others, the following:

1. Ensuring sustainable resource use and environmental protection;
2. Providing environmental empowerment and capacity building, and
3. Ensuring good governance and transformation.

Photo: NWDACE

Photo: SA Tourism

Photo: NWDACE

Box 1-2: NW cluster objectives (NWDACE, 2008)

The following cluster objectives have been determined by the province and are contained in the Second Edition EIP:

Cluster	Objective
Economic Development and Infrastructure Cluster	The objectives are to: ☐ Achieve sector and geographic specific growth and employment targets; ☐ Focus on and support opportunities for small, medium and micro enterprise (SMME) development; ☐ Create conditions conducive to entrepreneurial activity and investment; ☐ Leverage funding for productive infrastructure delivery; ☐ Improve access to and optimal utilization of productive resources; ☐ Support innovation, research and knowledge development; ☐ Market and provide economic development opportunities and products; ☐ Develop appropriate information management and monitoring systems; ☐ Ensure environmental sustainable economic and infrastructure development; ☐ Maximize private sector investment and facilitate public and private partnerships, and ☐ Support black economic empowerment (BEE) as part of overall economic development.
Social Cluster	The objectives are to: ☐ Improve human capital formation in the province through basic literacy and further education programmes; ☐ Improve availability and quality of social services; ☐ Provide basic services to all communities; ☐ Ensure access to sport and recreation facilities; ☐ Introduce appropriate HIV and AIDS awareness and treatment programmes; ☐ Improve management of social services institutions; ☐ Ensure accessibility to appropriate welfare programmes; ☐ Introduce a social development monitoring system, and ☐ Reduce poverty levels in the province.
Governance and Administration Cluster	The objectives are to: ☐ Improve cooperation governance framework in the NW Province; ☐ Ensure alignment and coordination of policies of various spheres of government; ☐ Promote effective and efficient governance through capacity building, and ☐ Promote a safe and crime free environment

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The province plans to monitor its progress towards sustainable development through the use of indicators. The province has proposed that a set of 105 sustainable development indicators, including 21 Millennium Development Goal (MDG) indicators, be adopted for monitoring their progress towards sustainable development. The NW Office of the Premier: Chief Directorate Policy and Planning has launched a project to collect data on these indicators, from which a pilot project was launched in 2007 to establish the current availability of data. The outcome of this pilot project was captured in a report on indicators for sustainable development and has been utilised as an important data source for this report (Urban-Econ, 2007).

The NWDACE is the provincial department responsible for environmentally related issues within the province. NWDACE plays a key role in implementing the province's goals for sustainable development as the provincial executive of environmental legislation and monitoring of the state of environmental resources within the province. The NWDACE's road map in implementing the sustainable development concepts of the province is embodied in the NWDACE Strategic Plan 2008-2011 (NWDACE, 2008), which is reviewed and up-dated annually. According to this strategic plan, the largest sustainability challenge to the province is achieving socially acceptable, economically justifiable and environmentally sound development. Specific issues which require attention are (NWDACE, 2008) *"the management, regulation and rehabilitation of environmental degradation as a result of mining, industry, human settlement and agricultural activities"*. Law enforcement and instituting public awareness programmes are identified as essential functions to protect the interests of the majority from law breakers. The four strategic goals of the NWDACE are (NWDACE, 2008):

1. To ensure a sound natural resources regulatory framework;
2. To ensure sound capacity building interventions;
3. To ensure sound delivery of services; and
4. To ensure internal departmental excellence.

Overcoming the challenges of sustainable development depends on confronting the political challenges and finding ways to unlock society's creativity, while taking into account some of the impediments that are particular to the province.

Photo: Lauret Muller

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Laurel Muller

CHAPTER 2

Drivers of environmental change

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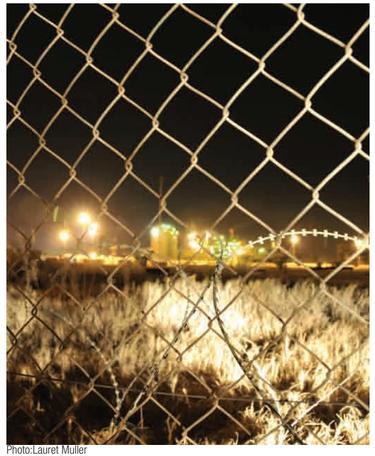
Photo:Mary-Ann Palmer



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Acronyms and abbreviations

AIDS	Acquired Immune Deficiency Syndrome
AMD	Acid Mine Drainage
AsgiSA	Accelerated and Shared Growth Initiative for South Africa
CITES	Convention on International Trade in Endangered Species
DACE	See NWDACE
DEAT	Department of Environmental Affairs and Tourism
DDLGH	Department of Developmental Local Governmnet and Housing
DME	Department of Minerals and Energy
DST	Department of Science and Technology
DWAF	Department of Water Affairs and Forestry
EAP	Economically Active Population
EIA	Environmental Impact Assessment
EIP	Environmental Implementation Plan
EMF	Environmental Management Framework
GDP	Gross Domestic Product
GEAR	Growth, Employment, and Redistribution Strategy
GDACE	Gauteng Department of Africaulture, Conservation and Environment
GGP	Gross Geographic Product
GNP	Gross National Product
GVA	Gross Value Added
HDI	Human Development Index
HIV	Human Immune Virus
ICT	Internet Communication Technology
IDP	Integrated Development Plan
IEM	Integrated Environmental Management
IMF	International Monetary Fund
MDB	Municipal Demarcation Board
MDG	Millennium Development Goal
MLL	Minimum Living Level
NACI	National Advisory Council on Innovation
NEMA	National Environmental Management Act
NW	North West
NWDACE	North West Department of Agriculture, Conservation and Environment
PGDS	Provincial Growth and Development Strategy
PGM	Platinum Group Metal
R&D	Research and Development
RDP	Reconstruction and Development Programme
RoD	Record of Decision
SASSA	South African Social Security Agency
SDF	Spatial Development Framework
SEA	Strategic Environmental Assessment
SLA	Sustainable Livelihoods Approach
SMME	Small, Medium and Micro Enterprises
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNESCO	United Nations Environmental, Scientific and Cultural Organisation

Photo: Anuschka Barac

Definition of terms

Economically Active Population (EAP)

Persons who provide labour to the production of goods and services over a specific period of time.

Employment Growth Rate

The rate at which employment in the economically active population, or persons aged between 15 and 64, is increasing or decreasing.

Functional Literacy

The percentage of the population over the age of 20, who have completed schooling up to grade 7 or higher.

Gross Geographic Product (GGP)

The value of final goods and services produced within a specific geographical area (region) in a given year divided by a total population in the same year. GGP per capita serves as an indicator of economic welfare in the region. A decrease in this ratio implies that population growth exceeds GGP (or GVA) growth rate.

Gross Value Added (GVA)

The level of economic activities within a specific area. GVA is calculated as the difference between output and intermediate consumption in the economy. That is the difference between the value of goods and services produced and the cost of raw materials and other inputs, which are used up in production by all sectors of an economy.

Human Development Index (HDI)

The extent of human development within a community based on the measures of: life expectancy, literacy, and income. It measures people's ability to live a long and healthy life, to communicate, to participate in the life of the community and to have sufficient resources to obtain a decent living. A HDI of 1 indicates the maximum level of human development, while a HDI of 0 the minimum level of human development.

Minimum Living Level (MLL)

The minimum revenue required by a person to service. Also known as the poverty line and the bread line, the MLL based on cost of rent and basic services, provision for the family to meet the minimum dietary requirements recommended by the Department of Health, schooling expenses, some clothing and washing materials, and travel expenses to and from work.

Potentially Economically Active Population

The total population between the ages 15 and 64.

Tress Index

The level that a particular region's economy is diversified or concentrated. A Tress Index of zero represents a completely diversified economy. On the other hand, the higher the index the more concentrated or vulnerable the region's economy will be to exogenous variables, such as adverse climatic conditions, commodity price fluctuations, etc.

Photo: Lizelle Prosch

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2.1. Introduction

The environment provides humans with a range of goods and services that are essential for their well-being, cultural diversity, and economic prosperity. These goods and services have formed the foundation from which people have been able to grow and develop to inhabit most parts of earth.

A conflict exists between human development and the destruction of the natural environment. This is central to the concept of sustainability. For a sustainable future, a healthy environment and ecosystems are of fundamental importance. The degradation of environmental resources has a direct impact on human well-being, since people are reliant on the environment for their survival.

The earth has limited space and resources which are shared by all living organisms. These resources are only able to sustain a predetermined number of organisms, or carrying capacity, based on the physical limit of available space, natural capital and services. The rate of consumption of resources relative to their regeneration is therefore important for humankind's survival.

While both natural events and human activities are responsible for change in the environment, the impacts of people's activities are often severe and not well monitored. People and their activities act as a driving force behind environmental change. Understanding the nature and extent of environmental change, caused by these drivers, enables people to manage the activities that are placing

Photo: Anuschka Barac

pressures on the environment (Goslar *et al.*, 2008). As human populations and their associated consumption rates increase, the ability of the earth to sustain people is diminished as a result environmental degradation by factors such as deforestation, soil erosion, desertification, and increasing levels of air and water pollution. The increasing pace of human-induced environmental change alters the ability of the environment to provide essential goods and services, which in turn impedes progress towards sustainable development.

The key forces that directly affect behaviour, and therefore exert particular pressure on the environment, are:

1. ***External factors*** *such as political priorities, legislation, public and media awareness, new scientific understanding, globalisation, partnerships and regional influences;*
2. ***Internal factors*** *such as delivery of services, innovation and new technology, performance and reputation, transparency and reporting, benchmarking and shareholder value and;*
3. ***Stakeholder interactions*** *particularly in the areas of community awareness, reporting, best practices, social responsibility and environmental liability.*

Not all human activities exert the same degree of change on the environment. These activities rather act as a driving force which places pressure on these resources and results in a particular state of the environment. The main human-induced drivers of environmental change are (UNEP, 2006; DEAT, 2006):

- Demography and human well-being;
- Economic growth;
- Governance, and
- Science and technology.

The relationship between drivers, pressures and the state of the environment is not linear but iterative (GDACE, 2004). For example, it is understood that a degraded environment reduces the availability of resources to the rural poor. The rural poor in turn poor further degrade the environment, thus affecting the availability of resources.

2.2. Pressures: the link between drivers and the environment

People's everyday activities act as drivers which place pressure on the environment. These everyday activities involve the production and consumption of goods which are necessary for human survival. The pressures placed on the environment can be summarised into the following categories (Kristensen, 2004):

- The excessive use of environmental resources;
- Changes in land use, and
- Emissions and effluent of chemicals, waste, tradiation and noise into the air, water and soil.

The significance of these pressures is a function of: the level of human activities, and the technology applied (Kristensen, 2004). For example, the pressure exerted by an increase in cultivation on natural habitats depends on the physical size of the field (which is the level of activity), and the chemicals utilised in the agricultural practices (which is the technology applied).

2.2.1. Excessive use of environmental resources

The demography and human well-being, and economic development drivers are instrumental in causing the excessive use of environmental resources. Examples of the relationship between these drivers and this pressure are provided below.

The main economic activity in the NW Province is mining. Mining is heavily reliant on available water resources for mineral extraction and processing. The NW Province is however a region with limited water resources. As mining expands, increased pressure is placed on the availability of water resources for other uses such as human consumption and natural functions within ecosystems.

Agriculture is the largest provider of employment in the province. Agriculture requires both arable land and sufficient water supply for the cultivation of crops. In order to increase agricultural production and yields, larger areas of land must be cleared and possibly irrigated. The increased footprint of agriculture however results in a reduction in the biodiversity of species responsible for the pollination of crops, which has a direct impact on many types of crops. Therefore, even though there is a finite area of land available for cultivation, a balance must be maintained between the area under cultivation and untransformed open spaces for the health of ecosystem (Goslar *et al.*, 2008).

In the case of poor rural populations, the environment is an important resource for people's survival. Many people in the NW Province are partially or completely reliant on the materials, energy and amenities that are directly provided by the environment for their survival.

2.2.2. Change in land use

Land use in the NW Province is an issue of contention due to land ownership and the types of use such as urban areas being located in close proximity to heavy industries. The type of land use in a particular area is influenced by the land owner, the type of resources available and regulation by authorities.

The increase of land use changes around platinum mining in the Bojanala Platinum District which serves as a good example. The Merensky Reef, the richest platinum reef in the world, runs from the Pilansberg to Brits over an 80 km stretch. This area has mining activities related to the western rim of the Bushveld Igneous Complex, including Platinum Group Metals (PGM), granite mining and chrome mining. Infrastructure associated with mining such as processing plants, roads, pipelines, waste dumps and tailings dams are also located close to the mines. Increased economic activity has resulted in migration to the areas around the mines. The result is a variety of associated changes in land use such as urban areas, mines and mining infrastructure, and subsistence agriculture, that are placing increased pressure on the receiving environment.

2.2.3. Emissions and effluent

Emissions and effluent comprise all chemicals, waste, radiation and noise that are discharged into the air, water and soil. Emissions and effluent are typically categorised according to a Source-Pathway-Receptor-Chain. The source is the activity which releases the pollutant, the pathway is the non-living component of the environment that transmits the pollutant and the receptor is the living component (including humans) that is the recipient of the pollutant. While pollutants are dispersed through non-living components of the environment, the ultimate effect is on living organisms. An example is air emissions from an industrial activity, where the boiler or furnace is the source, the air is the pathway and a close-by village (and the villagers residing therein) may be the receptor.

Emissions caused by human activities are regarded as production-related impacts on the environment. By-products and wastes created from the production of goods require physical space for disposal. The environment is effectively the receiver or sink for these. The pressures placed on the environment by emissions depend upon the toxicity of the emissions, the quantities, concentration and the location of sensitive receptors to the source relative to the pathway through which the pollutant is being transported. An example is the discharge of radioactive and toxic substances into the environment from mining in the NW Province. Extensive mining in the province has resulted in the threat of toxic substances being released into the environment, such as chrome VI, asbestos, and radon. Chrome mining and associated ferrochrome smelters are located in the Rustenburg and Brits areas while asbestos is a threat in Pomfret. Radioactive substances, most often contained within the mining wastes, such as gold mine tailings dams are a threat to communities in areas such as Klerksdorp and Carltonville.[1]

2.3. Driver 1: Demography and human well-being

2.3.1. Introduction

Demography is the statistical study of populations. The statistics on the size, structure and distribution of the human population is of particular importance in understanding the human population as a driver. The demographics of population are a reliant upon the social, economic and political conditions within the province.

An example is the distribution and density of the population in the province, as illustrated in Figure 2-1. The population density is illustrated by the clusters of green dots which indicate a higher density of people in the north-eastern and central portion of the province. Places with an increased density of people will most likely act as a driver, applying increased pressure on the environment. While demographics address the size and distribution of the population, human well-being addresses the actions people employ to ensure their health and survival. The well-being of humans is defined as having sufficient access to basic materials for a good life, health, freedom of choice and social relations (Goslar *et al.*, 2008).

This is closely related to human development, which is the extent to which people can develop their full potential and expand their choices. Human well-being is undermined by poverty and vulnerability, with implications for the receiving

1 Refer to chapter 3 for further discussion on radioactive and toxic substances.

Photo: Lauret Muller

environment. A degraded receiving environment results in increased vulnerability of those directly reliant upon it, i.e. the poor.

The environment is placed under pressure to supply humans with the means to sustain their livelihoods. Poor rural populations grapple with the burden of meeting their basic physiological needs, as defined in Abraham Maslow's hierarchy of needs (Maslow, 1943). Human well-being is therefore a key driver of environmental change, as people are immediately reliant on the surrounding environment for their livelihoods.

A recent approach to better understanding the livelihoods of poverty-stricken people is the Sustainable Livelihoods Approach (SLA). This approach is acknowledged in both the African Environment Outlook (UNEP, 2006) and South

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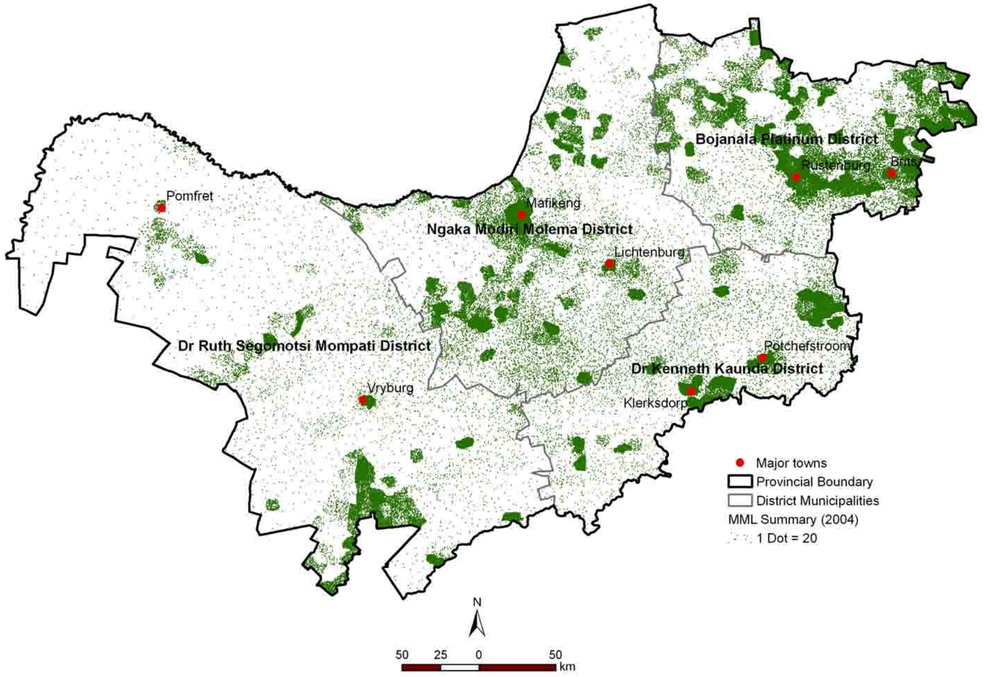

Figure 2-1: Population distribution and density for 2004 (CSIR, 2007)

Africa Environment Outlook (DEAT, 2006). The SLA places a focus on the poor sustain their livelihoods (International Fund for Agricultural Development (IFAD), 2007). At the centre of this framework are natural capital and access to resources, including natural resources, technologies, skills, knowledge and capacity, health, access to education, sources of credit, and networks of social support (IFAD, 2007). The focus of the SLA is on people and their livelihoods, rather than available resources or governance.

2.3.2. Demographics

2.3.2.1. Population and growth trends

The population of the NW Province was approximately 3.272 million people in 2007 (Urban-Econ, 2007). In the period of 1996 to 2005, the population grew by 15% from 3.355 million to 3.858 million people. During 2006, legislative amendments were passed to redefine municipal boundaries to ensure that cross-boundary municipalities were located entirely within one province [2]. With the change, the province's population was reduced by 0.484 million, or 13%. According to the StatsSA statistics, the population was projected to increase by 20,000 people between 2006 and 2007. The 2007 community survey however indicated that the population in 2007 was 122,000 less than the projected figures.

2 Further detail on the change in municipal boundaries is provided in Chapter 1

The average population density of the province is 28 people per km^2. The population density is largest in the Dr. Kenneth Kaunda District with 63 people per km^2, and lowest in the Dr. Ruth Segomotsi Mompati District with 11 people per km^2. The density in the remaining 2 districts is 28 people per km^2 in the Ngaka Modiri Molema District and 47 people per km^2 in the Bojanala Platinum District.

The population growth rate for the NW Province, as well as South Africa, shows a decreasing trend (Figure 2-3). The NW Province growth rate was decreasing at a slower rate than the rest of South Africa between 1996 and 2004, at which point a sharp decrease took place between 2004 and 2005 from just over 1% to 1%.

The district municipality growth rates show a decline in all districts between 1997 and 2005 (refer to Figure 2-4). The decrease in the growth rate over the period 1997 to 2005 was greatest in the Dr Kenneth Kaunda District at 0.5% followed by the Bojanala Platinum District at 0.3%. As a whole, the NW Province's population growth rate has consistently decreased by an average of 0.4%.

The rate of urbanisation in the province has increased steadily over the past 10 years. In 2006, there was over 11% more of the total population of the province living in urban areas than in 1996, and almost 9% more than in 2001.

The NW Province's urbanisation rate is however almost 10% lower than the South African urbanisation rate of 56%.

The projected population figures for the NW Province are presented in Figure 2-5. The projections are calculated with the high and low HIV and AIDS scenarios due to its potential influence on mortality (refer to Section 2.3.2.3 for further information). In the low growth scenario, the population of the NW Province could increase steadily to 5.517 million people by 2021, 2.245 million more than the 2007 population. In the high growth scenario, the population increases by 0.775 million people to 4.047 million in 2011. The population then remains effectively constant to 4.079 million in 2021.

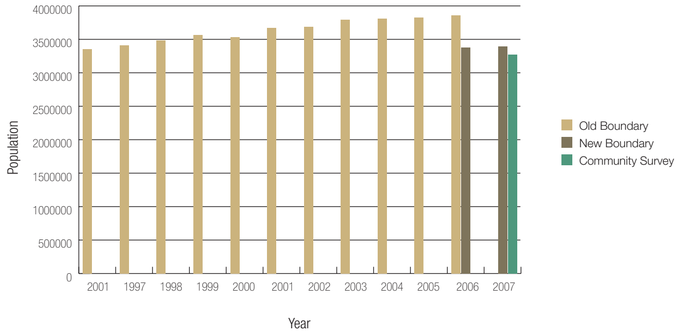

Figure 2-2: Population of the NW Province (Urban-Econ, 2007)

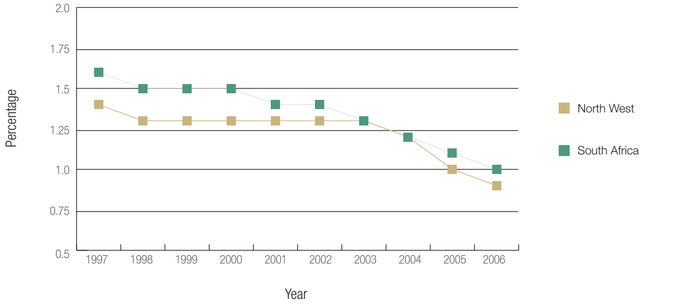

Figure 2-3: Comparison of the population growth rate between the NW Province and South Africa (Urban-Econ, 2007)

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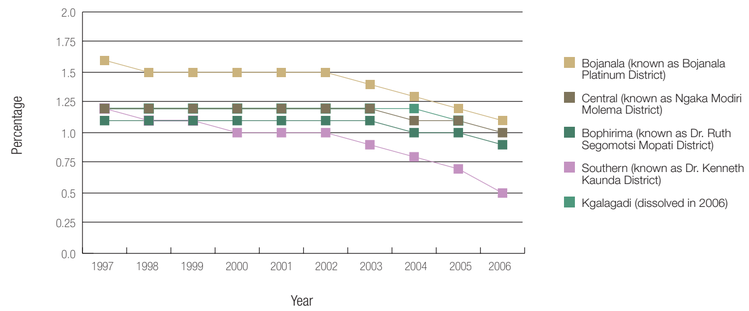

Figure 2-4: Population growth rate for the NW Province 1997-2006 (Global Insights, 2007)

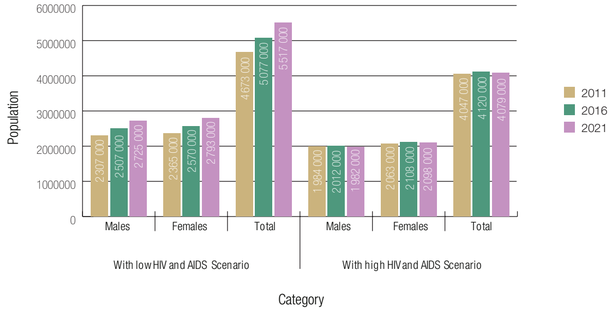

Figure 2-5: Estimated population growth rate in the NW Province using both low and high HIV and AIDS rates (Urban-Econ, 2007)

2.3.2.2. Population structure

The population structure refers to the gender and age ratios. The population pyramid for the NW Province in 2006, with the new boundaries, is presented in Figure 2-6. The population pyramid is an expanding population graph displaying a high birth rates, falling death rates in the middle age groups and a slightly longer than usual life expectancy. An anomaly in the graph is the higher population for both males and females in the 75+ age group when compared to the 70 to 74 age group. A steep step is observed between the categories of 30 to 34 and 35 to 39 year age groups.

The ratio of males to females in the province is 51% males to 49% females and is slightly skewed towards the male gender. This is contrary to the global trend which is a ratio of 51% females to 49% males (Urban-Econ, 2007).

2.3.2.3. Mortality

In 2006, life expectancy in the NW Province was slightly under 51 years. This figure had recovered from the dip during the period 2003 to 2005, where the rate dropped to 47 years in 2005 (Figure 2-7). The cause of this dip is not known.

The infant mortality rate in 2006 was 44 deaths per 1,000 births. This rate had decreased considerably from 62 deaths per 1,000 births in both 2002 and 2003. The rate in 2006 is still higher than 1998 which was 42 deaths per 1,000 births.

The under-5-years mortality rate shows similar patterns, although the increases in the early 2000's were not as pronounced as in the infant mortality rate. The under-5-years mortality rate in the NW Province, at 70 deaths per 1,000 births, is slightly lower than the national rate (Urban-Econ, 2007).

On average, 40% of all deaths in the NW Province are related to HIV and AIDS. When this figure is divided into various age groups, the impact of HIV and AIDS becomes more apparent, especially in children under 4 years of age (70 per 1,000 births) and in adults between 15 and 44 years of age. Among children less than 4 years, over 40% of deaths among males and over 43% of deaths among females were caused by HIV and AIDS. In adults between 15 and 44 years, which also forms a significant component of the economically active population of the NW Province, these figures were even higher at over 43% of deaths among males and over 63% of deaths among females (Medical Research Council, 2006). It is however possible that these figures may be higher, as not all deaths related to HIV and AIDS are recorded as being due to the pandemic (Urban-Econ, 2007).

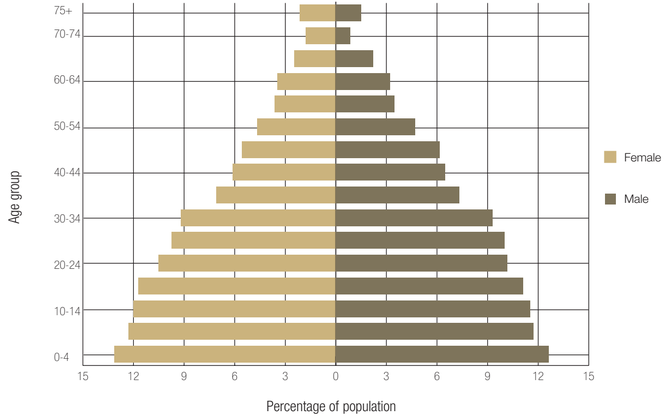

Figure 2-6: 2006 population pyramid for the NW Province (Urban-Econ, 2007)

2.3.2.4. Migration

The migration and changes in the spatial distribution of the population changes the nature and intensity of pressures placed on the environment. While urban migration means that less people are located in rural areas, directly placing pressure on the environment, a new set of pressures are introduced. These include factors such as the growth of urban footprints, the demand for land and services, and increased demands for goods such as food which are supplied from rural areas (DEAT, 1992). The resultant impact of urbanisation on the environment can be difficult to manage as the "ecological footprints" [3] of urban areas may cross into other provinces. An example is the case of the poor water quality in the Hartbeespoort Dam. A major contributing factor to the high nutrient load in the dam comes from the sewage works in the Gauteng Province.

The process of urbanisation is likely to continue and intensify the impacts of urban population areas on the environment. There is a need for the provision of housing and other bulk services, which places severe stress on municipalities. This is particularly the case in areas with high urbanisation rates with existing services backlogs[4]. In these cases, the poor are forced to settle in areas not suitable for human habitation as they are exposed to industrial hazards and pollution.

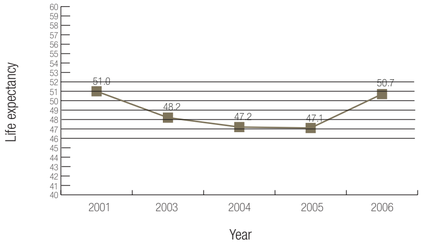

Figure 2-7: Life expectancy at birth in the NW Province (Urban-Econ, 2007)

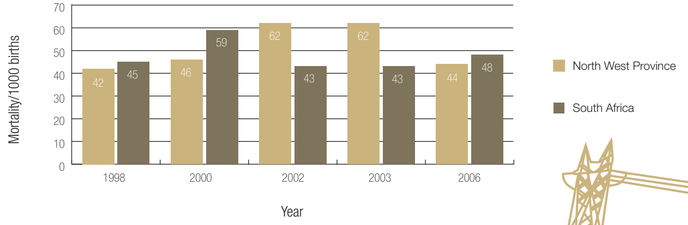

Figure 2 8: Infant mortality per 1,000 births in the NW Province (Urban-Econ, 2007)

3 The ecological footprint refers to the complete area, rural and urban, required to support the urban area. This includes the areas where goods such as food are grown and brought into the urban area to support the population

4 Refer to Chapter 7 for further information

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2.3.3. Human well-being

2.3.3.1. Population living in poverty

Defining poverty is a moral question as it deals with 'unacceptable hardship'. Unacceptable hardship extends beyond earnings per capita, to include:

- ***Material conditions*** *- needing goods and services, multiple deprivations, or a low standard of living;*
- ***Economic position*** *- low income, limited resources, inequality, or low social class, and*
- ***Social position*** *of the poor, through lack of entitlement, dependency, or social exclusion.*

The most accepted definition of poverty is that developed by (UNESCO, 2001), i.e. *"…poverty is a human condition characterized by the sustained or chronic deprivation of the resources, capabilities, choices, security and power necessary for the enjoyment of an adequate standard of living and other civil, cultural, economic, political and social rights."*

On a global level, the United Nations has established an absolute poverty line of USD 1.00 per person per day. This refers to the proportion of the population having a per capita consumption of less than USD 1.08 per person per day, measured at 1993 international prices (UNESCO, 2001). The NW Province's current poverty measure is the percentage of the population living below South Africa's Minimum Living Level (MLL), or poverty line, for a year of measurement. StatsSA (2007) preliminary estimates place the poverty line at R322 per person per month at 2000 prices, which is equivalent to approximately R430 per person per month at 2006 prices.

In 2006, approximately 53% of the NW Province's population were living in poverty. Although relatively small fluctuations were observed over the 5 years prior to this, the 2006 level is over 8% higher than it was 10 years earlier, i.e. in 1996 (Figure 2-9).

Poverty is a key issue affecting human vulnerability as the poor have insufficient funds to mitigate crisis. A poverty relief programme has been developed by the provincial government with the aim of achieving 4 key objectives simultaneously (Office of the Premier, 2003), namely:

Basic service delivery for poverty alleviation by meeting the socio-economic rights outlined in the Constitution;

- Poverty upliftment and reduction by helping the poor to help themselves;
- Human capital formation to assist the poor, and
- Improvement of institutions and management systems.

The largest concentration of people living below the MLL is close to the major urban areas and other potential centres of employment such as mines and industrial areas, as illustrated in Figure 2-10.

2.3.3.2. Health

Human health is central to the well-being of the population and their ability to actively function within the economy. It is estimated that approximately 25% to 33% of the global disease burden can be related to environmental factors (UNEP, 2008).

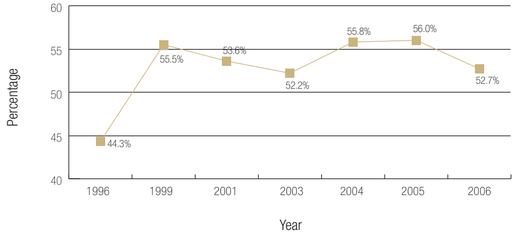
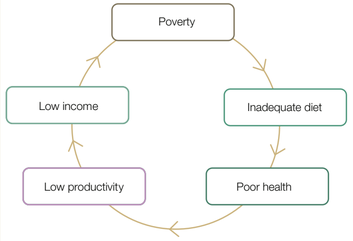


Figure 2-9: Percentage of the NW Province population living below South Africa's MLL (Urban-Econ, 2007)

Box 2-1: The vicious circle of poverty on an individual level (Barke and O'Hare, 1991)

The health of the poor is an issue that must be addressed due to the 'poverty trap'. The poverty trap refers to a vicious self-perpetuating cycle in which the poor are trapped by circumstances beyond their control. The cycle begins with people starting in poverty. Due to their poverty, they are unable to afford proper nutrition and therefore have an inadequate diet. The inadequate diet and poverty means that they are more vulnerable and prone to poor health. Due to poor health, they are unable to be as productive as they need to be. Due to low productivity levels, they are unable to earn a reasonable income. The low income means that they will remain in poverty. The cycle then begins once again and continues to occur until there is intervention at 1 or more of these 5 points.



The health care systems of the province and its municipalities are affected by environmental degradation, changes in biophysical conditions, inadequate access to basic services and health care, high levels of poverty, gender disparities, and structural inequalities. The poor suffer from greater ill health, due to multiple factors such as inadequate housing, water supply, sanitation and nutrition. The rural poor have greater difficulty in accessing health facilities due to their geographical position, and may receive a lower standard of care than those in urban areas.

Physical environmental conditions such as air quality, water quality, and toxic exposure also place pressure on the health of the population. It is estimated that one third of the disease burden is caused by exposure to wood, coal and paraffin smoke from indoor cooking fires, which is associated with respiratory infections such as pneumonia.

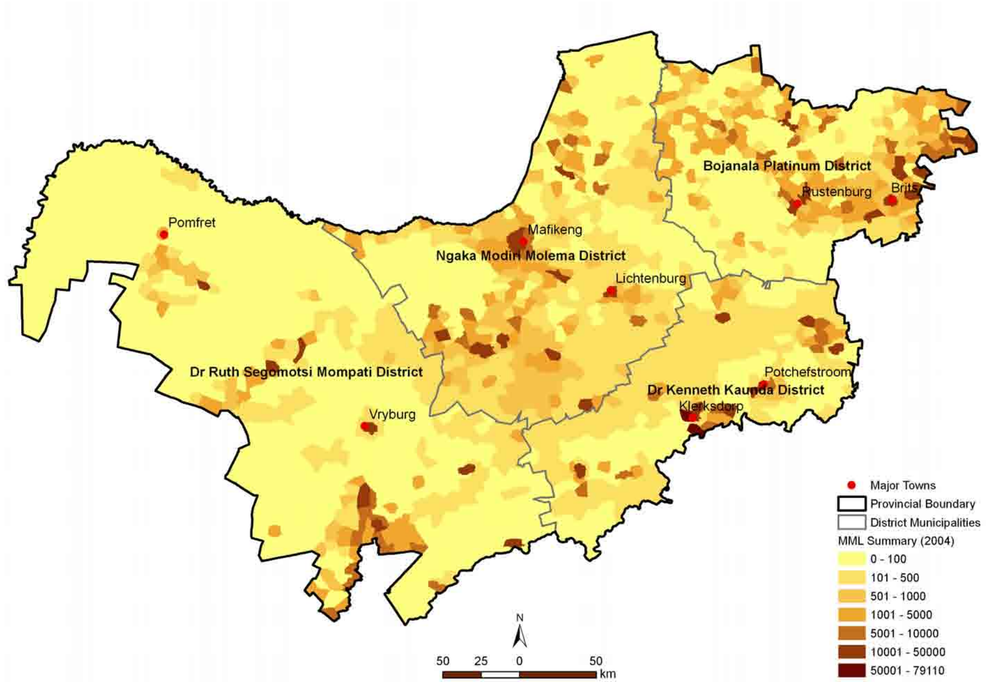


Figure 2-10: Distribution of the population living below the MLL per an area of approximately 50km² for 2004 (CSIR, 2004)

A large factor affecting the health of people within South Africa, and the NW Province, is the HIV and AIDS pandemic. According to the UNAIDS (2007) AIDS epidemic update for 2007, South Africa is the country with the largest number of HIV infections in the world. Prevalence among pregnant women was found to be 30% in 2005, and 29% in 2006.

The NW Province has a prevalence of over 31% overall, and 29% among pregnant women (Figure 2-11).

A factor that has contributed to AIDS mortality is a decline of almost 12% in the number of doctors per 100,000 of the population, and a 20% decrease in the number of hospital beds between 2001 and 2006. The number of nurses, according to the South African Nursing Council, has however remained fairly constant (Table 2-1 and Table 2-2). The current numbers of nurses and doctors in the NW Province are significantly lower than the national averages.

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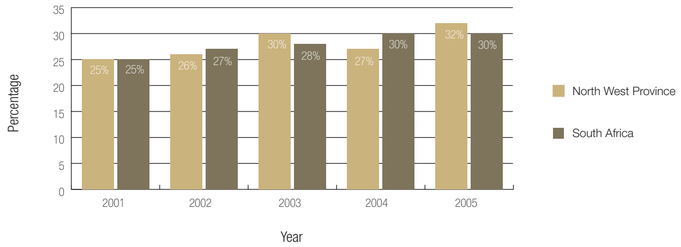

Figure 2-11: Prevalence of HIV and AIDS in the NW Province and South Africa (Urban-Econ, 2007)

Associated with increased AIDS mortality has been an increase in the number of AIDS orphans, which increased by over 25,000 orphans from 7,147 orphans in 2000 to 92,749 orphans in 2007, as illustrated in Figure 2-13.

The increased HIV and AIDS infection rates means that the number of HIV and AIDS orphans may continue to increase. This could impact on the economy, social security system, crime levels and poverty levels.

2.3.3.3. Social security

Social security refers to social welfare services concerned with social protection, or protection against socially recognized conditions, such as poverty, old age, disability, unemployment, and others. The South African Social Security Agency (SASSA) is responsible for the delivery of government social assistance grants to the poorest of the poor (SASSA, 2008). It provides social assistance or a financial award, in the form of grants provided by the government to residents who are unable to sustain themselves.

Year of measurement	1996	2001	2005	2006
NW Province (Number of doctors per 100,000)	12	17	12	15
South Africa (Number of doctors per 100,000)	No Data	No Data	No Data	74

Table 2-1: Number of doctors per 100,000 of the NW Province population (Urban-Econ, 2007)

Year of measurement	2004	2005
NW Province (Number of doctors per 100,000)	165	166
South Africa (Number of doctors per 100,000)	No Data	393

Table 2-2: Number of nurses per 100,000 of the population (Urban-Econ, 2007)

The objective of social security is to assist people by providing grants to those in need and pensions to the elderly. In a largely rural province such as the NW Province, social grants and pensions remain important instruments to fight poverty, as they provide the "social safety nets" aimed at limiting social and economic inequality, as well as the upliftment of the poor. Provincial budgets have been providing increased allocations for social spending because this is an area in which an almost immediate impact on the quality of life of people can be affected.

Over a million people in the NW Province population received grants in 2007 (Table 2-3). Based on the population, this implies that almost one third of the provincial population received some type of grant during 2007. The most plausible reason for this statistic is the poverty rate in the province. In 2007, over 646,000 children received care grants which were over 9 times greater than in 2001 and 244 times greater than in 1996.

2.3.4. Demography and human well-being and the environment

Demographics provide statistics on population dynamics and their distribution while human well-being addresses the actions people employ in order to survive.

The poorest sections of the population typically live in the most fragile, degraded and marginal areas. This has occurred due to historical land policies developed and adopted by the pre-1994 South African government as well as the creation of homelands such as Bophuthatswana. The consequences have included large portions of the population being landless,these areas becoming degraded due to overpopulation, overgrazing and unsustainable land use practices in many rural areas.

Box 2-2: HIV and AIDS and the economic consequences (Henry J. Kaiser Family Foundation, 2007)

Two-thirds of the households surveyed experienced decreases in income with 40% of households reporting that the primary caregiver had taken time off from formal employment, informal employment or schooling to take care of an infected individual, thus adding to the loss of household income, as well as under-schooling of children.

Medical expenses related to HIV and AIDS in poor South African households consume up to a third of income, whereas the national average household expenditure on health care was 4 percent per year.

Funeral costs, on average, were 4 times the monthly income of households surveyed in South Africa.

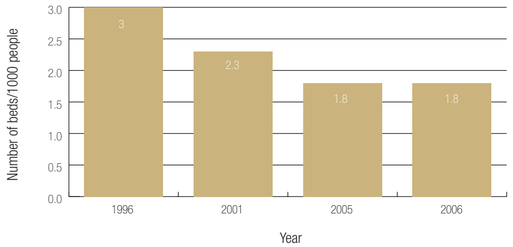

Figure 2-12: Number of hospital beds per 1,000 people in the NW Province (Global Insights, 2007)

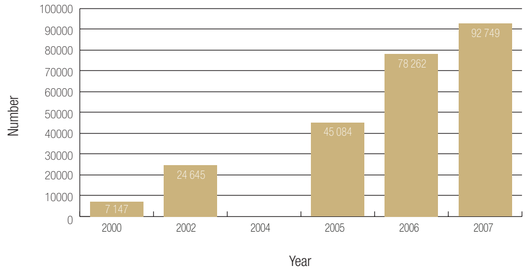

Figure 2-13: Number of AIDS orphans in the NW Province (Health System Trust, 2007)

The poor in urban areas live in degraded conditions such as informal settlements. These sites are often close to harmful land uses, such as waste disposal areas and/or areas vulnerable to flooding, with resultant impacts such as (United Nations Development Programme (UNDP), 2008):

- Land degradation caused by overcrowding and unsustainable agricultural practices;
- A lack of access to clean water;
- Health problems caused by air pollution;
- A lack of access to safe and efficient energy sources;
- Exposure to hazardous substances and waste, and
- Land and water degradation resulting from mining operations.

The poor often become practices that threaten animal and plant species as poaching, trade in CITES-listed species, and smuggling of protected plant species in order to sustain their livelihoods.

High levels of poverty and the decreased health of poor inhibits the population's chances of improving their socio-economic status.

Type of grant	North West Province
General	8,299
Care dependency	646,613
Child support	31,537
Foster care	1,627
Grant-In-Aid	2,492
Old age	195,089
Disability	120,007
War veteran	91
Total	1,005,755

Table 2-3: Number of beneficiaries per grant type in the NW Province, 2007 (SASSA, 2007)

2.3.4.1. Excessive use of environmental resources

The population and their lifestyle have a direct impact on environmental resources. The larger the population, the greater the resource base required to meet their basic physiological needs. Concurrently, the higher the standard of living, the greater the amount of resources that will be consumed and the larger the quantities of waste that will be produced.

While people living in poverty consume less per capita than the wealthy, they are directly reliant on the surrounding environment for their survival. For example, while the wealthier are able to purchase imported food, the poor do not have sufficient buying power for this. They are largely reliant on the production of food from subsistence agriculture.

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Box 2-3: How societal development affects the environment (GDACE, 2004)

In a positive manner by:

- Improving the quality of life,
- Addressing basic human needs,
- Providing higher levels of education, and
- Providing a greater degree of health and wellbeing.

In a negative manner by:

- Increasing the demand for resources and goods (increases consumerism),
- Facilitating unsustainable land use practices,
- Increasing the levels and concentrations of pollution and waste,
- Increased migration and rapid urbanisation, and
- Increased demand for basic services.

The poor's consumption patterns and reliance on the environment makes it difficult to implement sustainable practices. The poor often lack the resources and education for sustainable practices and therefore continue to place pressure on environmental resources. Increased reliance

on the environment and low buying power means that the poor are the most vulnerable to the loss of resources since it is the foundation of their livelihoods.

2.3.4.2. Changes in land use

Change in land use is associated with impacts such as habitat destruction and associated land degradation. This is due to the disruption of ecosystems which previously maintained a healthy balance for the environment within a particular area. An example of a region experiencing increased pressures due to land use changes in Rustenburg and the surrounding mining areas. Rustenburg is the fastest growing town in Africa due to increased mining activities (Business Day, 2008). In-migration by job seekers to the town and surrounding mines has created increased pressure from urban sprawl and the associated ecological footprint. The settlement of job seekers close to mines is an issue of concern as these areas have not been designated for urban settlement and may disrupt sensitive habitats. Most of these settlements are without basic services and therefore become reliant on the surrounding environment for activities such as agriculture and the collection of firewood.

2.3.4.3. Emissions and effluent

In environmentally sensitive areas, settlements that result from rapid urbanisation may damage environmental integrity through activities such as domestic fuel burning which cause air pollution and affect human health. These settlements are often informal and expand quickly, resulting in greater volumes and quantities of pollution. On a domestic level, services are of fundamental importance. Energy is required for heating and lighting purposes and potable water is required for drinking, cooking and cleaning. Waste services, both solid and liquid are required. In most urban contexts, bulk services such as electricity, water supply and sanitation and waste collection services are provided for these purposes. In many rural cases, and both formal and informal settlements occupied by the poor, these services are not or are only partially provided. In some cases they are unaffordable such as in the case of electricity provision. This means that fuels such as firewood or paraffin must be burnt as domestic fuel, and wastes are discarded into the surrounding environment without being treated, thus resulting in pollution.

Photo: Lauret Muller

2.4. Driver 2: Economic development

2.4.1. Introduction

Development is associated with being better off in the future than in the present. The definition and measurement of development are however important and contentious. In economics, development is measured in terms of goods that can be purchased or the 'standard of living'. Based on this concept, development is measured according to the accumulation of material assets. Another approach is to measure the 'quality of life' (Morris and Therievel, 2001). Quality of life seeks to measure development based on the experience of life, rather than the measure of material assets. The environment is central to the experience of people, and therefore their quality of life. Quality of life is however difficult to measure through markets, since natural capital is largely excluded in the measurement of markets as it is difficult to quantify.

The main linkage between economic drivers and the environment is based on production and consumption, as illustrated in Figure 2-14 (DEAT, 2006). This model is acknowledged in both the African Environment Outlook (UNEP, 2006) and South African Environment Outlook (DEAT, 2006). The link that exists between economic activities and the environment can be described as follows (UNEP, 2006):

- Goods are produced and consumed by humans;
- In order to produce goods, energy and material from the environment are utilised;
- The production of goods results in the creation of waste, which is then disposed of in waste sinks within the environment;
- Humans not only consume manufactured products, but also amenities provided by the environment, and
- This all takes place within the natural environment, as indicated with the dotted line.

In view of the above, it is clear that economic activities utilise environmental amenities for direct consumption, as a source of energy and materials, and for the disposal of wastes.

In order for the NW Province to achieve economic growth, certain key macro-economic objectives must be fulfilled. Environmental trade-offs are often the result of achieving these objectives, especially in a region dominated by mining as the primary economic sector.

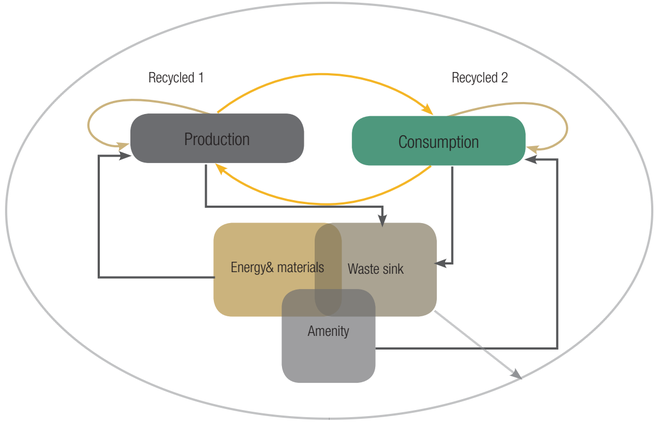

Figure 2-14: Interactions between the economy and the environment (UNEP, 1996; DEAT, 2006)

The economy has complex and extensive impacts on the environmental resource base. These stem from the nature of the economy, from its size and growth, and from the wealth and income it distributes.

Box 2-4: The link between economic growth and development (UNDP, 2008)

Creating the link between economic growth and human development is probably the most challenging task facing government departments, in terms of achieving a reduction in poverty and inequality. Central to this is the relationship between the macro-economic framework and the monetary and fiscal policies implied by this framework, and the implementation of sectoral policies. Growth has to be translated into human development if it is to benefit the population and this link determines the structure and quality of growth that is achieved.

2.4.2. South African economic performance

In 2007 the South African economy was worth R1.829 billion[5] [6](International Monetary Fund (IMF), 2008), ranking as the 29th largest economy in the International Monetary Fund (IMF) World Economic Outlook countries (IMF, 2008)[7]. The South African economy comprises 28% of Africa's USD 960 billion 5 GDP for 2007 and 36.5% of the Sub-Saharan Africa's USD 741 billion[6] 2007 GDP (IMF, 2008). The economy had a growth rate of 4% over the period of September 1999 to the end of 2007 which was the longest period of economic expansion in the country's history (SouthAfrica.Info, 2008b).

The South African economy is susceptible to global economic trends. The decade prior to 1994 experienced a growth rate of 1% per annum. This situation improved following 1994, where the economy grew by an average of 3.4% over the period September 1999 to 2004 (Urban-Econ; 2004). The size of the economy increased by R725 billion from R813 billion in 2004 to R1.539 billion in 2005, at 2007 prices.

5 At current prices 15 September 2008

6 At constant prices the GDP is R1203.638 billion

7 Calculated from the International Monetary Fund, World Economic Outlook Database, April 2006

The NW Barometer (Urban-Econ, 2005) noted that the growth was primarily due to lower interest rates, a growth in fiscal policy stance, higher international prices for export commodities and increased consumer confidence.

In terms of competitiveness, the economy was ranked as the 44th most competitive economy in 2006, up from 46th position in 2005 (SouthAfrica.Info, 2008b).

2.4.3. North West Province economic performance

Overall, the NW province has been registering steady economic growth and prosperity since 1996. Gross Domestic Product (GDP) in constant 2000 prices has grown from R58 billion in 1996 to more than R72 billion in 2006 (Sibongakonke, 2008). Since the launching of the Provincial Growth and Development Strategy (PGDS) in 2004, the economic growth per annum consistently outperformed the annual population growth of the province, registering growth rates of 3.6% in 2004, 4.9% in 2005 and 4.3% in 2006.

Box 2-5: Provincial growth and development strategy (NWPG, 2008)

The PGDS leans heavily on international protocols and agreements regarding sustainable growth and development that were formulated at the World Summit on Sustainable Development. At the same time, the PGDS represents the consolidated outcome of all the Municipal Integrated Development Plans in the province. The PGDS establishes the foundation blocks from where a consolidated Programme of Action for implementation is negotiated at joint Working Group meetings, and also forms the benchmark from where progress and achievements with implementation are monitored and evaluated.

By 2004, the total value of goods and services produced in the NW had exceeded R87 billion. As a result, income per capita increased from R16,000 in 1996 to over R18,000 in 2005 at constant prices. Annual total disposable income also increased from R31 billion in 1996 to over R38 billion

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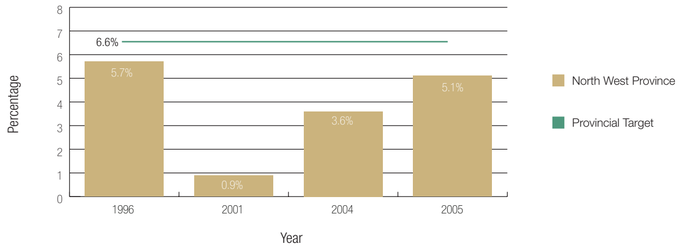

Figure 2-15: Real GGP growth rate for NW Province (Urban-Econ, 2007)

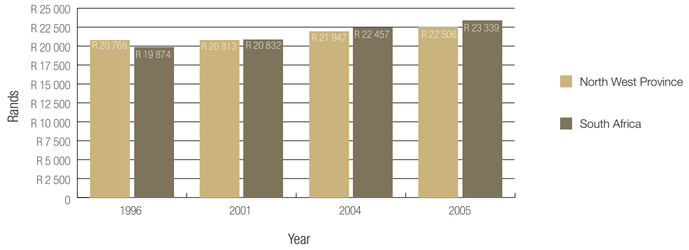

Figure 2-16: GGP per capita of NW Province compared with South Africa (Urban-Econ, 2007)

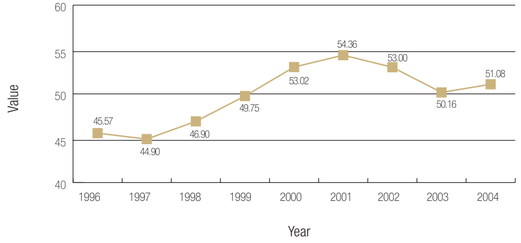

Figure 2-17: Tress Index for the NW Province (Urban-Econ, 2005)

in 2006 in constant prices (MEC Finance Budget Speech 2007). This is still lower than the 6.6% target set by the PGDS.

The NW provincial government adopted the PGDS in 2004. The strategy recognises that poverty and the provision of basic services are fundamental and inseparable from the process of growth and development in the province. Thus, one of the two key goals of the PGDS is to eradicate poverty by wiping out backlogs in basic services, including water and sanitation, within the next 10 years.

The real Gross Geographical Product (GGP)[8] growth rate in the NW Province increased significantly between 2001 and 2005 from 0.9% in 2001 to 5.1% in 2005. The GGP growth rate for 2005 is however below the provincial annual target of 6.6% (PGDS, 2005).

The GGP per capita increased marginally over the period 1996 to 2001 from R20,768 to R20,813. In 1996, the NW's GGP per capita[9] was higher than the national average of R19,874. By 2001, the GGP per capita fell below the national amount by R19 per capita, and R833 per capita in 2005.

Diversity within the NW Province's economy is calculated by the Tress Index[10] where zero represents a completely diversified economy. The diversity of the NW Province's economy has ranged between 45.57 and 54.36 for the period 1996 to 2004. The NW Province ranks as the fifth most diverse economy in South Africa. The dominating sectors in the economy are described below as the key sectors driving the North West economy. Even though it is not a large contributor to the NW Province economy, the agricultural sector is also discussed due to the role it plays as a driver from an environmental perspective.

8 GGP is (Urban-Econ, 2005) "the total output of goods and services for final use produced by an economy, by both residents and non-residents, regardless of the allocation to domestic and foreign claims. It does not include deductions for depreciation of physical capital or depletion and degradation of natural resources."

9 GGP per capita is (Urban-Econ, 2005) *"the value of final goods and services produced within the specific geographical area (region) in a given year divided by a total population in the same year. GGP per capita serves as an indicator of economic welfare in the region. A decrease in this ratio implies that population growth exceeds GGP (or GVA) growth rate."*

10 The Tress Index (Urban-Econ, 2005) is "\the level of diversification or concentration of a region's economy. Tress index of zero represents a totally diversified economy. On the other hand, the higher the index the more concentrated or vulnerable the region's economy to exogenous variables, such as adverse climatic conditions, commodity price fluctuations, and others"

11 GVA (Urban-Econ, 2005) is "a primary instrument to measure the level of economic activities within the specific area. Gross Value Added is calculated as the difference between output and intermediate consumption in the economy. That is the difference between the value of goods and services produced and the cost of raw materials and other inputs, which are used up in production by all sectors of an economy."

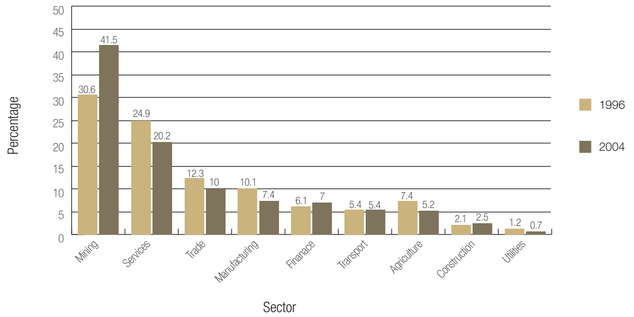

Figure 2-18: Sector contribution to GVA as percentage (Urban-Econ, 2007)

Sector	1996	2001	2006
Mining	R9,068,719	R25,517,242	R54,821,290
Community and Government Services	R7,886,243	R12,213,964	R16,347,483
Trade	R4,388,419	R6,870,167	R10,102,663
Finance	R2,491,488	R4,987,693	R8,435,337
Manufacturing	R3,993,420	R5,742,698	R6,968,080
Transport	R1,913,324	R3,448,481	R4,533,785
Agriculture	R2,522,102	R3,424,729	R4,326,428
Construction	R882,571	R1,672,808	R2,374,835
Utilities	R502,468	R618,123	R759,477
GVA 2007 prices	R33,648,754	R64,495,907	R108,669,377
Total (GDP)	R36,140,300	R68,628,265	R115,851,554

Table 2-4: Sector contribution to GVA in Rand value at 2007 prices (Urban-Econ, 2007)

2.4.3.1. Sectors of the economy

The economic profile of the NW Province can be divided into 9 major economic sectors. The largest sectors in the NW economy are mining and services. The mining sector increased in contribution by close to 11% between 1996 and 2004 (Figure 2-9). The mining sector therefore contributed above 41% to the NW Province's Gross Value Added[11] (GVA), and as such is the largest sector in the economic drivers. The contribution of each sector to the GVA for the NW Province is presented in Figure 2-18.

All sectors in the economy have experienced growth, however these have been below the national average for all sectors except agriculture. Only the construction sector has achieved and passed its provincial growth target of 7.5%. The trade and community services sectors are close to reaching their 5.9% and 4.6% targets respectively. The rest of the sectors are growing by 1.5% to 3.5% per annum, while their targets are set at 6.8% to 9.1% per annum. Thus, both public and private investment would be required to reach the 2014 targets. The agriculture sector was the only sector in the province that showed a higher growth rate than the national average in 2005 (Urban-Econ, 2005; Urban-Econ, 2007).

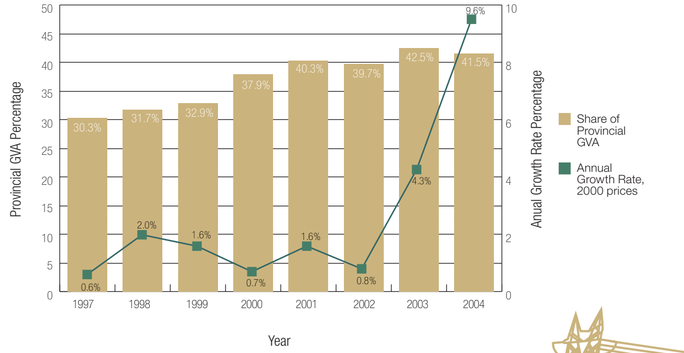

Figure 2-19: Mining contribution to provincial GVA and growth rate (Urban-Econ, 2005)

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Box 2-6: How mining affects the environment (GDACE, 2004)

In a positive manner by:

- Contributing to the provincial and national GDP,
- Creating employment,
- Creating opportunities for the expansion of infrastructure in rural areas,
- Sustaining local mineral processing industries, and The potential generation of income from heritage tourism.

In a negative manner by

- Changing the topography and visual character of the landscape,
- Contaminating surface and groundwater resources,
- Contaminating and degrading soils through salinization, acidification and pollution,
- Alterations to the ground water dynamics and surface water body flow regimes.
- For example excess groundwater pumped from the mines has augmented river flows,
- Dewatering of aquifers which may result in the formation of sink holes,
- Potential generation of radiation hazards
- Generation of air and water pollution from operations and wastes,
- The destruction of natural habitats which impacts on biodiversity, and
- Posing potential health and safety risks to nearby settlements.

2.4.3.1.1 Mining

The mining[12] sector has been the dominant sector in the NW Province for many decades. The province has a broad diversity of minerals and is regarded as having an economic advantage since some mining sub-sectors are relatively underdeveloped. The mining sector has become increasingly important in the NW Province's economy, contributing R54.821 million in 2006, up from R25.517 million in 2001 at 2007 prices (Urban-Econ, 2007).

In 2004, the mining sector grew by 9.6%, which is the highest growth rate recorded in over 8 years. The increase in the mining production value is primarily due to the substantial increase in international prices of commodities such as platinum and gold, and the expansion of mining in the Bushveld Igneous Complex with PGM, chrome and granite mining. In terms of employment, in 2004 the mining sector accounted for just over 20% of employment in the province (Urban-Econ, 2005).

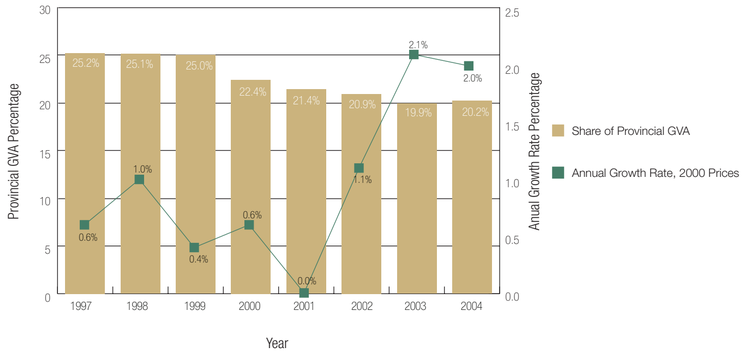

Figure 2-20: Community and government services contribution to provincial GVA and growth rate (Urban-Econ, 2005)

Community and government services include public administration and defence activities, education, health and social work, personal services, activities of membership organisations as well as recreational, cultural and sporting activities (Urban-Econ, 2005).

This sector is the second most important sector in the NW Province, contributing R16.347 million in 2006 to the economy, up from R12.214 million in 2001 at 2007 prices (Urban-Econ, 2007). In terms of employment, community and government services were the largest employer in the NW Province in 2004, accounting for over 22% of employment in the province (Urban-Econ, 2005).

2.4.3.1.3 Agriculture

Agriculture[13] in the NW is not a large contributor to the provincial GVA. It is however an important sector as it is entrenched into many communities as a way of life. The following agricultural products are exported from the NW Province (Urban-Econ, 2005):

- Live animals, animal products;
- Vegetable products, and
- Animal or vegetable fats and oils, prepared edible fats and animal & vegetable waxes.

Box 2-7: How agriculture affects the environment (GDACE, 2004)

In a positive manner by:

- Generating foreign exchange, and
- Alleviating household food insecurity.

In a negative manner by:

- Transforming natural habitats which causes habitat fragmentation and a reduction in biodiversity;
- Land degradation by inappropriate agricultural practices, and,
- Reducing waster water quality by increased sediment loads and contamination from pesticides and fertilisers.

12 Refer to Chapter 3 for further discussion of mining in the NW Province.

13 Refer to Chapter 3 for further discussion of agriculture in the NW Province.

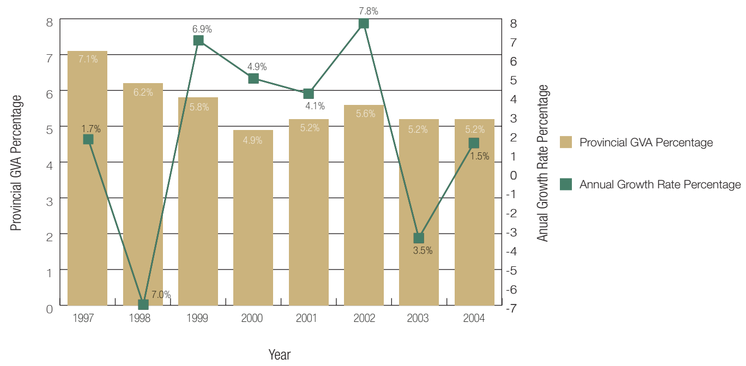

Figure 2-21: Agricultural contribution to provincial GVA and growth rate (Urban-Econ, 2005)

In 2004, the agricultural sector contributed 5.2% to the provincial GVA. As illustrated in Figure 2-21, the agriculture growth rate has varied considerably over the period 1997 to 2004 with a high of 7.8% in 2002 and low of -7.0% in 1998. A general decline is observed, however this is primarily due to gains in other sectors, particularly mining.

The variability in the production of the agricultural sector is driven primarily by markets (agricultural products' prices) and climatic conditions (Urban-Econ, 2005).

The NW Barometer (Urban-Econ, 2005) ascribes the 6.5% drop in the production output in 2003 compared to 2002 based on unfavourable climatic conditions.

In 2004, the agricultural sector was the fourth largest employer, accounting for 13.4% of employment in the NW Province, despite the sector only contributing 5.2% to the provincial GVA (Urban-Econ, 2005).

2.4.3.1.4 Education and skills

Socio-economic differentials in the quality and quantity of education make it difficult to achieve equity and empowerment in the labour market. A poorly educated population is limited in options and opportunities, and increases unemployment. It also reduces the capacity of the population to participate meaningfully in civil society. Low levels of education limit the percentage of the population who qualify for tertiary education, which in turn leads to greater inequalities in the distribution of opportunities and wealth.

Education, training, and skills development are some of the most crucial components required for people to prosper and reach their full potential. Agenda 21 emphasizes that "*… education is critical for promoting sustainable development and improving capacity of the people to address environmental and development issues*" (UNDESA, 2008). The benefits of education have been well documented, especially women's education, for health, lower fertility, poverty alleviation, and increased general quality of life. Investment in education, especially of the poor, yields returns in income, productivity, and economic growth, thereby addressing the poverty issue in the process.

The NW Province has the lowest number of people over the age of 20 (5.9%) who have received higher education (PPT, 2005). The province has a literacy rate of just over 54%.

Approximately 45% of people 20 years and older were functionally illiterate in 2003. It has been found that in recent years, many literacy programmes have increasingly focused on the local needs of people, with particular reference to community development and environmental protection (UN, 2005). These approaches tackle literacy at a comprehension level for people to be able to embrace life skills and relevant content.

The NW Province is one of the poorest provinces in South Africa with a provincial GGP of R3,964 per person, which is well below the national average of R6,498 (PPT, 2005). The Gini-coefficient, a measure of income inequality, was just above 0.62 in 2005 which has worsened since 1995 where the coefficient was 0.54 (Urban-Econ, 2007). This places the NW Province as one of the most unequal regions in the world. The coefficient is lower than the South African measurement of 0.68 for 2005, which remained constant from the same value measured in 1996.

2.4.3.1.5 Employment and unemployment

Mining is the largest employment sector in the province accounting for over 22% of the workforce (Figure 2-22). Mining's contribution to employment is not as significant as its dominance of the NW economy. Other sectors such as manufacturing, electricity, construction and transport are highly dependent on the mining sector for their survival. Thus, upsets and changes in the mining sector could potentially significantly affect other sectors in the economy.[14]

Photo: Werner Bentz

14 The official (expanded) LFS March and September 2003 (SSA, 2004) unemployment figures are 31.2% and 28.2% for South Africa respectively. Source: PROVIDE oject Background Document, 2005

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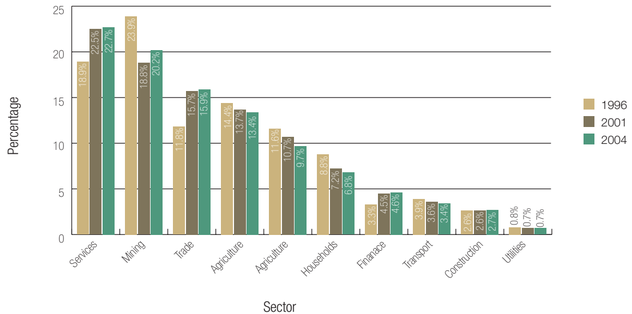

Figure 2-22: Comparative employment per sector in the NW Province (Urban-Econ, 2005)

Unemployment levels in the NW Province, based on the expanded definition, remained around 1 to 2% higher than the national average between 2001 and 2006 (Figure 2-23).

The unemployment rate in the NW according was just below 42% using the expanded definition[15] and 27% using the official definition[16]. The NW Province has the third highest unemployment rate in South Africa, behind the Eastern Cape and the Limpopo Provinces (PPT, 2005).

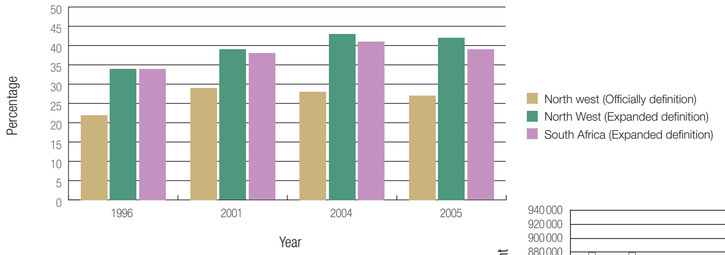

Figure 2-23: Unemployment in the NW Province compared with South Africa (Urban-Econ, 2007)

15 There is more than one accepted definition of "unemployment". StatsSA uses the official definition, which states that (PROVIDE, 2005): "The unemployed are those people within the economically active population who:

(a) did not work during the 7 days prior to the interview,
(b) want to work and are available to start work within a week of the interview, and
(c) have taken active steps to look for work or to start some form of self-employment in the four weeks prior to the interview."

16 The expanded definition of unemployment is also commonly utilised which excludes criterion (c) as quoted above

The unemployment rates on a magisterial district level indicate the unemployment rate amongst the African population to be significantly higher than other population groups in the majority of districts in the NW Province (PPT, 2005), with particular reference to the Ngaka Modiri Molema and Dr. Ruth Segomotsi Mompati Districts. The same trend is noted where the female unemployment rate is higher than the male population in all districts of the province (PPT, 2005). These discrepancies are especially prevalent in those districts where the mining sector is dominant e.g. in the Klerksdorp, Rustenburg and Brits regions.

The NW Province had a steady increase in employment between 1997 and 2001, as indicated in Figure 2-24. A sharp decline of greater than -9% took place in the employment growth rate in 2002, caused by unfavourable and micro-economic conditions in 1991 (Urban-Econ, 2005). The provincial economy recovered in 2003, increasing employment by over 4%. A sharp increase in employment in 2005 increased by over 11%.

Box 2-8: The relationship between the economy and the environment (Van Ravenswaay, 1999)

The purpose of an economy is to make goods and get them to people. Making goods and getting them to people requires matter and energy, creates wastes, and takes up space. The matter, energy and space are taken from the environment. The wastes are put back into the environment. Thus, the environment affects the economy and the economy affects the environment.

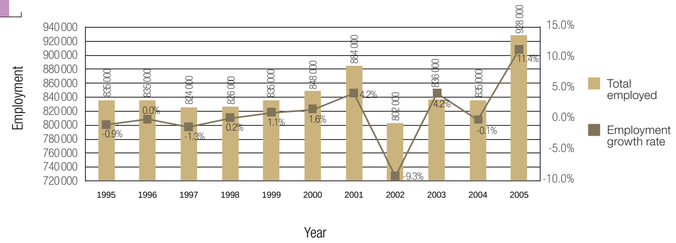

Figure 2-24: NW employment and employment growth rate

2.4.4. Economy and the environment

Production and consumption are the major activities comprising the economy. The environment provides capital and services which are utilised for the production of goods as well as a sink for the wastes produced both from production and consumption. The success of the economy is therefore directly and indirectly linked to the environment.

Sustainability requires a healthy economy over the long term which helps to ensure the health and well-being of people while ensuring that all significant detrimental impacts on the environment are properly avoided or mitigated.

The government has placed a high premium on economic growth in order to promote employment and to improve service delivery. To give effect to this policy, the Accelerated and Shared Growth Initiative for South Africa (AsgiSA) was launched in 2006[17]. The ultimate aim of AsgiSA is to halve unemployment by 2012.

The pressures that the economy places on the environment are described below.

2.4.4.1. Excessive use of environmental resources

As discussed in the introduction to this section, economic activities involve the production of goods for consumption by people. In order to produce goods, both materials and energy are taken from the environment. The challenge between economic growth and sustainable development is to ensure that the materials and energy taken from the environment are able to adequately replenish where possible for use in the future, while at the same time supporting increased demand for consumption.

Mining represents the largest economic sector in the province and primarily consumes mineral and water resources in mining operations. Mineral resources are non-renewable and will therefore disappear once they have been extracted. As a result, mining is not economically sustainable over the long term as the reserves will ultimately become depleted or not economically viable to mine. This scenario is playing out in the gold mining industry in Carltonville where the profit margins for extraction of gold are continually falling due to long term mining and extraction of large portions of the easily accessible reserves.

17 AsgiSA was launched by Deputy President Phumzile Mlambo-Ngcuka in February 2006 to address 6 "binding constraints on growth". AsgiSA's objectives could be achieved if the economy grew at an average rate of 4.5% in the period to 2009, and by an average of 6% from 2010 to 2014.

As mining utilises large quantities of water, this often involves the de-watering of mines to gain access to the mineral reserves. While this is a necessary action to access the minerals, it contributes to the scarcity of water resources in the province for use by other sectors such as agriculture and municipal services[18].

2.4.4.2. Changes in land use

Economic activities are a major driver to change in land use. In a market economy and to lesser extent a mixed economy, the economic drivers play an important role as pull factors. This stands to reason as the economy involves the activities of people to generate revenue to sustain their livelihoods. Economic drivers therefore pull people and consumers to a particular area where the economic activity is taking place. This is demonstrated by the settlement and migration patterns of the population which tends to move to urban, mining and industrial centres seeking employment.

The implications of these pull factors are the cultivation of fields for agriculture and a change of land for settlements and supporting infrastructure as described in Section 2.2.2. A change in land use places pressure on ecosystems[19] where the greatest pressure is the destruction of natural habitats.

2.4.4.3. Emissions and effluent

The major mines and industries in the NW Province are responsible for polluting the environment. This is an unfortunate inevitability of economic activities and one of the most challenging aspects of realising the economic and environmental sectors of the sustainable development pillars. Wastes are disposed of as outputs of these economic activities and consumption patterns into the environment by way of effluent and emissions into the air, water and soil. This places pressure on the organisms which share the environment as their natural habitat.

Pollution poses a direct threat to the health and well-being of humans in the NW Province. An example is Acid Mine Drainage (AMD) from tailings dams. AMD is a well-known impact from tailings dams which results in the highly acidic effluent entering surface and ground water resources. AMD can be highly destructive to aquatic ecosystems and pollute ground water aquifers thereby reducing the possible uses of these important water resources.

The production of waste and pollutants and disposal of these are pressures of considerable concern from the economic drivers.

18 Refer to Chapter 6 for further information on water resources and the availability of waster resources in the province.

19 Refer to Chapter 3 for further information on land use in the NW Province.

2.5. Driver 3: Governance

2.5.1. Introduction

Governance refers to the mechanisms used to ensure that institutions' or organisations' constituents follow its established processes and policies. Effective governance strategy implements systems to monitor and record compliance with the agreed policies, and provides for corrective action in cases of non-compliance.

The Government of South Africa is divided in 3 democratically elected spheres:

(i) National;

(ii) Provincial, and

(iii) Local municipal government.

The provincial and local level policies are guided by the national policies and legislation, or regulatory frameworks.

The Constitution of the Republic of South Africa Act 108 of 1996 is the supreme law of South Africa. Any law or conduct inconsistent with it is invalid and obligations imposed by it must be fulfilled. It is also the starting point in determining the responsibilities for the administration of environmental law, as it sets out the framework for the legislative and executive branches of government. Schedules 4 and 5 to the Constitution define the respective powers of national, provincial and local governments. The Constitution empowers the national parliament to pass legislation on any matter, including a matter referred to in Schedule 4, but excluding a Schedule 5 matter (unless it is a matter in which it can specifically intervene).

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The legislative authority of a province is vested in its provincial legislature. The provincial legislature has the power to pass legislation for the province in respect of any matter within a functional area listed in Schedules 4 and 5, as well as for any matter outside of these functional areas that is expressly assigned to the province in terms of national legislation, and any matter for which a provision of the Constitution envisages the enactment of provincial legislation (Helpline Law, 2007).

The Provincial Legislature may also assign any of its legislative powers to a municipality within its area of jurisdiction. Schedule 4 of the Constitution outlines functional areas of concurrent, i.e. national and provincial, legislative competence. Part A includes matters relating to environment, agriculture, industrial promotion, nature conservation (excluding national parks, national botanical gardens and marine resources), pollution control and soil conservation. Part B, which contains local government matters to the extent set out in Section 155 of the Constitution, includes air pollution. Stormwater management and water and sanitation services (limited to potable water supplies systems and domestic wastewater and sewage disposal systems).

In respect of areas where national and provincial government have concurrent legislative competence, and where both enact contradictory or conflicting legislation, in terms of Section 146 of the Constitution, the legislation as developed at a national government level will prevail. Essentially, this enables national government to maintain control over environmental issues by enacting legislation which provides uniform national norms and standards and / or which is necessary to uphold the environmental agenda.

Schedule 5 outlines functional areas of *exclusive provincial legislative* competence. Part A includes matters relevant to provincial planning and cultural matters and Part B includes matters relating to the control of public nuisances, noise pollution and refuse removal and solid waste disposal. Constitutionally, municipalities have the right to govern the local government matters of their communities, subject to national and provincial legislation.

Importantly, however, municipalities have executive authority and administration rights in respect of the local government matters detailed in Part B of Schedules 4 and 5, as well as any other matter assigned to them by national or provincial legislation. Accordingly, a municipality may develop and administer bylaws to facilitate the administration of the matters it has the right to administer. It is important to note that although national and provincial spheres of government may not compromise a municipality's right to exercise its

Photo: SA Tourism

Constitutional powers or functions, they are required to support and strengthen the capacity within municipalities, in order to enable them to fulfil their functions.

2.5.2. Mandate of the North West Department of Agriculture, Conservation and Environment (NWDACE)

NWDACE currently has the mandate, in terms of the National Environmental Management Act 107 of 1998 (NEMA), to administer the following:

- Environmental Impact Assessments (EIA) in accordance with Regulation 385 promulgated in terms of NEMA;
- Strategic Environmental Assessments (SEA) to assess the environmental implications of a proposed strategic decision, policy, plan, programme, piece of legislation or major plan;
- Environmental Management Frameworks, and
- Environmental Implementation Plans (EIP), which are a requirement for all provincial departments aimed at aiding integrated decision-making and planning.

As well as the application of Integrated Environmental Management (IEM) including:

- The evaluation of development applications, environmental management plans and environmental management programmes;
- The management of protected areas;
- The evaluation of environmental aspects relating to the rehabilitation of mines, spatial development initiatives, waste management and sanitation, and
- Pollution control.

The NWDACE currently does face challenges, as reported in the NW Province EIP Annual Reporting 2006/2007 (NWDACE, 2007a), *"Conflicting and duplication of statutory mandates and uncertainties as to the parameters of authorities' power and functions still exacerbate attempts to cooperative governance and coordination in the province. However, the working relation between certain Provincial Departments (Office of the Premier; DACE; DWAF; DME & DDLGH) and the Local Government is improving. The DACE is involved in the reviewing of the IDP's; waste management related projects (of which DWAF is also consulted); the working together of DACE, DWAF, DME and local municipalities in the evaluation of Environmental Impacts Assessments (EIAs)."* Communication has however improved between the Local and Provincial Government spheres. NWDACE is now more involved in the review of Municipal Integrated Development Plans (IDPs) and Waste Management Projects.

Box 2-9: NWDACE's mandate

National Acts

- Agricultural Debt Management Act, 2001 (Act 45 of 2001)
- Agricultural Pest Act , 1983 (Act 36 of 1983)
- Animal Health Act, 2002 (Act 7 of 2002)
- Animal Identification Act , 2002 (Act 6 of 2002)
- Animal Improvement Act, 1998 (Act 62 of 1998)
- Atmospheric Pollution Prevention Act, 1965 (Act 45 of 1965)
- Communal Property Association Act, 1996 (Act 28 of 1996)
- Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983)
- Development Facilitation Act, 1995 (Act 67 of 1995)
- Environment Conservation Act, 1989 (Act 73 of 1989)
- Extension of Security of Tenure Act, 1997 (Act 62 of 1997)
- Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act 36 of 1947)
- Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act 36 of 1947)
- Hazardous Substances Act, 1973 (Act 15 of 1973)
- Land Administration Act, 1995 (Act 2 of 1995)
- Land Reform (Labour Tenants) Act, 1996 (Act 3 of 1996)
- Land Survey Act, 1997 (Act 8 of 1997)
- Land and Agricultural Development Bank Act, 2002 (Act 15 of 2002)
- Livestock Brands Act, 1962 (Act 87 of 1962)
- Livestock Improvement Act 1977 (Act 25 of 1977)
- Marketing and Agricultural Production Act, 1996 (Act 47 of 1996)
- Meat Safety Act, 2000 (Act 40 of 2000)
- Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002)
- National Environment Management Act, 1998 (Act 107 of 1998)
- National Environment Management: Air Quality Act, 2004 (Act 39 of 2004)
- National Environment Management: Biodiversity Act, 2004 (Act 10 of 2004)
- National Environment Management: Protected Areas Act, 2003 (Act 57 of 2003)
- Prevention of Illegal Eviction from Unlawful Occupation of Land Act, 1998 (Act 19 of 1998)
- National Water Act, 1998 (Act 36 of 1998)
- Perishable Products Export Control Act, 1983 (Act 9 of 1983)
- Plant Breeders' Rights Act, 1976 (Act 15 of 1976)
- Plant Improvement Act, 1976 (Act 53 of 1976)
- Problem Animal Control Ordinance, 1957 (Act 26 of 1957)
- Provision of Land and Assistance Act, 1993 (Act 126 of 1993)
- South African Abattoir Corporation Act, 1992 (Act 120 of 1992)
- Spatial Data Infrastructure Act, 2003 (Act 54 of 2003)
- Subdivision of Agricultural Land Act, 1970 (Act 10 of 1970)
- Transformation of Certain Rural Areas Act, 1998 (Act 94 of 1998)
- Upgrading of Land Tenure Rights Act, 1991 (Act 122 of 1991)
- Veterinary and Para-Veterinary Professions Act, 1982 (Act 19 of 1982)
- World Heritage Convention Act, 1999 (Act 49 of 1999)

National Regulations

- NEMA Regulations Government Notice R385 of 2006
- Listing Notice 1 Government Notice R386 of 2006
- Listing Notice 2 Government Notice R387 of 2006
- Government Notice R1184, 5 September 1997
- Government Notice 1986, 24 August 1990 (as amended)

National Initiatives

- Accelerated Shared Growth Initiative of South Africa (ASGISA)

Provincial Acts

- Taung Agricultural College Amendment Act, 1994 (Act 16 of 1994)
- Cape Problem Animal Control Ordinance 26 of 1957
- Transvaal Nature Conservation Ordinance 12 of 1983
- North West Land Administration Act, 2001 (Act 4 of 2001)
- Cape Nature and Environmental Conservation Ordinance 19 of 1974
- Bophuthatswana Nature Conservation Act, 1973 (Act 3 of 1973)

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2.5.3. Environmental impact assessments (EIA)

It is reported in the EIP that more than 432 EIA Records of Decision (RoDs) were issued in the annual reporting cycle of 2006/2007; including township developments, telecommunication infrastructures, roads, and water supply infrastructures. The province has also started to build capacity for environmental compliance and enforcement monitoring. At least 77 operations have been inspected for RoD compliance in the annual reporting cycle of 2006/2007. Two environmental emergency incident investigations and 35 general duty of care breaches have been identified and legal directives issued for further monitoring.

Photo: Lauret Muller

2.5.4. Strategic environmental assessments (SEA)

NWDACE has undertaken the following SEA's within the province, including the:

- SEA for the Rustenburg (Phases 1 and 2);
- Mafikeng SEA;
- SEA for the North West Provincial SDF;
- Ditsobotla SEA;
- Vredefort Dome SEA; and
- Greater Taung SEA.

A review of the quality and effectiveness of SEAs was initiated by NWDACE in April 2008. One of the primary conclusions is that the findings and recommendations of the SEAs are generally not taken into consideration during the decision-making processes. In a response to this, NWDACE are currently investigating the viability of conducting Environmental Management Frameworks (EMF) instead of SEAs. EMFs have legal standing in terms of the NEMA, and therefore enforces implementation of the recommendations.

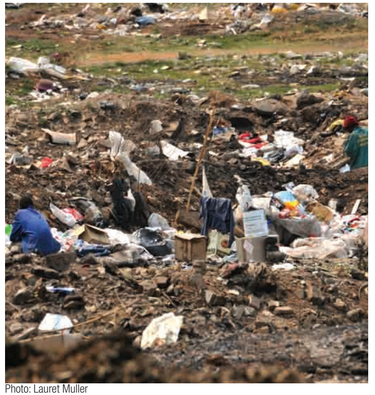

Photo: Lauret Muller

2.5.5. Environmental implementation plans (EIP)

The purpose of an EIP is to ensure co-ordination of environmental policies, plans, programs and decisions of the various departments that exercise functions that may affect the environment. Furthermore to:

- Minimize duplication of procedures and functions;
- Promote consistency in the management functions that may affect the environment, and
- Give effect to the principles of co-operative governance.

The NW Province 2006/07 EIP Annual Report is the fourth and the last annual report in terms of the first edition of the NW Province EIP, which was gazetted in April 2003.
The NW Province has commenced with the process of compiling the second edition of the EP and it is expected to be finalised at the end of 2008.

2.5.6. Governance and the environment

Human activities are increasingly impacting on the environment and affecting its ability to provide services in support of human well-being.

Photo: Werner Bentz

Timely and reliable environmental information and scientific knowledge are needed to mitigate and adapt the environmental change.

Information is required for action at national and regional levels, for mainstreaming environmental concerns into sectoral activities, and for implementing and monitoring multilateral environmental agreements and the development goals and objectives for sustainable development (UNEP, 2006).

Effective environmental governance within the province enables the identification of issues, the development of suitable responses and the monitoring of compliance which provides uniform national norms and standards and/or which are necessary to uphold the environmental agenda.

Governance does not place direct pressure on the environment as described in Section 2.2. A description has therefore not been provided in terms of the 3 main categories of pressures, as described in Section 2.2.

2.6. Driver 4: Science and technology

2.6.1. Introduction

The science and technology driver relates to the long-term economic sustainability of the NW Province. Recent research suggests that in order to achieve long-term economic growth, innovation and organisation responses are essential (Buys *et al.*, 2003).

It is important to note that science and technology do not necessarily equate to innovation. In 1988 the Commonwealth of Australia (quoted in Buys *et al.*, 2004, pp. 6) found that *"science is fundamentally about the pursuit of better understanding"* while *"technology is the development of practical devices or processes that operate reliably"*. Innovation, built upon science and technology, is the transfer of the science and technology into market capital.

Science and technology provide the ability to innovate. This driver is linked to the environment through, amongst others, the following:

- Economic sustainability since the long term economic growth is reliant on this driver;
- New economic activities due to the innovation creation by science and technology, and
- Change in technologies based on a variety of motivations.

The extent to which science and technology may act as a driver is based on the following concepts (Buys *et al.*; 2003):

- **Absorptive capacity** refers to "the ability to absorb new knowledge and adapt imported technologies". This capacity is noted as being essential for emerging economies to catch up;
- **Research and Development (R&D)** supply is important not only to generate new knowledge but also as mechanism to absorb it;
- **Diffusion and linkages** measure how many users, other than the innovator, are utilising the technology. This essentially justifies the R&D expenditure, and
- **Innovation demand (market pull)** which refers to the applicability of this technology for the market.

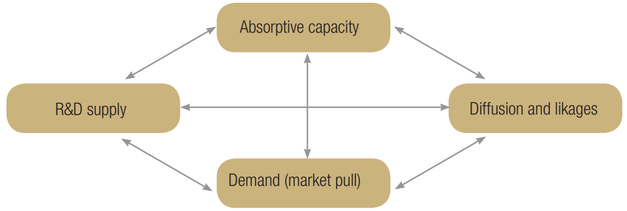

Figure 2-25: National Innovation Capacity Framework (Buys et al.; 2003)

Box 2-10: Indicators used to measure the 4 concepts of science and technology (Buys et al., 2003)

Absorptive capacity
- Expenditures in education as% of GDP
- Science and engineering graduates
- Population with 3rd level education
- Participation in life-long learning
- Employment high-tech manufacturing
- Employment high-tech services

Diffusion and linkages
- Training enterprises as% of all enterprises
- CVT as% of labour costs of all enterprises
- ISO 900 certifications per capita
- Internet users per 10,000 inhabitants
- PC per 100 inhabitants
- Internet and Communications Technology expenditures (% of GDP)

R&D supply
- Public R&D expenditures (% of GDP)
- Business R&D expenditures (% of GDP)
- R&D personnel per labour force
- European Patent Office (EPO) high-tech patents (per million of the population)
- United States Patent and Trade Office (USPTO) high-tech patents (per million of the pop)
- Resident patents per capita

Innovation demand (market pull)
- Stock market capitalization in% GDP
- Domestic credit provided by banking sector (% of GDP)
- Share of foreign direct investment in GDP
- Share of trade in GDP
- Index of patent rights

The above are utilised by the National Advisory on Innovation (NACI) as a framework to explain that, in order for science technology to translate into innovation, all 4 concepts are required (Figure 2-25).

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Science and technology are of fundamental importance in pulling the NW Province out of an economy built primarily on first, second and third dynasty activities into economic dynasties that return higher yields from capital investment.

2.6.2. Absorption capacity

The ability to absorb new ideas and adopt new technologies is fundamentally linked to poverty, education and human well-being. It is imperative that the population is involved in tertiary and life-long education and training to be able to participate in the knowledge economy.

Level of Education	2003		2004	
	Number	%	Number	%
None	312,000	14.3%	322,000	14.8%
Grade 0/R to Grade3/Std 1	139,000	6.4%	106,000	4.9%
Grade 4/ Std 2	78,000	3.6%	73,000	3.4%
Grade 5/ Std 3	96,000	4.4%	89,000	4.1%
Grade 6/ Std 4	128,000	5.9%	136,000	6.3%
Grade 7/ Std 5	146,000	6.7%	151,000	7.0%
Grade 8/ Std 6	200,000	9.2%	171,000	7.9%
Grade 9/ Std 7	155,000	7.1%	151,000	7.0%
Grade 10/ Std 8	199,000	9.1%	177,000	8.1%
Grade 11/ Std 9	148,000	6.8%	137,000	6.3%
Grade 12/ Std 10	403,000	18.5%	480,000	22.1%
NTC I - NTC III	29,000	1.3%	11,000	0.5%
Diploma/certificate with less than grade 12/ Std 10	11,000	0.5%	11,000	0.5%
Diploma/certificate with grade 12/ Std 10	79,000	3.6%	93,000	4.3%
Degree and higher	43,000	2.0%	42,000	1.9%
Don't know/ Unspecified	20,000	0.9%	24,000	1.1%
Total	2,186,000		2,174,000	

Table 2-5: Education level of population aged 20 years and above (Urban-Econ, 2005)

A primary requirement to create the ability to absorb technology is proper services and infrastructure. Without the platform of basic services, infrastructure, transportation, and Internet Communication Technology (ICT), it is difficult for the population to have the necessary exposure, time or resources to apply themselves to concepts outside of meeting their basic needs. The province's progress towards this is measured by the HDI. As discussed in Driver 1, the HDI for the province in 2005 was 0.54[20].

The NW Province has the University of the North West with 3 campuses: Mafikeng, Potchefstroom and the Vaal Triangle. According to the NW Barometer, 1.1% or 24,000 people in 2004 had university degrees or higher (Table 2-5). The province is currently addressing secondary education as 322,000 adults (14.8%) have received no education at all.

No information is available on the number of people trained for scarce skills and the training budgets towards this goal.Based on the HDI and the education figures of Table 2-5, the NW Province is in an unfavourable position for the necessary absorption capacity to handle new technology and innovation, unless the expertise migrates to the province.

2.6.3. Research and development supply

R&D is usually a costly exercise. This is not only due to the time spent on the projects, but also the returns received on the investment. R&D expenditure by the NW Province is presented in Table 2-6.

Provincial expenditure on R&D has remained below 5% for the period 2004 to 2008. The majority of expenditure has been allocated to professional fees. It is unclear whether this is towards professionals within the province or from outside provinces. The only data on expenditure on universities is for 2004, where R175,000 was spent.

Provincial expenditure is therefore not primarily focused on the science and technology, with the majority of expenditure being paid as professional fees.

2.6.4. Diffusion and linkages

Information on the diffusion and linkages of information is currently scarce for the province. Currently there are no figures available on the number of internet users or what is being accessed, training and ISO 9000 certifications.

20 where zero represents a low level of human development and "1" represents the situation when the regions has a life expectancy at birth of 85 years, 100% adult literacy rate, 100% gross enrolment rate, and $40,000 (PPP) GDP per capita

	2004/2005	2005/2006	2006/2007	2007 / 2008*
Professional fees	R343 m	R386 m	R627 m	R578 m
Universities	R0.175 m	no data	no data	no data
Total R&D expenditure	R343 m	R386 m	R627 m	R578 m
Provincial expenditure	R11,105 m	R13,137 m	R14,400 m	R15,532 m
Percentage	3.1%	2.9%	4.4%	3.7%

Table 2-6: R&D Expenditure as total of provincial budget (Urban-Econ, 2007)

*Medium-term expenditure framework

The internet can be accessed through a variety of protocols. The most commonly utilised are telephone lines and cellular. According to the Office of the Premier (2007), in 2005 13 out of every 100 households had a fixed telephone line. This means that very few households have fixed data lines. However, in 2005 approximately 60 out of every 100 households had a cellular phone. This figure is expected to have increased considerably between 2005 and present, meaning that more people may have access to data lines.

The high poverty rate however means that it is unlikely that these users can afford the costs for using these data lines.

2.6.5. Innovation demand (market pull)

The market pull or innovation demand in the NW Province is difficult to quantify. According to the NACI, the demand for innovation can be measured using (Buys *et al*., 2004):

- Employment trends;
- Availability of venture capital;
- Protection for patents, and
- Fiscal incentives.

Employment trends are discussed with Driver 2, which indicates high levels of unemployment within the province. A further point to note is that the government and community services sector is the largest employer.

Information on the availability of venture capital and protection for patents within the NW Province is not available.

The South African Department of Science and Technology (DST) provide tax incentives for R&D (DST, 2008) which supports this driver in the NW Province.

The NW Province has an opportunity for R&D in the mining and agricultural sectors. The opportunities include technologies for the better extraction of minerals and management of mining wastes. It is however difficult and costly to retrospectively apply technology to activities not included in the original design. Of particular applicability are Cleaner Technologies for the control of pollutants. Within the field of agriculture, there are opportunities around Genetically Modified Organisms, bio-fuels and organic farming techniques.

2.6.6. Science and technology and the environment

Science and technology produces innovative solutions to economic issues. As a driver, it can therefore reduce or increase pressures on the environment based on the type of solution being proposed. For instance, innovative solutions could be proposed for treating effluent before discharge into a river. This would reduce the pressures of pollution on the environment. However, a new technology could be introduced to cost-effectively mine platinum reserves at deeper levels, increasing the quantity of mining wastes in the east of the province.

It is argued, as a criticism against the concept of carrying capacity that *"necessity is the mother of invention"* (Boserup, 1965) and therefore science and technology do not drive environment change but are rather a response to the former 3 drivers discussed in this chapter.

With the recent and growing green revolution taking place around the planet, scientists and engineers are applying themselves more fervently to innovate in a manner which has less impact on the environment. However, this innovation will always have to be translated into market value and therefore faces the dual challenge of decreasing impacts on the environment while increasing profit margins.

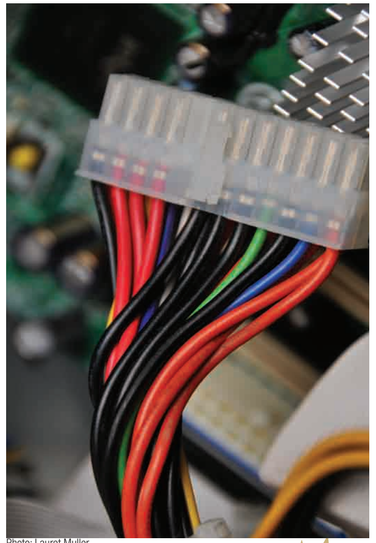

Photo: Lauret Muller

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2.7. Conclusion

Four key drivers have been identified which are primarily responsible for placing pressure on the environment: demography and human well-being; economic growth; governance, and science and technology.

These drivers are applying pressure on the environment through the excessive use of environmental resources; changes in land use, and pollution via effluent and emissions into the air, water and soil.

Chapters 3 to 8 provide discussion on how these pressures have affected the state of the environment in the NW Province.

Photo: Mary-Ann Palmer

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Photo: Laurel Müller

CHAPTER 3

Land use and transformation

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Acronyms and abbreviations

AGIS	Agricultural Geo-Referenced Information System
AMD	Acid Mine Drainage
ASgISA	Accelerated and Shared Growth Initiative for South Africa
BEE	Black Economic Empowerment
BIC	Bushveld Igneous Complex
CARA	Conservation of Agricultural Resources Act (Act No. 43 of 1983)
CASP	Comprehensive Agricultural Support Programme
DEAT	Department of Environmental Affairs and Tourism
DME	Department of Minerals and Energy
DWAF	Department of Water Affairs and Forestry
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross Domestic product
Ha	Hectares
KOSH	Klerksdorp-Orkney-Stilfontein-Hartbeestfontein
LCP	LandCare Programmes
LSU	Large Stock Unit
MMS	Minerals and Mining Sector
MPRDA	Minerals and Petroleum Resources Development Act (Act 22 of 2002)
MQA	Mining Qualifications Authority
Mt	Million tonnes
NW	North West Province
NWDACE	North West Department of Agriculture, Conservation and Environment
NWILARP	North West Province Integrated Land and Agrarian Reform Process
PGM	Platinum Group Metals
PLRO	Provincial Land Reform Office
PMR	Precious Metal Refiners
RPM	Rustenburg Platinum Mines Limited
SMME	Small, Micro and. Medium Enterprises
SOEs	State-Owned Enterprises
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
WfW	Working for Water Programme

Definition of terms

Gross Farming Income
Income earned from the sale of agricultural products.

Large-scale agriculture
Activities of large-scale commercial farms/entities in South Africa with an annual registered turnover of R2 million and above, and which were registered for Value Added Tax (VAT) and/or Income Tax (IT) for a specific collection period.

Acid Mine Drainage
Acid mine drainage is formed through a series of chemical and biological reactions that occur when a pyrite found in rock strata is disturbed and exposed to oxygen and moisture as a result of mining operations. AMD may contaminate surface and ground water.

Arable Land
Land that can be or is cultivated.

Biodiversity
The diversity of plant and animal life in a particular habitat.

Biofuel
Fuel such as methane produced from renewable biological resources such as plant biomass and treated municipal and industrial waste.

Biotechnology
The use of living organisms or other biological systems for environmental management, as in waste recycling: includes the use of bioreactors in manufacturing, micro-organisms to degrade oil slicks or organic waste.

Category 1 Invader
All plants outside biologically controlled reserves need to be removed. These plants may not be planted, maintained or propagated, imported or sold.

Category 3 Invader
Plants that shouldn't propagate, be planted, imported, sold/bought. If they have been growing from before the start of these regulations they can be left growing - but only if they are growing further than 30 metres from the 1:50 year flood line of stream, river etc.

Degradation
The negative impact on habitat and ecosystem size or quality resulting from human disturbances or land use changes commonly associated with urban or agricultural development.

Grazing Capacity
The maximum animal stocking rate possible without inducing damage to vegetation, water or related resources.

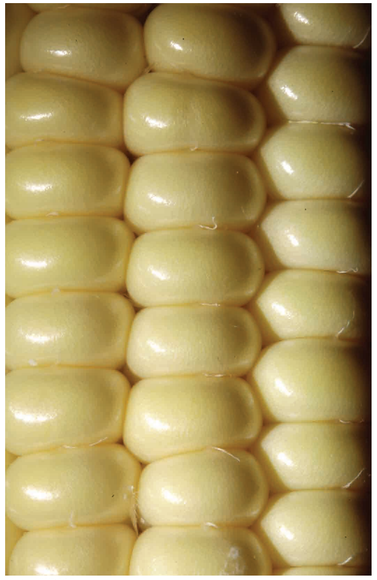
Igneous Rocks
Rocks solidified from molten magma at or below the surface of the Earth.

Land Degradation
Land degradation is the reduction or loss of the biological or economic productivity and complexity of rain-fed cropland, irrigated cropland, or range, pasture, forest or woodlands resulting from natural processes, land uses or other human activities and habitation patterns such as land contamination, soil erosion and the destruction of the vegetation cover.

Pioneer Species
In ecology a pioneer species is a plant species which colonises previously uncolonised land, usually leading to succession. Since uncolonised land usually has thin, poor quality soils with few nutrients pioneer species are typically very hardy plants, with adaptations such as long roots, root nodes containing nitrogen fixing bacteria, and leaves which reduce transpiration Pioneer species are often grasses.

Precision Farming
Precision farming is a farm management at a level that allows inputs to be tailored to variable conditions across short distances in a single field.

Sedimentary Rocks
Rocks formed from material, including debris of organic origin, deposited as sediment by water, wind, or ice and then compressed and cemented together by pressure.



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3.1. Introduction

This chapter outlines the status and the impacts of the two key primary land uses in the province - agriculture and mining.

The North West (NW) Province is considered to be an important part of the South African food basket. The province produces a third of South Africa's maize, as well as other cultivars such as sunflower oil, groundnuts, fruit, tobacco, cotton and wheat. Agriculture in the wetter eastern parts of the province largely comprises livestock and crop farming with a variety of crops, including tobacco, citrus, paprika, wheat, peppers, cotton and sunflowers being cultivated in the Rustenburg and Brits areas. General agricultural practices in the semi-arid central and western regions of the province include livestock and game farming. Some of the largest cattle herds in the world are found near Vryburg, located approximately 160 km southwest of the provincial capital, Mafikeng. The second largest irrigation scheme in the southern hemisphere, generally referred to as the Vaal-Harts Irrigation Scheme, is located along the Crocodile, Vaal and Harts Rivers. The irrigation scheme covers an area measuring 43,700 hectares (ha) in extent (PPT, 2004). The game farming industry has become a major economic force within the province. A large number of stock farmers have converted their stock farming enterprises to game farming however a number of farmers continue to farm game and live stock on the same properties. Large numbers of game are annually moved between game farms including the import and export of game to other provinces and countries outside South African borders. Game capture operations and game auctions also play a vital role in the distribution and sale of game species within the province. Their main purposes is the sale of game to current and new exempted property owners as well as the removal of excess game for ecological purposes.

Government is faced with the challenge of delivering land reform at a faster pace to reach the 30% target of commercial agricultural land by 2014 instituted by the Department of Land Affairs. Recognising this challenge, Government is piloting the Proactive Land Acquisition Strategy to acquire vast tracts of agricultural land for redistribution purposes. The strategy will assist in alleviating the administrative backlog of the current Land Redistribution for Agricultural Development Programme. Promoting agriculture will further encourage economic growth and supply a vehicle for rural development. Unfortunately, agriculture in the province is not contributing as much towards economic growth as it should, and has had a negative growth rate since 1988. The success and sustainability of the agricultural and agri-food sector in the NW Province therefore depends on its ability to utilize its natural resources in a responsible manner.

As in the rest of the world, agriculture in the NW Province has undergone significant changes in response to market demands, new production technologies, a shift towards more intensified operations, and advances in science, such as biotechnology and precision farming. The effects of these changes on the environment show that some key environmental pressures arising from agriculture and the inequities in access to land and its resources, and insecurity of tenure are becoming of greater concern. These have all put pressure on terrestrial resources including soil productivity and biodiversity, where unsustainable land use practices and lack of basic services (such as electricity and sanitation facilities) contribute to increased land degradation and desertification.

NW Province is known as the Platinum Province, producing approximately 94% of South Africa's platinum. The Bushveld Igneous Complex (BIC) contains the world's largest known deposits of Platinum Group Metals (PGMs) which include: platinum, palladium, rhodium, ruthenium, iridium and osmium. The Merensky Reef is the source of most of South Africa's PGMs with an estimated PGM reserve of approximately 17,000 tons. This reef is characterised by its high PGM grades and high ratios of platinum compared to other PGMs, especially those of major importance like palladium and rhodium. In the western BIC, where the major platinum mines are situated, the reef occurs in a narrow, 25 centimetre wide PGM-rich band bounded by two thin chromite layers. This pattern falls away in other areas resulting in the reefs diverging between the chromite bands until it is many meters wide.

The area surrounding Rustenburg and Brits boasts the single largest platinum-production area in the world. Mining contributes 24.6% to the economy at current prices and 34.4% of total employment in the province in 2006. NW Province is the dominant province in mineral sales with a contribution of 27.8% to the South African mining sector in 2006 (MQA, 2007). Diamonds are mined at Lichtenburg, Koster, Christiana and Bloemhof, while Klerksdorp-Orkney-Stilfontein-Hartbeestfontein (KOSH) is renowned for its gold mines. Most of the mining activities are in the Dr. Kenneth Kaunda and Bojanala Platinum Regions. Alluvial diamond mining still occurs in ancient river beds within the Harts River catchment and some rivers in the central and southern regions (PPT, 2004). With continual deep mining activity within the province over the past 100 years and especially in the Wonderfonteinspruit catchment, as well as the KOSH area, these are of the most problematic areas within South Africa relating to mining pollution (TCC, 2007). Other mineral resources in the NW Province include vanadium, nickel, manganese, phosphate, fluorspar, slate, limestone, silica and dimension stone.

3.2. Pressures and impacts

3.2.1. Agriculture

3.2.1.1. Food security

The Food and Agriculture Organization (FAO) of the United Nations (UN) defines food security as: *"… when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."* (FAO, 1996). The following conditions are imperative to ensuring food security:

- Stability of food supply;
- Accessibility to food;
- Affordability;
- Quality of food, and
- Adequacy of food supply or availability.

Current rising food prices largely affect poor households. Maize meal, the main food source of such poor households, has become excessively expensive compared to other basic products, compelling consumers to buy cheaper imported products such as rice or pasta (AIDC, 2005). Nominal prices of staple foods in most monitored local markets have been rising unseasonably this year (2008), with current levels well above last year (2007) and the past 4-year average for this time. High food prices will limit food access for many vulnerable households in urban and rural areas, and could negatively impact the procurement of food intervention programs.

Currently, within the South African context, 2 factors could potentially further compromise food security:

- The replacement of food crops with biofuel crops, particularly crops that are considered staple food crops, such as maize, and
- Insufficient water supply to grow food crops required to meet local demands, as well as for export purposes.

Box 3-1: Bush Encroachment (DEAT, 1999b)

Bush encroachment is the process which transforms a grass-dominated habitat into a habitat dominated by woody species. This is recognised as a severe problem throughout Sub-Saharan Africa, as it causes the destruction of grassland vegetation which is considered the most suitable for grazing purposes. This type of encroachment additionally results in:

- The reduction of the grazing capacity of fields where in instances such encroachment is in creasing in extent and severity;
- Transformation of floral and faunal habitats, and
- A reduction in species diversity occurring within a specific area.

3.2.1.2. Bush encroachment

Bush encroachment has a direct influence on the farming community since encroachment reduces the availability of land for grazing. In savannas, the natural balance between the ratios of trees to grasses can be distorted by livestock, for example cattle and sheep which primarily rely on grass for foraging rather than tree leafage. It is often assumed that grasses, being fast-growing plants with roots in the upper layers of the soil, out-compete trees which are slow-growing and have deeper root systems, for water and soil nutrients. However, when overgrazing occurs, grasses are removed and make water and nutrients available for trees which can then rapidly expand. This is known as bush encroachment. The primary species that are very opportunistic in these circumstances are thorn trees (e.g. *Acacia mellifera, A. karroo, A. reficiens, A. tortilis* and *Dichrostachys cinerea)*. Proliferation of these species reduces the ability of the land to sustain a livelihood and can lead to serious reductions in livestock, ultimately causing famine, which is often exacerbated by drought (Ward, 2008)[1].

3.2.1.3. Soil conservation

'Soil degradation' implies degradation that will occur in both the natural veld as well as the croplands. The most important types of soil degradation in the veld of the NW Province are rill, gully and donga erosion. These types of erosion occur in 71% of the municipal areas of the province. The most important forms of soil degradation in croplands are sheet erosion (water), a loss of topsoil (wind) as well as rill, gully and donga erosion (water).

1 Refer to Chapter 4 for further information on bush encroachment.

Integrated into the LandCare Programme are projects that are designed to teach the communities to make use of better cultivation practices, e.g. not to abandon land or leave it exposed for lengthy periods following ploughing or harvesting, not to over irrigate and with resultant water-logging, to use the correct equipment, to plant grass strips and not to do shallow ploughing. Efforts are also being made to teach them to select the correct sites for cultivation (not on steep slopes or highly erodible soils next to dongas), and to make suggestions with regard to changes to land-use practices. This also involves teaching community farmers natural resource management, methods to improve and maintain the nutrient status of soils for example by liming and correct cultivation practices, and pointing out the negative effects of deforestation on grazing lands without the necessary rehabilitation.

3.2.1.4. Agriculture

The drive for wealth and the growing population increases the pressure on agriculture production unequivocally, which in turn puts more pressure on the environment. Ammonium-based fertilisers and chemicals are considered the most important soil and water polluters in the province (Mangold *et al.,* 2002).

Since 1994, a broader spectrum of the community has access to land, and due to low job opportunities elsewhere, the people rely heavily on agricultural activities for a living.

The recent increase in international travel and international trade has introduced various alien species into the country, both intentionally and unintentionally. Certain introduced species rapidly dominate ecosystems, changing the endemic flora species composition and faunal species naturally occurring in the area, or by utilising large amounts of ground and surface water for survival. The alien species domination reduces the functionality of the natural ecosystem and lowers their ability to support natural life forms (DEAT, 1999).

3.2.2. Mining

3.2.2.1. Industry and mining

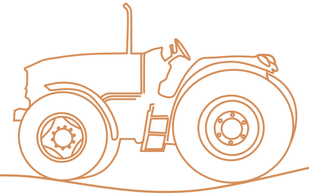
Solid wastes and effluent generated from industries and households are considered the most significant factors contributing to soil and water pollution in the province. Recently the threats of radiation and radioactive pollution have, in addition, been recognised as a concern in the province (Sharon Davis, 2007)[2].

Acid Mine Drainage (AMD) from the gold mines is the main source of radioactive water pollution. Recent laws and regulations put limitations on this, but it was not necessarily the case in earlier days, and old mine residues remain a problem. The Brenk Report (NRR, 2007), published by the National Nuclear Regulator in early July 2008, warns that 100 km of the Wonderfontein Spruit (from the rich goldfields of Randfontein in the Gauteng Province down to Potchefstroom in the NW Province), have been found to be dangerously polluted (Sharon Davis, 2007). Land becomes sterile because the water is contaminated and feedlots do not purchase animals from the affected areas. The report claims that the water in the river has been polluted by polonium and lead, by-products of gold mining activities in the close vicinity. There are claims that the natural water in the area affected by the pollution is unsafe for human, animal or plant consumption.

3.2.2.2. Commodity prices and the exchange rate

The Minerals and Mining Sector (MMS) is highly sensitive to fluctuations in local and international economic and market conditions. The local markets for mining and mineral products are relatively small and for this reason most of South Africa's mining production is exported. The profitability of operations is thus directly affected by world commodity prices, the exchange rate, as well as input costs. The volatility displayed by the South African Rand in recent years has had a profound impact on export industries, including the mining industry. The weakening of the Rand in 2001 obviously benefited the industry while the recovery of the Rand between 2002 and 2004 had an adverse effect. During the first half of 2003 the Rand appreciated by 23.6% against the US dollar. Despite the 10.2% increase in the average dollar gold price in the period, the Rand gold price declined by 13.6%. Similarly the platinum dollar price increased by 19.7% in the period and the coal price by 17.4%. However, as a result of the strengthening of the Rand, prices of these two commodities dropped by 7.1%

2 Refer to Chapter 2 for a description of the mining sector as a driver.



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and 12.2% respectively. The exchange rate also affects the cost of production in dollar terms. In the second quarter of 2003, when the Rand was trading at more than R6 to the dollar it was estimated that, on average, the gold sector was making a loss, that 7 out of 12 South African mines were making a loss and that some 70,000 workers were employed on these loss-making mines. In 2004 the Rand still gained in strength and the gold mining industry remained under pressure. The other sub-sectors also experienced pressure as a result of the strong rand, but this effect was countered by high commodity prices (MQA, 2007).

3.2.2.3. Environmental conservation and rehabilitation

Environmental conservation and the rehabilitation of areas where mining or exploration activities have occurred are regulated by various acts and government policies. The Mineral Petroleum and Resources Development Act (Act No. 28 of 2004) places the responsibility for rehabilitation on the holder of a prospecting permit or mining authorization. The Department of Minerals and Energy (DME) has specific policies regarding financial provision for rehabilitation upon the closure of a mining operation. Although environmental protection is of paramount importance and is generally supported by the industry, it has an economic impact on the sector, especially on small businesses operating in areas regarded as ecologically sensitive. Environmental considerations may limit the lifespan of certain operations and rehabilitation costs can become the last cost factor that drives a company out of business. In some instances, there is an inherent conflict between the need for job creation through mining activities and the need to protect the environment (MQA, 2007).

3.3. Current state

3.3.1. Land degradation

Land degradation is broadly defined by the United Nations Convention to Combat Desertification (UNCCD) as: *"the reduction or loss, in arid, semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands."* (UNCCD, 1994). The impacts of land degradation are both environmental and socio-economic and are intricately linked to food security, poverty, urbanization and biodiversity. Impacts relating to land degradation include, amongst others:

- Salinization of soil;
- Increased soil acidity;
- Bush encroachment;
- Decreased soil productivity, and
- Loss of biodiversity.

Degradation is regarded amongst other things as one of South Africa's most critical environmental issues, intricately linked to food security, poverty, urbanization, climate change, and biodiversity. Globally, desertification affects 70% of all drylands, and 73% of Africa's agricultural drylands are degraded. As much as 91% of South Africa comprises drylands, making it susceptible to land degradation. In light of the aforementioned, South Africa, during September 1997, ratified and officially became a signatory state to the Convention, thereby legally committing to the development and implementation of a national strategy to mitigate impacts related to desertification (Goslar *et al.*, 2008). Following the ratification of the Convention the Department of Environmental Affairs and Tourism (DEAT) commissioned a study during 1999 to assess desertification in South Africa. The study was undertaken by the National Botanical Institute (NBI) (now known as the South African National Botanical Institute / SANBI) as an inception phase to the formulation of a country wide National Action Programme. Land degradation in 367 magisterial districts was appraised. This involved thirty four workshops and the participation of 453 agricultural extension officers and resource conservation technicians. The outcome of the study was the development of indices (soil, vegetation and combined degradation indices) to monitor land degradation on a magisterial level.

According to the study conducted by the NBI (1999), the NW Province is listed fourth out of nine provinces in terms of the combined degradation index. In terms of the soil and veld degradation indices (Figure 3-1 and Figure 3-2), the province is listed in fifth and fourth places respectively. This index is an indication that degradation, *per sé,* is already a serious problem in the NW Province. The statistics also indicate that the combined degradation index (refer to Figure 3-3) in the communal areas is approximately 2.5 times higher than in the commercial areas.

From an analysis of the soil degradation index, it is evident that the province has a comparatively high degradation index value of 149. The severity (degree and extent) of soil degradation is 4.4 for the commercial areas and 6.0 for the communal areas respectively. The districts with the highest soil degradation index values are Madikwe, Lehurutshe and Mankwe. Both cropland and grazing lands are affected by wind and water erosion. The covering of farmland by wind-blown sand is especially problematic in the Vryburg district.

In addition, a fairly high provincial veld degradation index is recorded for the province. A comparative analysis of the severity of veld degradation between the communal and commercial areas indicated that veld degradation was significantly higher for communal areas (average severity value 2.54), compared to the value recorded for commercial areas (average severity value 1.47). The average severity value scored for the province is given as 1.89. The highest severity values are recorded for the Marico, Lehurutshe, Madikwe, Mankwe, Ganyesa, Kudumane and Taung areas. It is again evident that the veld degradation values, similar to that of the soil degradation values, are significantly higher for the communal areas (average degradation rate value 0.9) compared to the commercial areas (average degradation rate value 0.2). The average degradation rate value for the province is 0.25.

The three most prominent veld degradation types that occur in the province are the following:

- Bush encroachment/thickening;
- Loss of basal cover, and
- Change in species composition.

The aforementioned causes are interwoven and consequently make it difficult to pin point a single cause. Loss of basal cover and changes in species composition can result in bush encroachment. Bush thickening, for whatever reason, also leads to changes in the species composition and is accompanied by a decrease in the basal cover. The study assessed land degradation in 28 designated areas in the province and found that all the problems mentioned occurred in all of the 28 designated areas. Therefore, this indicates that veld degradation is a problem throughout the province.

The main reasons for the increase in the rate of degradation are the following:

- Overstocking;
- Poor or no camp systems;
- Poor or no veld management;
- Poor water reticulation;
- The communal grazing system leads to open access for those within the area;
- Lack of responsibility because of a lack of ownership;
- Settlements on grazing lands;
- Drought and other natural phenomena, and
- Injudicious burning practices – this often leads to bush encroachment.

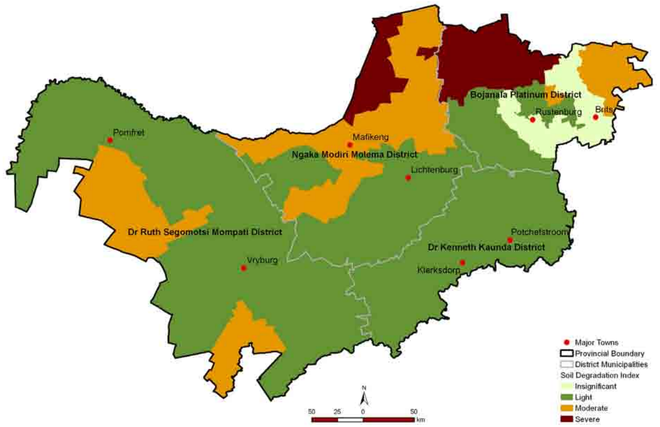


Figure 3-1: Soil degradation index (NBI, 1999)

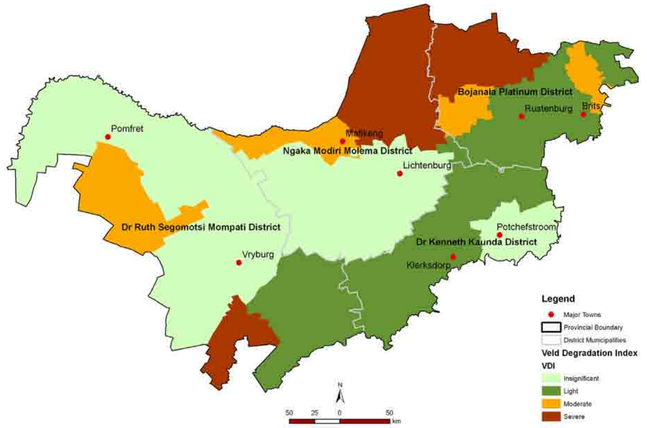
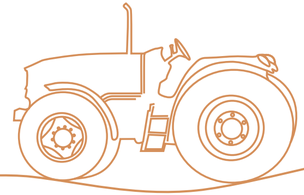


Figure 3-2: Veld degradation index (NBI, 1999)

Photo: Lauret Muller



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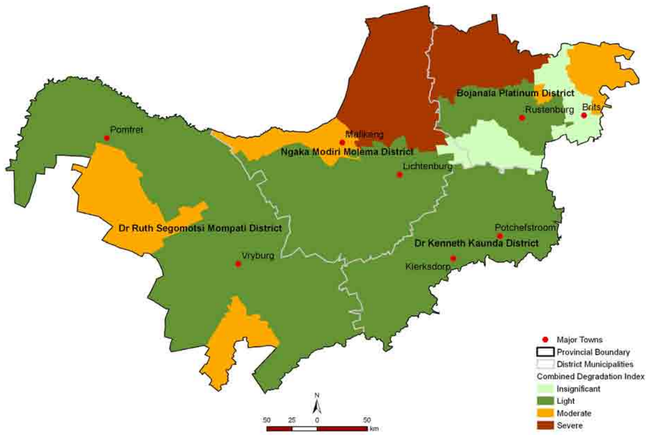


Figure 3-3: Combined degradation index (NBI, 1999)

3.3.1.1. Land desertification

Box 3-2: Desertification

Desertification is defined by the UN Convention to Combat Desertification as "land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities". Land degradation in drylands is defined as the reduction or loss of the biological or economic productivity of drylands.

In the Bojanala Platinum District, more specifically the Moses Kotane Local Municipality (east and west), approximately 17% of land is susceptible to desertification (Last, 2007). The contributing factors such susceptibility are ascribed to overstocking, erratic rainfall and drought patterns, poor farm planning, lack of land ownership, communal farming controls, poor legal services in combating overstocking and regular veld fires (more than once per season) resulting in the following:

- Grass species in the area are predominantly that of pioneer species;
- Soil compaction, especially around watering points;
- Pathways, and
- Increased water runoff.

Bush encroachment has increased in excess of 30% and higher in places, with the present poor control in bush thinning project under the LandCare Programme contributing directly to the severity of desertification. The predominant encroacher tree species in this area is Sickle bush *(Dichrostachys cinerea)*, while the main invader species is Black wattle *(Acacia mearnsii)* and Bluegum *(Eucalyptus spp.)*.

The Rustenburg and Kgetleng Local Municipalities are marginally affected by desertification. The vegetation in these areas is predominantly characterized by sub-climax to climax grass species and invader species are especially problematic in areas close to rivers.

In the Bojanala Platinum and Bophirima districts (currently known as the Dr. Ruth Segomotsi Mompati District Municipality), the extent of desertification is generally unknown, however a specialist Extension Officer reports that a 30% value is likely in several regions within the Bophirima district as a result of overgrazing. In addition the invasion of Prosopis, Black Thorn *(Acacia millefera)*, Vaalbos *(Terminalia sericea)* and Sickel bush *(Dichrostachys cinerea)* are recorded as being problematic in these areas (Dames, 2007).

Approximately 50% of land in the Southern District (currently known as the Dr Kenneth Kaunda District Municipality) is cultivated. The remainder of land is degraded by between 5 and 10%. The predominant weeds and invasive plants in the district area are *Stoebe vulgaris* and *Solanum elaeagnifolium*. In addition *Prosopis, Acacia* and *Opuntia* species are localized in the Wolmaranstad area and the Vredefort Dome World Heritage Site, respectively. In areas where such weeds and invasives occur, it is expected that the grazing capacity has been reduced by approximately 75 to 80%.

For the Ngaka Modiri Molema district, no information regarding desertification could be obtained. It is however common knowledge that Sickelbush *(Dishrostachys cinerea)* is problematic in this area.

Box 3-3: How can desertification be halted?

To halt desertification the following actions can be taken:

- Reduce the number of livestock units grazing on land. The reduction will allow plant species occurring within the grazing are to regrow;
- Soil conditions must be made favourable for plant growth by, for example, mulching. Mulch (a layer of straw, leaves or sawdust covering the soil) reduces evaporation, suppresses weed growth, enriches soil as it rots, and prevents runoff and hence erosion;
- Reseeding may be required for badly degraded areas, and
- Filling eroded areas with locally available materials like rock packs.

3.3.1.2. Overgrazing and grazing capacity

Overgrazing is generally the most important land-related environmental problem in the NW Province. Cattle are kept in small enclosures, resulting in trampling and considerable overgrazing. Impoverishment of the veld leads to bush encroachment resulting in invader plant species becoming problematic. Overgrazing is a serious threat to the condition of grasslands, however grasslands evolved collectively with mega-herbivores and plant species have developed robust underground survival systems. The grazing capacity in the NW Province is illustrated in Figure 3-4.

In the communal areas like Odi, Mankwe, Lehurutshe, Molopo, Taung and Ganyesa, the grazing area required to sustain one large stock unit (LSU) is approximately 50% or more than that of the commercial areas. This is mainly due to the communal use of land which leads to overgrazing and mismanagement.

Grazing capacity is influenced by the amount of fodder produced during a season. However, all the material produced is not available as grazing to the animal (palatable versus unpalatable species). Studies showed that more than 80% of fodder produced from good veld is palatable, whilst poor veld in contrast only produces as low as 10% palatable fodder. The grazing capacity of communal areas differ vastly to that of the commercial areas, mainly due to the degraded state of the veld resulting from unsustainable agricultural practices characteristic in the communal areas.

The communal land use sector does not have the same management objective as the commercial land use sector. The farming objectives of the communal farmers are ordinarily not for commercial purposes, but mainly for meat and milk for household use, ritual slaughter, bridal payments, and many other uses. The maximum number of animals is therefore kept on the veld irrespective of its quality and thus results in higher than recommended stocking densities. The result is severely degraded land.

3.3.1.3. Bush encroachment and invader species[3]

Bush encroachment, considered the distinctive threat to the agricultural productivity of farming land in the province, has become a major concern for farmers in the NW Province. This form of encroachment is ascribed to changes in the vertical distribution of soil moisture and nutrients advancing the growth of woody species (indigenous and alien), transpiring in the decrease of the natural herbaceous layer characteristic to the area. The impact of encroachment is the sterilisation of vast tracts of farming land, resulting in agriculturally unproductive farms.

3 Refer to Chapter 4 for further discussion on bush encroachment

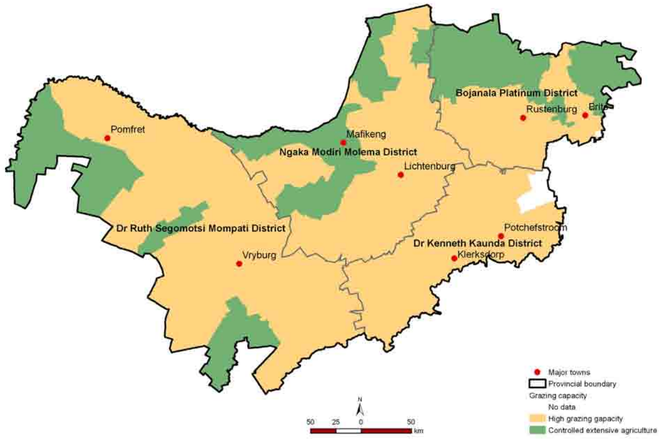
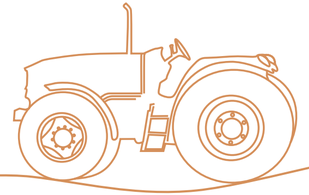


Figure 3-4: Grazing capacity in North West Province (Morgenthal *et al.*, 2005, Pretorius, 2001)

Box 3-4: Invasive, encroacher and indigenous species

A distinction should be made between an invader and encroacher plant species. Invasive species are species introduced and occurring in locations beyond their known historical range. These include introductions from other continents, bioregions, and also those not native to the local geographic region. An encroacher species is a species that demonstrates rapid growth and spread, invades habitats, and displaces other species. Species that are prolific seed producers, have high seed germination rates, easily propagated asexually by root or stem fragments, and/or rapidly mature, predispose a plant to being an invasive. An encroacher is an indigenous species that increases in number due to aspects such as overgrazing, mismanagement, accidental fire, etc. A native (indigenous) species is one that occurs in a particular region, ecosystem, and habitat without direct or indirect human actions.

Photo: Lauret Muller



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Invasive species commonly found or that may potentially become a problem plant in the NW Province (CRLR, 2007) are summarized in Table 3-1. Invasive species can be divided into three categories, as defined in the Conservation of Agricultural Resources Act (Act No. 43 of 1983) (CARA), namely:

- Category 1 (Table 3-1) plants or declared weeds are plants no longer to be tolerated on land or water surfaces, either in rural nor urban areas.
- Category 2 (Table 3-1) plant invaders (commercial value) are plants with the potential of becoming invasive, but have certain beneficial properties that permit their continued presence in certain areas. Regulations 15 and 16 of the CARA makes provision for retaining Category 2 plants in specially demarcated areas; however Category 2 species occurring outside the demarcated areas have to be controlled.
- Category 3 (Table 3-1) plant invaders (ornamental value) are plants which are undesirable as they have the proven potential of becoming invasive, although most of these species are popular ornamentals or shade trees that are timeously replaced. In terms of Regulation 15 of CARA, these plants are not allowed to occur anywhere unless they were already in existence when these Regulations came into effect.

Table 3-1 presents the plant species that are of specific concern in the NW Province, in line with the three categories defined under the CARA (Pretorius, 2007 & 2008). Declared bush encroachers in the NW Province are presented in Table 3-2.

Bush encroachment and overgrazing are most prominent in the Bophirima area (currently known as the Dr. Ruth Segomotsi Mompati District Municipality). Coach Grass invasion increased from 25,000 ha to approximately 30,000 ha during the past five years (Theron, 2007). Invasion of *Stoebe vulgaris* and *Asparagus* are also problems that require attention. *Stoebe vulgaris* is currently classified as a Category 4 species (a Category 4 species is an indicator of bush encroachment). However, this species has already invaded extensive areas (veld as well as crop fields) of the province. Legislation regarding the classification of this plant needs serious attention. Declared bush indicators of bush encroachment in the NW Province are presented in Table 3-2.

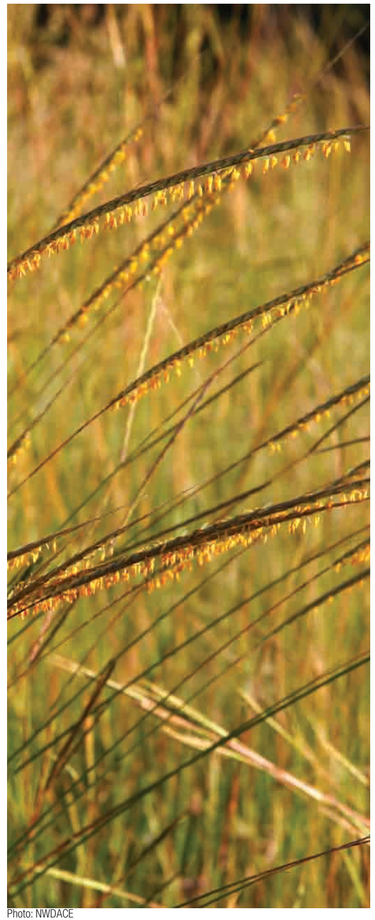


Photo: NWDACE

Photo: Lauret Muller

Category 1*	
Common name	Botanical name
Azolla, Red water fern	*Azolla filiculoides*
American bramble	*Rubus cuneifolius*
Australia pest pear	*Opuntia stricta*
Blue passion flower	*Passiflora caerulea*
Bugweed	*Solanum mauritianum*
Burweed	*Achyranthes aspera L.*
Cats claw creeper	*Macfadyena unguis-cati*
Creeping prickly pear	*Opuntia humifusa*
Fountain grass	*Pennisetum setaceum*
Gaint or Spanish reed	*Arundo donax*
Inkberry	*Cestrum laevigatum*
Jointed cactus	*Opuntia aurantiaca*
Lantana	*Lantana camara*
Large cocklebur	*Xanthium strumarium*
Longspin cactus	
Lucern and common dodder	*Cuscuta campestris Yunck*
Mauritius thorn	*Caesalpinia decapetala*
Mexican poppy	*Argemone achroleuca*
Moth catcher	*Araujia sericifera*
Oleander	*Nerium oleander*
Pampasgrass (Two types)	*Cortaderia jubata, C. selloana*
Parrot's feather	*Myriophyllum aquaticum*
Parthenium	*Parthenium hysterophorus*
Pereskia	*Pereskia aculeata*
Queen of the Night	*Cereus jamacaru*
Red sesbania	*Sesbania punicea*
Silver-leaf bitter apple	*Solanum elaeagnifolium*
Spear thistle	*Cirsium vulgare*
Spiny cocklebur	*Xanthium spinosum*
Sweet prickly pear	*Opuntia ficus-indica*
Sweetbriar	*Rosa rubiginosa*
Thorn apple	*Datura stramonium*
Torch cactus	*Echinopsis spachiana*
Water hyacinth	*Eichhornia crassipes*
Water lettuce	*Pistia stratiotes*
Wild morning glory	*Convolvulus arvensis*
Wild tabacco	*Nicotiana glauca*
Wild tomato	*Solanum sisymbriifolium*
Yellow bells	*Tecoma stans*

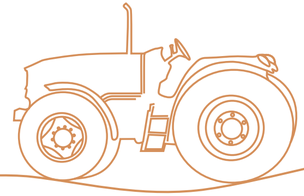
Category 2'	
Common name	Botanical name
Silver wattle	*Acacia dealbata*
Green wattle	*Acacia decurrens*
Black wattle	*Acacia mearnsii*
Sisal hemp	*Agave sisalana*
Old man salt bush	*Atriplex nummularia*
Kausaris/Beefwood tree	*Casuarina cunninghamiana*
Red river gum	*Eucalyptus camaldulensis*
Black iron bark	*Eucalyptus sideroxylon*
Honey locust	*Gleditsia triacanthos*
White poplar	*Populus alba*
Grey poplar	*Populus x canescens*
Honey mesquite	*Prosopis glandulosa var. torreyana*
Velvet mesquite	*Prosopis velutina*
Caster-oil plant	*Ricinus communis*
Black locust	*Robinia pseudoacacia*
European blackberry	*Rubus fruticosus*
Weeping willow	*Salix babylonica*

Category 3'	
Common name	Botanical name
Bailey's wattle	*Acacia baileyana*
Australian silky oak	*Grevillea robusta*
Morning glory	*Impomoea indica*
Jacaranda	*Jacaranda mimosifolia*
Privets	*Ligustrum spp*
Syringa.Persian lilac	*Melia azedarach*
White mulberry	*Morus alba*
Yellow firethorn	*Pyracantha angustifolia*
Himalayan firethorn	*Pyracantha crenulata*
Tipu tree	*Tipuana tipu*

Table 3-1: Most common Category 1, 2 and 3 declared weeds in the NW Province

(Theron, 2007)*
(The Conservation of Agricultural Resources Act (Act No 43 of 1983))'

Photo: Lauret Muller



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Botanical name	Common name
Acacia ataxacantha DC.	Flame thorn
Acacia borleae	Sticky thorn
Acacia caffra	Common hook-thorn
Acacia erubescens	Blue thorn
Acacia exuvialis	Flaky thorn
Acacia fleckii Schinz	Plate thorn
Acacia gerrardii Benth. Var. gerrardii	Red thorn
Acacia grandicornuta Gerstner	Horned thorn
Acacia hebeclada DC. Subsp. *Hebeclada*	Mousebush, Candle thorn
Acacia karroo Hayne	Sweet thorn, Karoo thorn
Acacia luederitzii Engl. Var. *luederitzii*	False umbrella thorn
Acacia nigrescens Oliv.	Knob-thorn
Acacia nilotica (L.) Willd. Ex Delile subsp. *Kraussiana (Benth.)* Brenan	Scented thorn, Redheart
Acacia permixta Burtt Davy	Slender thorn
Acacia terili (L.) Willd. Var. *rostrata* Brenan	Three-hook thorn, Three-thorned Acacia
Acacia sieberiana DC. Var. woodii (Burtt Davy) Keay & Brenan	Paperbark thorn
Acacia tenuispina I.Verd.	Fyndoring
Acacia tortilis (Forssk.) Hayne subsp. *Heteracantha* (Burch.) Brenan	Umbrella thorn, Curly pod Acacia
Asparagus spp.	Wild asparagus
Combretum apiculatum Sond. Subsp. *Apiculatum*	Red bush willow
Dichrostachys cinerea (L.) Wight & Arn. Subsp. teriliz Brenan & Brummitt	Sickle bush
Diospyros lycioides Desf.	Blue bush
Dodonaea angustifolia L.f.	
(= Dodonea terili Jacq._var._*angustifolia Benth)*	Sand olive
Euclea crispa (Thunb.) Guerke subsp. Crispa	Blue guarri
Euclea teriliz Thunb.	Common guarri
Grewia teriliz Juss.	Bastard raisin bush
Grewia flava DC.	Wild raisin, Velvet raisin
Grewia flavescens Juss.	Rough leaved raisin, Sandpaper raisin
Leucosidea sericea Eckl. & Zeyh.	Old wood
Lopholaena coriifolia (Sond.) E.Phillips & C.A.Sm.	Lopholaena
Stoebe vulgaris Levyns	Bankrupt bush
Strychnos madagascariensis Poir.	Black monkey orange
Tarchonanthus terilizati L.	Camphor bush, Sagewood
Terminalia sericea Burch. Ex DC.	Silver cluster leaf, Transvaal silvertree, Silver Terminalia

Table 3-2: Declared indicators of bush encroachment in the NW Province (The Conservation of Agricultural Resources Act (Act No 43 of 1983))

Soil erosion occurs when soil particles are detached from the soil aggregate, transported and deposited by physical processes, for example wind and water, at a rate exceeding soil formation, resulting in soil loss. Effects of soil erosion include amongst other the following:

- The deterioration of farmlands;
- The deterioration of forests;
- The occurrence of floods and droughts;
- The siltation of rivers and water reservoirs, and
- The destruction of houses and infrastructure.

Soil erosion as a result of unsustainable agricultural practices which include the clearing of natural vegetation, poor soil and veld management practices and overgrazing primarily affects the productivity of agricultural land. Repeated erosion reduces the fertility of the soil by:

- Removal of topsoil that is rich in crop nutrients and organic matter;
- Reduction of the depth of soil available for rooting, and water storage for crop growth, and
- Reducing infiltration of water into soil, thereby increasing run off and erosion.

More than 70% of South Africa's arable land is affected by soil erosion resulting from areas affected by prolonged soil erosion experience irreversible soil loss over time, resulting in soil fertility and productivity reduction. Table 3-3 indicates that approximately 16% of the NW Province is severely affected by soil erosion - such areas are primarily confined to the Bojanala Platinum District, Southern District (east) (currently known as the Dr. Kenneth Kaunda Dsitrict Municipality) and the Ngaka Modiri Molema District Municipality (north) with a clear band of high erosion risk between Rustenburg and Zeerust. The high erosion values recorded are a function of the steep slope characteristics of this area. Approximately 52% of the province has been classified as having a 'very low' soil erosion classification with an estimated soil loss ranging between 0 – 5 tonnes per hectare per year.

Level of erosion	Area (ha)	Percentage area
Level of erosion	Area (ha)	Percentage area
Very low	5,574,660	52.43
Low	1,674,960	15.75
Moderate	1,184,280	11.14
High	838,502	7.89
Very High	445,873	4.19
Extremely high	385,710	3.63

Table 3-3: Area and percentage area of actual soil loss against level of erosion for the NW Province (ARC, 2006)

Box 3-5: Did you know? (Collins, 2001)

- Annual soil loss in South Africa is estimated at 300 - 400 million tonnes, nearly three tonnes for each hectare of land.
- Replacing the soil nutrients carried out to sea by our rivers each year with fertilizer, would cost R1000 million.
- For every tonne of maize, wheat, sugar or other agricultural crop produced, South Africa loses an average 20 tonnes of soil.
- The FAO estimates that the global loss of productive land through erosion is 5-7 million ha/annum.

3.3.2. Land use

Land use can be used as a key for environmental themes and indicators in the NW Province. The categories provide a baseline of the current state of land use in the province. Table 3-4 presents these different land cover types with figures and percentages derived from Figure 3-5.

The NW Province is a province still dominated by vast open areas of natural vegetation, with 67.8% of the total area comprising grasslands, thickets, woodlands and forests. Urban development covers only 2.1% of the province and is concentrated in the eastern parts of the province, with growth nodes in the Rustenburg area, as well in the Klerksdorp/Potchefstroom area.

The Vryburg area is a growing node in the western parts. Agriculture in the eastern, wetter parts of the province largely comprises livestock and crop farming with a variety of crops, including tobacco, citrus, paprika, wheat, peppers, cotton and sunflowers, being cultivated around the Rustenburg and Brits areas. General agricultural practices in the semi-arid central and western parts of the province include livestock and game farming. Approximately 20.9% of the surface area has been cultivated, with the mining industry covering only 0.4% of the area in the province. Coverage of only 1% by wetlands and water-bodies illustrates the dryness of the province.

Photo: NWDACE

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NORTH WEST PROVINCE LAND-COVER AREA STATISTICS							
TRANSFORMATION STATUS	Area (Ha)	%	LEVEL-1	Area (Ha)	%	ORIGINAL	%
UNTRANSFORMED	7495387.0	70.4	TREE	525388.8	4.9	TREE & BUSH	166113.7
						BUSH	
			BUSH	1298022.8	12.2	OPEN BUSH	655623.9
						SPARSE BUSH	642398.9
			SHRUB	2119484.3	19.9	LOW SHRUB	705495.1
						SPARSE BUSH	1413989.2
			GRASS	3284711.4	30.8	GRASSLAND	3090126.5
(*Includes only natural water*)						SPARSE GRASSLAND	194584.9
			WATER (total)	57853.1	0.5	WATER NATURAL	24255.7
			WETLANDS	207372.6	1.9	WETLANDS VEGETATED	151351.9
						WETLANDS NON-VEGETATED	56020.7
			NATURAL NON-VEGETATED	36151.4	0.3	NATURAL NON-VEGETATED DUNES	43.6
						NATURAL NON-VEGETATED SODIC /SAND	10049.9
						NATURAL NON-VEGETATED ROCK	26057.9
TRANSFORMED	313340.5	29.4	IMPROVED GRASS	2714.9	0.0	SPORTS FIELDS	898.2
						GOLF COURSES	1816.6
			PLANTATION	31508.9	0.3	PLANTATION & WOODLOTS	31508.9
			WATER (total)	-		WATER ARTIFICIAL	33513.0
(*Includes only man-made water*)						WATER SEWAGE	84.4
			ARTIFICIAL NON-VEGETATED	488261.6	4.6	EROSION FEATURES	98176.7
						DISTURBED / DEGRADED LAND	389618.5
						LAND-FILLS	268.7
						AGRICULTURAL FEEDLOTS	197.7
			CULTIVATED	2226979.3	20.9	ORCHARDS	3310.0
						COMMERCIAL DRYLAND ANNUAL CROPS	1863045.3
						COMMERCIAL IRRIGATED (NON-PIVOT) ANNUAL CROPS	47385.7
						COMMERCIAL IRRIGATED (PIVOT) ANNUAL CROPS	63684.3
						SUBSISTENCE DRYLAND ANNUAL CROPS	155638.4
						OLD FIELDS	67902.0
						SMALLHOLDINGS (PLOTS)	14852.6
						SMALLHOLDINGS (CULTIVATED	11161.0
			BUILT-UP	306281.8	2.9	URBAN / BUILT-UP	144975.1
						INDUSTRY / COMMERCE	6862.1
						SCATTERED RURAL DWELLINGS	55889.4
						ROADS & TRUCKS	99257.1
						ANIMAL FEEDLOTS	1198.8
						GREENHOUSES	99.3
			MINES	42196.6	0.4	EXTRACTION PITS & TAILINGS	37309.0
						SURFACE INFRASTRUCTURE & SUB-SURFACE MINES	4887.6
CLOUD OBSCURED	24519.8	0.2	CLOUD OBSCURED	24519.8	0.2	CLOUD OBSCURED	24519.8
Totals (check)	10653447.2	100.0		10653447.2	0.2		10653447.2

Table 3-4: North West Land Cover Data (NWDACE, 2008)

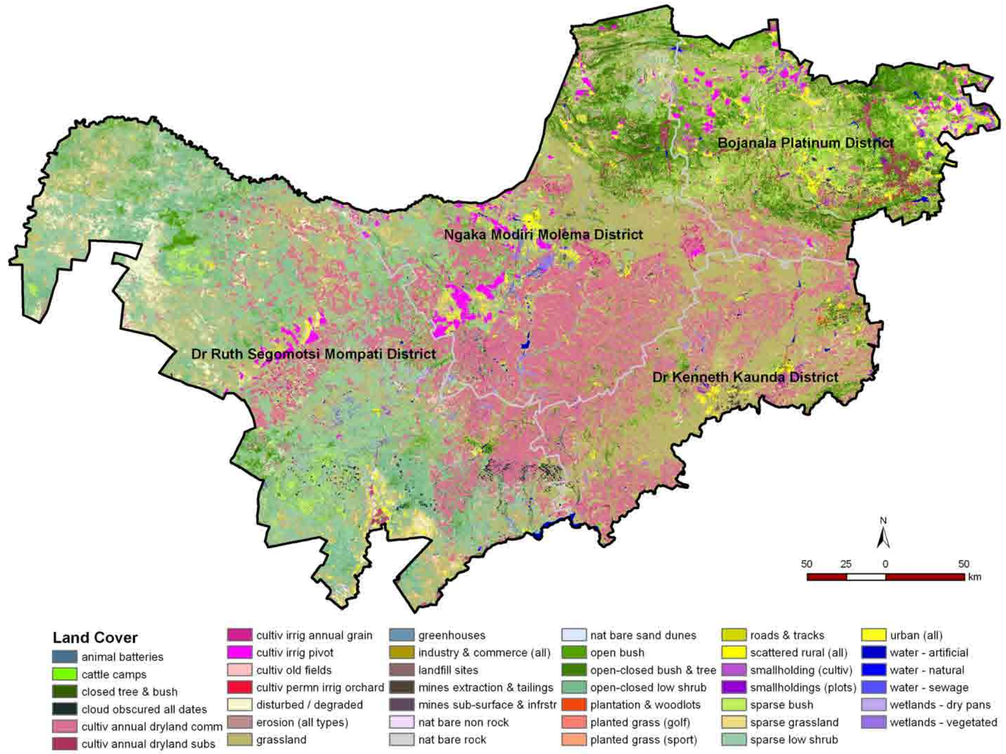

Figure 3-5: North West Province Land Cover Map (NWDACE, 2008)

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3.3.2.1. Agriculture

3.3.2.1.1. Agriculture in the North West Province

The average annual rainfall in the province varies between 700 mm in the east to less than 300 mm in the west, and dominates the agricultural activities practiced in the province. As expected, the vegetation type varies according to the provincial rainfall pattern. Four vegetation types are distinctive in the NW Province: the Kalahari Savanna, Grassland, Bushveld and Mountain Bushveld vegetation types (NWPG, 2007).

Soil potential is affected by numerous factors which include climate (rainfall, evaporation rates, frost), landscape morphology (hill slope gradients), soil depth and composition (relative percentages of clay, loam and sand). Soil potential is the overarching determinant of land arability and the type of crops that can be grown. The prime agricultural land areas for the province are illustrated in Figure 3-6.

The largest percentage of grazing land and cattle herds is concentrated in the western part of NW Province (Dr. Ruth Segomotsi Mompati District), particularly around Vryburg (refer to Figure 3-7) with noticeable bands in the Dr. Kenneth Kaunda, Ngaka Modiri Molema and Bojanala Platinum districts (eastern part of the province). The livestock industry is the major contributor to the agricultural sector in the NW Province with large cattle herds found at Stellaland near Vryburg, as well as in the Marico region.

An estimated area of 4,672,800 ha (equivalent to 43.9%) of the NW Province is categorised as 'arable' land (refer to Figure 3-7), producing approximately one-third of South Africa's maize. In addition sunflower, groundnuts, fruit, tobacco, cotton and wheat are cultivated. The Rustenburg and Brits areas comprise mixed-crop farming land, with crops including tobacco, citrus, paprika, wheat, peppers, cotton and sunflowers.

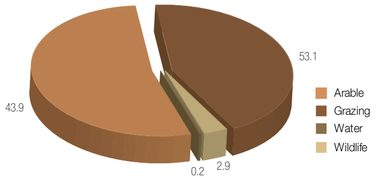

Figure 3-7: Soil potential per agricultural category (ARC – Institute for Soil, Climate and Water)

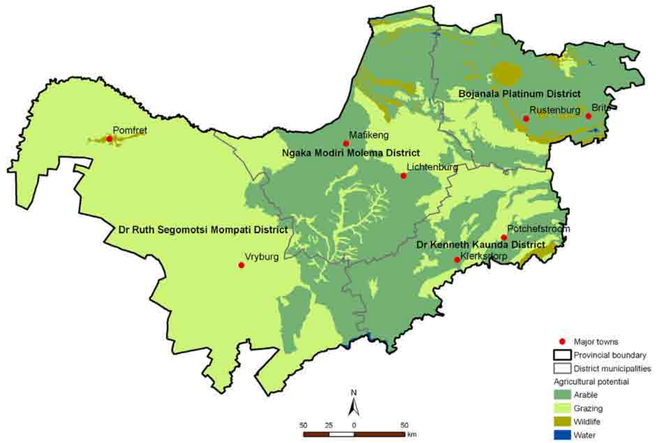

Figure 3-6: Agricultural potential for the NW Province (ARC – Institute for Soil, Climate and Water)

Livestock and crop farming are characteristic to the wetter eastern parts of the province, while the semi-arid central and western parts comprise of livestock and wildlife farming.

3.3.2.1.2. Provincial agricultural productivity

Some 5.6% of the South African Gross Domestic Product (GDP) in agriculture (refer to Table 3-5) and 16.96% of total labour in agriculture is based in the NW Province. The agricultural sector is the second-most important sector, next to that of mining, and contributes 13% to the provincial GDP, and jobs for 18% of the labour force in the province (Sharon Davis, 2007).

In total, the NW Province covers approximately 10.6 million ha, of which 8.8 million ha (81.1%) is agricultural land. Agricultural land can further be subdivided into 3.1 million ha (34.9%) of arable land, 4.6 million ha (56.3%) of veld and 700,791 ha (7.9%) of conservation land (LCSA, 2006).

Agriculture 2002		
Province	**R'000**	**% of GGP**
Western Cape	8,601,224	4.9
Eastern Cape	4,655,359	6.8
Northern Cape	2,547,116	13.9
Free State	4,483,148	9.1
KwaZulu-Natal	4,158,805	3.2
NW Province	3,701,317	5.6
Gauteng	1,993,735	0.5
Mpumalanga	4,902,814	6.1
Limpopo	2,630,237	5.9

Table 3-5: The relative importance of agriculture in the various provinces of South Africa (2002 gross value added) (www.dbsa.org/Research/Documents)

The NW Province has a dualistic agricultural economy, which is comprised of a well-developed commercial sector and a predominantly subsistence sector in communal areas (i.e. those who are on the fringes of the formal marketing channels).There are approximately 7,600 commercial farms. Approximately 147,000 small scale farmers practice in the area formerly known as Bophuthatswana. The objective of subsistence farming is to provide for the day-to-day household food demand, based on the diversified production of crops and livestock (Mangold *et al.*, 2002).

The present production levels in the communal areas of the province are estimated to be 16% of the average production potential, illustrating exceptional growth possibilities (LCSA, 2006). This percentage indicates that there is a relatively untapped resource base which could serve as a point of departure in growing and developing the agricultural sector in the province. However, rural farmers do not have ready access to formal markets for a variety of reasons, ranging from the cost of transport, poor road infrastructure and a lack of knowledge, often due to isolation or illiteracy. The ever increasing cost of fuel, and accompanying fertilizer, pesticides, herbicides and labour also discourage farmers. These high input costs combined with low productivity, sub-optimal business strategies, inefficiencies and unfair trade practices are enormous barriers to the viability of small-scale farming and are very difficult to overcome. A further barrier, which is likely to significantly affect the growth of the sector in the future is the availability of water (see Chapter 5).

Photos: NWDACE

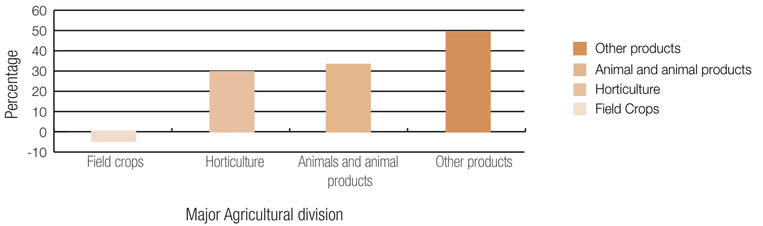

Figure 3-8: Trend in the gross farming income per major agricultural division (StatsSA, 2006)

3.3.2.1.3. Agricultural economics

Gross Farming income

The total gross farming income for the provincial large-scale farming sector increased by 8% over the period 2002 to 2005 (StatsSA, 2002 and 2006). A decline of 25% from the 2005 gross farming income was recorded for 2006 and can be ascribed to the remarkable decline in total large-scale farming units from 5,349 in 2002 to 716 during 2005. The NW Province accounted for a 10% share of the national gross farming income.

An analysis of the reported gross farming income per major division within the agricultural sector for the period 2002 to 2005 indicates the following trends (refer to Figure 3-8)

- Field crops: 1% decrease;
- Horticulture: 30% increase;
- Animals and animal products: 32% increase, and
- Other products: 50% increase.

Livestock production is practised throughout the province. Cattle, both beef and dairy, sheep, goats and pigs are the primary livestock enterprises with production through extensive systems as well as feedlots. Due to climatic constraints, the western regions are almost exclusively dependent on livestock production systems.

Figure 3-9 indicates that animals and livestock accounted for the largest contribution to farming income, estimated at R208 million. Field crop products were the second largest source of income in this sector with a reported contribution of R979 million (StatsSA, 2006).

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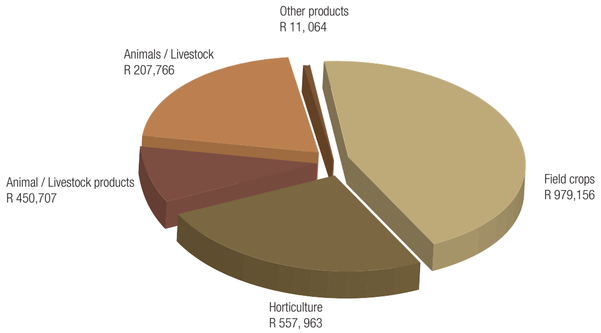


*Totals expressed as R 1000

Figure 3-9: Breakdown of gross farming income (excluding other income) by major division within agriculture in the NW Province (StatsSA, 2006)

A significant increase in livestock numbers was recorded for the province during the period 1999 to 2003 (Table 3-6), with the only exception being sheep and pigs. The 18% decrease in the provincial sheep stock is primarily as a result of livestock theft, which is a major concern in the province. Commercial and sub-commercial scale poultry farming is prevalent and increasing significantly, with the largest recorded number of farms in the Potchefstroom area. The poultry stock increased from 5.8 million to 16.6 million for the specified period.

The contribution by communal areas to the total cattle, sheep and goat stock in the NW Province was reported as 30%, 28% and 80%, respectively. The province also has a large equine population, with an estimated 15,000 horses and 27,000 donkeys. The latter are used primarily for ploughing in the sub-commercial sector (Mangold *et al.*, 2002).

Livestock	Number (thousands) 1999*	Number (thousands) 2003	% contribution by Communal areas
Cattle	1,475	1,816	(30.2)
Sheep	890	734	(28.5)
Pigs	572	172	(6.0)
Goats	113	771	(80)
Poultry	5,838	16,585	NA
Ostrich	NA	13	NA

Table 3-6: Estimated Livestock numbers in NW Province (DoA, 2003).

Despite the shrinking and comparatively small contribution to the GDP, the agriculture sector remains a significant source of employment in the province. The total employment in the large scale agriculture sector in 2002 was 26,438 which included permanent and seasonal/casual employees and proprietors (Table 3-7).

Large scale commercial farmers paid R342 million in salaries and wages in 2002. The poverty index percentages indicate that the people in the southern and western parts of the province are extremely vulnerable as there is a high degree of poverty (AGIS, 2007).

Within the agricultural sector a large disparity still exists between gender groups employed therein. Farm managers, foreman and full-time employees are still principally males, while women are ordinarily employed as casual and seasonal workers.

Employment category	Total number in NW Province
Proprietors	493
Full time employees	14,925
Seasonal/casual employees	11,020
Total employees	26,438
Salaries and wages (Rand)	342,811,390

Table 3-7: Total employment and employee remuneration within large scale agriculture in the NW Province (StatsSA, 2006)

Farming debt and losses

The ratio of farming debt to the market value of farming assets in the large-scale farming sector of the province is reported at 25% for the financial year ending 28 February 2006. This is below the average estimated percentage of 31% recorded for the country. The ratio of farming debt to gross farming income in the large-scale farming sector was 31%, well below the country's average of 39%.

A breakdown of the financial losses of farmers during 2002 is presented in Table 3-8. Farmers in the Ventersdorp area are plagued by both stock and crop theft. Burglary is strikingly high in the Wolmaranstad area, while the theft of tools and equipment is reportedly high in the Delareyville and Schweizer Reneke areas.

District	Total	Stock theft	Theft of tools and equipment	Burglary	Pilfering and stealing of crops
Brits	18,762	2,024	3,055	1,504	3,456
Christiana	1,760	455	208	82	338
Delareyville	14,469	1,335	7,628	368	645
Huhudi	442	0	0	0	41
Klerksdorp	7,095	1,939	923	548	874
Lichtenburg	27,458	3,039	3,380	1,785	2,487
Madikwe	7,516	761	280	312	200
Mmabatho	691	32	6	180	14
Phokwani	15	10	1	0	0
Potchefstroom	76,432	1,70	1,594	430	257
Rustenburg	31,525	2,902	1,868	1,572	649
Schweizer-Reneke	65,690	9,920	6,237	695	3,057
Ventersdorp	398,492	93,847	1,341	592	299,071
Vryburg	34,448	4,897	2,237	1,038	1,092
Wolmaransstad	14,771	2,633	1,681	3,497	853
North West	699,566	125,495	29,438	12,602	313,035

Table 3-8: Losses reported by large scale farmers during the financial year of 2002 (StatsSA, 2006)

Farming expenditure

Livestock

Total expenditure (excluding livestock purchases) by the large-scale agricultural sector amounted to R2.9 billion for the year ending 28 February 2006 (Table 3-9) with a reported capital expenditure estimated at R117 million (StatsSA, 2006).

Crop Production

Large-scale crop production enterprises under dry land conditions in the commercial sector principally include maize, grain sorghum, sunflower, groundnuts and dry beans. Irrigated crops include tobacco, paprika, citrus, wheat, pepper, cotton and sunflowers, cut flowers and vegetables, which are cultivated on a smaller scale.

The Crocodile and Vaal rivers are the main source for irrigation. Small irrigation schemes include Manyeding, Bodibe and Thlaping – Thlaro. Irrigation in the province is limited to areas adjoining river systems (Brits, Rustenburg, Taung and Molopo), however irrigation from groundwater sources is practiced in isolated areas (Ventersdorp, Ottosdal, Marico and Vryburg/Louwna) (Mangold *et al.*, 2002).

	Total (Rand)
Gross farming income	4,076,558,055
Current expenditure	2,969,252,474
Livestock purchases	852,747,472
Capital expenditure	117,072,458
Market values	5,026,069,275

Table 3-9: Gross farming income (excluding other income), expenditure (current and capital expenditure) and market value of assets within agriculture in the NW Province (StatsSA, 2002)

An important statistical indicator is the number of registered game farms. These farms are registered according to prescribed provincial legislation as captured in the three ordinances currently in use in the province. Statistics indicated that during 2007 a total number of 699 game farms were registered for the North West Province. Large numbers of game are annually moved between exempted game farms which include the import and export of game to other provinces and countries outside the borders of South Africa. Game capture operations and game auctions also play a vital role in the distribution and sale of game species within the province. Their main purposes is the sale of game to current and new exempted property owners as well as the removal of excess game for ecological purposes.

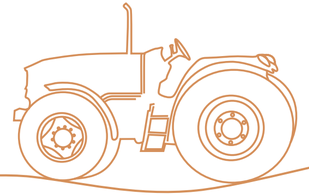
All though a large number of stock farmers converted their stock farming enterprises to game farming it must be stressed that a number of farmers continue to farm game and live stock on the same properties. Mixing stock and game is a good idea as long as it is managed and farmed in a responsible manner. Management and control of ticks is one of the benefits of this practice.

3.3.2.1.4. Game farming and hunting in the NW Province[4]

According to Bothma (2002) the game farming industry has clearly become a major economic force within South Africa. Game farms increased from a total of 3,357 in 1993 to over 9,000 farms in the year 2000, covering some 10,364,154 hectares (Bothma, 2001). The surface area of game farms on agricultural land within South Africa increased from 8.5% in 1993 to 13.3% in the year 2002. According to Eloff (2002) the wildlife industry grew at a mean rate of 5.6% per annum since 1995.

Local and especially overseas hunters are prepared to pay big money for trophy animals. This in return motivates the private sector to purchase wild animals and stock them on farms where they had become extinct long ago. In the year 2000, the income from live game sales was R180 million. The total annual turnover from the private game industry (live game sales, hunting, meat production and tourism) in 2000 was R843 million and increased to over a billion rand for 2001 (Bothma, 2002). Currently the value is over R2 billion per annum (Dr. Dry, personal communication).

4 Report compiled by Willem Boshoff: *"A comprehensive overview on the nature & atemt of game farming and hunting in the North West Province"* (NWDACE, 2007)



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The North West province is one of the few provinces in the country where roan and sable antelope are farmed semi intensively with great success. Farming of clean buffalo originating from ADDO and Eastern Africa is also farmed semi intensively and extensively with great success. Although the majority of species farmed within the province are indigenous a small number of exotic species occur on selected farms.

The following game farming figures (refer to Table 3-10) show continuous annual growth, which supports the growing economy in the province. Not encouraging is the limited number of black owned exempted game farms in the province.

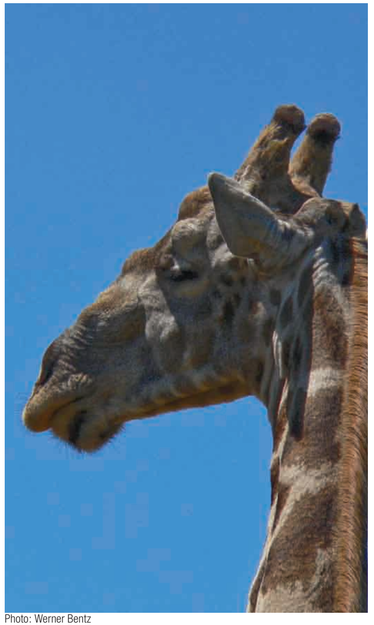


Photo: Werner Bentz

Detail	Bophirima	Bojanala	Southern	Central	Total (Province)	% Species of total	Value	Total value (Rand)
Sole	99	193	75	92	459			
Company	6	51	21	30	108			
Partnership	4	28	4	15	51			
Corporation	4	23	2	1	30			
Trust	8	31	11	1	51			
Exempted farms	121	326	113	139	699			
Exempted size (ha)	497,365	272,275	138,014	263,678	1,171,332		7125	R8,345,740,500
% ha of all farms	42.46	23.24	11.78	22.51				
Avg. size of game farms	4,110	835	1,221	1,897	2016			
% game species	16.41	39.83	14.45	29.28				
Permits issued	1,014	2,849	894	1,215	5,972			
CITES permits issued					873			
Game capture operations	1	3	1	1	6			
Game auction facilities	1	3	1	0	5			
No. of game auctions	0	5	3	0	8			
African buffalo	247	312	102	267	928	0.388	R178,803'	R165,929,184
African elephant	12	14	0	0	26	0.011	R90,000*	R2,340,000
Black rhino	3	21	0	0	24	0.010	R450,000*	R10,800,000
Black wildebeest	605	313	2,113	455	3,486	1.458	R2,500*	R8,715,000
Blesbok	4,725	7,454	6,331	7,929	26,439	11.057	R1,038'	R27,443,682
Blue duiker	0	2	0	0	2	0.001	R8,000'	R16,000
Blue wildebeest	2,129	7,480	1,898	5,448	16,955	7.091	R1,510'	R25,602,050
Bontebok	8	0	0	0	8	0.003	R8,000*	R64,000
Burchell zebra	904	4,617	1,134	2,335	8,990	3.760	R4,680'	R42,073,200
Bushbuck	0	1,528	106	805	2,439	1.020	R3,752'	R9,151,128
Common duiker	851	563	127	420	1,961	0.820	R1,500'	R2,941,500
Eland	2,840	3,157	1,745	2,395	10,137	4.240	R4,884'	R49,509,108
Gemsbok	5,414	1,699	2,086	3,113	12,312	5.149	R4,566'	R56,216,592
Giraffe	118	784	235	353	1,490	0.623	R14,415'	R21,478,350
Grey rhebok	0	387	111	361	859	0.359	R1,600*	R1,374,400
Hartman zebra	0	0	12	0	12	0.005	R25,000*	R300,000
Hippopotamus	9	50	7	4	70	0.029	R25,034'	R1,752,380
Impala	4,812	41,749	6,250	21,512	74,323	31.084	R667'	R49,573,441
Klipspringer	0	80	0	223	303	0.127	R5,500*	R1,666,500
Kudu	2,475	12,259	1,685	7,836	24,255	10.144	R2,031'	R49,261,905
Livingstone eland	0	0	14	102	116	0.049	R11,468'	R1,330,288
Mountain reedbuck	5	1,590	550	909	3,054	1.277	R1,833'	R5,597,982
Nyala	350	1,761	459	2,167	4,737	1.981	R4,748'	R22,491,276
Red hartebeest	3,095	3,343	2,177	4,599	13,214	5.526	R4,118'	R54,415,252

Table 3-10: Summary of game statistics in the NW Province for 2007

* Sourced from Game Farmers
' Sourced from SA Wild en Jag – Game Auction Statistics

Detail	Bophirima	Bojanala	Southern	Central	Total (Province)	% Species of total	Value	Total value (Rand)
Red lechwe	64	5	0	55	124	0.052	R8,500*	R1,054,000
Reedbuck	47	584	230	1,029	1,890	0.790	R2,000*	R3,780,000
Roan antelope	123	177	18	126	444	0.186	R106,300'	R47,197,200
Sable antelope	267	614	135	428	1,444	0.604	R99,161'	R143,188,484
Schmitar oryx	26	0	0	0	26	0.011	R15,000*	R390,000
Springbok	8,478	734	5,831	4,153	19,196	8.028	R1,025'	R19,675,900
Steenbok	853	381	166	473	1,873	0.783	R1,500'	R2,809,500
Tsessebe	43	189	44	338	614	0.257	R17,590'	R10,800,260
Waterbuck	670	3,239	947	2,120	6,976	2.918	R4,657'	R32,487,232
White rhino	92	160	58	69	379	0.159	R180,814'	R68,528,506
Totals	39265	95246	34571	70024	239106	100.000		R939,954,300
Property and game value								R9,285,694,800

Photo: NWDACE

From the table above it is clear that the majority (459) of exempted game farms are under sole ownership. The biggest number (326) of game farms occur in the Bojanala region with the Bophirima region covering the largest area (497,365 ha) of exempted game farms, as well as the largest average size (4,110 ha) of exempted game farms within the province. The biggest percentage (39.83%) of game on exempted game farms occur in the Bojanala region. The highest number of permits (2,849) are also issued in this region per annum.

The most popular game species present on game farms in the province include: Impala, Kudu, Gemsbok, Springbok, Blesbok, Red hartebeest and Blue wildebeest. The estimated value of exempted game farms in the province calculated at R7,125 per hectare accumulates to in excess of R8 billion. The estimated value of game species in the province on exempted game farms are R940 million. The combined figure for the province totals to an estimated R 9.3 billion.

Species generating the bulk of income in the NW Province

Since game ranching became fashionable in recent years, large amounts were invested in re-establishing animals in areas where they formally occurred (and also areas where they did not historically occur), the demand has become so fervent that animals are now even imported from Malawi, Zambia, West and Central Africa and are bred at great expense. It has almost become a status symbol to own game from the above-mentioned countries on ones property.

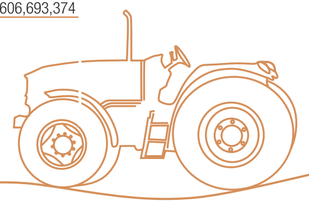
In the past, occurrence of populations of the indigenous roan antelope, sable antelope, buffalo, lions, leopard, cheetah, as well as black and white rhino have been limited mainly to governmental nature reserves in South Africa. The above mentioned species are also the most profitable wildlife production species (hunting and trade). The objective of government in breeding these endangered species was to establish free roaming breeding herds of the above-mentioned species on provincial nature reserves.

Thereafter, breeding herds were made available to the public. By doing this, government was ensuring that if anything impacts negatively on one population, there would be other viable populations left as founder populations for the future.

Because of the threatened status of roan and sable antelope, they have a very high commercial value and it was not long before the game industries' demand for roan antelope was higher than what could be supplied by government and the private sector (Bothma, 2002).

Species	Number	Average value/ animal	Total value
Sable antelope	1,444	R99,161	R143,188,484
Roan antelope	444	R106,300	R47,197,200
Buffalo	928	R178,803	R165,929,184
White rhino	379	R135,000	R68,528,506
Black rhino	24	R450,000	R10,800,000
Lion	1,700	R100,000	R170,000,000
Leopard	21	R50,000	R1,050,000
Total			R606,693,374

Table 3-11: General statistics on number and values of some species generating the bulk of income within the province for 2007



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Hunting in the NW Province

The specific industry benefits South Africa financially (during 2006 approximately R1 billion, the equivalent of USD146 million, was injected into the economy). South Africa is arguably the most sought after destination for travelling trophy hunters. Over 60 species are available for hunting in South Africa. This certainly is the highest number worldwide and coupled with the fact that all of the Big Five (even the classic Big Five, with the recent inclusion of the Black Rhinoceros) can be hunted, it makes South Africa the top hunting destination in Africa. Some of South Africa's better managed game ranching industries in the provinces benefit from this and also provide many local business opportunities, generate satellite markets and marketing possibilities:

The NW Province is well renowned as one of the preferred hunting destinations in South Africa. The professional hunting industry generates in the region of between USD8 million to USD10 million annually based on international exchange rates. This form of hunting mainly takes place on exempted game farms. It is estimated that 4,325 animals are hunted per overseas client, with each hunter spending in the region of between R70,000 to R100,000 per visit. Lion hunting is the biggest contributor to the above-mentioned figures.

	2004	2005	2006	Total
Registered professional hunters	258	254	246	
Registered hunting outfitters	107	115	113	
Clients	815	873	794	2482
Total animals hunted	4,339	4,126	3,428	
Animal per client	5,32	4,73	4,32	
Clients per PH	5,82	5,20	6,46	
Clients per HO	11,01	10,39	18,47	
Total hunting days	5,257	5,235	6,114	
Average length of hunt	6,45	6,00	7,70	
Daily rates (USD)	1,839,950	1,989,300	2,751,300	6,580,550
Species hunted (USD)	6,007,846	9,241,904	8,936,001	24,185,751
Springbok	402	397	347	1,146
Impala	402	389	321	1,112
Blesbok	353	348	297	998
Lion	134	260	272	666
Kudu	286	291	239	816
Blue wildebeest	268	295	205	768
Warthog	217	215	192	624
Black wildebeest	163	219	185	567
Red hartebeest	199	223	153	575
Burchell zebra	175	224	163	562
Eland	146	171	104	421
Waterbuck	103	128	103	334
White rhino	21	29	38	88

Table 3-12: Professional hunting statistics for the NW Province

Currently there are approximately 130 registered professional hunting outfitters and an estimated 305 registered professional hunters in the NW Province.

The biltong hunting industry mainly involves local South African hunters. This is also a very big industry generating enormous income and work. This industry targets exempted game farms and tribal areas. In the year 2007 the following numbers of hunting permits were issued for selective game species on tribal areas within the North West Province.

Hunting takes place on exempted game farms throughout the year and seasonally (May to July) on open private land and state land which includes communal land. It must be mentioned that a number of bird species are also hunted annually also regulated through permits and seasons that are gazetted annually. The industry is regulated through permits issued in terms of nature conservation ordinances.

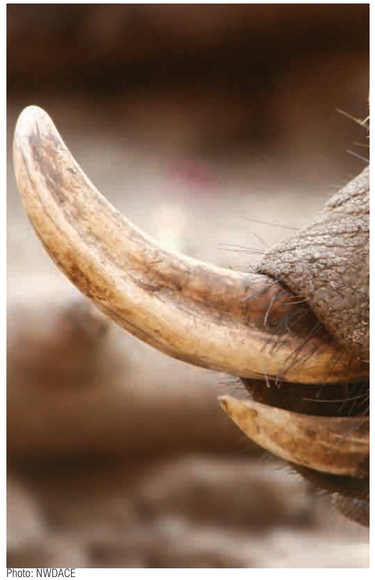

Photo: NWDACE

Communal quotas	2004	2005	2006	2007	Total
Impala	1072	963	963	963	3961
Kudu	218	161	161	161	701
Springbok	70	85	85	85	325
Red hartebeest	25	25	25	25	100
Duiker	20	20	20	20	80
Steenbok	20	20	20	20	80
Permit fees (Rand)	R42, 250	R37,645	R37,645	R37,645	R155,185

Table 3-13: Summary of annual hunting quotas on tribal and state land within the NW Province for the period 2004 to 2008

3.3.2.1.5. Emerging Issue – Bio-fuels

The Accelerated and Shared Growth Initiative for South Africa (ASGISA) identifies particular industries of the economy that should be targeted for accelerated growth. Among these high priority industries are agriculture, agro-processing and bio-fuels. It is further indicated in ASGISA that in order to promote private sector investment, sectoral strategies for high priority industries necessitate further development.

The DME and the NW Province have begun a process of developing a bio-fuels initiative. The project is estimated to create more than 800 jobs during a period of three years and 2,000 fulltime jobs over three phases. The implementation of the bio-fuels strategy carries enormous financial implications for both the sector and the NW Province. The strategy is intended to prioritize cultivation of marginal and disused crop areas, particularly in the former homeland areas. These areas will therefore require a great deal of support in mechanization and production inputs to meet the required targets.

The NW Provincial Government (Invest North West, the Investment Promotion Agency for the North West Provincial Government) in partnership with the Barolong Bo-Rratshidi Development Company, Mafikeng Bio-Technologies, Clean Air Nurseries and the Mafikeng Industrial Development Zone company, launched the Mafikeng Biodiesel pilot project in May 2006 as an initiative aligned with the ASGISA objectives for economic growth in the agricultural sector. The aim of the pilot project is to develop into a full-scale, R850-million initiative, employing 10,000 people to commercially cultivate oilseed trees for the production of biofuel (Engineering News, 2007).

The North West Provincial Government has to date injected R10 million into the initiative for the construction of the tree nursery at the Setumo Dam outside Mafikeng. Current operations at the nursery employ 21 people, the majority of whom are part of learnerships.

The pilot project is currently in an experimental phase, entailing the cultivation of the *Jatropha curcas* and *Moringa oleifera* oilseed species for the harvesting of the oilseeds for laboratory testing to determine the viability of these oils for the production of biofuel. Bio-diesel production is not expected before 2010.

Photo: NWDACE

3.3.2.2. Mining in NW Province

3.3.2.2.1 Important commodities

Platinum

Platinum has overtaken gold as the most important mining product in the province (Mangold et al., 2002). Platinum group metal mines have increased (both in extent and figures) over the last 20 years, resulting in the amplification of production volumes from 1,523 tons in 1992 to 2,217 tons in 1999. Sales of PGM products locally soared to a record R2.5 billion in 2000. Increased local and international demands by mainly the automotive and jewellery manufacturing industries have resulted in increased production of platinum by major South African mininghouses.[5]

Anglo Platinum, the world's largest platinum and palladium producer, operates 4 platinum mining operations in the BIC, under its subsidiary company, Rustenburg Platinum Mines Limited (RPM). The four operational RPM platinum mines located in the Rustenburg area include the RPM Bafokeng–Rasimone, RPM Union, RPM Amandelbult and RPM Rustenburg mines. The two largest platinum mines in the world and the world's largest platinum refinery, Precious Metal Refiners (PMR), wholly owned by the Anglo American Platinum Corporation Limited, or otherwise known as Anglo Platinum, is situated near Rustenburg. These mines process approximately 70% of the world's platinum.

Impala Platinum, generally known as Implats is South Africa's second largest platinum producer. Implats produced an estimated 1 million ounces (oz) of PGM during 2003, including 493,000 oz palladium and 131,000 oz rhodium. A record total production of 2 million ounces of platinum was recorded by the mining house in the preceding 12 months to end June 2007. Implats, in addition to its wholly-owned operations, has a 27% share in LonMin, South Africa's other major producer, as well as business interests in Aquarius Platinum which operates the Kroondal mine near Rustenburg.

5 Refer to Chapter 2 for further discussion on the mining sector in the NW Province economy.

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Box 3-6: Platinum mining

The mining of platinum ore is similar to gold mining in as much as the ore body is a thin, tabular reef covering an extensive area. This enables a progressive method of mining: the drilling and blasting to advance the face of the reef, whereafter support for the local control of hanging walls is installed. As in the gold mining industry, platinum mining is following on with the incorporation and use of mechanisation and trackless-mining methods in stopes little more than one metre high.

Platinum mining, however, differs from gold mining in several ways. Unlike gold reefs, which are sedimentary deposits resulting from the settling of granular particles on the bed of an inland lake and subjected to great pressure, platinum reefs are igneous rocks. They were intruded into the Bushveld area as molten volcanic magmata rising from below the earth's crust, later cooling and solidifying. This phenomenon created a strata control environment differing markedly from that of gold mines. As a result, there are far more dykes and faults occurring in the platinum area compared to where gold is mined. A further geological feature also affects platinum mining: the occurrence of parboils in the plane of the reef. Varying in diameter from some 30 to 500 metres, and causing rapid sinking or rising of the reef, these potholes disrupt stoning operations, often requiring the re-establishment of stone faces.

Photo: Anuschka Barac

Chrome

Chrome mines are geographically located in the same region as platinum mines, enhancing the positive economic effects of the platinum mines and the associated mineral processing facilities and infrastructural developments associated with mining development (Mangold *et al.,* 2002).

Chromite is mined primarily from the Upper Group 2 Reef (UG2), and Lower (LG) and Middle Group (MG) chromitite seams. There are several primary chrome mines, specifically maintained to provide chromite to feed to the developing ferrochrome industry. Most of South Africa's chrome mines are developed along the Eastern BIC, in the Steelpoort Valley. Rich chrome deposits can also be found near Nietverdiend and the areas surrounding Brits.

South Africa is the world's largest producer of ferrochrome. Approximately 70% of the world's total chrome reserves occur in South Africa (mostly in the BIC) producing 75% of the world's ferrochrome (Mbendi, 2007). South Africa produced an estimated 7.4 million tonnes of chromium ore in 2003.

Samancor, the world's largest integrated ferrochrome producer, currently operates two chrome mines, producing 1.1 Mt of ferrochrome annually. Samancor operates the Eastern Chrome Mines as well as the Western Chrome Mines. The Western Chrome Mines are located between Rustenburg and Brits on the western limb of the BIC in the NW Province. Western Chrome mines comprise of five mining operations, the Waterkloof, Buffelsfontein, Elandsfontein, Millsell and Mooinooi mines. The total combined ore reserves exceed 450 Mt, calculated to a depth of 300 meters, with an annual production capacity of more than 4 Mt. In addition to the ferrochrome operations Samancor also owns several manganese operations in South Africa.

South African smelting technology and equipment specialists Pyromet, announced in November 2007 the construction of the long-awaited R1.1 billion Transvaal Ferrochrome project near Brits (Mining Weekly, 2006).

Kimberlite & alluvial diamonds

Diamond mining, mainly of open-cast alluvial diggings, primarily occurs in the lower reaches of the Vaal River catchments (Mangold *et al.,* 2002). Diamonds are mined at Lichtenburg, Ventersdorp, Koster, Christiana, Schweizer Reneke and Bloemhof. Diamonds of a better quality occur within the alluvial gravels, extending from the Lichtenburg to Barkley West districts along the Orange and Vaal Rivers. Currently the area north of Lichtenburg is popular for alluvial diamond exploration.

The Helam Diamond mine, located in the Swartruggens area, is a very rich source of diamonds within the NW Province. The mine has been in continuous production for over 60 years, and consistently produced more than 80,000 carats annually over the past 3 years (Investegate, 2005).

Australian Synergy Metals has commenced the exploration of an alluvial resource containing over 18 Mt of gravel near Bloemhof - the resource is outlined for two deposits, the Kareefontein and Gansvley.

Etruscan Diamonds (a joint venture between Etruscan Resources Inc. and the Mountain Lake Resources diamond mining company) completed mining feasibility studies for the potential mining of several alluvial deposits in the Ventersdorp region. The Tirisano Diamond property alluvial deposit, which formed part of the feasibility study is estimated to contain a 8.2 million m^3 alluvial reserve averaging 2.9 carats per 100 m^3. Following the completion of the feasibility study, the joint venture successfully completed the mining development with production starting in late 2002. An annual production of 19,000 carats is envisaged at full processing capacity (Mbendi, 2007).

Monroe Minerals has identified a diamondiferous gravel resource at its London prospect located near Schweizer Reneke. Initial feasibility studies estimate an annual production of approximately 8,000 carats per year at an average sales price of USD450 per carat (Mbendi, 2007).

Gold

The most occurrences of gold deposits in South Africa are found within conglomerates of the Witwatersrand and the Ventersdorp Supergroups. The majority of current gold mines are operational in these Supergroup areas. Approximately 92% of the gold produced in 2004 was from mining operations exploiting the Witwatersrand Basin (DME, 2006b). Some of the richest mines in South Africa are found in the Klerksdorp, Orkney and Hartebeesfontein regions (Mangold *et al.,* 2002). Small gold deposits are also found in the Klerskraal region.

Fluorspar

Rich deposits of fluorspar can be found at Witkop mine, south of Zeerust in the Marico district (Mining Weekly, 2007). The Witkop fluorspar mineral deposit lies within the Marico Fluorspar Field, an area of expansive outcropping and sub cropping of low- to medium-grade fluorspar in dolomite. The majority of mineralised fluorspar occurs as discontinuous zones in the Frisco Formation of the Malmani Subgroup of the Transvaal Sequence. The predominant host rock of the fluorspar ore is described as a grey, medium-grained, sparry dolomite (Mining Weekly, 2007).

Granite

The Bafokeng-Rustenburg granite mining area has been defined as the cluster of quarries in an area that stretches from 6 km north-east of Rustenburg over a distance of 54 km with a varying band width ranging from 4 to 9 km and a calculated area of approximately 390 km^2. The area traverses the municipalities of Madibeng and Rustenburg, both in the Bojanala Platinum District Municipality of the NW Province. There are currently 30 active and 46 defunct (dormant) quarries in this area. The main type of granite mined in the area is the Rustenburg Grey, quarried from the Main Zone of the BIC. An estimate of the total mineable granite reserves in the area, calculated by Granville, is estimated to be 1,493 Mt, of which 224 Mt are saleable (Mintek, 2006). During 2003, 1,800 people were employed in the granite quarries of the Bafokeng Rustenburg area with a total remuneration of R57 million.

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3.3.2.2. Contribution of mining to North West Province GDP

An analysis of the provincial GDP data (refer to Figure 3-10) indicates an upward trend in the percentage contribution of the mining sector to the provincial GDP between 1997 and 2000, with a 9% increase recorded for this period. The highest contribution of the mining sector to the provincial GDP was recorded during 2001 (28%). The period 2001 to 2004 was characterised by a downward trend, with a lowest recording of 24% (2004) before marginally increasing to 25% in 2005 (StatsSA, 2007).

South Africa's rich mineral resource diversity enables companies to explore various accessible mineral investment opportunities. The country is recognized as a world leader and supplier of a variety of mineral resources and products of consistent high quality. This is evident from the foreign and local companies' significant contribution to both mining exploration and development projects (DME, 2006a). In 2005, 59 different minerals were produced from 993 mines and quarries countrywide.

The NW Province, and the Limpopo and Gauteng Provinces accounted for 72% of reported total newly committed mineral related projects, of which over 71% of mineral investment projects in the NW Province are platinum related (DME, 2006a) (Figure 3-11).

Photo: Anuschka Barac

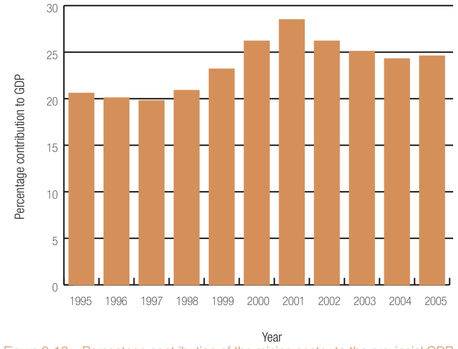


Figure 3-10: Percentage contribution of the mining sector to the provincial GDP (1995- 2005) (StatsSA, 2007)

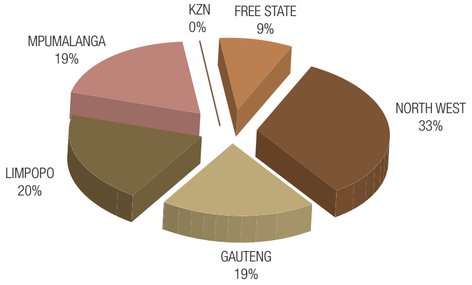


Figure 3-11: Proportion of new projects by province

3.3.2.3. New investments

For the purposes of this report, newly committed mineral related projects refer to mineral or mining projects to which funds have already been committed and are being utilised in the advancement of these projects. Potential mineral related projects refer to projects to which development funds have not yet been allocated however feasibility studies have been completed in order to estimate the funds required for development of these projects. The figures supplied refer to the state of new investments in August 2006 (DME, 2006a).

Gold

South Africa's gold producers committed to a total of 6 gold mining related projects in the NW Province during 2006. The total cost of the projects were estimated at R6.4 billion (Table 3-14) – costs for only 4 projects were available and used for estimation purposes. Anglogold Ashanti's investment of R4.2 billion in the Moab Khotsong North West mine in the NW Province is the single largest investment of gold in South Africa (DME, 2006a), with an estimated 2012 completion date.

Photo: Anuschka Barac

Platinum

South African platinum producers committed to 34 PGM related projects in the NW Province during 2006. Financial costs for only 19 of the 34 listed projects are available. The total cost of the 19 PGM projects are estimated at R22.5 billion. The single largest platinum mining investment in South Africa, worth R4.5 billion, is from the Impala Platinum Shaft 16 followed by the Anglo Platinum investment of R2.4 billion. Both mines are located within the NW Province (DME, 2006a).

Processed Minerals

The investment in newly committed mineral processing projects in the NW Province for 2006 is estimated at R1.7 billion (DME, 2006a) (Table 3-15).

Potential new projects

Approximately R7.6 billion worth of projects were earmarked for "potential gold related projects" in the province. However only 7 of the 11 identified projects had costs assigned to them (DME, 2006a).

R9.3 billion was earmarked for platinum projects. Approximately 14 projects were recorded, of which the cost of 7 projects are available (DME, 2006a).

Completed projects

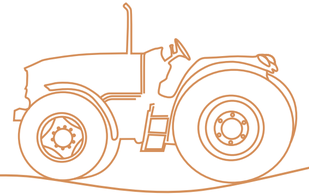
Records show that 3 gold-related projects were completed between 2002 and 2005, with a minimum value of R119 million (DME, 2006a). Between 2002 and 2005, 24 PGM projects in the NW Province worth R6.7 billion were completed. Other mineral projects estimated at R1.5 billion were completed between 2002 and 2005. These estimates are based on available data for 13 from a total of 15 projects (DME, 2006b).

Holding Company Mine/Project Province	Project cost R'million	Completion Date
AfriOre/African Pioneer Mining Dwaalboom North West Exploration program	unknown	unknown
AngloGold Ashanti Moab Khotsong North West New mine	4,185	2012
AngloGold Ashanti Mponeng North West Shaft Deepening Project	1,334	2010
AngloGold Ashanti Vaal River Ops. North West Mizpah Low Grade Plant	unknown	2007
Harmony Elandskraal North West Elandsrand shaft deepening	798	2010
Harmony Orkney North West Re-opening 6 & 7 shafts	90	unknown
Total	6,407	

Table 3-14: Gold mining – newly committed projects – NW Province (DME, 2006a)

Holding Company Mine/Project Province	Project cost R'million	Completion Date
Anglo Platinum Rustenburg Section North West Waterval Concentrator retrofit	700	2007
Anglo Platinum Rustenburg Section North West Sulphuric acid plant	unknown	2006
Implats Impala Platinum North West Smelter expansion	900	unknown
Lonmin Platinum Smelter & refineries Gauteng & North West Metallurgical capacity expansion: Feasibility study	60	2007
TOTAL	1,660	

Table 3-15: Processed minerals – newly committed projects – NW Province (DME, 2006a)



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3.4. Conclusion

Agriculture is of the utmost importance to the NW Province, since it is the second-most important sector after mining. Commercial farming has contributed significantly to the country's economic growth. Agriculture shows the best employment ratio of 19 for every R1 million Gross Value Added in the province. The aim of the North West Provincial Government for the agricultural sector should be directed towards providing agricultural support services to farmers in order to ensure sustainable management of agricultural resources and sustainable agricultural development.

Despite the presence of vast undeveloped, 'high' agricultural potential land within the province, existing unsustainable agricultural practices and resource management significantly affect both natural ecological and agricultural resources pertinent to the province. Bush encroachment and aggressive invasion of alien species in certain areas of the province are considered to be distinctive threats to the agricultural productivity of communal and commercial farming land. These forms of land degradation should be prioritised and addressed by means of a concerted strategic effort between landowners and the North West Provincial Government.

The development of a local bio-fuels industry within the agricultural sector of the province forms part of the overarching objective of ASGISA to increase the average economic growth rate of South Africa to 6% between 2010 and 2014. The government envisages that the development of a bio-fuels industry will contribute to job creation and the emergence of small-scale farmers, as well as to a reduction of greenhouse gas emissions, diversification of fuel supplies, and a reduction of South Africa's crude oil import expenditure. The 2007 State of the Nation Address alluded to the fact that the NW Provincial Government will be required to intensify the implementation of investments in bio-fuels business opportunities. A sustainable supply of bio-fuels requires low input cost, high yield and surplus agriculture production, the latter which means that the support for the establishment of this industry will come from targeting existing agriculture support programmes. However, while bio-fuels create alternative markets for farmers and jobs in rural areas, without proper policies to regulate their production, they could at the same time threaten foods supplies and potentially intensify food insecurity.

There is a growing need to exchange knowledge and experience at various levels. A mentorship programme can accomplish this goal. The identification of suitable markets and access to those markets can only be achieved through the initiation of adequate support services (DoA, 2003).

On a provincial scale, granite production represents 70% of all granite quarried in South Africa. Mining and quarrying contributes 23% of the NW Province's GDP. The quarrying scenario is the same as on the national scale, where mining yields are low, waste generation is excessive, the environmental impact is significant and beneficiation is negligible. This leads to the conclusion that given the current situation, where immaterial quantities of raw materials are beneficiated locally, the granite industry in the NW Province is not economically viable on the basis that the potential rehabilitation costs associated with granite mining activities outweigh the financial benefit of the exports derived therefrom. It is a concern that the international market receives 90% of South Africa's raw blocks of granite, while the South African market exploits the rest and people are excluded in the benefits reaped from this industry. Downstream beneficiation could increase the value of the granite produced, however currently this is not considered. In order to ensure the long-term viability of the granite industry in the Bafokeng-Rustenburg area, the problem factors require resolution. Such factors include the environmental impact, the industry ownership, downstream beneficiation and local distribution of raw blocks. To resolve the environmental issues associated with this industry, a strategy must be developed to enforce rehabilitation of abandoned quarries. Furthermore, companies applying for mining rights should submit a rehabilitation plan for approval by the relevant competent authorities prior to the commencement of quarrying activities. A strategy should be developed, to ensure that granite mining is not decommissioned without undergoing due process as prescribed by legislation, which includes prescribed closure procedures.

Mining companies have an obligation towards Black Economic Empowerment (BEE) as outlined in the Mining Charter. It is essential to create a strategy to enforce BEE in the granite industry. It will be beneficial for the development and implementation of a marketing strategy, including a campaign in order to inform and attract emerging small and medium scale mining companies.

Vast quantities of processed mineral products are being exported to international markets. Consideration should be given to increasing the local distribution of such products in order to further stimulate local economic growth. This can be achieved by developing a marketing strategy to attract local consumers.

Uranium is expected to play a very important role in future energy provision.

Photo: NWDACE

Photo: Lauret Muller

Photo: NWDACE

With the gold and platinum prices buoyant at all time highs above USD900 and USD1,500, respectively and the weaker Rand, the mines are looking forward to a good economic future. However mining activities and the rehabilitation of old mining areas (especially informal diamond prospecting in ancient river beds) need to be controlled.

3.5. Reponses

3.5.1. Agriculture

3.5.1.1. Current

The NWDACE is charged with the responsibility to harness the vast potential for sustainable agricultural growth and development within the province. The combined challenges of poverty, unemployment, meeting the basic needs of the people, transforming society and HIV/AIDS have created increased demand on the Department to sharpen its policy directives, strategic focus and to deliver results.

To date, there are three major agriculturally-focused, project-based interventions that have been implemented by government to promote poverty eradication through sustainable development. They are the Working for Water Programme (WfWP) initiated by the Department of Water Affairs and Forestry (DWAF) and the LandCare (LCP) and Comprehensive Agricultural Support Programme (CASP) by the Department of Agriculture (WGRD,1993). The purpose of the WfWP is the eradication of alien invasive plant species responsible for the depletion of surface and ground water, damaging of biodiversity, and its contribution to the danger of runaway fires. Approximately R824 million was spent on this programme between 1999 and 2000. The LandCare Programme was allocated R25 million following the Presidential Job Summit of 1998. During the 2005/2006 financial year, the NW Province received R5 million for Land Care and R33 million for CASP (WGRD, 1993).

The Agricultural Extension Services department, which is responsible for implementing the above Programmes, has made significant progress towards its goals and objectives, and is discussed in more detail hereafter.

It must be borne in mind that although these initiatives have spurred job creation, the developmental significance of the combined Working for Water and LCPs may not only be in terms of direct employment or the secondary industries that emerge, but also in preventing further encroachment of alien vegetation and soil degradation.

3.5.1.1.1. Land reform

The total land reform targets for both restitution and redistribution stands at 294,000 ha as at March 2007. From 1994 to 2007, the NW Provincial Government has transferred 216,000 ha of land under various land reform services (i.e. housing, tenure upgrades and farm settlement (www.polity.org.za, 2008). The land reform process has benefited over 10,000 households.

The total number of land claims in the province currently stands at 1,715, of which a total of 1,301 claims have been settled. To date, 146 claims have been dismissed and 268 remain unresolved. A total of 79,271 ha have been transferred (restituted) to land claimants.

The current distribution of land in South Africa is racially highly skewed with whites owning 87% and blacks 13%. Over the last twelve years, i.e. since the implementation of the new dispensation, the rate of transfer of land has been slow, the general quality and sustainability of land reform projects questionable and the provision of settlement support to land reform beneficiaries not aligned to the planning and implementation of land acquisition and transfer of land. It is therefore a provincial imperative that the pace of land reform be accelerated and the sustainability of emerging farming enterprises dramatically improved.

The North West Province Integrated Land and Agrarian Reform Process (NWILARP) provides an innovative framework for delivery and collaboration on land reform and agricultural support to accelerate the rate and sustainability of transformation through aligned and joint action between the NWDACE, Provincial Land Reform Office (PLRO), the Land Commission and other involved stakeholders. NWILARP further intends to support initiatives that will have the maximum impact on the eradication of poverty, job creation, and economic growth in the following three years, with specific focus on vulnerable groups, such as women and youth. The importance of cooperative governance, integration and coordination between the NWDACE, PLRO, Land Commission, Municipalities, agricultural state-owned enterprises (SOEs) and sector partners is highly emphasized in the roll out of the NWILARP.

One of the critical core features of the NWILARP is the added pro-active and integrated approach during implementation to fast-track land and agrarian reform. Focus areas have been defined for the NW Province, based on existing surveys and studies on opportunities, agricultural comparative

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advantages, and the needs of the target populations to be served. These focus areas include:

- Livestock production and beneficiation;
- Dry land field crop production;
- Irrigation field crop production;
- Vegetable production;
- Dairy production, and
- Aquaculture/Fish farming.

Each project within the NWILARP framework will be coherently planned and supported for a five year incubation period, with the objective of achieving sustainability over this period. This support will be articulated in individual business plans which will be utilised for monitoring progress.

The annual provisional land acquisition targets for NWILARP over the next two years is 142,107 ha during 2008/09 and 284,214 ha for 2009/10 respectively. The total extent of land to be transferred by 2010 is estimated at 426,321 ha. The province envisages placing on average 500 farmers per year possessing an average 500ha each for livestock production, 150 ha each for dry land crop production and 30 ha each for crop production under irrigation.

3.5.1.1.2. Anti stock theft programme

This programme was conceptualized after rising levels of livestock theft were recorded in the province. Since its inception, stock theft levels have decreased to very low levels per annum, compared to 4% in 2003 (www.polity.org.za, 2008).

3.5.1.1.3. Modimong (Poverty Relief)

This project is part of the Western Frontier Corridor. Its focus is to alleviate poverty through food security and nutrition in Modimong village and Taung in the Dr. Ruth Segomotsi Mompati District. The project has created 253 jobs and additionally benefits 10 of the 100 targeted households with vegetable gardens and 20 chickens each family. All but ninety families were however supplied with twenty chickens each. The remaining families will be accommodated in the next financial year. An amount of R484,905 has been spent on this project to date.

3.5.1.1.4. Modimola (Poverty relief)

This project is part of the Mafikeng Integrated Development Programme. Its focus is to alleviate poverty through food security and nutrition in Modimola village, Mafikeng in the Ngaka Modiri Molema District. 529 jobs have been created through the agricultural activities in Modimola. 9 people are employed on a permanent basis. This 15ha project assists in the cultivation of carrots, pumpkin, beetroot, jam squash, peanuts, cabbage, tomatoes and potatoes. 30 families currently benefit from the project. It further has a fowl run and 1.000 egg layer unit. An amount of R6m has been spent on this project to date.

3.5.1.1.5. LandCare Programme (LCP)

As mentioned above, one of the most significant programmes of the Department is the LCP. The Land Care objective is to optimise resource productivity and sustainability in order to ensure increased productivity, food security, job creation and quality of life. In other words, the NW Province LCP aims to mobilise the public at large to take up its responsibility of a “duty of care”.

The specific objectives of the North West LCP are:

- To improve veld management through implementation of different veld management systems;
- To improve production and composition of veld through improved bush control practices;
- To improve veld production and composition through limiting stocking density;
- To establish an effective LCP through which the resource owners and users will take responsibility for maintenance, correct management, improvement and sustainable utilisation of the natural resources, and
- To monitor and evaluate the impact of the programme on resources, on society and on the economy.

This programme rehabilitates land for optimal utilisation by owners and beneficiaries. 485 people have been employed in these projects to support their livelihoods. Training has already commenced and the projects will commence soon. An amount of R2.8 billion has been spent on land care since April 2006.

3.5.1.2 Proposed

- A Provincial Land Degradation Monitoring Programme must be developed to include the establishment of monitoring committees at a district level. This will enable the ongoing monitoring of soil and veld degradation to ensure that short-term remedial measures can be identified and implemented, and
- A State Grant Initiative must be developed to facilitate agri-business development in the province. The purpose of this initiative is to ensure beneficiation of small- and medium-scale communal farmers and to optimise, through stimulating economic growth, the contribution of the agricultural sector to the provincial GDP. As part of this process, a project must be initiated for the implementation of an Agricultural Resources Management Training programme, intended for subsistence farmers in the both communal and commercial farming areas of the province that will ensure sustainable agricultural land use practices.

3.5.2. Mining

3.5.2.1 Current

3.5.2.1.1. Mining Supplier Park

This project is an initiative coordinated by Invest North West to establish an agreement between active mining houses in the province to manage and support Small, Micro and. Medium Enterprises (SMME) suppliers to the mining industry. The implementation phase of the project is pending. An agreement by mining houses will be signed in the current year (2008) to seal the provincial partnership on development (www.polity.org.za, 2008). A total of R10 million has been allocated to this project for the coming financial year.

3.5.2.1.2. Platinum beneficiation projects

Platinum beneficiation projects are currently being implemented through the establishment of a trust and a company registered to beneficiate platinum into jewellery products. A business park where offices and jewellery centres will be built and further agreements between the province and Canada will also be finalized to complete a Platinum Theme Park. The Business Incubation Centre, which is located at Orbit College near Rustenburg, is already operational.

3.5.2.1.3. Granite beneficiation project

The options to increase local beneficiation are limited, but South Africa has vast amounts of granite waste material that could be used in small-scale beneficiation. Further beneficiation of raw blocks could be carried out by means of cobbling, production of colour reconstituted products and by secondary and tertiary cutting of raw blocks.

Average raw block prices amount to typically R600 to R3,500/tonne, while slabs with only one side polished cost R2,000 to R8,000/tonne. Average countertop prices range from R2,000 to R25,000/tonne, while tiles generally cost R6,000 to R30,000/ton. The value increase that is coincident with the increase in the level of beneficiation is vast and it is only logical to consider downstream beneficiation in the future of this industry.

A granite beneficiation project is located in Bethanie, approximately 13 km south of Brits. Investment of R40 million is available for the Medium Term Expenditure Framework period. Foreign investment is available from a Belgian investor pending the availability of raw materials (www.polity.org.za, 2008).

3.5.2.2. Proposed

The extent of current soil degradation caused by mining activities must be determined, and areas suitable for remediation must be identified and prioritised. This initiative must be a collaborative effort by the DME, NWDACE and the mining houses.

3.5.3. Land use mangement

3.5.3.1. Current

The DDLGH, with the support of the SESDNW project, is currently in the process of developing a provincial Land Use Management Bill. The draft document has been completed and will be submitted to the provincial legislature for gazetting after which public review of the said document will commence. The objective of the Bill is to promote the use of land that are socially and economically beneficial, ecologically sustainable and which assists in the conservation of the environment and cultural heritage of the North West Province by:

- Establishing integrated and efficient planning and decision-making systems for land use management based on co-operative governance principles;
- Establishing mechanisms for provincial support to, and monitoring and oversight of, municipalities in respect of planning and managing the use of land, and
- Facilitating the integration of environmental and heritage impact assessment processes with land use planning processes and other decision-making processes affecting the use of land.

3.5.4. General

3.5.4.1. Proposed

Various indicators have been identified and initiatives must be developed and implemented for data capturing to measure each of the following indicators in order to monitor land use practices and impacts related consequential of unsustainable land use practices in the NW Province.

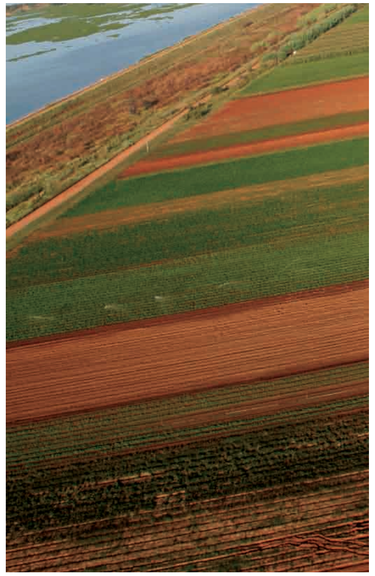

Photo: Anuschka Barac

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Indicator	Objective
Proportion of land affected by desertification	Monitor land degradation
Soil Degradation Index	Monitor land degradation
Veld Degradation Index	Monitor land degradation
Combined Degradation Index	Monitor land degradation
Soil Quality Standards enforced	Monitor soil quality due to agricultural practices to prevent low crop yields
Loss of top soil through run-off	Monitor permanent loss of soil to prevent land degradation
Rate of development in all zoning categories	To determine land available for housing and Industrial development
Change in land use	To protect cultural relevant sites and recreation sites of cultural/historic significance
Demand for housing and other urban developments	Monitor urban sprawl
Recipients of land claims and reform process and use of recipient land	Ensure reasonable land redistribution practices
Rezoning applications vs provision of services	Monitor rapid urbanization
Development within the 1 in 100 year floodline or close to water courses, wetlands; no buffer zones	Avoid flooding of developments and damages related thereto
Adherence to SDI plans and development nodes	Monitor implementation of SDI Plans
No of sites where soil contamination has been investigated	Determination of the extent of sterilized land resulting from petrochemical, agrichemical and heavy metal contamination
Percentage of wetlands rehabilitated out of degraded wetland areas that require rehabilitation	Ensure land rehabilitation
Percentage of land rehabilitated out of the total land area that require rehabilitation	Ensure land rehabilitation
Agricultural land productivity vs. potential productivity	Ensure sustainable utilization of land
Change of land use from agricultural to hard development (consideration of agricultural land area	Ensure sustainable utilization of land
Arable land area per capita (m^2)	Ensure sustainable utilization of land
Settlement, grazing and arable land area as a percentage of total area	Ensure sustainable utilization of land
Average gross residential density in urban areas	Ensure sustainable utilization of land
Area with organic farming as a percentage of total arable land area.	Ensure sustainable utilization of land
N, P and L losses from agricultural land	Ensure sustainable utilization of land
Veld condition score	Ensure sustainable utilization of land
Accumulation of heavy metals in agricultural top soil	Ensure sustainable utilization of land
Proportion of land affected by desertification, Soil/ land degradation index/ Percentage of land rehabilitation out of degraded lands/ veld condition scores/ changes ofland use	Land degradation/Ensure the management of natural habitat
Percentage of land affected by alien and invasive species/ Budgetary allocation for alien eradication programmes	Soil erosion, alien plants & animals
Percentage of land rehabilitation out of degraded lands/ changes of land use	Land rehabilitation
Number of EIA applications/ Changes of land use	Urban sprawl

Table 3 16: Indicators for future monitoring

3.6. References

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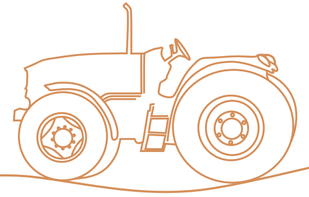

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CHAPTER 4

Biodiversity and ecosystem health

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Acronyms and abbreviations

AIDS	Acquired Immune Deficiency Syndrome
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species
DD	Data Deficient
DEAT	Department of Environmental Affairs and Tourism
EN	Endangered
EWT	Endangered Wildlife Trust
GEF	Global Environment Facility
HIV	Human Immunodeficiency Virus
IUCN	International Union for Conservation of Nature
LC	Least Concern, i.e. not threatened
MEC	Member of Executive Council
NBI	National Botanical Institute
NEMA	National Environmental Management Act of 1998
NEMBA	National Environmental Management: Biodiversity Act 10 of 2004
NEMPA	National Environmental Management: Protected Areas Act 57 of 2003
NP	National Park
NSBA	National Spatial Biodiversity Assessment
NT	Near Threatened
NW Province	North West Province
NWDACE	North West Department of Agriculture, Conservation and Environment
PAJA	Promotion of Administrative Justice Act
SANBI	South African National Biodiversity Institute
TOPS	Threatened or Protected Species
VU	Vulnerable

Definition of terms

Aridification
The process by which a humid region becomes increasingly dry, either through climatic change or human interference with the ecology.

Azonal
Zones or layers that cannot be distinctively distinguished from one another because, for example, they are of recent formation.

Biodiversity resources
The number and variety of species of flora and fauna found within a specified geographic region.

Biomes
A major regional or global biotic community, such as a grassland or desert, characterized chiefly by the dominant forms of plant life and the prevailing climate.

Ecosystems
An ecological community together with its environment, which together function as a unit.

Plant taxa
The taxonomic categories or groups, such as a phylum, order, family, genus, or species.

Refugia
An area that has escaped ecological changes occurring elsewhere and so provides a suitable habitat for relict species.

Trophic-dynamic
The feeding habits or food relationship of different organisms in a food chain.

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4.1. Introduction

4.1.1. Defining and understanding the value of biodiversity and ecosystems

Biological diversity or biodiversity is defined by the National Environmental Management: Biodiversity Act 10 of 2004 (NEMBA) as *"the variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part and also includes diversity within species, between species, and of ecosystems"*.

Ecosystems consist of the biological communities that occur in the same location, and the physical and chemical factors that make up its non-living or abiotic environment. Ecosystem properties depend on biological diversity which supports primary production and enhances the ability of ecosystems to deliver ecological services to humans

These essential services provided by natural ecosystems are summarized in Table 4-1.

A healthy ecosystem has the self-correcting capability of recovering itself toward an end-state that is normal for that system in the event of disturbance. The loss of biodiversity leads to loss of ecosystem integrity and results in the loss of stability as the ecosystem becomes vulnerable to any additional disturbance or perturbation such as climate change.

Within the NW Province a large portion of the human population is dependant on healthy ecosystems and the services they provide. Such dependence is apparent in rural areas, where individuals are directly affected by the availability of common property resources such as food, water, medicinal plants and firewood. A decline in ecosystem health affects the ability of the system to provide services to poor rural communities who relies on the environment for the production of goods like food (crops and livestock) and fuel. Wealthier sectors of society are buffered from this, as they are able to purchase basic necessities and scarce commodities made available with the help of technology.

Ecosystem goods and services	Ecosystem functions
Gas regulation	Regulation of atmospheric chemical composition
Climate regulation	Regulation of temperature and precipitation
Disturbance regulation	Absorbing capacity, damping and integrity of ecosystem response to climate fluctuations
Water regulation	Regulation of hydrological flows
Water supply	Storage and retention of water
Erosion control	Soil retention within an ecosystem
Soil formation	Soil formation processes
Nutrient cycling	Storage, internal cycling, processing and acquisition of nutrients
Waste treatment	Recovery of mobile nutrients and removal or breakdown of excess nutrients and compounds
Pollination	Movement of floral gametes
Biological control	Trophic-dynamic regulation of populations
Refugia	Habitat for populations
Food production	Portion of gross primary production extractable as food
Raw materials	Portion of gross primary production extractable as raw materials, e.g lumber, fuel, fodder
Genetic resources	Sources of unique biological materials and products, e.g. medicines
Recreation	Providing opportunity for recreational activities, e.g. eco-tourism
Cultural	Providing opportunities for non-commercial use, e.g. aesthetic, spiritual, scientific

Table 4-1: Renewable ecosystem services and functions

4.1.2. What causes the loss of biodiversity and declining ecosystem health?

The most significant cause for the loss and degradation of biodiversity systems is the use of natural resources by humans for economic and social development (Tait, 2004). At a provincial scale, the current and predicted future pressures which cause a declining in ecosystem health include:

- The loss of natural habitat;
- Climate change;
- Invasion by alien species;
- Modification of rivers;
- Water abstraction;
- External inputs of nutrient loading, and
- Pollution and overexploitation.

4.2. Ecosystems and species in North West Province

4.2.1. The vegetation types of the North West Province

The North West (NW) Province falls within the Savanna and Grassland Biomes and is rich in natural assets and represents significant biodiversity resources. It contains 61 vegetation types of a total of 435 described for South Africa, of which 12 are wholly or primarily (more than 75%) found only within the NW Province. The province contains approximately 3,025 plant species, 138 mammals, 384 birds, 27 amphibians and 59 reptile species. The extent and distribution of the vegetation biomes and vegetation types across the Province is illustrated in Figure 4-1 and Figure 4-2.

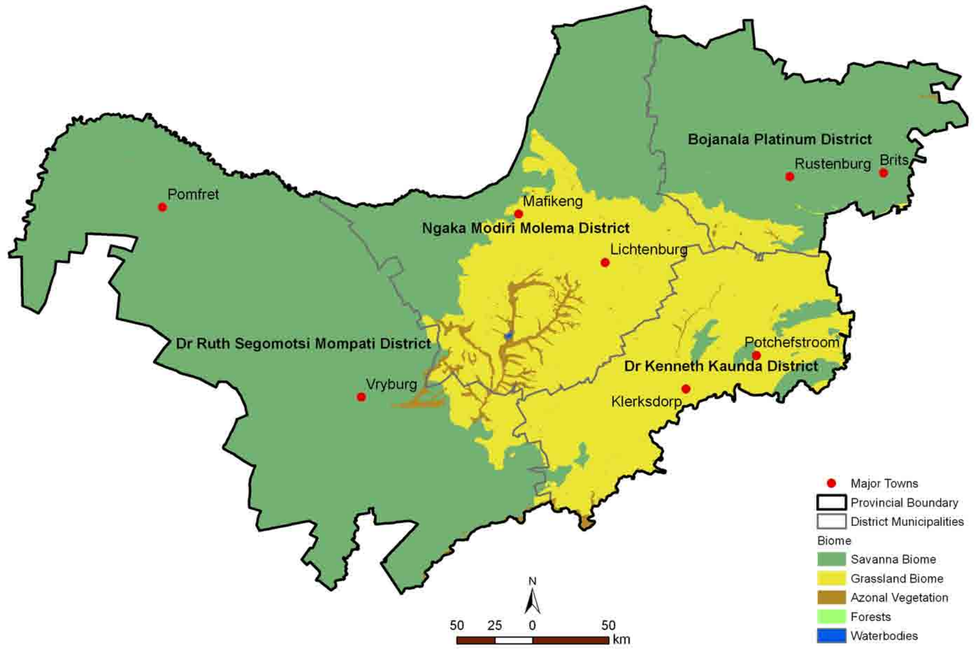

Figure 4-1: Distribution and extent of biomes across the NW Province (Mucina, Rutherford & Powrie, 2005)

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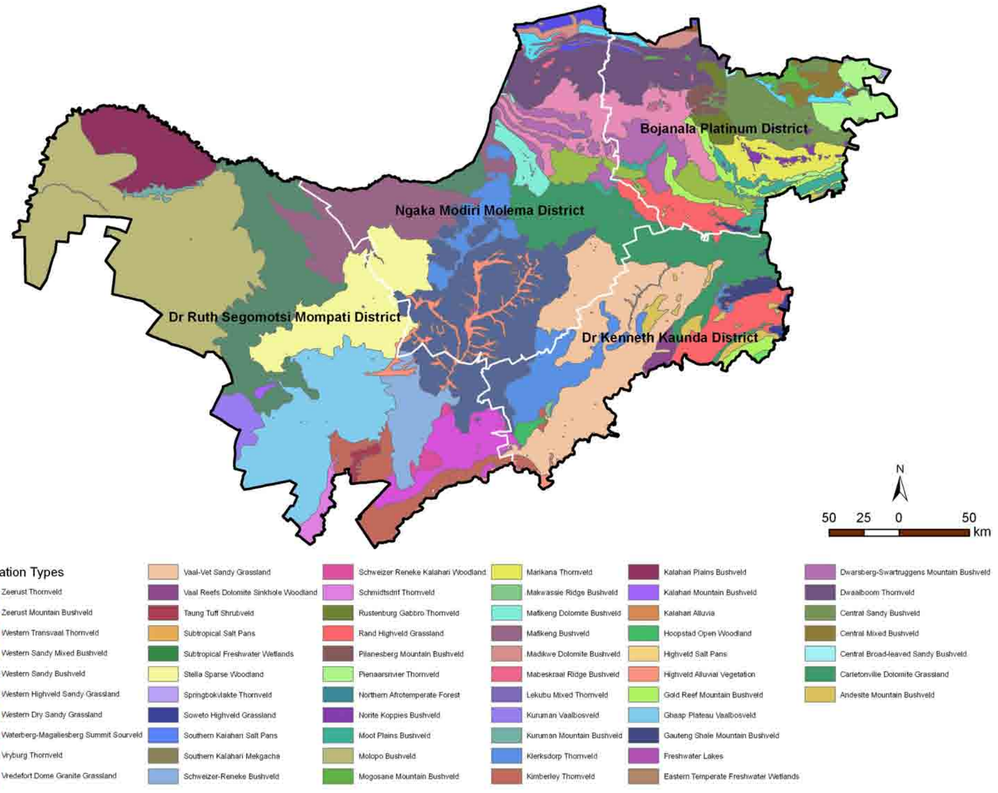

Figure 4-2: Distribution and extent of vegetation types across the NW Province (Bredenkamp *et al.*, 2003. Mucina, Rutherford & Powrie, 2005)

4.2.1.1. Loss, fragmentation and degradation of natural habitats

The most significant cause of biodiversity loss is due to severe land degradation[1]. The most severe transformation of habitat arises from the direct conversion of natural habitat for human requirements, including:

- Cultivation and grazing activities;
- Rural and urban development;
- Industrial and mining activities, and
- Infrastructure development.

Indirect impacts related to land transformation includes the introduction of alien invasive plant species and overgrazing and overexploitation of particular organisms or ecosystems.

The NW Province land-cover project was completed in 2008 (NWDACE. 2008) and was undertaken to determine the current land-cover (use) for the NW Province. This dataset indicated that 29.4% of the Province is transformed of which 21% is due to cultivation. Apart from cultivation, other activities that affect transformation are soil erosion, landfill sites, feedlots, urbanisation, infrastructure development, sports fields, golf courses and mining activities.

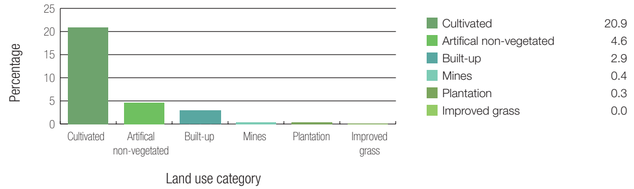

Figure 4-3: Percentage of transformation by category of total area transformed (Geoterraimage (Pty) Ltd. 2008)

4.2.1.2. Overexploitation

The poor rural communities depend heavily on natural biodiversity for their food security, while, in turn, food insecurity threatens biodiversity when it leads to overexploitation of natural resources. Overexploitation of ecosystems is not evenly distributed across the Province, but as can be expected, is concentrated around the major urban areas and rural settlements. In these areas subsistence and commercial over-harvesting of indigenous plants are posing a threat to various species.

4.2.1.2.1 Overgrazing

The over-utilization of grazing resources is a problem in many rural parts of South Africa, and the NW Province is no exception. Communal areas are often grazed at stocking rates that exceed the carrying capacity of the land. The result is:

- The continuous removal of biomass, which exposes the soil surface resulting in accelerated soil erosion;
- A change in species composition from palatable to less palatable herbaceous species caused by selective grazing;
- A reduction in the grazing capacity of the land, which places additional pressure on remaining grazing areas, and
- An increase in the exposure of the soil surface to sunlight, thus raising soil surface temperatures affecting localised climate changes.

Overgrazing is one of the most important factors contributing towards land degradation in the province and has caused extensive degradation in the western parts and in places in the north-central to north-eastern part of the province.

4.2.1.2.2 Harvesting of plants and animals

The rural communities throughout South Africa harvest woody plants for fuel, furniture, building materials, food and for their medicinal value. Plants and animals are also harvested by non-rural communities for commercial use in medicines, as cultural artefacts, live animals for the pet markets, timber and ornamental plants.

These forms of overexploitation can have severe impacts on biodiversity, and the combined effects of extensive harvesting practises and subsistence agriculture will continue to transform natural woodlands in the province.

Target species of plants and animals in the province are harvested for food and for their medicinal or "magical" properties. An ever increasing population, coupled with health challenges such as HIV/AIDS, has lead to increased demand on medicinal plants in particular, which has resulted in the addition of a number of species to the list of threatened and rare plants. Commercialisation of the medicinal plant trade via the development of "muthi" markets has lead to a decrease in the traditional methods of harvesting species, which were designed to protect populations of species being harvested.

Box 4-1: Crinum bulbispernum (Olivier, 1990)

The Orange River lily is a large bulbous plant up to 1 m high, which produces attractive grey green gracefully arching leaves during the summer months.

This plant is used in traditional healing for the common cold, rheumatism, varicose veins, reduction of swelling and the treatment of septic sores. It is also used during the delivery of babies and to stimulate breast milk. Local people believe that this plant protects homes from evil.

Source: Hankey, A. 2001. Witwatersrand National Botanical Garden. Crinum bulbispermum. http://www.plantzafrica.com/plantcd/crinumbulbisp.htm

1 Refer to Chapter 3 for a detailed discussion regarding land degradation.

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Specific endemic bulbs that are harvested for their medicinal value includes:

- *Crinum bulbispermum* and *C. macowanii,* and
- Succulents such as *Lithops leslei subsp. leslei.*

Insufficient information exists with regard to the extent of harvesting activities and trade of medicinal and commercial plants to make an adequate assessment of the threat to targeted plant and animal species. Studies should be undertaken to provide baseline data that could enable future monitoring and comparative assessments.

4.2.1.3. Alien plant invasions

In the NW Province there are 71 plant species recorded that is invasive[2]. Of those, 30 are considered to be 'major invaders' that are well established and have already had a substantial impact on natural ecosystems. Forty one 'emerging invaders', with suitable attributes and potential habitat, have been identified which may result in an increased dispersion range of invaders in the province.

Though there is limited data available from the South African Plant Invader Atlas, it is noted that there is a comparatively small portion of the NW Province, centered around Rustenburg, that has a moderate cover of alien plants. The remainder of the province either has low alien cover, or there is no data available.

Around 20% of the NW Province has a high suitability for the invasion by alien plants. These areas are situated on the eastern to north-eastern portions of the Province and the more densely populated regions of the province.

It is however anticipated that this is an under-representation of the true abundance and extent of alien plant invasion in the province. Therefore, more thorough and systematic surveys need to be undertaken to determine the extent of alien invasion and to enable the development and implementation of eradication and management plans.

Invasive alien plants use more water than indigenous vegetation and may be responsible for up to 7% of South Africa's water usage. Due to the relative low availability of water in the NW Province this issue becomes significant. Alien plants can decrease agricultural capacity, intensify flooding and fires, and can cause destruction of rivers and siltation of dams. They can also contribute to the decline of indigenous plant and animal species through competing for the same resources.

2 Refer to Chapter 3 for a complete list of invaders within the province.

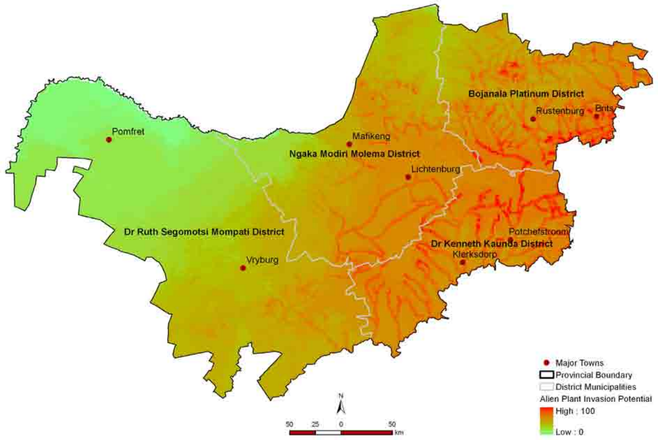

Figure 4-4: Distribution of areas with a high suitability for invasion by alien plants (SANBI, 2007)

Class	Description
Least threatened	Ecosystems are still largely intact (>80% natural habitat).
Vulnerable	Ecosystems are reasonably intact (<80% and >60% natural habitat), but are nearing the threshold beyond which they will start to lose ecosystem function.
Endangered	Ecosystems have lost significant amounts of their natural habitat, which impairs their functioning (<60% but still containing more natural habitat than the biodiversity target).
Critically endangered	Ecosystems have so little natural habitat left that their functioning has been severely impaired (they have less natural habitat than their biodiversity targets), and species associated with this ecosystem class are in decline or becoming locally extinct.

Table 4-2: The four classes of ecosystem threat (SANBI, 2007)

The most problematic declared weeds in the NW Province are *Opuntia ficus-indica, Datura stramonium* and *Datura ferox*. Rivers and wetlands are more sensitive to the effects of aliens, and some species such as *Eichornia crassipes* may severely affect ecosystem health.

4.2.2. Terrestrial ecosystems

The National Spatial Biodiversity Assessment (NSBA) is an assessment of the state of South Africa's terrestrial,freshwater, estuarine and marine ecosystem in relation to the pressures outlined in Section 4.1.2. It categorizes ecosystems into four classes of threat based on their degree of habitat loss, relative to the biodiversity targets that have been set for these ecosystems:

Of the ecosystems in NW Province, 42% are threatened, those classified as vulnerable, endangered, and critically endangered. These are located primarily within the central to eastern parts of the Province. Of these:

- 8 terrestrial ecosystems (20%) are endangered, most of which are in the southern to south-eastern parts of the Province affected by extensive cultivation; and
- 9 terrestrial ecosystems (22%) are vulnerable: most of these are in the central to eastern parts of the Province, affected by cultivation and degradation (Mucina & Rutherford, 2006).

The area covered by these ecosystems represents 56% of the land area of the NW Province.

4.2.3. River ecosystems and wetlands

The state of river ecosystems depends on the extent of transformation activities within the rivers and on their banks, as well as on how land is managed throughout their catchments. The NW Province contains four main basins, the Kalahari Basin, the Bushveld Basin, the Highveld Basin and the Ghaap Plateau[3].

4.2.3.1. National Spatial Biodiversity Assessment

The NSBA report assesses the status of river ecosystems, derived by calculating the extent of remaining untransformed river length of each main river ecosystem in relation to its biodiversity target. Untransformed length is then compared to the total length of each main river ecosystem to calculate conservation status categories of each ecosystem.

Class	Definition
Least threatened	River heterogeneity signatures have an intact length ≥ 60% of their total length.
Vulnerable	River heterogeneity signatures have an intact length ≥ 40% of their total length.
Endangered	River heterogeneity signatures have an intact length ≥ their conservation target (in this case, 10% of their total length).
Critically endangered	River heterogeneity signatures have an intact length below their conservation target (in this case 10% of their total length).
Critically endangered ecosystems	Have lost so much of their original natural habitat that ecosystem functioning has broken down and species associated with the ecosystem have been lost or are likely to be lost.
Endangered ecosystems	Have lost significant amounts of their original natural habitat, so their functioning is compromised.
Vulnerable ecosystems	Have lost some of their original natural habitat, and their functioning will be compromised if they continue to lose natural habitat.
Least threatened ecosystems	Have lost only a small proportion of their original natural habitat, and are largely intact (although they may be degraded to varying degrees).

Table 4-3: Classifications of rivers (NSBA: Technical Report, 2004)

3 Refer to Chapter 5 detailing the river basins and providing more information regarding wetlands

Box 4-2: Link between wetlands and rivers, water quality and biodiversity (MA, 2003)

Biodiversity can assist with pollution detoxification. Certain aquatic and marine organisms provide water filtration services that significantly reduce the impacts of pollution on water quality. For example, the hydrological processes in wetlands, and particularly the slowing down of water-flow by vegetation and the creation of anaerobic zones, bring about the deposition of heavy metals from streams and rivers, reduction in nitrogen loading through de-nitrification, and reduction of pathogens through predation by other micro-organisms. Well-vegetated watersheds significantly reduce the volume of sediment flowing down rivers. Protecting the ecosystems and organisms that provide such services is generally far more cost-effective than the alternative of building and operating water filtration plants.

Photo: Werner Bentz

The categories are defined in Table 4-3. In the province, the rivers of the Kalahari Basin drain to the north-west and westwards and constitute the main drainage from the western parts. The rivers of this basin are classified as Least Threatened. The rivers within the remaining basins are classified as either Endangered or Critically Endangered.

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4.2.3.2. National River Health Programme

The National River Health Programme (RHP) was initiated by the Department of Water Affairs and Forestry (DWAF) in 1994. The aim of this programme is to provide more information on the state of South Africa's river systems. The primary objectives of the programme are to measure and assess the ecological state, identify emerging problems within the systems and identify and report spatial and temporal trends in the ecological state of aquatic ecosystems.

This programme was launched in the NW Province in 1999. Monitoring of selected sites was initiated in 2000 and in 2005 the Crocodile (West) Marico Water Management Area State of Rivers Report was published. The study concluded that the ecological state of the management area is in a poor condition due to urbanisation and the alteration of river flow patterns due to canalisation[4].

4.2.4. The status of species

The conservation status of plant and animal species can be used as an indicator of the state of biodiversity of a region, although it needs to be seen in context of the species richness of the region. The NW Province is not particularly high in species richness when compared to other areas of South Africa.

Investigations by the South African National Biodiversity Institute (SANBI) are currently in progress to determine the status of threatened species in South Africa. This will result in an ability to highlight priorities for research, as well as areas of concern where conservation needs to be addressed. The updating the status of threatened species is an ongoing endeavour undertaken by the Threatened Species Programme of SANBI.

4.2.4.1. Plants

In accordance with the Threatened Species Programme, it has been determined that there are eight plant taxa that are now threatened in the NW Province, and according to the IUCN Version 3.1 Categories and Criteria, of these, two are Endangered, and six are Vulnerable.

Species that are Near Threatened, Data Deficient, Rare or Declining but do not meet the criteria for Red List categories are now recognised though a concept of an Orange List.

4 Refer to Chapter 5 for further information regarding the river health programme.

Photo: SA Tourism

Orange List species are identified through a systematic method for assessing rarity and is used in addition to Red Lists to highlight species that should be conserved in order to pre-empt the possibility of such species becoming threatened in the future.

Since the 2002 NW Province State of the Environment Report, 25 plant taxa have been added to the lists of plants of special concern. One of these is Endangered, two are Vulnerable, three are Data Deficient and the majority are Orange List species. Furthermore, 21 taxa that were previously thought to be Rare or Threatened are now known to be much more widespread than previously thought, and are now classified as Least Concern.

In 2002 there were 21 taxa in the NW Province that were listed as Insufficiently Known or Indeterminate, but now there are only nine in the equivalent category of Data Deficient. This illustrates that knowledge of threatened plants of the province is increasing.

However, in spite of improvements in collecting data and assessing threat status of plants, there is still much scope for field work to collect further data and research, not only for species which are Data Deficient, but also for taxa that are listed as Threatened or on the Orange List. The Red List is dynamic and continually changing due to updated information being added to existing data sets. Assessments are revised by SANBI whenever more information is available, and this can result in either upgrading or downgrading of assessments.

The rationale behind having an Orange List is to set aside adequate numbers of these taxa for conservation, since adequate protection would ensure that the taxa do not become threatened in the future.

At present, Gauteng Nature Conservation is the only province in South Africa that has implemented methods for ensuring conservation of Orange List species. This involves setting targets for the number of populations that need to be conserved, and not allowing transformation or development of these areas. NWDACE has not yet implemented conservation targets for Orange Listed species, but the opportunity exists to do so with the 14 Orange List species so far identified as occurring in the Province.

Taxon	Family	Endemic to:*	1996 Red List status**	Current IUCN Red List category***	Orange List category
Aloe peglerae	Asphodelaceae	SA	R	EN	
Delosperma macellum	Mesembryanthemaceae	SA	not listed	EN	
Brachycorythis conica subsp. transvaalensis	Orchidaceae	SA	not listed	VU	
Brachystelma incanum	Apocynaceae	NW	I	VU	
Ceropegia stentiae	Apocynaceae	SA	R	VU	
Marsilea farinosa subsp. arrecta	Marsileaceae	FSA	not listed	VU	
Rennera stellata	Asteraceae	SA	E	VU	
Rhus maricoana	Anacardiaceae	NW	R	VU	
Brachystelma canum	Apocynaceae	NW	not listed	DD	
Brachystelma gracillimum	Apocynaceae	NW	R	DD	
Commelina bella	Commelinaceae	SA	K	DD	
Cynodon polevansii	Poaceae	NW	K	DD	
Drimia elata	Hyacinthaceae	NOT	not listed	DD	
Euphorbia perangusta	Euphorbiaceae	NW	E	DD	
Euphorbia knobelii	Euphorbiaceae	NW	R	DD	
Lotononis minima	Fabaceae	SA	R	DD	
Myrothamnus flabellifolius	Myrothamnaceae	NOT	not listed	DD	
Adromischus umbraticola subsp. umbraticola	Crassulaceae	SA	not listed	NT	
Cineraria austrotransvaalensis	Asteraceae	SA	not listed	NT	
Cleome conrathii	Capparaceae	SA	I	NT	
Drimia sanguinea	Hyacinthaceae	NOT	not listed	NT	
Elaeodendron transvaalense	Celastraceae	NOT	not listed	NT	
Kniphofia typhoides	Asphodelaceae	SA	K	NT	
Lithops lesliei subsp. lesliei	Mesembryanthemaceae	FSA	not listed	NT	
Prunus africana	Rosaceae	NOT	not listed	NT	
Sporobolus oxyphyllus	Poaceae	SA	not listed	NT	
Stenostelma umbelluliferum	Apocynaceae	SA	not listed	NT	
Crinum bulbispermum	Amaryllidaceae	FSA	not listed	LC	Declining
Crinum macowanii	Amaryllidaceae	NOT	not listed	LC	Declining
Drimia altissima	Hyacinthaceae	NOT	not listed	LC	Declining

Table 4-4: Past and current conservation status of plant taxa in the NW Province, along with level of endemism of each species (IUCN Red List Categories and Criteria: version 3.1. 2001, South African Journal of Science, 2004)

(Note* that arrangement of plant taxa in this table is first according to current IUCN Red List category, Orange List category, and then taxon name).

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Taxon	Family	Endemic to:*	1996 Red List status**	Current IUCN Red List category***	Orange List category
Eucomis autumnalis subsp. clavata	Hyacinthaceae	FSA	K	LC	Declining
Gunnera perpensa	Gunneraceae	NOT	not listed	LC	Declining
Hypoxis hemerocallidea	Hypoxidaceae	NOT	not listed	LC	Declining
Ilex mitis var. mitis	Aquifoliaceae	NOT	not listed	LC	Declining
Pelargonium sidoides	Geraniaceae	FSA	not listed	LC	Declining
Gladiolus filiformis	Iridaceae	NW	not listed	LC	Critically Rare
Ceropegia insignis	Apocynaceae	NW	K	LC	Rare
Frithia pulchra	Mesembryanthemaceae	SA	R	LC	Rare
Habenaria culveri	Orchidaceae	FSA	not listed	LC	Rare
Ledebouria atrobrunnea	Hyacinthaceae	NW	not listed	LC	Rare
Gnaphalium nelsonii	Asteraceae	SA	not listed	LC	Rare-Sparse
Asclepias eminens	Apocynaceae	NOT	R	LC	
Asclepias fallax	Apocynaceae	FSA	R	LC	
Barleria bolusii	Acanthaceae	SA	K	LC	
Boscia foetida subsp. minima	Capparaceae	NOT	R	LC	
Brachystelma dimorphum subsp. dimorphum	Apocynaceae	SA	I	LC	
Ceropegia mafekingensis	Apocynaceae	FSA	R	LC	
Cynanchum virens	Apocynaceae	FSA	V	LC	
Elephantorrhiza obliqua var. glabra	Fabaceae	SA	K	LC	
Erythrophysa transvaalensis	Sapindaceae	NOT	R	LC	
Loudetia pedicellata	Poaceae	NOT	K	LC	
Melhania integra	Malvaceae	SA	K	LC	
Mosdenia leptostachys	Poaceae	SA	K	LC	
Nananthus vittatus	Mesembryanthemaceae	FSA	K	LC	
Nuxia glomerulata	Buddlejaceae	SA	R	LC	
Nuxia gracilis	Buddlejaceae	SA	K	LC	
Ochna glauca	Ochnaceae	NOT	K	LC	
Panicum volutans	Poaceae	SA	K	L	
Parapodium costatum	Apocynaceae	FSA	K	LC	
Rhynchosia nitens	Fabaceae	FSA	K	LC	
Scirpus varius	Cyperaceae	SA	K	LC	
Tristachya biseriata	Poaceae	SA	K	LC	

*	FSA = South Africa, Namibia, Botswana, Lesotho and Swaziland, i.e. Flora of Southern Africa region; SA = South Africa; NW = North West Province; NOT = Not endemic
**	E = Endangered; I = Indeterminate, i.e. suspected to be threatened but lacking evidence; K = Insufficiently Known; R = Rare; V = Vulnerable; not listed = not listed in Hilton-Taylor (1996).
***	EN = Endangered; VU = Vulnerable; DD = Data Deficient; NT = Near Threatened; LC = Least Concern, i.e. not threatened

4.2.4.2. Mammals

In 2002 the Endangered Wildlife Trust (EWT) and the IUCN's Conservation Breeding Specialist Group instigated a project to initiate a concerted effort by mammal specialists to assess the status of all mammals in South Africa (Friedmann, Y. & Daly, B, 2004). The result of this collaborative effort was a detailed compilation of knowledge from many specialists; resulting in an updated status of Red List as mammal species as indicated in Table 4-5.

As a result of this initative, increasing data is available for the threatened mammals of the NW Province. In the NW Province, large mammals which are considered as threatened are only found in National Parks or other conservation areas, and it is neither practical nor beneficial to re-introduce them into unprotected natural areas. Threatened small mammals, such as the rough-haired golden mole and the white-tailed mouse, however, are not confined to conservancies and occur in varied habitats in the province and are significantly impacted on by human activities and urgent conservation attention needs to be directed towards the threatened small mammals in the province, The spotted-necked otter has recently become Near Threatened, and efforts to protect this species must be considered.

4.2.4.3. Reptiles and amphibians

Two of the identified Red List reptiles depend on grassland habitat for survival (Table 4-6). The threatened status of these species reflects the poor conditions of suitable grassland habitat in South Africa.

There is a high occurrence of suitable habitat for these Red Data species in the NW Province. Suitable habitats for the Southern African python and the Giant Bullfrog are abundant in the province though these habitats are severely impacted on by human activities.

Numerous rural settlements are situated in close proximity to the koppies and ridges, and the pythons are hunted for bush meat while the Giant Bullfrog is severely impacted on by the degradation of the wetland habitat in the province.

Order	Scientific name	Common name	Previous conservation status	Current IUCN category	Habitat
Insectivora	*Chrysospalax villosus*	Rough-haired golden mole	V	CR	Dense grasslands with sandy soils close to marshlands
Artiodactyla	*Damaliscus lunatus lunatus*	Tsessebe	R (National)	EN (National)	Grasslands and grassland/ woodland ecotones.
Carnivora	*Lycaon pictus*	Wild dog	E	EN	Savanna woodland, broken, hilly country, open plains, arid areas
Rodentia	*Mystromys albicaudatus*	White-tailed mouse	V	EN	Highveld and montane grassland in holes in the ground
Carnivora	*Acinonyx jubatus*	Cheetah	R	VU	Open plains, savanna woodland, desert fringes.
Carnivora	*Lutra maculicollis*	Spotted-necked otter	not listed	NT	Permanent, un-silted, unpolluted rivers, streams and freshwater lakes where sufficient numbers of its prey are

Table 4-5: Red Data List: Mammal species (Red Data Book of the Mammals of South Africa, 2004)

Scientific name	Common name	IUCN category	Habitat
Homoroselaps dorsalis	Striped Harlequin snake	R	Underground, in old termitaria or under stones in grassland.
Python natalensis	Southern African Python	V	Favours rocky or bushy habitats, well-wooded valleys, usually close to water
Dalophia pistillum	Blunt-tailed Worm Lizard	DD	Fosorial, occurring in areas with sandy soils.
Crocodylus niloticus	Nile Crocodile	V	Rivers, farm dams
Pyxicephalas adspersus	African Giant Bullfrog	NT	Breeds in shallow margins of temporary rain-filled depressions

Table 4-6: Red Data list of amphibians and reptiles occurring in NW Province

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Scientific name	Common name	IUCN category	Habitat
Alcedo semitorquata	Half-collared Kingfisher	NT	Heavily wooded rivers with clear, fast-flowing water
Anastomus lamelligerus	Openbilled Stork	NT	Vagrant to NW, breeding in large wetlands
Anthropoides paradiseus	Blue crane	VU	Open grassland, vleis and other wetland habitat and short grasslands, where livestock are grazed
Aquila rapax	Tawny Eagle	VU	Savanna/ woodland. Vulnerable to poisoning
Ardeotis kori	Kori Bustard	VU	Grassland, scrubby, semi-desert and open savanna
Balearica regulorum	Grey Crowned Crane	VU	Wetlands. Vagrant in NW
Buphagus erythrorhynchus	Red-billed Oxpecker	NT	Dependent on game/ safe-dipped livestock. Variety of bushveld habitat
Certhilauda chuana	Short-clawed Lark	NT	Grassy areas in arid savanna
Charadrius pallidus	Chestnut-banded Plover	NT	Shorelines of brackish pans
Ciconia nigra	Black Stork	NT	Could appear at any water body, breeds on cliff ledges in mountainous areas
Circus maurus	Black Harrier	NT	Non-breeding winter migrant to the highveld from SW Cape
Circus ranivorus	African Marsh Harrier	VU	Permanent wetlands (marshes, pans, vleis and other wetland habitats), requiring > 2 ha sized wetlands for breeding
Crex crex	Corncrake	VU	Damp grassland, fallow fields and cropland. Scarce, non-breeding migrant
Ephippiorhynchus senegalensis	Saddle-billed Stork	EN	Vagrant to NW
Eupodotis caerulescens	Blue Korhaan	NT	Highveld grassland - somewhat nomadic in response to winter burns
Falco biarmicus	Lanner Falcon	NT	A variety of open habitat. Nests on cliff ledges, or in crow nests on trees/pylons
Falco peregrinus	Peregrine Falcon	NT	F. perigrinus minor usually found associated with cliffs, F.p.calidris found in a variety of wooded/ dry savanna habitats - both rare in NW
Falco naumannii	Lesser kestrel	VU	Non-breeding summer migrant. Occurs in large flocks in open savanna/ semi-desert and grassland. Roost communally in tall trees, mainly Eucalyptus, in urban areas.
Glareola nordmanni	Black-winged Pratincole	NT	Often large flocks in open grassland. Also around pans and wetlands. Non-breeding migrant.
Glareola pratincola	Red-winged Pratincole	NT	Vagrant
Gorsachius leuconotus	White-backed Night Heron	VU	Larger, well-treed rivers. Easily overlooked - under-reported in NW
Gyps africanus	African White-backed Vulture	VU	Nests in colonies in large trees, often in riverine areas - forages widely
Gyps coprotheres	Cape Vulture	VU	Breeds in mountainous areas, nomadic elsewhere. Forages over open grassland and woodland.
Hieraaetus ayresii	Ayres's Eagle	NT	Well-wooded hilly country. Rare. Non-breeding migrant
Leptoptilos crumeniferus	Marabou Stork	NT	Vagrant to NW. Uncommon outside major game reserves.
Mirafra cheniana	Melodious Lark	NT	Open grassland (Themeda) or grassy clearings in savanna
Mycteria ibis	Yellow-billed Stork	NT	Variety of aquatic habitats, including lakes, large rivers. Non-breeding migrant in study area.
Neotis denhami	Stanley's Bustard	VU	Montane grassland. Vagrant in NW
Neotis ludwigii	Ludwig's Bustard	VU	Dry, open plains of the semi-arid Karoo. Vagrant in NW
Nettapus auritus	Pygmy Goose	NT	Vagrant to NW. Water with floating/emergent vegetation (Nymphaea spp.)
Pelecanus onocronatus	White Pelican	NT	Vagrant to larger water bodies - dams, pans and vleis
Pelicanus rufescens	Pink-backed Pelican	VU	Vagrant to larger water bodies - dams, pans and vleis
Phoenicopterus minor	Lesser Flamingo	NT	Nomadic - occurrence in NW erratic depending on water conditions
Phoenicopterus ruber	Greater Flamingo	NT	Nomadic - occurrence in NW erratic depending on water conditions
Podica senegalensis	African Finfoot	VU	Permanent rivers with overhanging trees - secretive and may be under-reported
Polemaetus bellicosus	Martial Eagle	VU	Open grass/scrub/woodland. Ranges over a wide area
Pterocles gutturalis	Yellow-throated Sandgrouse	NT	Short grassy areas on black-clay soils
Rostratula benghalensis	Painted Snipe	NT	Vleis, marshes and pools in flooded grassland. Shallow water bodies with emergent vegetation
Rynchops flavirostris	African Skimmer	Regionally EX	Odd vagrants recorded at larger pans, dams and slimes dams in NW
Sagittarius serpentarius	Secretarybird	NT	Grassland and open woodland/savanna
Sterna caspia	Caspian Tern	NT	Larger inland dams/pans. Has bred at Barberspan Nature Reserve
Terathopius ecaudatus	Bataleur	VU	Rare (vagrant) outside of large protected areas. Vulnerable to poisoning
Torgos tracheliotus	Lappet-faced Vulture	VU	Vagrant to NW
Trigonoceps occipitalis	White-headed Vulture	VU	Vagrant to NW
Tyto capensis	Grass owl	VU	Rank grassland, vleis and, rarely Typha spp. Reedbeds

Table 4-7: Red Data species list for avifauna in NW Province

4.2.4.4. Birds

The large number of bird species in the NW Province that are either Near Threatened or Vulnerable is cause for concern due to the fact that this reflects degradation in the types of habitats that they require for breeding and foraging.

Table 4-7 includes a list of these bird species and indicates their threatened status.

Birds, like all animals, are dependent on the availability of intact habitat for foraging and breeding to ensure their protection and future survival. The way of ensuring this is to set aside sufficient conservation areas in known breeding grounds for threatened species, especially those containing wetlands.

4.2.4.5. Butterflies

Scant information exists on the status of butterflies in South Africa, and the NW Province is no exception.

SANBI is currently overseeing the process of re-assessing the Lepidoptera (butterflies) of the entire country, so that the information can be used to determine how to ensure adequate conservation of threatened butterfly species. Information which currently exists for taxa in the Province is summarized in Table 4-8.

Photo: Lauret Muller

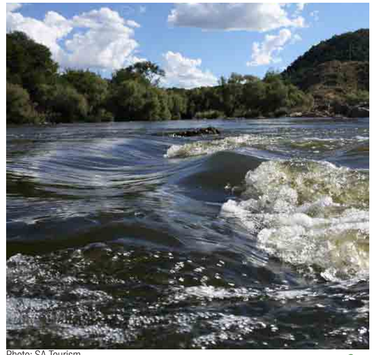

Photo: SA Tourism

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Scientific name	Common name	Old Red List category	Habitat and species upon which dependant
Acraea machequena Grose Smith	Machequena Acraea	Indeterminate	Bushveld, unknown
Spialia paula (Higgins)	Mite Sandman	No information	Bushveld, unknown
Lepidochrysops praeterita Swanepoel	Highveld Blue	No information	Grassveld, *Becium grandiflorum, Camponotus* sp
Aloeides dentatis maseruna(Riley)	Maseru Copper	No information	Grassveld, *Hermannia jacobeifolia, Lepisiota capensis*
Platylesches dolomitica Henning and Henning	Dolomite Hopper	No information	Grassveld, *Parinari* sp
Lepidochrysops hypopolia(Trimen & Bowker)	Morants' Blue	No information	Grassveld, unknown
Metisella meninx (Trimen)	Marsh Sylph	Indeterminate	Riparian, *Leersia hexandra*
Gegenes hottentota (Latreille)	Marsh Hottentot Skipper	No information	Riparian, *Poaceae*
Tuxentius melaena griqua (Trimen & Bowker)	Griqua Pied Blue	No information	Riparian, *Ziziphus mucronata*

Table 4-8: Lepidoptera species found in NW Province

There are two National Parks in the NW Province, the Pilanesberg and the Borakalalo National Parks.

These parks contain important areas of biodiversity, but do not represent all the vegetation types of the province. Other parks and reserves within the province include:

- Madikwe Game Reserve;
- Barberspan Bird Sanctuary (RAMSAR Convention Kgaswane Mountain Reserve;
- Bloemhof Dam Nature Reserve;
- Botsalano Game Reserve;
- Molopo Game Reserve;
- Madikwe Game Reserve;
- Mafikeng Game Reserve;
- SA Lombard Nature Reserve;
- Vaalkop Dam Nature Reserve;
- Boskop Dam Nature Reserve;
- Wolwespruit Dam Nature Reserve,
- Molemane Eye Nature Reserve.

According to the NW Parks and Tourism Board (NWP&TB), the total area formally protected is 283,308ha which amounts to approximately 2,4% of the Province. This includes national parks, provincial nature reserves, private nature reserves and protected natural environments. This falls below the 10% of each vegetation type suggested by the 1992 UNCED Convention (NWP&TB, 2008).

4.2.4.6. Fish

The three fish species, as recorded in Table 4-9, on the Red Data list are endemic to parts of river systems that occur in the NW Province. The state of the rivers has resulted in a decline in populations of these species.

4.2.5. Conservation areas

The Magaliesberg is a protected environment and provides the area with protection of biodiversity in that it limits the types and amount of development that can take place without restricting private land ownership.

Scientific name	Common name	IUCN category	Habitat
Austroglanis sclateri	Rock catfish	LC	Endemic to Vaal-Orange River system
Labeobarbus kimberleyensis	Largemouth yellowfish	VU	Endemic to the larger tributaries of the Vaal-Orange River system
Barbus motebensis	Marico barb	VU	Confined to headwater tributaries of the Marico and Crocodile Rivers

Table 4-9: Red data fish species found in NW Province

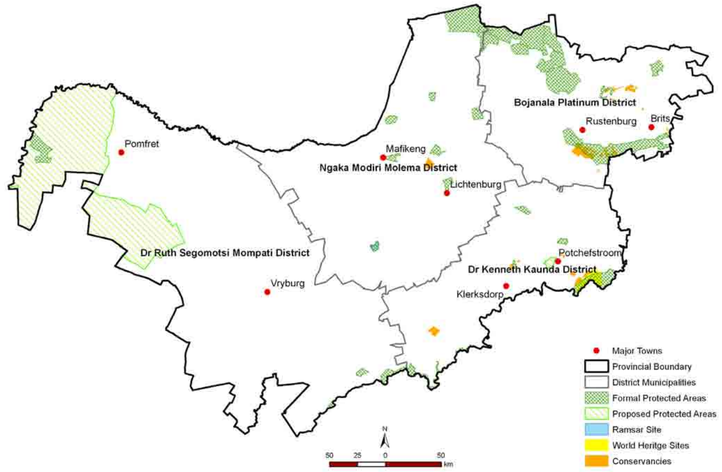

Figure 4-5: Conservation areas

4.2.6. Climate change

Human-induced global warming, i.e. linked to elevated atmospheric carbon dioxide levels, is regarded as one of the greatest threats to biodiversity and ecosystem functionality. Climate change has begun to manifest itself primarily as increased global temperatures and rising sea levels, changing annual precipitation and an increasing intensity of extreme weather conditions[5].

This is exacerbated by the high levels of fragmentation of the landscape as a result of habitat transformation as this fragmentation will inhibit natural migration of fauna in the event of changing environmental conditions.

The most dramatic responses to climate change are predicted to be shifts in the climatic suitability of areas occupied by different biomes, leading to the decrease in their extent. Predicted changes in biome boundaries could affect more than 75% of the NW Province by the year 2050 (Midgley, Rutherford, and Bond, 2001), with existing savanna vegetation shrinking towards the eastern corner of the Province. There is expected to be increasing aridification along an east to west gradient. This will lead to increased rates of extinction and reduction in the ranges of many species, as favourable habitats become more narrowly distributed.

4.3. The impact caused by the loss of biodiversity and ecosystems

The loss of biodiversity will leads to loss of integrity of stability of the ecosystems. Impaired ecosystem health can lead to reduced goods and services that they provide which results in costs to social and economic systems. The ecosystems then become much more vulnerable to any additional disturbance or perturbation.

In summary, the potential impacts of loss of biodiversity and compromised ecosystem function in the NW Province are likely to be:

1. Extinction or economic extinction of useful species;
2. Decreased carrying capacity for domestic livestock;
3. Soil erosion;
4. Loss in quantity and quality of water resources, and
5. Ecosystem instability.

4.4. Conclusion

Based on the data collected as part of the NW Province land-cover project completed in 2006, almost 30% of the natural habitats in the NW Province are either already lost or degraded, and much of what remains has suffered the effects of fragmentation. At least one third of the NW Province therefore supplies reduced levels of ecosystem goods and services.

Climate change exacerbates all other human-induced impacts on ecosystem function. Predicted changes in biome boundaries could affect more than 75% of the NW Province. There is expected to be increasing aridity, especially in the western parts of the Province. This will lead to increased rates of extinction and reduction in the ranges of many species. Increased aridity will reduce productivity, one of the impacts of which will be reduced carrying capacity for domestic livestock.

5 Refer to Chapter 6 for a detailed description of Climate Change

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4.5. Current responses to the loss of biodiversity

4.5.1. International

The global community has recognised that it is imperative to slow the escalating loss of plant and animal species, as preservation of natural resources is the key to human survival. Efforts to control threatening processes and protect species have lead to the ad hoc development of a number of treaties, conventions, protocols and the like, which resulted in international environmental laws protecting biodiversity.

Photo: Lauret Muller

Legislation has been formulated in response to what is regarded as the two main causes of biodiversity loss: (1) destruction of species, and (2) destruction of habitats. Habitat destruction may occur either directly, when land transformation takes place for human needs such as agriculture and urbanisation; or indirectly, for example by pollution, alien infestation or a change in a critical component of the ecosystem.

Plant and animal species are lost through the exploitation for use such as food or timber; or extermination of perceived problem species, such as natural predators that hunt domestic animals. Laws pertaining to conservation of biodiversity can thus be broadly classified as follows:

- Regulations protecting species from exploitation;
- Laws aimed at safeguarding habitats that are threatened by destruction; and
- Laws controlling processes that harm or destroy ecosystems or habitats (such as pollution).

On a global scale there are e two applicable environmental laws dealing with conservation of biological, including the:

- Convention on Biological Diversity (CBD), and
- Convention on International Trade in Endangered Species (CITES).

The CBD is the first international treaty attempting to protect all levels of diversity. It sets out a framework for action with three objectives, to:

- Conserve biological diversity;
- Use biological resources sustainably, and
- Share, in a fair and equitable manner, the benefits arising from the use of genetic resources.

CITES aims to regulate and monitor the international trade in selected species of plants and animals to ensure that it does not endanger their survival. The international trade in listed species is controlled by means of a permit system which allows exporting countries to set trade at levels which they consider to be sustainable.

4.5.2. National legislation

The act most applicable to the protection of biological diversity is the National Environmental Management: Biodiversity Act 10 of 2004. In terms of this act, SANBI was formed in 2004 and replaced the National Botanical Institute (NBI). SANBI has several functions, including the reporting of the:

- Status of South Africa's biological diversity;
- Status of all listed invasive species;
- Conservation status of all listed threatened or protected species and listed ecosystems, and
- Impacts caused by genetically modified organisms that have been released into the environment.

SANBI must also coordinate and promote the taxonomy of South Africa's biodiversity as well as manage, control and maintain all national botanical gardens. Other functions include advising the Minister on management and conservation of biological diversity, the sustainable use of indigenous biological resources and the conservation and sustainable use of indigenous biological resources.

Other national legislation that governs issues related to biodiversity and degradation are summarised in the following section.

4.5.2.1. Environmental management guiding principles

National Environmental Management Act 107 of 1998

The National Environmental Management principles, listed in Section 2 of the National Environmental Management Act 107 of 1998 (NEMA), which provide for the social, environmental and economic sustainability of activities, apply *"to the actions of all organs of state that may significantly affect the environment"*. These principles include:

- *Environmental management must place people and their needs at the forefront of its concern, and serve their physical, psychological, developmental and cultural and social interests equitably (Section 2(2)).*
- *Pollution and degradation of the environment must be avoided, or, where they cannot be altogether avoided, are minimised and remedied (Section 2(4)(ii).*
- *The use and exploitation of non-renewable natural resources is responsible and equitable, and takes into account the consequences of the depletion of the resource (Section 2(4)(v).*
- *A risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions (Section 2(4)(vii).*
- *The participation of all interested and affected parties in environmental governance must be promoted, and all people must have the opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation, and participation by vulnerable and disadvantaged persons must be ensured (Section 2(4)(f)).*
- *Decisions must take into account the interests, needs and values of all interested and affected parties, and this includes recognising all forms of knowledge, including traditional and ordinary knowledge (Section 2(4)(g)).*
- *The social, economic and environmental impacts of activities, including disadvantages and benefits, must be considered, assessed and evaluated, and decisions must be appropriate in the light of such consideration and assessment (Section 2(4)(i)).*

4.5.2.2. Weeds and invader plants

The Conservation of Agricultural Resources Act 43 of 1983

The cct specifies certain plants that are declared weeds and invader plants that must be controlled or eradicated. These species are divided into three categories, and the control measures applicable to the respective categories are defined

4.5.2.3. The protection of biodiversity

National Environmental Management: Biodiversity Act 10 of 2004

The objectives of the Act are –

a) *Within the framework of the National Environmental Management Act, to provide for –*

   (i) *The Management and conservation of biological diversity within the Republic and of the components of such biological diversity;*

   (ii) *The use of indigenous biological resources in a sustainable manner, and*

   (iii) *The fair and equitable sharing among stakeholder of benefits arising from bioprospecting involving indigenous biological resources;*

b) *To give effect to ratified international agreements relating to biodiversity which are binding to the Republic;*

c) *To provide for co-operative governance in biodiversity management and conservation, and*

d) *To provide for a South African National Biodiversity Institute to assist in the achieving of the objectives of this Act.*

Bioprospecting means the process of researching the chemical and genetic elements of biodiversity that may have value to humans and is defined in the Act as follows:

"bioprospecting", *in relation to indigenous biological resources, means any research on, or development or application of, indigenous biological resources for commercial or industrial exploitation, and includes-*

a) *The systematic search, collection or gathering of such resources or making extractions from such resources for purposes of such research, development or application;*

b) *The utilisation for purposes of such research or development of any information regarding any traditional uses of indigenous biological resources by indigenous communities, or*

c) *Research on, or the application, development or modification of, any such traditional uses, for commercial or industrial exploitation.*

Photo: Werner Bentz

Photo: Lauret Muller

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4.5.2.4. Protected areas

National Environmental Management: Protected Areas Act 57 of 2003

The objectives of this Act are-

- *to provide, within the framework of national legislation, including the National Environmental Management Act, for the declaration and management of protected areas;*
- *to provide for co-operative governance in the declaration and management of protected areas;*
- *to effect a national system of protected areas in South Africa as part of a strategy to manage and conserve its biodiversity;*
- *to provide for a representative network of protected areas on state land, private land and communal land;*
- *to promote sustainable utilisation of protected areas for the benefit of people, in a manner that would preserve the ecological character of such areas;*
- *to promote participation of local communities in the management of protected areas, where appropriate, and*
- *to provide for the continued existence of South African National Parks.*

The National Department of Environmental Affairs and Tourism (DEAT) also published the White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity in 1996 to guide a Biodiversity Policy and Strategy in South Africa.

The national legislation guides provincial processes and the development of provincial legislation.

4.5.3. Provincial

There is no conservation plan for NW Province; however the province is currently conducting a Biodiversity Assessment which will form the basis for the development of a Conservation Plan. This is a collaborative effort between the NWDACE and SANBI should be completed during the next two years and implemented soon thereafter. This is an essential management tool that will enable a system for allowing development in areas that will not cause further loss of intact or conservation-worthy habitat. The only bioregional programme that covers the North West Province is the National Grasslands Biodiversity Programme.

Photo: Anuschka Barac

Photo: NW DACE

Photo: Anuschka Barac

4.5.3.1. Development of the North-West Biodiversity Conservation Bill

The NW Province includes the former Bophuthatswana, Western Transvaal and the Cape of Good Hope Provinces. Each of these pre-1994 provinces had its own parts of legislation to manage and conserve biodiversity and is still applicable, namely:

- Bophuthatswana Nature Conservation Act No. 3 of 1973;
- Cape Problem Animal Control Ordinance 26 of 1957;
- Transvaal Nature Conservation Ordinance12 of 1983, and
- Cape Nature and Environmental Conservation Ordinance 19 of 1974.

These ordinances are not only inconsistent in their application, but are fragmented, creating confusion among stakeholders and government officials and are in certain circumstances also unconstitutional. Their focus is also largely on hunting and there is lack of attention to habitat protection and biodiversity conservation.

Although Section 104(1)(b)(i) of the Constitution of the Republic of South Africa, Act 108 of 1996, provides for legislative authority of provinces to pass their own legislation, there was no framework to properly guide integration of legislation. National legislation dies not specifically address NW Province's unique provincial situation.

In 2006, a decision to consolidate all the pre-1994 laws into a single North West Biodiversity Conservation Act and Regulation was taken, in the context of co-operative governance and to avoid duplication with already existing national legislation.

This process was delayed by the publication of the Threatened or Protected Species (TOPS) Regulations as the province waited for the promulgation of the proposed

Bill to ensure that the provincial Biodiversity Conservation Act does not conflict with these Regulations. During 2006, a draft document was finally developed and it was officially presented by the Department through the lawyer to the Chief State Law Advisor in April 2008.

4.6 Proposed responses

Current responses to the loss of biodiversity and protection of ecosystem health proposed and undertaken by the province will address the identified concerns. The consolidation and implementation of provincial legislation and regulations regarding biodiversity and ecosystem health is crucial and should be prioritised.

It should also be ensured that the Biodiversity Assessment currently undertaken by the province, with the assistance from SANBI, report on the current status of biological diversity, the occurrence of Red and Orange Data species in the province and the occurrence and extend of alien invasive species. This data will inform the proposed development of the proposed conservation plan for the province.

The basis of this report on the current state of biodiversity and ecosystem health was based on the indicators identified for the report. The following indicators have been identified to inform this report; however, insufficient data exists to enable meaningful reporting on all the issues. These indicators should be considered when future state of the environment reporting is planned.

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Photo: SA Tourism

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Objective	Indicator	Units of measurement
Promote integrated environmental management and compliance	Number of environmental impact assessments approved per district per year	Number of environmental impact assessments approved per district per year as a% of total EIAs received
	Expenditure on environmental management as a percentage of budget	Expenditure on environmental management by Department. Of Agriculture, Conservation and Environment / Department Of Agriculture, Conservation and Environment budget
	Percentage of EIA ROD compliance monitoring conducted per year	Number of inspections conducted per RODs issued
	Percentage of pollution and waste compliance investigated per year	Number of investigated pollution and waste compliance cases / Number of pollution and waste incompliance cases reported
	Number of compliance notices/directives/interdicts issued per year for the companies that do not have permits	Number of compliance notices/directives/interdicts issued per year for the companies that do not have permits
Promote Integrated Environmental Management & Compliance	Immediate and clear identification of ecological sensitive areas, preventing significant damage to sensitive areas	Number of environmental applications per year
Promote Integrated Environmental Management & Compliance	Immediate and clear identification of ecological sensitive areas, preventing significant damage to sensitive areas	% Clear identification of sensitive areas within ecological reports
Promote Integrated Environmental Management & Compliance	Immediate and clear identification of ecological sensitive areas, preventing significant damage to sensitive areas	Expenditure on biodiversity assessments as percentage of budget
Amend requirements for biodiversity investigations for new developments	Increase the existing knowledge of biodiversity of the region	Expenditure on biodiversity assessments as percentage of budget, level of information contained within EIA reports, biodiversity requirements for EIA applications
Compliance monitoring of EIA ROD	Ensuring proper protection for the natural environment	Percentage of EIA ROD compliance monitoring conducted per year
	Percentage of IDP's that include Integrated Environmental Management (IEM)	Number of IDP's that include Integrated Environmental Management / Number of IDP's
Species Diversity	Prevent the loss of T&P species	Threatened & Extinct species per taxonomic group/ Endemic species per taxonomic group/ Population trends of selected species
	Increase existing knowledge of biodiversity	Endemic species per taxonomic group/ Endemic species per taxonomic group/ Threatened species per taxonomic group (invertebrates)
Loss of species	Prevent/ determine the loss of species	Number of environmental applications per year/ Population trends of selected species/ Distribution and abundance of selected species
Status o f invasive plants & species	Control the spread of alien and invasive plants/ animals into areas of natural habitat, particularly wetlands	Alien (non-indigenous) species / Contribution to job creation: eradication of alien species/ Land degradation
Protection of sensitive ecosystems & habitat	Provide clear and detailed guidelines for biodiversity assessments as part of EIA investigations	Guidelines utilised in EIA documents/ applications
Enforcement of environmental legislation	Enforce terms presented in ROD for maximum protection of the environment	Number of investigations into developments, number of convictions for illegal developments, number of transgressions on RODs
Status of known protected habitats	Provide protection for sensitive ecosystems	Percentage of sensitive/ irreplaceable ecosystems transformed/ ecologically sensitive areas as percentage of whole, status of protected areas
Identification and declaration of additional protected areas	Provide protection for sensitive ecosystems	Percentage of sensitive/ irreplaceable ecosystems transformed/ ecologically sensitive areas as percentage of whole, status of protected areas
Freshwater Ecosystem Integrity	Provide protection for areas of surface water	Percentage of areas of surface water transformed or degraded/ areas of surface water officially protected, status of protected areas
Identification of sensitive habitats	Provide protection for areas of high slopes	Percentage of areas of high slopes transformed or degraded/ areas of high slopes officially protected, status of protected areas
Identification of sensitive habitats	Provide protection for areas of unique biodiversity attributes	Percentage of unique biodiversity attributes transformed or degraded/ areas of unique biodiversity attributes officially protected, status of protected areas
Ensure protection of ecologically sensitive areas	Protected areas as a percentage of the total area (MDG)	Protected land area (heritage sites, reserves) / Land area
	Percentage of representative vegetation types and other sensitive eco-systems under formal protection	Total area of representative vegetation types and sensitive ecosystems/Land area
Protect natural heritage sites	Status of natural heritage sites (international, national, provincial)	Status of natural heritage sites (international, national, provincial)
	Percentage of budget allocated to the protection of natural heritage sites	Expenditure of protection of natural heritage sites by Department of Agriculture, Conservation and Environment / Department of Agriculture, Conservation and Environment budget
Natural heritage sites	Number of natural heritage sites	Number of natural heritage sites
Identification of Biodiversity Sensitive Areas	Provide protection for areas of floristic/ faunal endemism, high biodiversity, areas known to be ecologically sensitive, rd localities	Percentage of areas of floristic/ faunal endemism, high biodiversity, areas known to be ecologically sensitive, rd localities transformed or degraded/ areas of high slopes officially protected, status of protected areas
Public awareness of environmental importance	Increase knowledge of environmental importance/ sustainable utilisation	Number of environmental education programmes/ Budgetary allocation on environmental awareness programmes/ Budgetary allocation to environmental research
Promote environmental education and awareness	Number of schools implement awareness/education programmes	Number of pupils or schools involved in environmental education programmes as a percentage of total
The pet trade (CITES).	Introduction of non endemic species as pets that cause pressure	No of non-endemic species introduced through the pet trade
Sensitive areas need proper identification	Designate limited development areas.	No of formally designated limited development areas, and proposed sites

Table 4-10: Listing the indicators that have not been measured and should be considered for future monitoring

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Objective	Indicator	Units of measurement
Conservation outside of officially designated areas needs better regulation – i.e. ridges, wetlands.	Loss of other tourism opportunities	No of private game farms as a% of total land cover
Management of the Protected Areas.	Only local/provincial conservation areas are managed and monitored	% of formal protected areas/total land cover
Veld Fires	Contributes to habitat pressure	Veld fire incidence (seasonal)
Non-endemic fauna such as bears, tigers, etc. being brought into the area.	Displacement of other animals causing pressure (see permitting office for information).	No. of non-endemic species introduced
	Hybrids i.e. white springboks or golden wildebeest which are being bred on game farms to attract tourists. These are a threat to biodiversity.	Alignment of species analysis with those defined in national legislation.
"Canned lion hunting"	With the increase in game farms and the associated hunting, an increase in lion breeding and numbers has occurred. A big game farm can have up to 200 lions.	No of farms breeding lions for hunting purposes

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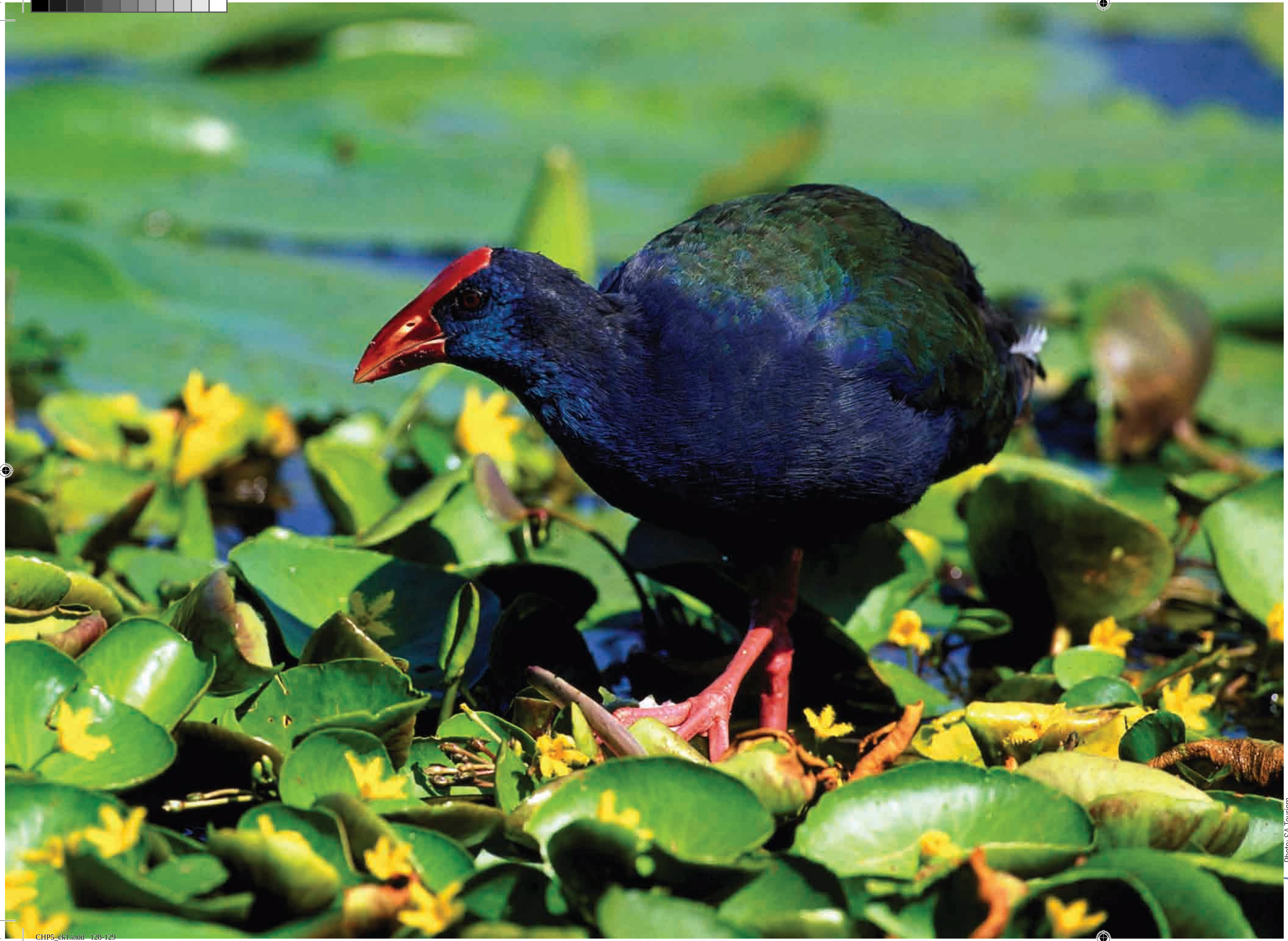

Photo: SA Tourism

CHAPTER 5
Water resources and aquatic ecosystems

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Acronyms and abbreviations

CMA	Catchment Management Agency
DWAF	Department of Water Affairs and Forestry
ER	Ecological Reserve
IDP	Integrated Development Plan
MDG	Millennium Development Goal
NWA	National Water Act
NWWSF	North West Water Sector Forum
PIF	Premier's Intergovernmental Forum
RDP	Reconstruction and Development Programme
RHP	River Health Programme
SADC	Southern African Development Community
SAEO	SA Environmental Outlook
SoER	State of the Environment Report
TDS	Total Dissolved Solids
TWQR	Target Water Quality Range
WMA	Water Management Area

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Definition of terms

Dam
A barrier that divides waters and generally serves the purpose of retaining or storing water

Catchment
An extent of land where water from rain drains downhill into a body of water, such as a river, lake, reservoir, estuary, wetland, sea or ocean. A catchment includes both the streams and rivers that convey the water as well as the land surfaces from which water drains into those channels.

Catchment Management Agency
Unit responsible for the protection, use, development, conservation, management and control of water resources within the Water Management Area

Groundwater
Water located beneath the ground surface in soil pore spaces and in the fractures of underground rock formations.

Groundwater aquifer
An underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt, or clay) from which groundwater can be usefully extracted using a borehole or water well.

Groundwater potential
The volume of water than can be contained within an aquifer.

Dolomitic eye
Water bodies fed by groundwater originating from fractures in the underlying dolomite.

River
A natural stream of water, usually freshwater, flowing toward an ocean, a lake, or another stream.

Spring
A point where groundwater flows out of the ground, and is thus where the aquifer surface meets the ground surface.

Surface Water
Water collecting on the ground or in a stream, river, lake, wetland, or ocean.

Water Management Area (WMA)
An area established as a management unit in terms of the National Water Resource Strategy.

Wetland
An area of land consisting of soil that is saturated with moisture, such as a swamp, marsh, or bog.

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Chemical abbreviations

Ca	Calcium
Chl-a	Chlorophyll-a
Cl	Chloride
CO	Carbon Monoxide
CO_2	Carbon dioxide
F	Fluoride
K	Potassium
Mg	Magnesium
Na	Sodium
NO_3	Nitrate
NO_2	Nitrite
PO_4-	Phosphate
SO_4	Sulphate

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5.1. Introduction

Surface water resources are defined in the National State of the Environment Report (1996) as rivers, dams, pans, wetlands and dolomitic eyes fed by underground water sources. Groundwater is the term used to describe underground water resources, which flow between soil pore spaces and within underground rock formations. In the NW Province, ground and surface water are integrated and interdependent, as groundwater flowing to the surface at dolomitic eyes or springs is the source of several major rivers within the boundaries of the NW Province, such as Groot Marico, Mooi, Schoon Spruit and Molopo. As a result, water quality and quantity issues affecting groundwater also have implications for surface waters.

There are four Water Management Areas (WMAs) within the North West Province:

- Lower Vaal;
- Middle Vaal;
- Upper Vaal, and
- Crocodile Marico.

Figure 5-1 shows the WMAs as well as the major surface water sources within each management area.

Box 5-1: Targets for the water services sector

The Strategic Framework for Water Services, approved by Cabinet in September 2003 contains targets for the water services sector, and provides a challenge to all the water services stakeholders, to individually and collectively meet the targets. The following targets are specifically notable:

1. All people in South Africa have access to a functioning basic water facility by 2008.
2. All people in South Africa have access to a functioning basic sanitation facility by 2010.
3. All schools have adequate and safe water supply and sanitation services by 2005.
4. All clinics have adequate and safe water supply and sanitation services by 2007.
5. All bucket toilets are eradicated by 2006 (extended to 2007).
6. 70% of households with access to at least a basic sanitation facility know how to practice safe sanitation by 2005 (100% by 2010).
7. Free basic water policy is implemented in all water services authorities by 2005.
8. Free basic sanitation policy implemented in all water services authorities by 2010.
9. All assets of water services schemes are transferred from DWAF to water services authorities by 2008.
10. By-laws are promulgated in every water services authority areas by 2005.
11. All water services authorities report annually on progress against their water services development plans by 2005.
12. All external water services providers are rendering services in terms of a contract with the applicable water services authorities by 2005.
13. All water services providers are rendering services in terms of a business plan by 2005.

5.1.1. Water governance[1]

Policy and legislation such as the National Water Act (NWA) (Act 38 of 1998) are central to the management of water resources from national to WMA level. Legislation therefore influences the pressures, state, impact and responses pertaining to the water resources.

Management of the environment is considered to be a provincial competency under the Constitution of South Africa. Some key national legislation, which impacts on environmental policy and management in the Province, includes the:

- Constitution of the Republic of South Africa (Act No. 108 of 1996);
- National Environmental Management Act (Act No. 107 of 1998);
- Environment Conservation Act (Act No. 73 of 1989);
- National Water Act (Act No. 36 of 1998);
- Atmospheric Pollution Prevention Act (Act No. 45 of 1965);
- Minerals Act (Act No. 50 of 1991), and
- Conservation of Agricultural Resources Act (Act No. 43 of 1983).

5.1.1.1. Conventions regulating water resources

The Protocol on Shared Watercourse Systems (1995) of the Southern African Development Community (SADC), ratified by South Africa, Lesotho, Botswana and Mauritius is, of relevance to the management of the Limpopo and Molopo Rivers, which are shared by the NW Province and Botswana. All surface water from the Bojanala Platinum District (Rustenburg and Brits) and Moses Kotane Local Municipality (Sun City) flows into the Limpopo River.

Since the Limpopo and Molopo Rivers are shared between the NW Province and Botswana, international obligations surrounding shared water resources require that NW Province assist and supply water to its neighbours. Cooperation between South Africa and Botswana for the management of these rivers is formalised by the Limpopo Basin Technical Committee, which is hosted at a national level.

1 Refer to the Preamble for more information on Governance

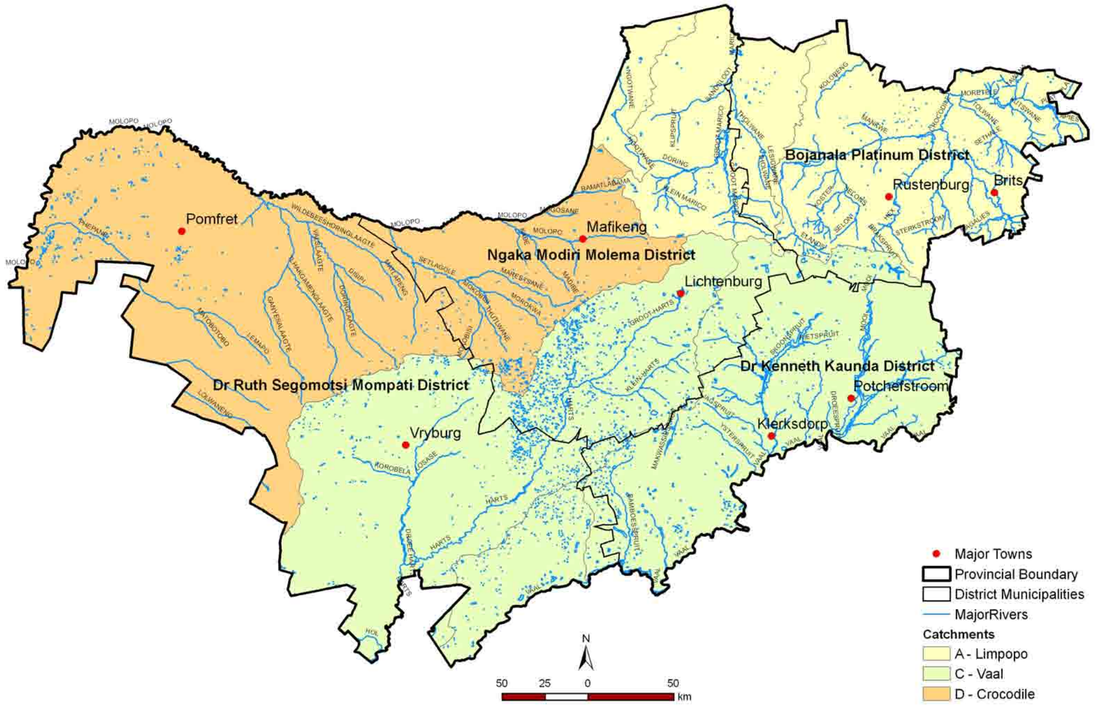

Figure 5-1: Map of the North West Province showing the major rivers and Water Management Areas.

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5.1.1.2. Institutional arrangements

The National Department of Water Affairs and Forestry (DWAF) is responsible for water resources management within South Africa (SAEO, 2007), to ensure that water is protected, used, developed, conserved, managed and controlled in a sustainable and equitable manner. Management of catchment level water resources is the responsibility of Catchment Management Agencies (CMAs). Their duties include:

- Investigating and advising interest parties on the management of water resources within a WMA;
- Developing a catchment management strategy that is consistent with the National Water Resource Strategy, as well as with local water services development plans of local government;
- Coordinating water-related activities of water users and water management institutions within a WMA, and
- Promoting community participation in the management of water resources.

DWAF currently serves as an interim CMA, while local CMAs are being established within the Province (DWAF, 2008). The WMAs also fall across provincial boundaries and this presents a challenge for provincial sector planning.

Catchment Forums have been established for the purpose of consultation between institutions, for input into the establishment of CMAs and Water User Associations in each WMA. Water User Associations are being established to manage and control water use at local level. Members will include Water Service Authorities, farmers and other water users.

There are 12 municipalities that fulfil the Water Service Authority function in the Province, namely:

- Bojanala Platinum District Municipality;
- Dr. Ruth Segomotsi Mompati District Municipality;
- Moretele Municipality;
- Local Municipality of Madibeng;
- Rustenburg Municipality;
- Kgetleng Rivier Municipality;
- Moses Kotane Municipality;
- Ventersdorp Municipality;
- Tlokwe Municipality;
- City of Matlosana;
- Maquassi Hills Municipality, and
- Merafong Municipality.

There are four water boards operating in the Province:

- Sedibeng Water;
- Magalies Water;
- Rand Water, and
- Botshelo Water.

The provincial government has the overall responsibility of coordinating the implementation of local government functions, including water services. Support is being provided through Project Consolidate and other local government support programmes. Water resources and water services responsibilities are spread across the following provincial departments:

1. *Department of Developmental Local Government and Housing* – which plays pivotal role in the implementation of water services infrastructure.
2. *Department of Health* – implementation of health programmes; facilitation of environmental health including drinking water quality monitoring; and implementation of water and sanitation facilities for clinics.
3. *Department of Education* – implementation of education programmes including environmental education (including water-related issues); and implementation of school water and sanitation facilities.
4. *Department of Public Works* – implementation of community infrastructure through the Extended Public Works Programme, which includes water and sanitation.
5. *Department of Agriculture* – coordination of water use for agriculture and supporting emerging farmers, e.g. implementation of irrigation infrastructure.

The North West Water Sector Forum (NW WSF), established in 2004, continues to operate as a coordinating structure on all water sector activities in the Province. The NW WSF comprises subcommittees that deal with sanitation coordination, transfers and institutional support, water resources and infrastructure planning and development. District forums have also been established by municipalities to coordinate municipal level activities.

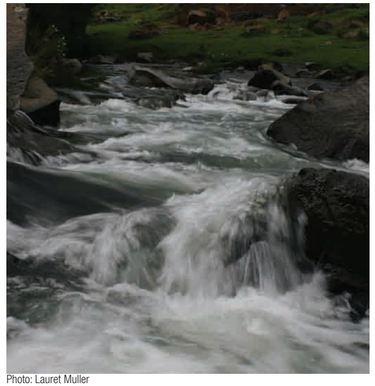

Photo: Lauret Muller

5.1.2. Ground and surface water pressures[2]

5.1.2.1. Groundwater

Groundwater is of importance in the NW Province as it is the only source of water for many communities. Up to 80% of water used in rural and agricultural communities is from groundwater resources, particularly in the arid western region. Both the quality and supply of groundwater resources in the NW Province are impacted upon by extraction for domestic and agricultural use.

Two main pressures affecting groundwater resources are depletion of the resource and impacts on water quality. The depletion of groundwater is associated with:

- Reduction of surface streams recharge;
- Abstraction for irrigation, drinking and stock watering purposes, and
- Removal or transfer associated with mining operations and industrial development.

The state of groundwater is discussed in the Water Situation Section of this chapter.

2 Refer to Chapter 2 for a discussion on drivers and pressures in the NW Province

Photo: Lauret Muller

5.1.2.2. Surface water

Population growth, environmental changes (e.g. climate change) and water demands from mining and industrial sources exert pressure on the water quality and supply of surface water. Factors that will impact on future use are:

- Domestic use –
  - *Population growth* – although the Province is currently experiencing decreased population growth due to migration out of the Province into urban areas, mining development, especially in the Bojanala Platinum district, will increase migration into the area and affect water requirements for both industrial and domestic use. For example, Rustenburg is currently the fastest growing city in Africa.
  - *Improved living standards* – Per capita use will grow due to improvement in living and service standards. This is likely to result largely from the eradication of the water services backlog and, in particular, from the bucket eradication programme in peri-urban areas as water-borne systems are introduced.

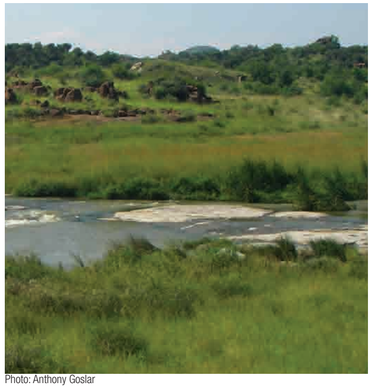

Photo: Anthony Goslar

- Mining, agriculture and industrial use – in areas of intense mining such as the Bojanala District, water consumption is very high relative to demand by other consumers.
- Water conservation and water demand management – to manage the effectiveness of Catchment Management Agencies, permitting, and enforcement capacity.

The scarcity of water is compounded by the deterioration in quality as a result of water pollution. The major sources of pollution are:

- Urban/industrial effluent return flows;
- Mining effluent and dewatering;
- Non-compliance of sewage works due to lack of finances and human resources;
- Eutrophication;
- Agriculture (nitrates from fertiliser application and salinisation);
- Acidification (for example, from acid mine drainage);
- Diffuse pollution from dense settlements;
- Sedimentation and silt migration;
- Treated sewage effluents, and
- Impoundments.

Non-point source or diffuse pollution, reported to comprise up to 80% of the pollution entering major river systems, includes agricultural runoff of fertilizers, insecticides and herbicides from agricultural land and storm water runoff from urban surfaces such as roads. Non-point source pollution is the most difficult to manage as it is readily dispersed in water.

The state of surface water is discussed in section 5.2.4 of this chapter.

5.2. Water Resources of the North West Province

5.2.1. Groundwater situation

In the State of the Environment Report (SoER) (NWDACE, 2002) the state of the groundwater resources in the NW Province was reported to be substantial and of a reasonable quality. There are a number of aquifers in the NW Province:

- Dolomitic (karstic) aquifers– dolomite is porous and groundwater may attenuate in dolomite;
- Intergranular aquifers – is characterised by perched water bodies over a bed of clay, and
- Fractures – groundwater flows through a crack in the underground rock formations.

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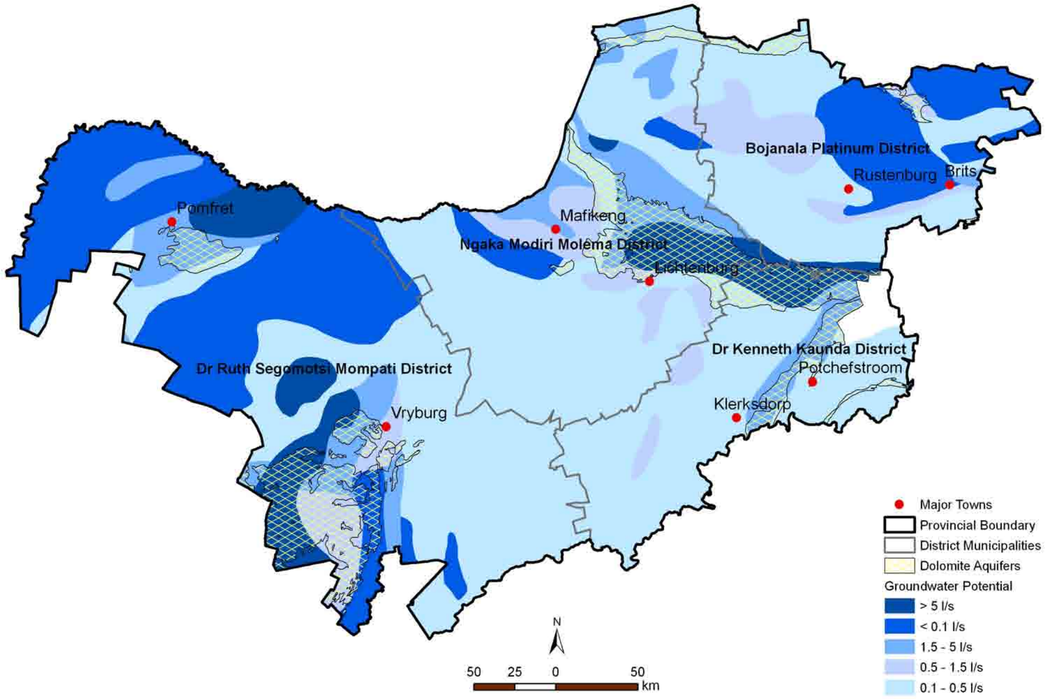

Figure 5-2: Map showing the groundwater potential of the NW Province, as well as the location of dolomite aquifers.

5.2.2. Groundwater quality

The water quality was found to be reasonable in most parts of the NW Province. Average major ion concentrations were found to be within drinking water quality limits for more than 60% of the groundwater samples (Zitholele Consulting, 2008).

The following lists the general findings of the specialist study:

- Regions of high Total Dissolved Solids (TDS) concentrations exist, which result from natural causes vand human impacts.
- High levels of nitrates as a result of human activity, such as agriculture, and naturally occurring inorganic nitrate.
- The high fluoride concentrations in groundwater are limited to small areas underlain by fluoride-rich rocks and are associated with the Bushveld Complex.
- High sulphate concentrations were associated with acid mine drainage. Sulphates present in the dolomite springs were associated with the gold mines from the far West Rand.

As communities in the NW Province are highly dependent on groundwater as a source of domestic water; the water quality for the current state is compared to the water quality guideline for domestic use (DWAF, 1996), Target Water Quality Range (TWQR) and the indicator limit identified for this study. Groundwater monitoring is conducted twice a year and sites were not always sampled simultaneously for the period 2002 to 2005. Therefore all data presented has been averaged for this period and for each drainage region.

All secondary drainage areas, except A2, were below the set DWAF guideline for electrical conductivity of 150 mS/m (Figure 5-3). Similarly, A2 exceeded the set DWAF guideline of 0.75 mg/l for fluoride while the other secondary drainage regions were below (Figure 5-4).

All of the secondary drainage regions of the North West, except for C2 and D4, exceeded the set DWA guideline for nitrate of 0 to 6 mg/l for domestic use (Figure 5-5). For A3 and C3, groundwater nitrate concentration was higher than surface water by up to 12 mg/l. This increase in nitrates in groundwater has been noted as a gradually prevalent trend in the last 3 years, and is associated with an increase in pit latrine use in rural areas as and population and informal settlements in the urban areas (Wiegmans, 2008).

The phosphate concentration in the groundwater at all the secondary drainage regions was found to be at least ten times below the indicator guideline (Figure 5-6).

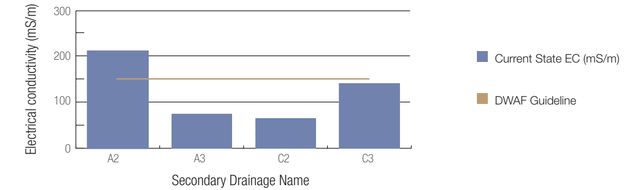

Figure 5-3: Average groundwater electrical conductivity in the NW Province secondary drainage regions compared to the DWAF guideline of 150 mS/m (Zitholele Consulting, 2008).

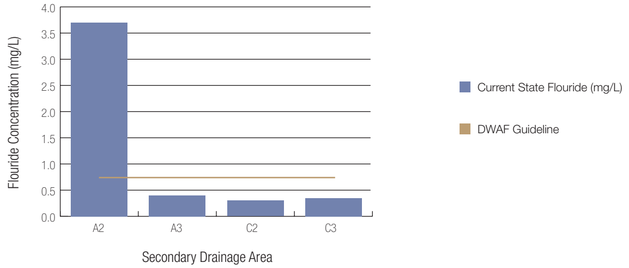

Figure 5-4: Average fluoride concentration in groundwater in the NW Province secondary drainage areas compared to the set DWAF guideline of 0.75 mg/l, for domestic use.

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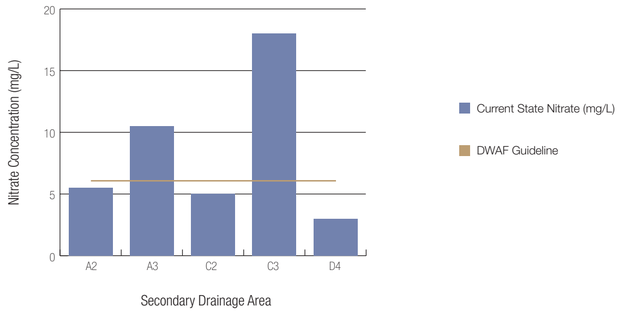

Figure 5-5: Average nitrate concentration of groundwater in the NW Province secondary drainage regions compared to the set DWAF guideline of 0 to 6 mg/l for domestic use.

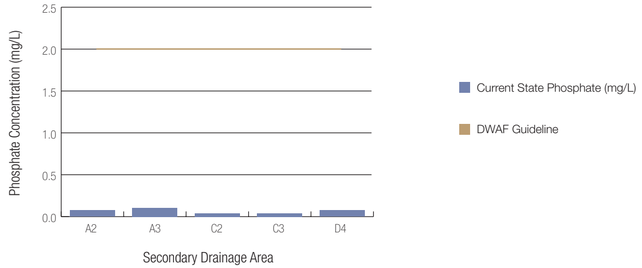

Figure 5-6: Average phosphate concentration for groundwater in the NW Province secondary drainage regions compared to the set DWAF guideline of 2 mg/l, for domestic use.

5.2.3. Impacts from human activities on groundwater[3]

Major impacts resulting from human activities on groundwater quality and quantity are related to:

- Reduced recharge;
- Reduced storage;
- Acid mine drainage;
- Increase in nitrates;
- Salinisation of water source;
- General pollution of groundwater;
- Public awareness (positive impact), and
- Adoption of sustainable development techniques and approaches to water quality management (positive impact).

Human activities impacting on the quantity and availability of groundwater include:

- With more rapid urbanisation, there is increased stormwater runoff, which minimises seepage of water back into the groundwater, thereby preventing recharge;
- Abstraction from boreholes for drinking water and central pivots for irrigation of crops, and
- Dewatering of the dolomitic compartments for mining activity.

Human activities directly impacting on the water quality of the water resource include:

- Pollution from return flows and surface waters which infiltrate and percolate into the groundwater;
- Poor sanitation provision in rural areas and cemeteries result in seepage of sewage into groundwater sources, and
- Long-term domestic consumption of groundwater with high nitrate concentration may pose serious health threats for infants and young children.

3 Refer to Chapter 3 for more information on mining and agriculture in the NW Province

Figure 5-7 : Map detailing the location of the catchments and quaternary drainage regions of the NW Province

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5.2.4. Surface water situation

The Crocodile West – Marico Water Management Area (WMA 3) borders on Botswana to the north-west. It includes two major river systems, the Crocodile and Groot Marico, which give rise to the Limpopo River at their confluence. Figure 5-7 shows the catchments within the North West Province WMA.

The water resources of the Crocodile West – Marico WMA support major economic activities of the WMA and a population of approximately 5 million people. This area has the largest proportionate contribution to the national economy, generating almost a third of the country's Gross Domestic Product (GDP). The WMA is highly altered due to catchment development and economic activity, dominated by urban areas and industrial complexes of northern Johannesburg, Midrand and Tshwane, and with platinum mining north-east of Rustenburg.

Extensive irrigation activities occur along the major rivers, with game and livestock farming occurring in other parts of the WMA. The two major rivers in the Crocodile West – Marico WMA (Crocodile River and Groot Marico River) form the south-western part of the Limpopo River basin (Drainage Region A), which eventually drains into the Indian Ocean off the coast of Mozambique. The WMA also includes the headwaters of the Molopo River, which is a tributary of the Orange River, draining westwards to the Atlantic Ocean. The WMA includes the tertiary drainage regions A10, A21 to A24, A31, A32 and quaternary drainage region D41A. The WMA covers a total catchment area of 47,565 km2. The Pienaars, Apies, Moretele, Hennops, Jukskei, Magalies and Elands rivers are the major tributaries of the Crocodile River which together make up the A20 tertiary drainage catchment, with 39 quartenary catchments. The Crocodile River contributes to the flow of the Limpopo River, which has an international river basin shared with Botswana, Zimbabwe and Mozambique.

The upper part of the catchment, south east of Hartebeespoort Dam, is located in the Gauteng Province. The north and north east corners lie in Limpopo Province and the central and western areas of the catchment lie in North West Province. The northern suburbs of Johannesburg, as well as Ekurhuleni and Krugersdorp, are situated in the Upper Crocodile sub-catchment (A21). Rustenburg is located in the Elands sub-catchment (A22), while Tshwane and Bela Bela are situated in the Pienaars sub-catchment (A23). These three sub-catchments feed into the Lower Crocodile sub-catchment (A24), within which Thabazimbi is located.

4 Refer to Chapter 3 for a discussion on land use and Chapter 7 for information of human settlements in the Province

5.2.4.1. Water availability and demand[4]

Catchments and water availability

The state of the water resources in the NW Province is characterised by an overall scarcity of water as many surface water systems are non-perennial. The quantity of available surface water decreases from east to west in the NW Province, with significantly higher flows in the east. The converse is true for the Crocodile West River: the flow in this river is increasing on an annual basis due to the discharge of treated waste water from the Johannesburg Northern Sewage Works.

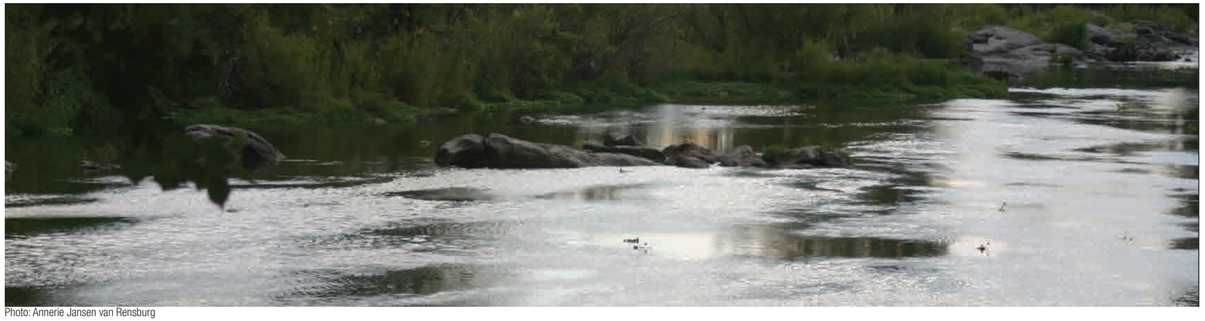

Photo: Annerie Jansen van Rensburg

The quantity of the water in the NW Province is affected by the following:

- Abstraction of groundwater from dolomitic compartments, which results in the effect on the quantity flowing from dolomitic eyes;
- Construction of dams and reservoirs result in changes in river and lake systems, and
- Interbasin transfers of water from different catchments, which has major flow ramifications for the rivers

Of the six major catchments in South Africa, the Limpopo, Orange and the Vaal flow through the NW Province. With the exception of the Vaal River, the highly variable runoff from the non-perennial water sources prohibits direct abstraction of water from rivers on a large scale in the NW Province (NWDACE, 2002).

Water use intensity in the catchments

The naturalised mean annual runoff in the Crocodile West catchment area is about 646 million m^3 per annum, with an exploitable groundwater resource of about 125 million m^3 per annum. The WMA receives water from the Upper Vaal and Olifants WMAs, of which the most significant transfer is by Rand Water from the Upper Vaal WMA to supply the urban and industrial demands of Johannesburg, Midrand, Tshwane and Rustenburg, as well as the larger mines in the WMA. Water is transferred from the Crocodile (West) – Marico WMA to Botswana (Gaborone) and the Limpopo WMA (Nylstroom). It is estimated that WMA has a natural mean annual runoff (MAR) of 855 million m^3 per annum.

It is estimated that 549 million m^3 per annum of the total MAR flows out of the WMA, with approximately 96% of this to the Limpopo River.

The Crocodile West catchment is heavily reliant on the Upper Vaal WMA for its water, which supplies approximately 90% of all municipal and bulk industrial water use and 50% of mining water use. This water contributes to 87% of the urban, industrial and mining return flow in the WMA. While the return flow offers considerable potential for re-use, effluent from industry and mining operations is causing major pollution of the rivers in the WMA. Further, municipal water use is expected to increase at 1% per year, and industry, mining and power at 2.5% per year. Irrigated agriculture and forestry use is not expected to increase.

Urban domestic and industrial users currently require about 529 million m^3 per annum, while bulk industrial users and mining requires about 120 million m^3 per annum.

A total of about 505 million m^3 per annum of this urban, industrial and mining use is supplied directly from the Upper Vaal WMA, and to a minor extent the Olifants WMA. The urban, industrial and mining uses contribute a little over 356 million m^3 per annum through return flows. Due to reduction in gold mining activities in the Upper and Middle Vaal WMAs, many mining companies are shifting their focus to the mineral wealth in the Crocodile (West) – Marico WMA and it is expected that this sector will show a larger than normal growth rate in the near future.

Rural users currently require about 70 million m^3 per annum: 25 million m^3 per annum is used for domestic consumption and the remainder is used for stock-watering and subsistence agriculture.

Due to the high intensity water use in the Crocodile West – Marico WMA, the CMA faces significant challenges in terms of:

- Reconciling and managing the requirement for water with the availability, taking account of the water transfers from the Upper Vaal WMA;
- Managing the water quality impacts associated with effluent discharge, urban runoff and mining in the Crocodile River catchment;
- Collecting and managing the data and information required for effective water related decision making;
- Implementation of Reserve requirements, and
- Co-ordinating the range of powerful institutions associated with the WMA (DWAF, 2003).

The land use characteristics of the Marico catchment comprise rural economic activities consisting of subsistence dryland agriculture and cattle grazing with some commercial irrigation in the upper catchment and along the Marico River downstream of the Marico Bosveld Dam and Molatedi Dam. There are no major towns in the catchment but smaller settlements are scattered throughout. The surface water runoff is highly variable and the available surface water resources of the area are highly developed with limited potential for further development. Groundwater in the Marico area is an abundant source of water because of the geology of the area. Groundwater is important at two levels, as there are high yielding dolomitic aquifers in the NW Province, and groundwater is the main source of water for rural settlements.

5.2.4.2. Changed hydrology in major rivers

Many impoundments or dams in the rivers of South Africa have been constructed due to the high volumes of water required for domestic use, industry, mining and agriculture. The Vaal is one of the most important rivers in the NW Province, and the construction of many large dams and the transfer of water from other catchments into the Vaal River have had a significant impact on the natural hydrology of the river system.

Johannesburg's Northern Waste Water Works discharges effluent into the Jukskei River, which flows into the Crocodile West River, resulting in South Africa's largest inter-basin transfer. Consequently, the natural mean annual runoff of the Crocodile West River is currently exceeded by at least 100%. This has allowed for an increased area for irrigation of crops below Hartebeespoort Dam and the lower Crocodile West River, as well as for potential power stations to be constructed in the area.

The Marico River is seasonal, and originates from groundwater at a dolomitic eye. The dolomitic eyes are under pressure due to exploitation by irrigation exceeding recharge. The Schoon Spruit eye and river are similarly impacted upon due to the irrigation usage.

Mining

Mining places significant negative pressure on the NW Province's water resources. Mining activities require high volumes of water for production and for disposal of waste products into the used water, as effluent. Depletion of surface water resources due to mining activities is difficult to differentiate from the depletion of the groundwater, as mine water balances are generally not measured. The deep mining operations in the Klerksdorp area are an example of the depletion of the aquifers in the vicinity of the mining activities.

The mining of the platinum belt within the NW Province is increasing and Rustenburg is the fastest growing city in Africa (Business Day, 2008). Associated with this growth is an increased demand of industrial and domestic water supply. Consequently, there is also an increased production of waste, and mining effluent. The mining support industries are also growing especially within the greater Rustenburg area.

Agriculture

There is a pressure on the water supply for dry-land crop production, as well as stock and game farming. Irrigation in the agricultural sector accounts for the greatest water use where the majority of water for irrigation is abstracted from groundwater.

Industry

Industrial activities in the NW Province largely support the mining, agriculture and foodstuff industries. These industries cause an impact through the demand for water, the influx of labour living close to the work place, and through the discharge of various waste products into water sources (NWDACE, 2002). This results in heightened negative impacts on aquatic and terrestrial ecosystems.

Tourism

The tourism sector places pressure on the surface water resources of the NW Province through the need for sanitation and water-supply services; increased water consumption

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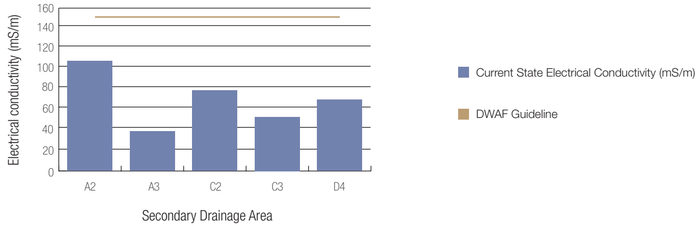

Figure 5-8: Average electrical conductivity (mS/m) of the NW Province secondary drainage regions compared to the DWAF guideline of 150mS/m (Zitholele Consulting, 2008).

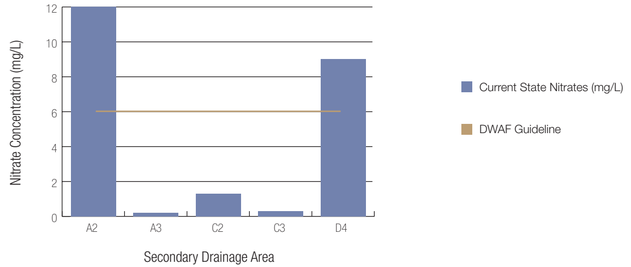

Figure 5-9: Average Nitrates (NO2 and NO3) concentration of the NW Province secondary drainage region in the NW Province compared to the 6 mg/l.

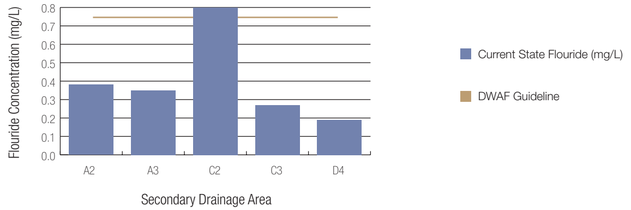

Figure 5-10: Average fluoride concentration of the NW Province secondary drainage regions compared to the DWAF guideline of 0.75 mg/l.

and pollution from domestic sewage. These are, however, offset by the positive aspects such as increased wetland creation and protection, and the general uplifting of workers in the industry.

5.2.5. Water quality [5]

5.2.5.1. Rivers

The rivers data (NWDACE, 2002) that follows covers a five year period from 2002 to 2007. The water quality of the rivers was compared using the TWQR for aquatic, domestic and recreational uses, and where these values exist the comparison has taken all three uses into account.

All the secondary drainage areas had electrical conductivity averages below the target 150mS/m guideline (Figure 5-8), while the nitrates and nitrites (NO_3 and NO_2) exceeded the DWAF guideline at A2 and D4 (Figure 5-9). The average fluoride (F) levels (Figure 5-10) and phosphate (PO_4) levels (Figure 5-11) were below the 0.75 and 2.0 mg/l guidelines respectively (Zitholele Consulting, 2008).

Faecal coliforms are not monitored at most of the rivers and the data available was only for six sites in the A2 secondary drainage region. All of the sites, as well as the average value for the sites, exceeded the DWAF guideline of 2,000 counts per 100ml (Figure 5-12), and this could result in the risk of gastrointestinal illnesses. At these sites, the more stringent full contact TWQR for recreational purposes should be applied.

5.2.5.2. Dams

The analysis of dam water quality was reported in detail in the SoER (NWDACE, 2002). The reported data was assumed to be an average for each of the variables measured, thus all data collected for the period 2002 to 2007 was also averaged.

Dam fitness for use (Chlorophyll-*a*)

Chlorophyll-*a* (Chl-*a*) concentration (mg/l) is used as an indication of a dam's fitness for use for recreational purposes and the TWQR for Chl-a for non-contact recreation is set at 0 to 30µg Chl-*a*/l for full recreational use, while non-contact recreation range is at 0 to 15µg Chl-*a*/l (DWAF, 1996). Figure 5-13 shows that only 8 out of 15 of the dams where Chl-*a* monitoring was conducted were acceptable for non-contact recreation. Taung Dam had the highest concentration of 326µg/l.

5 Chapter 7 provides additional information of potential issues surrounding poor water quality

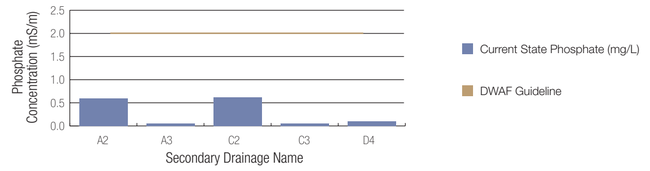

Figure 5-11: Average phosphate concentrations of the NW Province secondary drainage regions compared to the DWAF guideline of 2 mg/l.

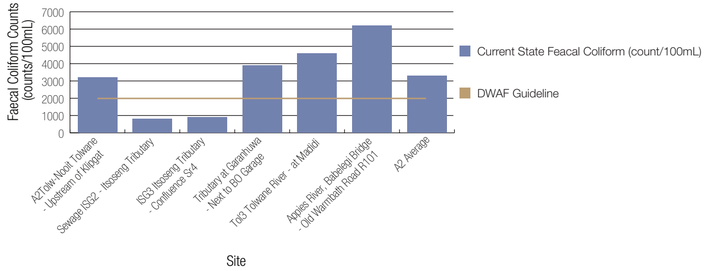

Figure 5-12: Faecal coliforms data and average for sites in the A2 secondary drainage region (data not available for other drainage regions in the Province).

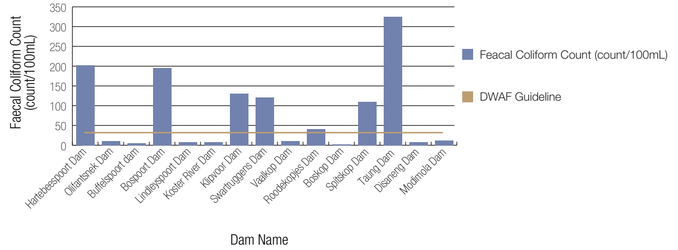

Figure 5-13: Average Chlorophyll-a data for the NW Province dams compared against the TWQR guideline (DWAF, 1996) for non-contact recreational use.

The high levels of Chl-*a* are indicative of eutrophication in the dams, however, no significant health effects are expected.

Water quality

The current water quality status of the dams was determined from a five year average, from 2002 to 2007, for similar variables reported in the SoER (SO_4, F, Cl, F, TAL, Na, K, Mg and Ca).The trend established in dam water quality data was that there was generally a slight increase in concentration of each of these variables between 2002 values and the current data. There was a decrease in total alkalinity of between 5 and 50 mg/l in the Vaalkop, Roodekopjes, Kosterrivier, Swartruggens and Rietspruit Dams.

5.2.6. Impacts from human activities, including transboundary impacts[6]

Surface water quality is impacted on by the following:

- ☐ Impoundments;
- ☐ Sewage effluents;
- ☐ Pollution of surface water resources from surface run-off and other sources;
- ☐ Salinisation;
- ☐ Acidification from mining effluents; and
- ☐ Diffuse pollution from dense settlements;

These impacts in turn have an effect on the habitat integrity and aquatic biodiversity. The enrichment of surface water and eutrophication (as indicated by Chlorophyll-a levels of 200 µg/L in several dams) as reported in section 5.2.5.2 results in the formation of algal scums, proliferation of macropytes and the formation of incubation sites for potentially toxic algae, as observed on the surface of the shallow Bospoort Dam.

6 Refer to Chapters 2 and 7 for more information on the social situation in the Province

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The total water reconciliation shows a need to examine water requirements in all the NW Province's major river catchments. Development in the province may be potentially halted, according to the high and base scenario for the year 2025 as reflected in the National Environment Outlook (SAEOR, 2007).

The potential water quantity impacts include:

- The construction of dams and reservoirs result in changes from the riverine to lacustrine systems, and
- Interbasin transfers of water from different catchments have major quantity ramifications for the rivers.

5.2.7. Impacts of poor water quality on water users[7]

In line with the national inland water indicators (DEAT, 2001) and including the issues raised, the following indicators were identified as important for freshwater resources in the NW Province (Zitholele Consulting, 2008). These indicators need to be regularly monitored, trends need to be derived and in cases where downward trends have been identified, the necessary remediation measures need to be implemented:

- Nitrites, resulting from on-site sanitation, waste water treatment facilities, fertilizer industry and in agricultural practices have a negative impact on water quality and can result in eutrophication in water bodies such as dams characterised by high algal blooms. This results in reduced oxygen or anoxic conditions. Data obtained through regular monitoring should be analysed and compared to the baseline (prior to impact) as well as against the DWAF guidelines for the specific water users;
- Phosphates in water have a similar effect to nitrites, resulting in algal blooms;
- Faecal coliforms, resulting from the impact of poor sanitation and non-compliance of wastewater treatment facilities to DWAF guidelines for waste water discharge. At high levels, faecal coliforms counts can result in the outbreak of water borne diseases such as cholera;
- Radionucleids, resulting from chemicals used in mining activities, may have adverse health effects on humans and other water users;
- Electrical conductivity in water is an indication of high salts resulting from industrial and mining activities where effluent discharged does not meet DWAF standards;
- The presence of high levels of heavy metals in the water resources can result from mining and industrial activities where discharge standards are not met. The impacts of heavy metals also include bioaccumulation in fish and plants and transfer through the food chain through the ecosystem. Other heavy metals are considered carcinogens, and
- Other indicators of concern will be determined from the type of activities taking place in the NW Province (such as effects of chrome from chrome mining).

Photo: Werner Bentz

5.3. Aquatic ecosystems[8]

RAMSAR defines a wetland as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt" (Cowan, 1995). This includes water bodies such as pans, springs, seeps, bogs, mires, marshes and riverine wetlands. Wetlands contribute to natural filtration and purification of water, as well as providing habitat for amphibians, fish and waterfowl and breeding grounds for a number of these species. Wetlands are caused by unique aquatic and terrestrial conditions, and consist of highly complex ecosystems. Wetlands are considered to be one of the most threatened habitats worldwide. Wetlands have a high biodiversity, and flora and fauna in these habitats show extensive variation, due to the variable hydrological processes in each specific wetland (NWDACE, 2002).

The NW Province is part of the Western Plateau of the Plateau Wetland Group which has the highest concentration of pans and wetlands in South Africa. The majority of the pans in the NW Province are endorheic pans (closed wetlands with no outlet) and have an average size of 8 ha (there is a total of 636 pans located in the Western Plateau). Several of these pans are found on the watershed between the Vaal and the Limpopo river systems, as well as on the Ghaap Plateau; the remainder are located in the area drained by the Harts River system (NWDACE, 2002).

There are approximately 40 major wetland areas within the NW Province (NWDACE, 2007). They are composed of riverine wetlands, dolomitic eyes, palustrine wetlands and endorheic wetlands or pans of which Barbers Pan is the NW Province's largest. Many wetlands have been lost or seriously degraded worldwide, and the remaining wetlands in NW Province are considered to be ecologically sensitive areas, particularly the dolomitic eyes, namely the Molopo and Ventersdorp eyes. Unpredictable seasonal changes lead to a range in physical and chemical properties of the substrata and water in pans, such as major changes in salinity (NWDACE, 2002).

Barbers Pan, situated 15 km north-east of Delareyville, is a large permanent alkaline lake and was declared a natural reserve in 1954, and more recently, a RAMSAR site, and is now a protected area. The pan is approximately 2,000 ha in area and has an average depth of 10 m with a catchment area of 30 km^2. The pan is considered to have a high ecological status and is an important resting point for many species of migrating birds, and is the only location in South Africa where the pintail Anas acuta has been sited. Several species of waterfowl use the wetland as a breeding ground. Seven endangered bird species and two endangered mammal species have also been recorded in the Pan. Barbers Pan also supports a rich plankton community (Walmsley & Pretorius, 1996). Pans are usually not permanent, such as those fed by dolomite springs. Barbers Pan is one of the only perennial pan wetland systems in the NW Province, and becomes a significant habitat for fauna species during dry periods.

5.3.1. The unique dolomitic eyes of the Crocodile (West) and Marico Water Management Area

Dolomitic eyes are water bodies fed by groundwater originating from fractures in the underlying dolomite. The fractures and intrusions of geological formations impenetrable to water in the dolomite layer, form aquifers, dolomite compartments and dolomitic eyes. Aquifers are subterranean waterways/tunnels and reservoirs from which water is forced above ground through openings (fractures), which are then called dolomitic eyes or springs. The dolomite area covers approximately 4,022km^2 of the NW Province and forms the main watershed of the east-flowing Limpopo River system and the west-flowing Molopo River (NWDACE, 2002).

The interdependence of ground and surface water is apparent in the ecology of the dolomitic eyes. These eyes are influenced by the water quality and quantity of both the surface water and the groundwater.

The sources of the Molopo, Molemane and Marico rivers are unique dolomitic eyes (springs) and associated wetland systems, which have great conservation significance. One of the main contributing factors to the unique resident ecological communities is the geographical isolation at surface water level. Eyes have been isolated for millennia, allowing for speciation through genetic mutations and adaptation to localized environmental conditions. The groundwater linkages in the aquifer systems contribute to the sensitivity of the dolomitic eyes, and groundwater abstraction further away from the source can reduce the water levels at the dolomitic eyes.

Box 5-2: What is biomonitoring? (CSIR, 2008)

Biomonitoring is the use of living organisms in aquatic systems as biological indicators of ecosystem or environmental "health". Flora and fauna provide a long-term outlook of water quality and quantity, habitat quality and other environmental conditions.

Organisms and indicators of ecosystem health include:

- Fish (Fish Community Integrity Index)
- Aquatic Invertebrates (South African Scoring System SASS5)
- Aquatic Habitats (Integrated Habitat Assessment System IHAS)
- Plants (Riparian Vegetation Index RVI)
- Water flow (Hydrological Index)
- Water quality (Dissolved Oxygen, pH, Conductivity, Temperature)
- River channel condition (Geomorphological Index)

Photo: NWDACE

5.3.2. River Health Programme[9]

The River Health Programme (RHP) was initiated in 1994 by DWAF. The RHP was developed in response to the need for monitoring, assessment and reporting on the ecological status of river ecosystems, based on their biological condition in relation to the anthropogenic impacts on the water resources (CSIR, 2005).

Rivers in the NW Province that have been included in the RHP are as follows:

- Groot Marico River;
- Hex River near Rustenburg;
- Elands River near Rustenburg;
- Crocodile River downstream of Hartebeespoort Dam;
- Mooi River near Potchefstroom;
- Schoonspruit near Ventersdorp to Orkney;
- Harts River from Lichtenburg to Spitzkop Dam;
- The section of the Vaal River forming the boundary between the Free State and the North West, and
- The dolomitic eyes or springs such as the Molopo, Groot Marico, Schoonspruit, Malmane and Wondergat Eyes.

7 A discussion of health related issues as a driver in the NW Province is included in Chapter 2

8 Refer to Chapter 4 for a discussion of biodiversity in the province

9 Refer to Chapter 4 for further discussion of the RHP

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Based on monitoring and assessment of the above river, the RHP concludes that the overall EcoStatus of the Crocodile (West) Marico WMA is as follows (CSIR, 2005):

- The Apies/Pienaars sub-management area has a poor ecological status due to the impacts of impoundments, urbanisation and effluent discharges from urban areas, agriculture, and alien and invasive species.
- The upper Crocodile area has a poor ecological status, due to mining operations, industries, agricultural runoff, urban developments and informal settlements. The Sterkstroom River does, however, have a good to fair status.
- The Elands sub-management area is considered to have a fair ecological status, but the Lower Hex River is in a poor state. The rivers in this area are impacted by alien and invasive flora species, impoundments, irrigation from agricultural activities, mining operations, and road construction.
- The Lower Crocodile sub-management region is considered to have a status of fair to poor. The rivers in this area are impacted upon by invasive species, dams and weirs, which alter the hydrology of the rivers.
- The ecological status of the Marico sub-management region is good to fair in the upper reaches of the Groot Marico, and decreases to fair to poor downstream. The rivers are affected by dams and weirs, mining, agriculture, alien fish species, and water demands that exceed supply.

5.3.3. Impacts on wetlands and aquatic ecosystems

Based on a visual assessment of the existing impacts and communications with a wetlands specialist who has worked extensively in the area (Otto, 2008), the following impacts were identified:

- Mining:
  - Dumping of waste material onto wetlands,
  - Compacting of wetland soils by heavy duty vehicles,
  - Diversion of water courses from natural flow patterns, and
  - Possible contamination of water courses through discharge of point source pollution;
- Agriculture:
  - Ploughing and planting in wetland areas;
  - Isolation of pans (depressions) by ploughing around the pan thus cutting off corridors for biotic movement, and
  - Overgrazing of grassland and wetland vegetation leading to gully erosion.
- Other:
  - Uncontrolled veld fires.

Many of the wetlands in the NW Province are largely degraded as mining and agriculture have contributed to the loss in function and form of the wetlands. There are however some areas where the level of disturbance is low, thus increasing the possible occurrence of wetlands of a moderate to high status (Zitholele Consulting, 2008).

Photo: Mary-Ann Palmer

5.4. Demand for water resources[10]

5.4.1. Domestic demand for water

Access to clean potable water is identified as a basic right in the Constitution. As a result, population growth and the subsequent demand for water is one of the largest pressures influencing the state of water resources. In a semi-arid and potentially vulnerable Province such as North West, rising population numbers and the ever-increasing wealth and standard of living exert a burden on almost every conceivable aspect of the environment. The tendency to migrate to urban areas has resulted in a gradual increase in demand for water resources in these urban areas.

Communities, rural communities in particular are becoming more developed and economically empowered than previously. Raised expectations and higher standards of living are resulting greater volumes of water required to ensure a basic supply of potable water available at a point 200m of their homes. For South Africa as a whole, the expected increase in demand for urban and domestic water over the next thirty years is 219% (Walmsley & Pretorius, 1996).

5.4.1.1. Access to basic services

- Approximately 1 million people are still without access to basic water supply in the NW Province (NWDACE, 2007). According to the current estimate, 19% of the total population does not have access to basic services or have services below basic standards.
- Backlogs have been reduced considerably since 1994, however the remaining 19% must be addressed within the next two years to meet the 2008 target (NWDACE, 2007).
- Areas most affected are rural villages, farm settlements and informal/peri-urban settlements which form part of new developments and not backlogs.
- Factors that impact on the eradication of backlogs include insufficient water resources, insufficient bulk infrastructure and needs for higher levels of services.

10 For more information, refer to Chapter 7

District Municipality	2005			2006*		
	Estimated Population (March 2005)	Population below RDP Water	% of Population below RDP Water	Estimated Population (March 2006)	Population below RDP Water	% of Population below RDP Water
Ngaka Modiri Molema	1,034,481	312,520	30.21	815,342	199,956	5.86
Bojanala Platinum	1,514,488	366,300	24.19	1,270,363	254,478	7.46
Dr Ruth Segomotsi Mompati	517,056	174,760	33.8	448,563	118,873	3.49
Dr Kenneth Kaunda	835,525	67,544	8.08	876,012	39,560	1.16
NW Province	3,901,550	921,123	23.61	3,410,280	612,867	17.97

Table 5-1: Water supply below RDP standards (DWAF, 2006)

* Figures are based on the new demarcation of the province

5.4.2. Water Supply

Sustainable access to an improved water supply refers to the proportion of the population, urban and rural, who use any of the following types of water supply for drinking (DWAF, 2006):

- Piped water;
- Public tap;
- Borehole or pump;
- Protected well;
- Protected spring, or
- Rainwater.

Improved water sources do not include vendor-provided water, bottled water, tanker trucks or unprotected wells and springs.

According to DWAF (2006), approximately 23% of the Province was below the RDP water standards in 2005, as shown in Table 5-1. The situation improved to 18% in 2006 (aligned with new demarcation). The Dr Kenneth Kaunda District indicates the most favourable situation with only 1.1% of its population below RDP standards in 2006, while the Bojanala Platinum (7.5%) and Ngaka Modiri Molema Districts (5.8%), with their larger populations, did not fare as favourably in 2005. As the 2006 figures are aligned with a revised demarcation, the improvement may be less substantial than shown here.

According to StatsSA (2007), the percentage of households with sustainable access to an improved water source in the NW Province has been steadily increasing from 78% in 2001 to 97.3% in 2005, representing a 5.7% growth rate over this period. This shows that the Province has already achieved the millennium development goal (MDG) of halving the proportion of the population without sustainable water source and is close to achieving the WHO goal of 100% access to an improved water source.

Access to piped water in the NW Province improved from 86.6% in 2001 to 89.9% in 2007. The Dr Kenneth Kaunda District accounts for the most households with access to piped water (97% in 2007). The most significant growth in access to piped water was seen in the Bojanala Platinum and Ngaka Modiri Molema Districts.

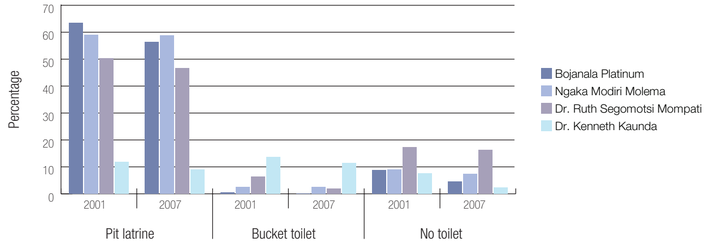

Figure 5-14: Households with access to piped water (%) (Stats SA Community Household Survey, 2007)

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5.4.3. Sanitation

According to DWAF (2006), a total of 49.79% of the population in the Province was below the RDP standards for sanitation[11]. Approximately 1.94 million people were below the RDP sanitation level in 2005, which decreased to 1.37 million in 2006.

An overall improvement in sanitation has been noted in the NW Province, through the installation of pit latrines and bucket toilets. Eradication of sanitation backlogs remains a significant challenge for the Province. Upgrades to the waterborne sanitation systems are also proposed for the near future within the Province.

Photo: Lauret Muller

5.4.3.1. Services to institutions

Approximately 300 schools are still without access to adequate water supply and sanitation services. Most clinics have basic water supply and sanitation facilities. The estimated backlog is below 10% (NWDACE, 2007).

11 Refer to Chapter 7 for more details.

5.4.4. Water demand for economic activities

5.4.4.1. Primary sector - mining

The various forms of mining undertaken in the region place significant negative pressure on the Province's water resources. The pressures exerted on the water resources are manifested as the following impacts:

- Changed hydrology;
- Increased waste water production;
- Reduction in water quality, and
- Reduction in water availability.

Mining activities require large volumes of water for production and also disposal of waste products, which is discharged as effluent into rivers and other water bodies. Mining wastes, such as overburden, waste rock or slimes have a negative impact on the aquatic environment, due to leaching of pollutants into water sources. Mining at depth cannot be conducted safely below dolomite aquifers, so the standard practice of the industry is to dewater such aquifers for safe operations. As a result, many local aquifers have been significantly impacted.

The water balances for the mines are not generally measured or monitored. As a result it is difficult to determine the extent of the impact of mining activities on the depletion of surface and groundwater sources.

Most underground mining operations pump water out of the deep shafts. While this has cost implications for the mine, for the implications on water quality are as follows:

- Often mining production is affected by flooding, leaving acid mine drainage problems for the authorities in the future, and
- Many mines recycle and re-use their water and, with the threat of discharge charge systems with penalties for both quality and quantity, mines refrain from continuously pumping polluted water into the water bodies.

The consistent increase in the price of platinum over the last decade has turned Rustenburg into a mining boomtown. This has resulted in the rapid growth of the formal planned urban area, as well as informal unplanned urban growth within the province. Population growth and urbanisation place additional demands on groundwater resources.

The influence of other major driving forces is expected to intensify in the future. However, population growth projections have to be gauged against the on-going AIDS epidemic. Corrected population estimates are important in determining the demand on groundwater resources and quality protection measures.

Mining activities attract support industries which amplify the impact and create a simultaneous rise in demand for water, production of waste, specifically sewage and mining effluent. The consequence of increased labour and settlement density is a rise in volume of solid and liquid domestic discharges, both of which can exert considerable pressure and have an impact on local ecological systems.

Because the groundwater reserves have not been quantified in the NW Province, in many instances demand for water may exceed supply.

5.4.4.2. Primary sector - agriculture

A well-developed agricultural industry provides food for the population and raw materials for industry, and earns foreign exchange by exporting surplus production. Irrigation to sustain this industry is the largest water consumer in the NW Province. The pressure on the water supply from dry-land crop production, as well as stock and game farming, is insignificant compared with the demand from irrigated farming. Irrigated agriculture is the major water user in the catchment area, requiring about 418 million m^3 per annum, much of which is abstracted from groundwater

Irrigation farming depends on two factors: a constant supply of water and the availability of good arable soil. In many of the dolomitic areas, the overlaying soil is arable and highly fertile.

As dolomites generally retain water in the form of underground reservoirs, the historical practice of farmers has been to extract groundwater for irrigation. Currently, a significant proportion of the total area under irrigation in the province uses wasteful flood irrigation methods. Extraction of water held in dolomitic reservoirs for irrigation and other activities has a significant impact on these pristine water sources. Changes in pH, caused by mining and agricultural activities, and high abstraction rates can cause the collapse of the dolomitic cavities, leading to the permanent loss of the reserve. Another negative effect of irrigation is the washout of fertiliser and agrochemicals into the receiving watercourses.

In the Upper Molopo catchment, the land use pattern is mainly grazing and dry-land subsistence agriculture.

WMA	Natural surface water resource	Natural Groundwater resource	Reliable local yield*	Transfers in	Local req	Transfers out	Balance	Potential for development
Limpopo	160	98	281	18	322	0	-23	8
Crocodile West and Marico	203	146	716	519	1,184	10	41	0
Middle Vaal	-67	54	50	829	369	502	8	0
Lower Vaal	-54	126	126	548	643	0	31	0

Table 5-2: Reconciliation of the requirements for and availability of water (106 m^3/annum) for year 2000 and the potential for development for the year 2025

* - Includes usable return flow

Mafikeng is the major urban and industrial town in the catchment. Commercial irrigated agriculture occurs in the northern and western portions where the dolomites traverse the Upper Molopo catchment. In the Upper Ngotwane catchment, cattle grazing and subsistence agriculture are predominant.

Overgrazing in some portions of the catchment, particularly the Upper Molopo and Upper Ngotwane, has resulted in excessive soil erosion and loss of land cover with an impact on groundwater recharge. There is very little urbanisation in the catchments of the Marico, Upper Molopo and Upper Ngotwane. The significant urban areas in these catchments are:

- Mafikeng, the capital of the North West Province, situated in the Upper Molopo catchment, and
- Zeerust, a mining and agricultural town, situated in the Marico catchments.

To supply the ever-increasing population with crop foods, an increase in agricultural production is anticipated, resulting in an increase in irrigation demand. For South Africa as a whole, the expected increase in demand for irrigation water over the next thirty years is 28%, while mining and industrial growth is estimated at 111%.

5.4.4.3. Tertiary sector – tourism

Tourism and game ranching rely on the ecological environment. The tourism sector places pressure on the surface water bodies via reticulated water and sanitation services, as well as increased pollution from recreational use. These are offset by the positive aspects such as increased wetland creation and protection, and the general upliftment of workers in the industry.

Dams are used for tourism and recreation, and this is a positive revenue generator for the NW Province. However, high volumes of sewage and high nutrient run-off lead to eutrophication in these dams. Recreation sports are negatively impacted, as eutrophication leads to anaerobic conditions, which results in nuisance odours, fish kills and potential human health risks. There is an urgent need for upstream users to discharge effluent that is compliant with relevant DWAF standards. Periods of decreased rainfall and increased temperature result in an increase in evaporation, and may lead to an increase in concentration of the pollutants in the water, all of which affects the tourism potential of the area.

The total water reconciliation of the requirements for water and the availability of water in all the NW Province's major river catchments, for the year 2025, is shown in Table 5-2.

5.5. Conclusion

Water quality in rivers is generally acceptable for aquatic and domestic use. Water quality in dams has slightly declined when compared to the data presented in the SoER (NWDACE, 2002), and there is an indication of eutrophication in 8 out of the 15 dams for which Chl-*a* is measured. This is an indication of poorer water quality entering the dams as a result of upstream activities. Further, Hartbeespoort Dam has for a number of years experienced unacceptable high levels of algae on the dam. This has had a negative affect on the water quality, the fish life, use of the dam and the environment. Although the groundwater quality is generally acceptable, the growing population, industrial and mining activities will, in the foreseeable future, impact negatively on this water resource.

The Crocodile (West) Marico WMA is a highly altered catchment area, and supports a growing population, extensive agriculture, industrial activities and mining operations. These activities impact on both the availability of water as well as water quality. The NW Province is considered a water scarce region and due to the high demand for water in the NW Province, the potential for future development is restricted.

An overall assessment of the water resources quality in accordance to the selected outlook indicators was not possible due to the lack of or limited data of the following indicators:

Surface water toxicity;

- Faecal coliforms;
- Surface water radioactivity;
- Groundwater toxicity, and
- Groundwater radioactivity.

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5.6. Responses[12]

DWAF have implemented the "Harties metsi a me" programme to remediate the excessive algal blooms and subsequent eutrophication at Hartebeespoort Dam. The programme includes a number of activities to improve the water conditions in and around the dam (DWAF, 2008):

- Development of a Resource Management Plan to ensure sustainable management of the dam;
- Investigation of the recreational use of the dam and management of such activities;
- Removal of the algal bloom and disposal of removed matter;
- Removal of the sediment and investigation of the uses of the removed material;
- Re-establishment of the fish population and investigation of the potential for job creation;
- Restoration of riparian vegetation for the purpose of establishing habitat for aquatic species;
- Consideration of alternative, sustainable methods for water treatment;
- Rehabilitation of wetlands as well as establishment of artificial wetlands upstream of the dam basin created to assist with water cleansing, and
- Continual monitoring of water quality in the dam to ensure that the rehabilitation programme is effective.

The programme is currently being implemented by Rand Water.

The South African River Health Programme is a national initiative to monitor the condition of rivers in the country using standardised biomonitoring methods (CSIR, 2008). The RHP is co-ordinated by DWAF, DEAT, and the Water Research Commission (WRC), and a number of reports and posters have been produced to illustrate the issues identified in each province and the management initiatives.

It requires specific management actions to ensure that the capacity of our rivers do not exceed sustainable levels. These management actions are summed up in Table 5-3.

12 For more detail on responses, refer to Chapter 10.

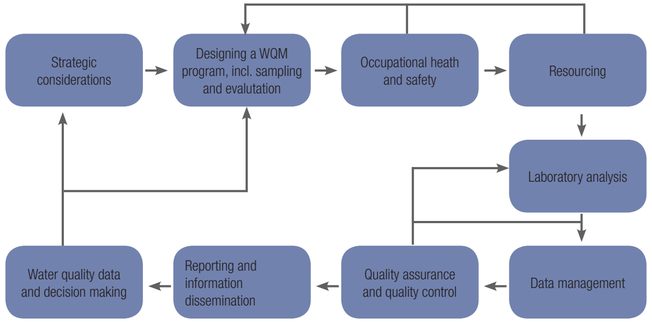

Figure 5-15: Water Quality Monitoring Process (Water Quality Monitoring Toolkit, 2008)

As impacts on the water resource and on the water user are interrelated, responses are focused on the sustainable supply of suitable quality water for communities, industry and natural ecosystems, as well as on the quality of such resources.

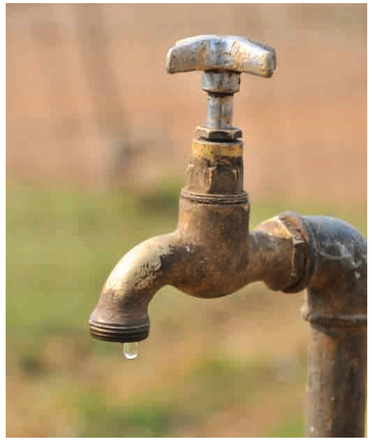

Photo: Lauret Muller

Water quality monitoring provides an understanding of the patterns and trends in the condition of water resources as a result of natural change or anthropogenic impacts, as well as a tool to evaluate the effectiveness of management practices. Figure 5-15 above illustrates the generic water quality monitoring process.

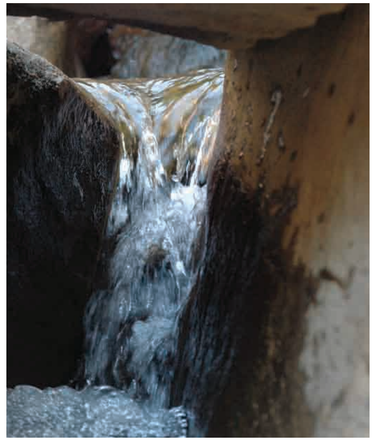

Photo: Lauret Muller

Management / mitigation measure	Responsible group
Minimise future development within the riparian zone. Control and manage existing activities such as urban development, road construction, grazing and mining activities which, sometimes irreversibly, change the structure and functioning of the riparian zone.	☐ Department of Water Affairs and Forestry ☐ Department of Environmental Affairs and Tourism ☐ National Department of Agriculture ☐ Department of Minerals and Energy ☐ Provincial Departments of Conservation and Environmental Affairs ☐ Water User Associations and Future Catchment Management Agencies
Clear alien vegetation.	☐ Department of Water Affairs and Forestry ☐ Provincial Departments of Conservation and Environmental Affairs ☐ Working for Water
Set water resource quality objectives for the rivers and monitor to ensure compliance.	☐ Department of Water Affairs and Forestry
Improve farming practices: water abstraction; agricultural return flows pollute water resources.	☐ Department of Water Affairs and Forestry ☐ National Department of Agriculture ☐ Landowners, farmers
Adhere to licensing conditions for discharges.	☐ Department of Water Affairs and Forestry ☐ Landowners, farmers ☐ Developers ☐ District and Local Municipalities ☐ Industry and Mining
Upgrade sewage systems and improve their management.	☐ Department of Water Affairs and Forestry ☐ District and Local Municipalities
Characterise, delineate and classify seeps, springs and palustrine wetlands within the WMA in order to derive their protection status.	☐ Department of Water Affairs and Forestry ☐ National Department of Agriculture ☐ Provincial Departments of Conservation and Environmental Affairs ☐ Rural communities
Manage surface runoff at the source - impervious surfaces (roads, paving, roofs, etc.) that accompany urban development cause water that would naturally percolate into the ground to form rapid flowing surface runoff.	☐ Department of Water Affairs and Forestry ☐ Landowners, farmers ☐ District and Local Municipalities
Control alien flora and fauna - alien fish cross breed and their feeding behaviour alter in-stream habitat.	☐ Provincial Departments of Conservation and Environmental Affairs
Install fish ladders and eelways in flow regulating structures - allow natural migration patterns; improve functional connectivity.	☐ Provincial Departments of Conservation and Environmental Affairs
Release water from dams to simulate natural flow patterns.	☐ Department of Water Affairs and Forestry
Implement in-stream flow objectives; classify rivers to determine protection level required.	☐ Department of Water Affairs and Forestry

Table 5-3: Management Actions given in the River Health Programme, and the corresponding responsible party (CSIR, 2005)

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5.6.1.1. Responses

Gaps in current water monitoring practises have been identified by the specialists (Zitholele Consulting, 2008). As a result, the following minimum monitoring requirements for each water resource are provided to ensure that monitoring programmes are sufficient to provide information on the state of water availability, supply and quality within the province, as well as to determine changes in water resources due to natural causes or anthropogenic impacts:

- **Dams:** Regular monitoring of Chl-a, to determine the dam's fitness for use (non-contact recreational use). The data should be recorded and made available.
- **Rivers:** Regular monitoring and recording of nitrites, phosphate, conductivity, faecal coliforms, fluoride, toxicity and radionucleids. The collected data needs to be recorded and made available.
- **Groundwater:** Frequent (twice per year) monitoring of nitrites, phosphate, conductivity, faecal coliforms, fluoride, toxicity and radionucleids. The data needs to be recorded and made available. There is a need to reconciling future supply and demand imbalances with regard to groundwater and surface water resources.
- **Wetlands:** Use of a standardised protocol for wetland determination and delineation. The DWAF water quality guidelines set out specific indicators; if these are monitored on a regular basis and data is recorded and made available, trends can be formulated and the state and Outlook of wetlands can be determined.
- **Demand management:** There is a need to invest in improving practices, technology, and capacity in water demand management.
- **Water re-use:** Opportunities available for the re-use of wastewater need to be explored by application of appropriate treatment technology and quality control. Further inter-basin transfer potential need to be explored.
- **Invasive alien vegetation:** The working for water programmes need to be enhanced in order to address the control of alien vegetation, particularly in the NW Province where groundwater resource availability is at risk.
- **Surface water resource development:** There is a need for surface water resource development which however requires intensive capital investment.
- **Economic and population growth:** The increased mining and population growth should be monitored and managed to minimize the possibility of the water resource variables reaching unacceptable concentrations.

Limitations of a province-wide water quality monitoring programme include large distances to be covered by monitoring teams, technical skills required for maintenance, calibration of equipment and costs. Municipalities should consider obtaining monitoring equipment, data collection, analysis and reporting, as well as human resource requirements. Indicators that were not included in the report, but which must be considered as part of monitoring programmes, are summarised in Table 5-4.

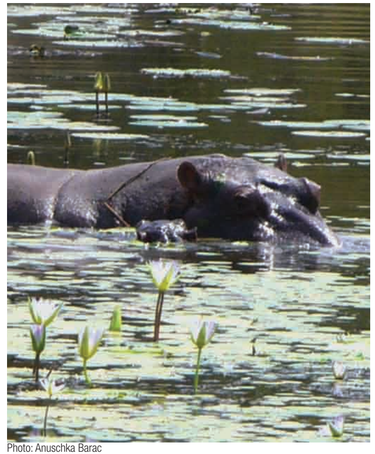

Photo: Anuschka Barac

Photo: Anuschka Barac

Objective	Indicator	Indicator calculation/data collection
Promote wise use of water resources	Allocation of water use in relation to the reserve determination of catchments	Amount of water in reserves
	Ratio of water demand vs. water reserves level	Water demand vs. Water reserves
	Mean annual rainfall	Based on readings at the specific sites
	Ratio of surface water consumption per capita vs. surface water resources per capita	Surface water consumption / Population vs. Surface water resources / Population
	Percentage where DWAF guidelines are exceeded for nitrites in surface water	Based on a water sample and laboratory research (DWAF guidelines for nitrites = 50 mg/l)
	Percentage where DWAF guidelines are exceeded for total phosphate in surface water	Based on a water sample and laboratory research (DWAF guidelines for total phosphate = 2 mg/l)
	Percentage where DWAF guidelines are exceeded for conductivity in surface water	Based on a water sample and laboratory research (DWAF guidelines for conductivity = 150 mili-Siemens per meter)
	Percentage where DWAF guidelines for faecal coliforms in surface water	Based on a water sample and laboratory research (DWAF guidelines for faecal coliforms = 2,000 per 100 ml)
	Percentage where DWAF guidelines are exceeded for fluoride in surface water	Based on a water sample and laboratory research (DWAF guidelines for fluoride = 0.75 mg/l)
	Surface water radioactivity in selected rivers	Based on a water sample and laboratory research
Groundwater extraction	Dependence on groundwater	%people supported by groundwater
Ensure groundwater quality	Groundwater toxicity	Based on a water sample and laboratory research
	Percentage where DWAF guidelines are exceeded for nitrites in groundwater	Based on a water sample and laboratory research (DWAF guidelines for nitrites = 50 mg/l)
	Percentage where DWAF guidelines are exceeded for total phosphate in surface water	Based on a water sample and laboratory research (DWAF guidelines for total phosphate = 2 mg/l)
	Percentage where DWAF guidelines are exceeded for conductivity in groundwater	Based on a water sample and laboratory research (DWAF guidelines for conductivity = 150 mili-Siemens per meter)
	Percentage where DWAF guidelines for faecal coliforms in groundwater	Based on a water sample and laboratory research (DWAF guidelines for faecal coliforms = 2,000 per 100 ml)
	Percentage where DWAF guidelines are exceeded for fluoride in groundwater	Based on a water sample and laboratory research (DWAF guidelines for fluoride = 0.75 mg/l)
	Groundwater radio-activity in selected underground rivers and compartments	Based on a water sample and laboratory research
	Ratio of groundwater consumption per capita vs. groundwater resources per capita	Underground water consumption / Population vs. Underground water resources / Population
	Total surface water resources per capita	Surface water resource / Population

Table 5-4: Table of indicators not examined

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Objective	Indicator	Indicator calculation/data collection
Ensure wetlands water quality	Wetland status and function	wetlands toxicity
		Nitrites
		Total Phosphates
		Conductivity
		Faecal coliforms
		Fluorides
		Radionuclide
Ensure water quality in dams	Total underground water resources per capita	Underground water resources / Population

Photo: NWDACE

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Photo: Werner Bertz

CHAPTER 6

Air Quality and climate change

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Acronyms and abbreviations

AQA	Air Quality Act
AQO	Air Quality Officer
AQMP	Air Quality Management Programme
DEAT	Department of Environmental Affairs and Tourism
DME	Department of Minerals and Energy
EPA	Environmental Protection Agency
EU	European Union
GDP	Gross Domestic Product
GDPR	Gross Domestic Product per Region
NAPCF	National Air Pollution Control Forum
NGO	Non-Governmental Organisation
ppm	Particulates per million
QA	Quality Assurance
QC	Quality Control
RLM	Rustenburg Local Municipality
UK	United Kingdom
UN-ECE	United Nations Economic Commission for Europe
UNFCC	United Nations Framework Convention on Climate Change
USEPA	United Sates Environmental Protection Agency
WHO	World Health Organisation

Chemical abbreviations

CFC	Chlorofluorocarbons
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
H_2S	Hydrogen Sulphide
HAPs	Hazardous Air Pollutants
HCFC	Hydrochlorofluorocarbons
HCl	Hydrochloric Acid
HF	Hydrogen Fluoride
N_2O	Nitrous oxide
NH_3	Ammonia
NMHC	Non-methane hydrocarbons
NO_x	Oxides of nitrogen
PAH	Poly Aromatic Hydrocarbon
Pb	Lead
PM10	Particulate Matter with a diameter of less than 10 nano meters
PM2.5	Particulate Matter with a diameter of less than 2.5 nano meters
SO_2	Sulphur dioxide
SVOC	Semi-Volatile Organic Compounds
TSP	Total Suspended Solids
VOC	Volatile Organic Compounds

Definition of terms

Bagasse
The biomass remaining after sugarcane or sorghum stalks are crushed to extract their juice, and it is currently used as a renewable resource in the manufacture of paper and wall insulation.

Carcinogenic compound
Any substance, radionuclide or radiation that is an agent directly involved in the promotion of cancer or in the increase of its propagation.

Criteria Pollutant
Those pollutants which are harmful to human health, the environment, or cause property damage. Currently, carbon monoxide (CO), lead (Pb), nitrogen oxide (NO_2), Ozone (O_3), particulates (TSP), and sulphur dioxide (SO_2) are the most referred to criteria pollutants.

Dioxin
A family of chemical compounds that are formed through combustion, chlorine bleaching and manufacturing processes. The combination of heat and chlorine creates dioxins.

Emission
Gaseous substance released into the atmosphere.

Furan
Family of compounds formed through combustion of fuels with high chloride content such as municipal solid waste, some types of straw and salt water contaminated wood waste.

Greenhouse Gas
Gases, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface.

Hydrocarbons
Compounds consisting entirely of hydrogen and carbon. Carbonates, oxides of carbon, cyanides, and allotropes of carbon are considered inorganic.

Organic Compounds
Any member of a large class of chemical compounds with carbon-containing molecules.

Ozone
A molecule consisting of 3 oxygen atoms (O_3). Ground-level ozone is an air pollutant which may have harmful effects on the respiratory systems of animals and humans. Ozone in the upper atmosphere filters potentially damaging ultraviolet light from reaching the Earth's surface.

Particulates
Tiny particles of solid or liquid suspended in a gas, alternatively referred to as particulate matter (PM).

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6.1. Introduction

"Air pollution can be defined as the presence in the external atmosphere of one or more contaminations (pollutants), or combinations thereof, in such quantities and of such duration as may be or may cause injury to human health, plant or animal life, or property (materials), or which unreasonably interfere with the comfortable enjoyment of life, or property, or the conduct of business" (Canter, 1996).

Box 6-1: Interesting fact

The earth's atmosphere is made up of nitrogen (78.08%) and oxygen (20.9%) and a small percentage (less than 1%) of other gases such as argon, carbon dioxide, neon and helium.

Air quality was identified, through stakeholder consultation, as one of the top three issues to be addressed in the North West (NW) Province. In order to address this issue and develop associated indicators for air quality management, the following questions need to be addressed:

- What is ambient air quality? Refer to Section 6.1.1 for a discussion on this;
- What are the causes of poor air quality (i.e. what types of air pollution exist)? Refer to Section 6.2, where air quality pressures or sources of pollution are discussed;
- What is the status of air quality within the NW Province? Refer to Section 6.3, which discusses the state of ambient air quality, climate change, ozone depletion and air quality management, and the relevance of each of these to the NW Province;
- What is the impact of current air quality? Refer to Section 6.3, which discusses the impacts of ambient air quality, climate change and ozone depletion on the surrounding environment and communities, and the relevance of each of these to the NW Province, and
- What can be done to improve this? Refer to Section 6.6 wherein the responses to air quality challenges are discussed.

Box 6-2: Air quality definitions

According to the National Environmental Management: Air Quality Act (Act No. 39 of 2004) (NEM:AQA), the following definitions apply:

- "Air pollution" means any change in the composition of the air caused by smoke, soot, dust (including fly ash), cinders, solid particles of any kind, gases, fumes, aerosols and odorous substances.
- "Atmospheric emission" or "emission" means any emission or entrainment process emanating from a point, non-point or mobile source that results in air pollution. Point sources are stationary sources of emissions, such stacks at industrial operations or mine dumps. Non-point sources of pollution generally come from many smaller sources, such as veld fires or fugitive dust. Mobile sources are not fixed or stationary sources, such as emissions from vehicles are air travel..
- "Ambient air" is defined as any area not regulated by the Occupational Health and Safety Act, 1993 (Act no. 85 of 1993). *Ambient air quality therefore considers the impact of pollution on the ambient air and applies to public areas usually outside industrial zones.*

The purpose of this chapter is to assess the state of air quality in the NW Province and provide an overview of the impacts, in order to determine a method to sustainably manage air quality within the Province.

6.1.1. What is air quality?

Air pollutants are chemicals or substances that are emitted into the atmosphere and when the concentrations exceed certain thresholds, this can have a detrimental effect on human health and the environment, directly or indirectly (DEAT, 1990).

Major air pollutants may be described as:

- *Dominant long-lived gases*, which affect air quality, include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and chlorofluorocarbons (CFCs). These are global atmospheric gases, which may not have been generated within the NW province, but will influence the air quality of the province. Of global importance is the emission of *greenhouse gases* (such as CO_2 and CH_4), which contribute to the greenhouse effect by trapping heat within the atmosphere;
- *Short-lived gases* such as nitric oxide (NO) and sulphur dioxide (SO_2) have more localised effects within the Southern African region. These gases may have been produced elsewhere on the sub-continent but can impact on the air quality of the NW Province;
- *Radioactive gas* emissions such as the noble gases pose an additional threat to the environment and to human health, and
- The emission of *ozone depleting substances* (such as CFCs, hydrochlorofluorocarbons (HCFCs) and methyl bromide) poses a threat to the ozone layer and is hence an issue of global importance.

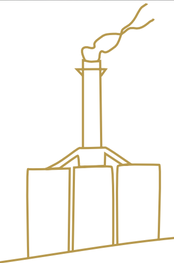
6.2. Pressures[1]

Mining and agriculture are the main contributors to the local economy, with diversification of the economy in other sectors such as energy, construction, trade, transport and communication, community, social and personal services, manufacturing and finance, insurance and business services.

Sources of atmospheric emissions include both natural and anthropogenically-induced releases. Natural sources include biogenic releases, wind blown dust, veld fires and lightning (inducing oxides of nitrogen (NO_x) formation). Anthropogenic sources include:

- Industrial and commercial activities:
  - These include scheduled processes and fuel burning appliance operation by businesses, hospitals and schools, and
  - Emissions include Total Suspended Solids (TSP), Particulate Matter (PM10), SO_2, NO_x, CO, (Volatile Organic Compounds (VOCs), Ammonia (NH_3), Hydrogen Sulphide (H_2S), Hydrogen Chloride (HCl) and heavy metals from such sources.
- Electricity generation:
  - This involves power stations for the generation of electricity for the national grid, and
  - The primary pollutants from coal burning is CO_2 and suspended particles (i.e. dust or soot).
- Waste treatment and disposal:
  - Waste treatment processes may be responsible for the following emissions: H_2S, mercaptans, NH_3, formaldehyde, acetone, toluene, ethyl benzene, xylenes, perchloroethylene, and fatty acids, including butyric acid, propionic acid, valeric acid and acetic acid.
- Residential:
  - Emissions from residential sources include household combustion of coal, paraffin, Liquid Petroleum Gas (LPG) and wood, and
  - The following emissions may be generated from urban areas, rural and informal settlements: CO, NO_x, VOCs, TSP, PM10 and PM2.5, metals, heavy metals, inorganic ash, polycyclic aromatic hydrocarbons, and benzo(a)pyrene.
- Transport:
  - Sources of emissions relating to transport include petrol and diesel driven vehicle tailpipe emissions, vehicle entrained road dust, brake and tyre wear fugitives, and rail and aviation emissions, and
  - Emissions from transportation include CO, NO_2, NO_x, SO_2, VOCs, Suspended particulates (PM10 and TSP).
- Mining:
  - Emissions from mining specifically relate to wind-blown emissions from mine tailings impoundments, and include particulates (TSP, PM10 and PM2.5).
- Agricultural:
  - Agricultural sources include crop residue burning, enteric fermentation and fertiliser and pesticide application, and
  - Emissions include CO_2, CO, CH_4, NMHC, NO_x and N_2O, SO_2, and particulates (TSP, PM10, PM2.5).
- Informal / miscellaneous:
  Other sources of emissions that should also be considered include tyre burning and fugitive dust from construction and erosion of open areas.

Photo: Lauret Muller



1 Refer to Chapter 2 for a discussion on drivers and pressure and Chapter 3 for a discussion on land within the Province

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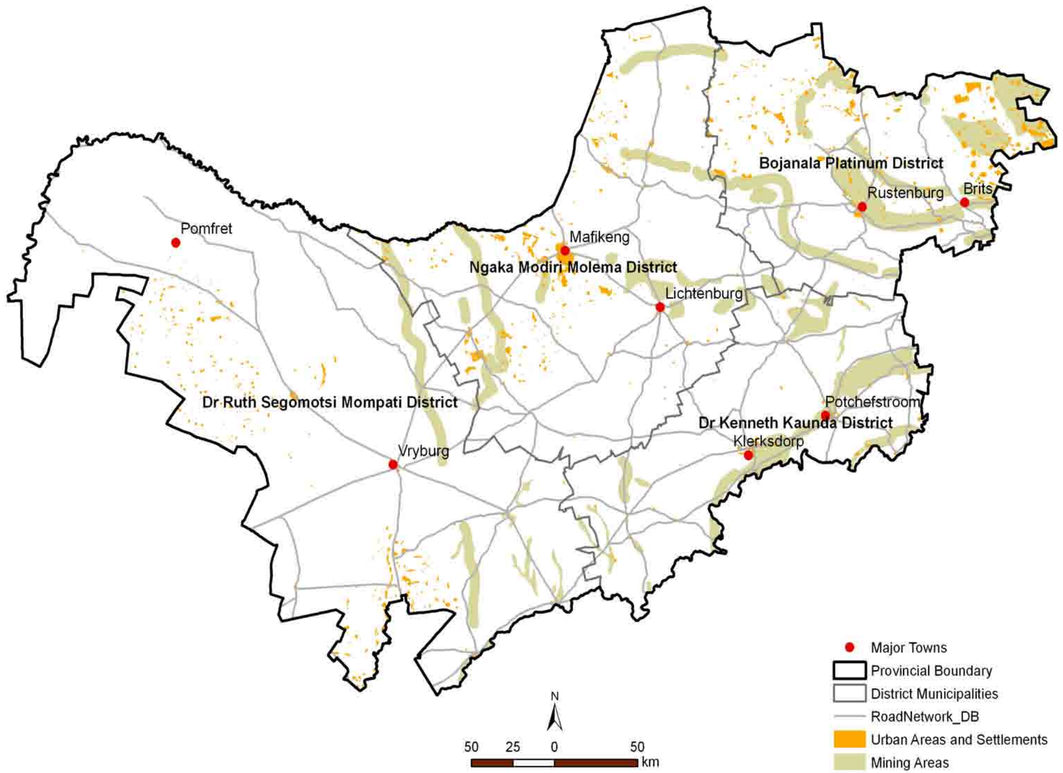


Figure 6-1: Major sources of pollution in the NW Province

6.2.1. Industrial sources

Industrial operations emit pollutants from stack, vent and fugitive emission sources. Industrial emissions include various criteria pollutants (such as SO_2, NO_x, CO and particulates), greenhouse gases (CO_2 and CH_4), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), various heavy metals and other toxins such as dioxins and furans.

All major sources of air pollution within the NW Province are included on the following map (Figure 6-1), which indicates major and national roads, industries and mines and rural and urban settlements.

All major industries within the district municipalities of the NW Province are listed in Table 6-1, as well as their sector groupings and the corresponding potential pollutants. Mining companies listed here refer to the processing plants and not to the mining operations. Sources of emission at these operations typically include stack emissions, including main stack releases which comprise furnace and converter off-gases, acid plant stack emissions, and releases from flash dryer stacks. The furnace and converter operations are also associated with significant fugitive emissions, as well as boiler stacks.

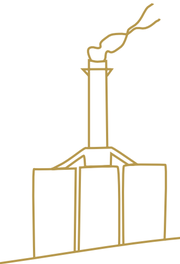
6.2.2. Small industrial sources and fuel burning appliances

There are various smaller industrial and commercial operations in the NW Province. This includes activities such as spray painting, sand blasting, dry cleaning, small boiler operations and incineration process, materials handling, etc. Smaller industrial sources for the Rustenburg area were identified as part of the air quality management plan developed for the Rustenburg Local Municipality (RLM). These included tobacco processes, chicken farms, an abattoir, and the Rustenburg Provincial Hospital, amongst others.

The emissions from these sources include various criteria pollutants such as SO_2, NO_x, CO and particulates, greenhouse gases (CO_2 and CH_4), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), various heavy metals and other toxins such as dioxins and furans (Scorgie *et. al.*, 2005).

District Municipality	Industry Name	Industry Sector	Pollutants
Bojanala (Bojanala Platinum District)	Anglo Platinum	Platinum Processing	TSP, PM10, SO_2, NO_x, CO, VOCs, Cl, HCl, and heavy metals
	Impala Platinum		
	Lonmin Platinum		
	Omnia Phosphates	Fertiliser	NH_3, HF, SiF_4, TSP and PM10
	Samacor Ferrochrome	Ferrochrome	TSP, PM10, SO_2, NO_x, CO, VOCs, NH_3, H_2S, HCl and heavy metals (specifically hexavalent chrome)
	Xstrata Rustenburg		
	Xstrata Merafe		
	Xstrata Wonderkop		
	Hernic Ferrochrome		
	International Ferrometals		
	Rhovan Vanadium	Vanadium	TSP, PM10, SO_2, NO_x, CO, VOCs, NH3, and heavy metals
	Vametco		
	Various Brickworks	Brickworks	TSP, PM10, SO_2, NO_x, CO, VOCs, PAHs, and heavy metals
Southern District (Dr. Kenneth Kaunda)	AngloAshanti Weswits	Gold	TSP, PM10, SO_2, NO_x, CO, VOCs, NH_3, H_2S, HCl and heavy metals (arsenic, mercury etc.)
	Buffelsfontein Gold Mine		
	Stilfontein Gold Mine		
	PPC Cement Orkney	Cement manufacturing	TSP, PM10, SO_2, NO_x, CO_2, HCl, and HF
	Various Brickworks	Brickworks	TSP, PM10, SO_2, NO_x, CO, VOCs, PAHs, and heavy metals
Central Distric (Ngaka Modiri Molema)	PPC Slurry	Cement manufacturing	TSP, PM10, SO_2, NO_x, CO_2, HCl, HF
	Holcim		
	Various Brickworks	Brickworks	TSP, PM10, SO_2, NO_x, CO, VOCs, PAHs, and heavy metals
Bophirima (Dr. Ruth Segomotsi Mompati)	Various Brickworks	Brickworks	TSP, PM10, SO_2, NO_x, CO, VOCs, PAHs, and heavy metals

Table 6-1: Industrial processes within the NW Province



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6.2.3. Mining sources

The NW Province, also known as the Platinum Province, is responsible for 94% of South Africa's platinum, 46% of the granite and 25% of the gold produced in the South Africa (North West Tourism website, 2008). Mining contributes to 33% of the Province's Gross Demographic Product (GDP).

There are various sources of emissions from mining operations. A list of operating mines, sourced from the Department of Minerals and Energy (DME) for 2006 is depicted in Table 6-2.

Particulates represent the main pollutant of concern at mining operations, whether it is underground, opencast or the tailings facility. The amount of dust emitted by these activities depends on the physical characteristics of the material and the handling of the material. Dust is classified into three primary categories, respirable dust (typically size fractions less than 2.5 µm), inhalable dust (typically size fractions less than 10 µm), and total suspended dust (typically size fractions less than 75 µm). PM10 and PM2.5 readily penetrate the lungs and and are associated with respiratory impacts.

6.2.3.1. Asbestos mines

Asbestos refers to several naturally occurring fibrous silicate minerals that are mined for their engineering properties such as thermal insulation, chemical and thermal stability, and high tensile strength.

The Department of Environmental Affairs and Tourism (DEAT) commissioned a survey in the former asbestos mining regions of the NW Province (CSS, 2006). The Gefco mine, located outside of Pomfret,was one of the mines identified in this study. The mine was rehabilitated in the 1980's, however residual contamination has since been noted on site. Remediation is recommended. The dump site of the mine has been partly rehabilitated, and it is recommended that radiation of this site be made a high priority. Another of the dumpsites of this mine can be found alongside the main access route to Pomfret. Other sites were identified in Heuningvlei, Nchweng, Reivilo and Gamopedi.

The report (CSS, 2006) further identifies other areas that should be surveyed, such as the village of Kagiso and the roads surrounding Pomfret and Kagiso, however additional studies are required to determine the extent of the asbestos contamination in the province.

District municipality	Industry name	Number of mines	Pollutants
Bojanala (Bojanala Platinum District)	Platinum mining	9	TSP, PM10, and heavy metals (including Cr, Pt, Ni, Cu, Ag, Rh etc.)
	Chrome mining	11	TSP, PM10, and heavy metals (including Cr, Pt, Ni, Cu, Ag, Rh etc.)
	Vanadium mining	2	TSP, PM10, and heavy metals (including Cr, Pt, Ni, Cu, Ag, Rh etc.)
	Granite quarries	16	TSP, PM10, and heavy metals
	Sand, silica & aggregate mining	8	TSP, PM10
	Limestone quarry	1	TSP, PM10, and heavy metals
Southern District (Dr. Kenneth Kaunda)	Gold mine	6	TSP, PM10, and heavy metals including (arsenic, silver, cyanide, etc.)
	Limestone quarry	1	TSP, PM10, and heavy metals
	Clay mining	4	TSP, PM10,
	Sand, silica & aggregate mining	5	TSP, PM10, and heavy metals
	Diamond mining	6	TSP, PM10
	Manganese mining	1	TSP, PM10, and heavy metals
Central District (Ngaka Modiri Molema)	Diamond mining	5	TSP, PM10
	Limestone quarry	4	TSP, PM10
	Pyrophyllite	2	TSP, PM10
Bophirima (Dr. Ruth Segomotsi Mompati)	Diamond mining	29	TSP, PM10
	Limestone quarry	4	TSP, PM10
	Sand, silica & aggregate mining	1	TSP, PM10
	Clay mining	2	TSP, PM10
	Gold mine	1	TSP, PM10, and heavy metals including (As, Ag, CN, etc.)

Table 6-2: Mining Operations within the NW Province (Liebenberg-Enslin, 2007)

Photos: Werner Bentz

Photos: Anuschka Barac

6.2.4. Agricultural activities

Agriculture contributes 6.2% to the GDP and 19% to formal employment in the NW Province. Maize and sunflowers are important crops with cattle being one of the province's major farming activities.

In terms of air pollution sources from agriculture, the main pollutant of concern is particulate matter, which is generally composed of soil dust and plant tissue fragments (chaff) which becomes entrained by wind. Cattle farms are also significant sources of fugitive dust especially when feedlots are used and the cattle trample confined areas. Odours and VOCs associated with animal manure from feedlots is also a concern.

6.2.5. Fugitive dust sources

These sources are termed fugitive because they are not discharged to the atmosphere in a confined flow stream, but rather 'escape' to the atmosphere through leaks in industrial processes or unplanned releases from industrial activities. Sources of fugitive dust identified in the study area include paved and unpaved roads, mine dumps and wind erosion of sparsely vegetated surfaces. Similar to mining, the main pollutant of concern includes particulates in the various size fractions (i.e. PM10, PM2.5 and TSP).

6.2.6. Domestic fuel combustion

Domestic coal combustion within informal settlements and rural areas has been identified during various studies to be potentially one of the greatest sources of airborne particulates and gaseous emissions. Fuel used for domestic energy generation typically comprises coal, wood, paraffin and LPG, with dung and bagasse used to a smaller extent. Electricity is used where available, but factors such as cultural traditions also play a role in the continuing use of other fuels. Traditionally, use is made of wood, dung and bagasse. This is being increasingly replaced in the urban areas by paraffin and LPG. Coal consumption figures for each province in South Africa are high; this is mainly due to the relatively inexpensive nature of coal and the fact that it is easily accessible.

Coal burning generates a large amount of gaseous and particulate pollutants, including sulphur dioxide, heavy metals, total and respirable particulates including heavy metals and inorganic ash, carbon monoxide, polycyclic aromatic hydrocarbons, and benzo(a)pyrene. Polyaromatic hydrocarbons are carcinogenic compounds. Pollutants from the combustion of wood (including veld fires) include respirable particulates, NO_2, CO, polycyclic aromatic hydrocarbons, particulate benzo(a)pyrene and formaldehyde. Particulate emissions from wood burning within South Africa have been found to contain about 50% elemental carbon and about 50% condensed hydrocarbons (Terblanche *et al.*, 1992). The main pollutants emitted from the combustion of paraffin are NO_2, particulates, CO and polycyclic aromatic hydrocarbons. No comprehensive emissions data exists for household fuel combustion.

6.2.7 Biomass burning

Biomass burning includes the burning of evergreen and deciduous forests, woodlands, grasslands, and agricultural lands. Within the NW Province, crop-residue burning and veld fires represent significant sources of combustion-related emissions.

Biomass burning is an incomplete combustion process (Cachier, 1992), with CO, CH_4 and NO_2 gases being emitted. Other pollutants associated with biomass burning are CO_2, CO, CH_4, non-methane hydrocarbons (NMHC), formaldehyde, NO_x, N_2O, SO_2 and particulates (TSP and PM10).

6.2.8. Vehicle tailpipe emissions

The major vehicle activity within the NW Province is confined to the main routes. These include the Platinum Highway (N4) running from Tshwane in Gauteng (east of the NW Province) past Brits and Rustenburg towards Botswana on the western boundary of the Province. The N12 and N14 are also busy roads, with the N12 going through Potchefstroom, Klerksdorp, Wolmaranstad and Christiana, and the N14 through Ventersdorp, Delareyville, and Vryburg towards Kuruman. The N14 is the main road to Namibia.

Air pollution from vehicle emissions may be grouped into primary and secondary pollutants. Primary pollutants are those emitted directly into the atmosphere, and secondary pollutants are formed in the atmosphere as a result of chemical reactions, such as hydrolysis, oxidation or photochemical reactions. The significant primary pollutants emitted by motor vehicle exhausts include CO_2, CO, hydrocarbons, SO_2, NO_x, particulates and lead (Pb). Secondary pollutants formed due to vehicle exhaust emissions include: NO_2, photochemical oxidants (e.g. ozone), hydrocarbons, sulphuric acid, sulphates, nitric acid, sulphates, nitric acid and nitrate aerosols. Emission estimates are currently available only for primary pollutants.

6.2.9 Waste treatment facilities[2]

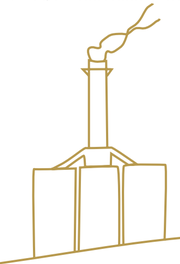
Specific industrial activities producing toxic emissions and waste disposal sites, including landfills, waste water treatment works and waste incinerator facilities, represent potential "hot spots" in terms of air pollution. Insufficient emission and air quality data are currently available on which to base a comprehensive assessment of the health impacts within these "hotspots". These areas should therefore be included in future monitoring strategies.

6.2.9.1. Landfill sites

The bulk of waste collected by the local authorities is disposed to landfill, usually within a 10 to 20 km radius of the residential areas within which the waste was generated. Landfill gas emissions and fugitive dust emissions represent one of the main environmental issues related to landfill operations.

Photo: Lauret Muller

2 Chapter 7 includes a discussion of waste management within the NW Province



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Sources of fugitive dust emissions include:

- Vehicle-entrained dust from paved and unpaved roads;
- Materials handling operations (e.g. Waste movement, compaction and tipping operations);
- Wind erosion of open areas and soil cover, and
- Vehicle activity on the landfill site, including general vehicle traffic (tractors, trucks, etc.) and earthmoving activities.

Such particulate emissions present a health hazard since they may have adsorbed molecules of toxic substances.

Highly odorous compounds are produced by the waste itself, and are common in both municipal and industrial waste sites. These include limonene, xylene, ethyl benzene, propyl benzenes and butyl benzenes (SoER, 2005). Compounds frequently included in local air quality impact assessments, due to their potential impacts on human health, include:

- Various carcinogens such as
  - benzene,
  - carbon tetrachloride,
  - methylene chloride,
  - chloroform, and
- Several non-carcinogenic toxins such as
  - phenol,
  - chlorobenzene.

Toluene is considered a key VOC and is estimated to comprise approximately 9.6% of the total VOCs emanating from landfills. The VOC emissions from landfills may be important precursors of ozone, and the quantification of such emissions is therefore necessary for regional ozone modelling purposes.

6.2.9.2 Waste incineration

Incineration became a Scheduled Process in October 1994 in terms of the Atmospheric Pollution Prevention Act of 1965. Permit requirements for such operations include operating temperature, combustion retention time and emission standard stipulations. Since March 1998, Environmental Impact Assessments have been required for proposed incinerator operations.

Gas emissions from incinerators may be grouped into:

- Criteria gases (SO_2, NO_x, CO, Pb and particulates);
- Acid gases (HCl, hydrogen bromide, hydrogen fluoride);
- Metal gases (chromium, arsenic, cadmium, mercury, manganese, etc.), and
- Dioxins and furans - (such as polychlorinated dibenzo-p-dioxins – PCDD – and dibenzo furans – PCDF) . Data on PCDD and PCDF emissions is currently scarce and incomplete due to the high costs of monitoring.

6.2.9.3. Waste water treatment facilities

The potential for emissions of VOCs during wastewater treatment is a cause for concern. Pollutants measured at local waste water treatment works have included H_2S, mercaptans, ammonia, formaldehyde, acetone, toluene, ethyl benzene, xylenes, perchloroethylene, butyric acid, propionic acid, valeric acid and acetic acid. Species which represent the most important odorants include H_2S, mercaptans, NH_4, and the various fatty acids (butyric, propionic, valeric and acetic).

6.2.10. Long range pollution transportation

Regionally-transported, aged-aerosols also contribute to background air pollutant concentrations within the NW Province. This might be predominantly from the highly-industrialised areas in the Gauteng Province (i.e. City of Johannesburg, the Sedibeng Municipality and Ekurhuleni Metropolitan Municipality) located to the east of the Province. Source apportionment studies have identified four major contributing source types of regional significance to the atmospheric aerosol loading.

The four source types include:

- Aeolian crustal material consisting of mineral soil dust;
- Marine aerosols from both the atlantic and indian oceans;
- Biomass burning particles occurring mainly north of 20° s, and
- Aerosols from industrial emissions.

Emissions from these four sources have been observed in the past at remote sites in South Africa (Annegarn, *et al.,* 1992; Piketh, 1995; Piketh *et al.,* 1996; Salma *et al.,* 1992; Maenhaut *et al.,* 1996). The exact contribution of aged aerosols to fine particulate loadings over the NW Province is not known.

6.2.11. Synopsis of sources of emissions identified for the NW Province

Sources of emissions identified for the NW Province are listed in Table 6-3. The significance of transboundary sources through their contribution to regional aerosol levels

is noted in the table below, despite such sources not being located in the region. Pollutants released by each source are indicated in Table 6-1. The synopsis serves as an indicator to the pollutants that would need to be considered in the formation of a monitoring network for the Province.

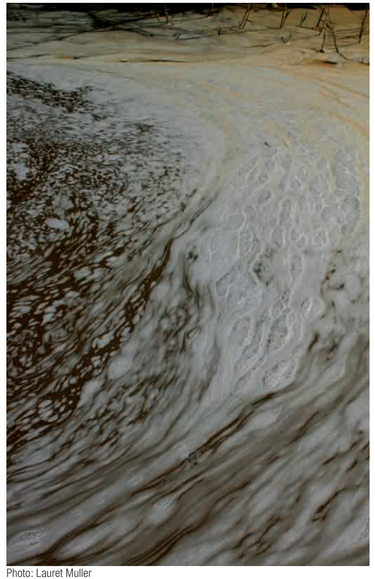

Photo: Lauret Muller

Box 6-3: Long range pollution transportation

The two main sources of emissions of long-range pollution transport are biomass burning and industrial emissions. Biomass burning is a highly seasonal source and is easily detected over the subcontinent using satellite imagery. The biomass burning season starts near the equator around June and moves southward where it reaches maximum intensity in Southern Africa around September. Associated with biomass burning is the long-range transport of both aerosols and trace gases across the subcontinent. The NW Province falls within the band of impact of southward transport of biomass burning products.

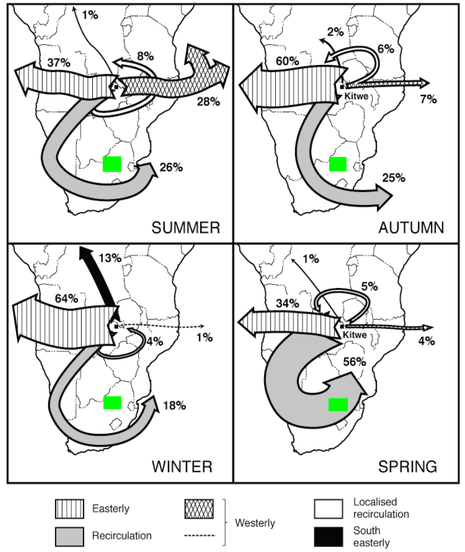

Figure: Seasonal atmospheric transport from Zambia over the Southern Africa subcontinent (Piketh *et al*, 1996). The position of the NW Province is denoted by a green square on the map.

Industrial operations within the Mpumalanga highveld in the eastern part of South Africa are the second largest source of long-range transported atmospheric pollutants. Emissions in this region of South Africa have a significant industrial signature with SO_2 (and related secondary pollutants such as sulphate) being the predominant pollutant. An analysis of transport from this region of the Highveld shows that pollutants are likely to impact on the NW Province. This could occur directly through easterly transport or by recirculation of air masses from the industrial region. The concentrations of the pollutants will vary significantly depending on the time of atmospheric transport (Piketh et al., 1996)

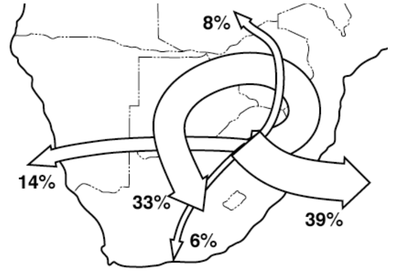

Figure: Atmospheric transport from the industrial Mpumalanga Highveld based on a five year trajectory climatology (Piketh *et al*, 1996).

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Sources	PM	SO_2	NO_x	CO	CO_2	CH_4	HAPs
Industrial activities	×	×	×	×	×	×	×
Mining activities	×						
Agricultural activities	×						
Vehicle-entrainment of road dust	×						
Wind blown dust from open areas	×						
Domestic fuel combustion	×	×	×	×	×	×	×
Biomass burning	×	×	×	×	×	×	×
Vehicle-tailpipe emissions	×	×	×	×	×	×	×
Landfills	×				×	×	×
Incineration	×	×	×	×	×	×	×
Tyre burning	×	×	×	×	×	×	×
Abandoned asbestos mines	×						×
Regional aerosol (from distant sources)	×						
Notes:							
HAP – hazardous air pollutants (includes toxins and carcinogens)							
× – indicates pollutant is emitted by particular source type							

Table 6-3: Sources of atmospheric emissions within the NW Province and their associated emissions (Liebenberg-Enslin, 2007)

6.3. Ambient air quality and indoor air quality

In order to manage air quality within the NW Province, it is pertinent to understand what pollutants are present in the atmosphere and at what concentrations. This is typically done through ambient air quality monitoring.

One of the main indicators that has been identified is the monitoring of ambient air to determine the status thereof. This pertains to ambient particulate matter, SO_2, NO_2, CO and Ozone (O_3) concentrations. The other indicator for air quality management includes the amount of pollutants emitted by the various sources and limiting these through imposing emission limits on such pollutants.

Limited ambient monitoring stations are currently in place in the NW Province. The NW Province Ambient Monitoring Programme report provides a full description on the current monitoring network for measuring meteorological parameters and ambient air quality (Liebenberg-Enslin & van Rookhuijzen, 2007). A synopsis of the findings of this report is included below.

The main shortfall in characterising air quality within the Province is the limited availability of high quality, long duration air pollution monitoring data. This is largely due to the fact that, historically, government officials were not tasked with air quality monitoring under the Air Pollution Prevention Act (APPA). Also, monitoring guidelines were not published for use by those government departments undertaking voluntary monitoring campaigns. Ambient air quality monitoring has therefore primarily been undertaken by non-governmental organizations and industry.

It is important to note that the monitoring objectives between industry and government differ. Whereas government is concerned with the general quality of ambient air quality, and specifically in residential areas, industry is more focused on understanding their specific contribution to the localized ambient air.

6.3.1. Ambient air quality status[3]

There are limited ambient monitoring stations currently in place in the NW Province The ambient air quality monitoring that has occurred in the NW Province over recent years has been largely performed by individual industries, and not by government. There are currently eight air quality-monitoring stations in the entire province: Impala Platinum operates three stations, Eskom four (for Anglo Platinum) and one mobile caravan is operated by Lonmin. Since criteria pollutants (i.e. PM10, SO_2 and NO_x) are the main pollutants associated with ambient air quality standards, industries generally only measure these parameters. The locations of all SO_2 and PM10 stations are provided in Table 6-4. An additional three monitoring stations are planned for this area in the future. As part of their permit requirements, these companies send their results to the DEAT on a regular basis. Some companies also conduct their own additional monitoring. For example, Vametco monitors dust outfall, as well as potential vanadium accumulation in nearby cattle herds.

Table 6-4 provides information on the industry, the pollutants being measured and the duration of ambient monitoring. Additional information includes the frequency of monitoring and the responsible parties conducting the monitoring.

All aspects of air quality monitoring are subjected to recognised procedures to ensure standardisation, conformity in approach so that the resultant data are representative and comparable. These procedures relate to:

- The siting of stations, site and equipment operating procedure;
- Routine equipment performance tests and calibration procedures;
- Site and equipment auditing;
- Inter-laboratory testing, and
- Data processing and storage.

Standard site operating procedures have been detailed by organisations such as US Environmental Protection Agency (USEPA), World Health Organisation (WHO) and Standards South Africa.

3 Refer to Chapter 7 for information on infrastructure, electricity, domestic fuel burning

Box 6-4: Legislative framework

National, provincial and local authorities (district and metropolitan municipalities) are responsible for managing air quality under the National Environmental Management: Air Quality Act (Act No. 39 of 2004) (AQA). The AQA makes provision for the setting of ambient air quality standards and emission limits on a National level, which provides the objective for air quality management. In addition, AQA requires the development of a national framework which will set national norms and standards for various air quality management components (i.e. air quality -monitoring; -management planning, - information management etc.) to ensure compliance is achieved with ambient air quality standards and emissions limits. The national framework was published in the Government Gazette (no. 30284) on 11 September 2007.

The AQA has shifted the responsibility of air quality management to local government level. This includes responsibilities such as air quality monitoring, emissions monitoring, development of Air Quality Management Plans (AQMPs), collaboration with national and provincial government and issuing atmospheric emissions licenses for all listed activities. In order to fulfil these functions, local authorities will have to appoint a dedicated Air Quality Officer. Provincial authorities will be responsible for similar functions as would national government. On a national level, however, the focus is more on policy making and regulations.

Ambient air quality standards

A few air pollutants result from various sources and activities. These pollutants, referred to as criteria pollutants, can injure health, harm the environment, and damage property. Health based ambient standards have been developed for these pollutants internationally and locally. The current South African standards have been revised and were published for comment in the Government Gazette of June 2006. The newly proposed standards include particulate matter specifically for PM10 (particulates with a diameter of less than 10 micrometer), SO_2, NO_x, O_3, Lead, CO and benzene. The revised National Ambient Air Quality Standards will be published in 2008 with allowable frequency of excedences linked to each and compliance timelines provided. The proposed standards are provided in the following table, and are proposed as indicators in the current Outlook to determine the impact of the ambient air quality on human health.

Ambient air quality standards for common pollutants (DEAT, 2006)

Substance	10-minute maximum	1-hour maximum	8-hour maximum	24-hour maximum	Annual average
	(µg/m³)	(µg/m³)	(µg/m³)	(µg/m³)	(µg/m³)
Sulphur dioxide (SO_2)	500	350	-	125	50
Nitrogen dioxide (NO_2)	-	200	-	-	40
Carbon Monoxide (CO)	-	30,000	10,000	-	-
Particulate Matter (PM10)	-	-	-	75	40
Ozone (O_3)	-	200	120	-	-
Lead (Pb)	-	-	-	-	0.5
Benzene (C_6H_6)	-	-	-	-	5

Provincial regulations

The AQA imposes regulations on the development of AQMPs for provinces and district municipalities. The AQA stipulates that an air quality management plan must achieve the following:

(i) Improve air quality;

(ii) Reduce negative impacts on human health and the environment;

(iii) Address the effects of fossil fuels in residential applications;

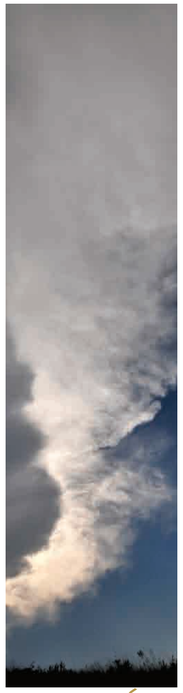
(iv) Address the effects of emissions from industrial sources;

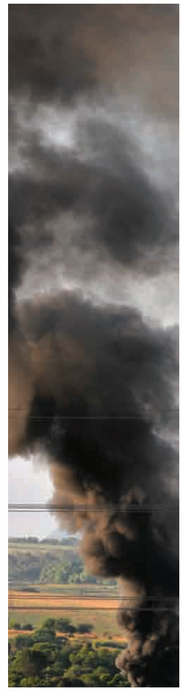
(v) Address effects from emissions from any point or non-point source of air pollution;

(vi) Implement the republic's obligations in respect of international agreements; and

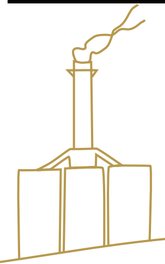
(vii) Give effect to best practice in air quality management.

The approved AQMP for a priority area must be published in the Gazette within 90 days of approval.





Photos: Lauret Muller



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Location	Monitoring year	Issue	% Data availability	Highest 10-min	Highest hourly	Highest daily	Annual average	Indicators			
				(µg/m³)	(µg/m³)	(µg/m³)	(µg/m³)	Excedence per year (10 min Limit)	Excedence per year (hourly limit)	Excedence per year (daily limit)	Annual average as ratio to Annual limit
Rustenburg	2006/7	SO_2	Raw data received but months missing								
	2006/7	PM10	Raw data received but months missing								
	2005	SO_2	58%	ND	271	42	11	-	0	0	0.2
	2005	PM10	Incomplete data received								
Kroondal	2006/7	SO_2	Raw data received but months missing								
	2006/7	PM10	Raw data received but months missing								
	2005	SO_2	99%	ND	240	30	12	-	0	0	0.28
	2005	PM10	Incomplete data received								
Rustenburg Region (a)	2006	SO_2	75%	ND	439	103	14	-	2	0	0.28
	2006	PM10	74%	NS	NS	112	48	-	-	79	1.2
	2005	SO_2	99%	ND	585	61	16	-	6	0	0.32
	2005	PM10	Incomplete data received								
	Oct 2007	SO_2	98%	1,804	918	65	-	-	-	-	-
	Oct 2007	PM10	81%	NS	NS	11	-	-	-	-	-
Marikana region (a)	2005/6	PM10	Incomplete data received								
	2005/6	SO_2	Incomplete data received								
	2004	PM10	ND	NG	NS	484	90	-	-	65	2.25
	2004	SO_2	ND	ND	2,065	653	70	-	3	14	1.40
	2003	PM10	ND	NS	NS	518	129	-	-	-	3.22
	2003	SO_2	ND	ND	1,614	632	82	-	5.4	20	1.60
Klerksdorp region (a)	2006	SO_2	72%	2,615	1,651	314	31	470	113	13	0.62
	2006	PM10	85%	NS	NS	86	21	-	-	0	0.53
	2005	SO_2	61%	2,618	2,556	969	76	1,366	332	53	1.52
	2005	PM10	76%	NS	NS	61	41	-	-	3	1.02

Notes: ND – No Data Available NS – No ambient air quality standards exist

(a) Represents Industry located stations mostly located within the industrial or mining properties

Table 6-4: Ambient air pollutant concentrations recorded at Industry monitoring stations presented linking the issue with the related indicator (Liebenberg-Enslin, 2007)

The air pollution data presented in Table 6-4 highlights the following air quality challenges:

- From the limited data supplied at the various stations within the NW Province, it is evident that PM10 concentrations are elevated. For all stations where PM10 data were supplied, the proposed SA Standards were exceeded over a daily average and annual average. In general, an increase in ambient PM10 concentrations was reflected. The data for PM10 is however inconsistent and more comprehensive records are required to determine trends of PM10.
- SO_2 concentrations close to industrial sources were high, exceeding the SA Standard for all averaging periods (10-minute, hourly, daily and annual averages). In the residential area of Rustenburg, a slight increase in SO_2 concentrations was noted over the past 3 years whereas a slight decrease was recorded near the industrial zone of Anglo Platinum. The current total SO_2 emissions in the Rustenburg area are approximately 250 tons/day.
- Sulphur dioxide (SO_2) concentrations are likely to be high in low income settlements where use is made of coal and wood as energy sources. This has been proven in areas such as Soweto and Orange Farm in Gauteng.
- Although NO_2 concentrations have not been recorded to date in the NW Province, it is likely to be high close to busy roads and intersections such as the N4 Platinum Highway.
- Hexavalent chrome is a concern within the NW Province, due to the number of Ferro-Chrome smelters located in the area. Hexavalent chrome is very difficult to measure in the atmosphere and sources emitting Hexavalent chrome should be controlled through emission limits recorded in the atmospheric emission license for the operation.

6.3.2. Air quality criteria

It is well established that human health and well-being are affected by air pollution, which has both acute and chronic impacts. In addition, the degradation of materials by air pollution has been observed over centuries with specific reference to impacts on stone and iron from acidifying sulphur compounds. The impact of air pollution on the natural environment is also an important factor that should be considered (Fenger *et al.* 1998). The main aim of spatial development is to avoid any adverse effects on public health and the environment.

Environmental indicators are increasingly used in Environmental Land Use Planning and Management to simplify environmental assessments. Indicators are defined as a single measure of a condition of an environmental element that represents the status or quality of that element. An index is a combination of a group of indicators to measure the overall status of an environmental element, and a threshold is the value of an indicator or index (Randolph, 2003).

Single indicators are used to determine the significance of the ambient air quality. The value of the indicators was primarily based on health thresholds, since no odourifous or nuisance pollutants were monitored.

6.3.2.1. Climate change indicators[4]

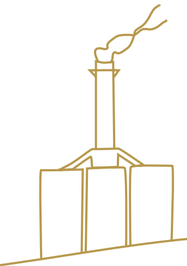
Indicators commonly used in the United Kingdom (UK), and which can be applied to the NW Province, are as follows (Indicators of Climate Change in the UK, 2008):

- Annual-mean temperature and the number of hot and cold days each year. A hot day is defined as when the daily mean temperature (i.e., the average of minimum and maximum) is above 20°C; a cold day is when the daily mean temperature is below 0°C.
- Precipitation - any shift towards drier summers and wetter winters will be most easily seen in this indicator.
- Number of days per year that the soil moisture deficit exceeds 60mm (the >dry= soil indicator or is less than 10mm (the >wet= soil indicator). Soil moisture levels are calculated from daily rainfall, net radiation and mean air temperature.
- The flow of water in rivers is measured daily. Prevalence of notably low and high river flows, providing a guide to the frequency of drought and flood episodes.
- Groundwater levels - levels are in metres above mean sea level so that high values indicate that the groundwater level is relatively close to the surface, low values indicate that the groundwater level is at greater depth.
- Ozone levels - indicator chosen is the accumulative exposure over the threshold of 40ppb during daylight hours during summer months. The most meaningful measure is one which integrates exposure over the summer when plants can be adversely affected.

South Africa's climate is highly variable, both temporally and spatially. Given global warming it is expected that this variability will be exacerbated with an increase in the frequency and intensity of droughts and floods. Projected climate changes in South Africa, based on the integration of findings from simulations using a range of climate models (Hewitson, 2005), are summarised as follows:

- The majority of models indicate a net drying on the western two-thirds of the subcontinent, south of about 10 °C;
- East coast regions, where topography plays a significant role in rainfall formation, are likely to become wetter. The extent to which this wetting will extend into the interior is currently uncertain;
- The Western Cape appears to be facing a shorter rainfall season, with the eastern interior portions of the Province likely to experience increased late summer rainfall, and
- Ambient air temperature is predicted to increase across the country with the interior experiencing the greatest increases. Maximum warming for the interior is likely to be in the range of 3 °C to 4 °C.

Historical records exist for various stations within the NW Province on temperature and rainfall. This data is, however, reported as average values over the historical period and therefore do not provide adequate information for trend analysis (Hewitson, 2005).



4 Refer to the Preamble for a discussion of indicators

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6.3.2.2. Health criteria

Urban environments are typically associated with high population densities and the proximity of many communities to sources of air pollution. There is a need to protect the most vulnerable citizens from the health impacts of air pollution. Effects on vulnerable groups were explicitly taken into account in the development of the WHO guidelines on which European Union (EU) air quality objectives are based (Liebenberg-Enslin, 2007).

The ambient air quality guideline values indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Air quality guidelines and standards are normally given for specific averaging periods. Preference was given to the proposed South African Standards in the assessment of the impacts.

6.3.2.3 Environmental criteria

While air quality management is generally focused on the protection of human health, it is important that the broader environment also be protected. Critical levels, defined as concentrations above which adverse affects may occur on sensitive receptors, have been established by the UN-ECE (Fenger *et al.*, 1998). These guideline values are established typically for specific groups such as agricultural crop species, trees, harsh environments and lichens, and are based on any changes in the natural state of such species.

Box 6-5: South African guidelines for ground level concentrations (Source DEAT 2000)

Time interval	SO_2	NO_x	NO	NO_2	O_3	Particulate matter (PM10 in ug/m^3)
Instantaneous	600	1400	900	500	250	-
1 hour average	300	800	600	200	120	-
24 hour average	100	400	300	100	50	180
Monthly average	50	300	200	80	-	-
Annual average	30	200	150	-	-	50 - 60

6.3.2.4. Nuisance criteria

Odour criteria are dependent on human settlement, and indicate the increasing environmental nuisance associated with increasing potential for community exposure to the odour. Based on similar studies in Australia, odour impacts can generally be for distances up to 3 to 5km from the source depending on the dispersion potential of the site (Australian EPA, 2000).

6.3.2.5. Additional criteria

The Australian Environmental Protection Agency (EPA), in their draft Guidelines for Separation Distances, 2000, includes visual impacts and nuisance dust as criteria to define suitable buffer zones around waste facilities.

Poor visibility is a side effect of atmospheric pollution caused by the attenuation, scattering, and absorption of light by the polluted air. It is usually easily recognisable with the unaided eye merely in the reduction of the number of objects that can be seen and the clarity of the objects (Fenger *et al.,* 1998).

Photo: Anuschka Barac

Nuisance impacts due to dust are associated with dustfall, soiling impacts and reductions in visibility. Atmospheric particulates scatter light and therefore change the spectral transmission of light to diminish visibility (Burger & Watson, 2001).

The loss of visibility can cause increased costs, including: the need for artificial lighting and heating; traffic delays, disruption and accidents; reduced growth of vegetation associated with reduced photosynthesis; and commercial losses associated with aesthetics. The soiling of building and materials due to dust frequently gives rise to damages and costs related to the increased need for washing, cleaning and repainting. Dustfall may also impact negatively on sensitive industries, e.g. bakeries or textile industries. Dust fallout was not simulated due to the lack of emissions information.

6.3.3. Ambient air quality impacts

6.3.3.1. Ecological impact[5]

The ecological impact of poor air quality depends largely on the actual pollutants found in the atmosphere as well as their concentrations. Air pollutants eventually impact upon the terrestrial and aquatic environment through precipitation and condensation. Acid deposition, caused by sulphur and nitrogen oxide emissions, result in changes in soil and water pH, and nutrient concentrations. This commonly affects local flora and fauna, particularly sensitive species, and may have an impact on agricultural activities (NWADCE, 2002). Acid rain (due to sulphur dioxide being transformed in the atmosphere into sulphuric acid and nitrous oxide into nitric acid) results in acidic river water, particularly at the beginning of the rainy season. A storm event accompanied by acid rain causes a sudden drop, although small, in pH in the river water.

Box 6-6: How will a changing climate influence us?

Higher temperatures will influence rainfall patterns, but it is still uncertain how the annual rainfall will change. It could increase in some parts of the country, and decrease in other parts.

Water resources: South Africa's industrial, domestic and agricultural users are highly dependent on a reliable supply of water. A reduction in rainfall amount or variability, or an increase in evaporation (due to higher temperatures) would further strain the already limited water resources. An increase in rainfall, or a reduction in plant water use (due to a higher atmospheric concentration of carbon dioxide) would ease the problem slightly.

Human and animal health: there are several important insect-carried diseases of humans and livestock which are sensitive to the climate. A small increase in temperature would allow, for instance, malaria to spread into areas which are currently malaria-free, and would increase its severity in areas where it already occurs.

Maize and wheat: it is currently estimated that a 10% increase in rainfall coupled with an increase in carbon dioxide would lead to a 10-20% increase in wheat and maize production, while a 10% decrease in rainfall would be approximately balanced by the rising carbon dioxide content of the atmosphere. Slightly warmer temperatures may lead to a small reduction in wheat yields, but would have little effect on maize. These predictions are not very certain.

Exacerbation of drought periods: an increase in temperature and a change in the climate are predicted to cause recurrent droughts in most of the region.

Reduction in soil fertility: an increase in temperature is likely to reduce soil moisture, moisture storage capacity and the quality of the soil, all of which are vital for agricultural crops.

Grazing livestock: higher carbon dioxide levels will lead to less protein in grazing grass, which will reduce any benefit resulting from increased plant growth. Less rainfall would lead to proportionately less animal production.

Biodiversity: plants, in particular, have trouble keeping up with rapid climate change. Small, isolated populations could go extinct as a result. South Africa has about 10% of all the plant species in the world, of which about half occur nowhere else on earth. Warming and a change in the seasonal rainfall are issues of concern to conservationists.

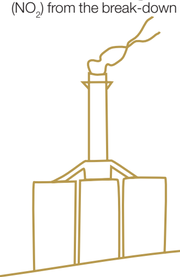
Source: SA Weather Bureau, www.weathersa.co.za/references

Due to the rapid pH change, the slightly acidic river water has the potential to mobilise uranium and other heavy metals found in the sediment. This may be have serious effects on aquatic ecosystems which are very sensitive to water quality.

As the number of species in an ecosystem declines in response to pollution, so other changes in the ecosystem function occur. Species sensitive to environmental perturbations, such as air quality deterioration, are normally the first to vanish. Certain lichens are particularly sensitive to smoke and soot pollution from industry and their presence or absence can therefore be used as an indicator of prevailing air quality. Sulphuric acid and nitric acid are also deposited with other fine particles directly into the terrestrial environment, resulting in the acidification of soils. This has an impact on the ability of soils to support plant growth, with shallow sandy soils being most vulnerable to acidification (DEAT, 1999). This is known to occur on the escarpment of Mpumalanga Province (where a large number of coal-fired power stations and other industries are situated), but it is not known whether this occurs in the NW Province, although the smelters in the Rustenburg area all burn coal.

Methane itself is not toxic at present levels, but it is reactive with other hydrocarbons and nitrogen oxides, readily forming low-level tropospheric ozone, which is toxic to plants and animals. Such tropospheric ozone, i.e. at ground level, is known to periodically exceed levels, which are harmful to plants in the Highveld region (DEAT, 1999), possibly including the eastern region of the NW Province. Stratospheric ozone, at approximately 10km above the earth's surface, depletion gives rise to increased UV-B radiation, which contributes towards reduced crop productivity, genetic changes and altered photosynthetic activity (Godish 1997).

Sulphur dioxide (SO_2), heavy metals and nitrogen dioxide (NO_2) from the break-down of fertilisers may cause damage



5 Refer to Chapter 4 for information on biodiversity in the NW Province

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to vegetation. Industries that emit SO_2 cause significant damage to plants under ambient conditions. Industries that emit high concentrations of NO_2 and particulate matter are a minor cause of plant injury (Godish 1997). Particulate matter from gold mine dumps in Potchefstroom, Klerksdorp, Orkney and Stilfontein may contain toxic substances such as arsenic, cyanide and radioactive substances such as uranium and radium. Uranium content is also very high in the sludge from platinum waste materials that are deposited in the tailings dams around Rustenburg. Anglo Platinum's Annual Sustainable Development Report for 2005 confirms the possibility of wind borne particulate matter from its 23 tailings dams, of which 15 are active (Anglo Platinum, 2005, p. 62).

Abandoned and unrehabilitated asbestos mines in the Pomfret, Heuningvlei, Nchweng, Reivilo and Gamopedi areas have been a significant source of wind-borne asbestos fibres for several decades. Asbestos fibres are not soluble in water, are not transported through soil, nor are they degradable. They therefore persist in the environment for long periods. Damage to plants due to atmospheric pollution includes chlorophyll destruction and tissue death, with the formation of pigmentation also occurring.

6.3.3.2. Human health impact[6]

The impact of air quality on human health is largely governed by the level of exposure (concentration of the pollutant) as well as the length of time individuals are exposed to a pollutant, hours per day, days per year and number of years (US EPA, 1996). In determining the health effects of each pollutant exposure, it is therefore critical to know this information. Stratospheric ozone depletion and the associated increase in UV-B radiation reaching the Earth's surface is a leading cause of sunburn, cataracts and skin cancers (such as melanoma) (BMA, 1999).

Unemployment and poverty in the NW Province in general, and in the Platinum region in particular, are major factors affecting the state of the environment. Overcrowding in urban and peri-urban areas and rapidly increasing informal settlements, where people live in cramped conditions with inadequate ventilation, have a major impact on air quality in these areas and on human health. The domestic use of fossil fuels by large numbers of people without access to electricity is also a contributing factor to poor air quality in these areas. Some of the highest air pollution levels have been recorded in similar low-income indoor environments. Indoor SO_2 levels become dangerously high when cooking with coal (up to 5,2 mg/m^3) for one hour, with total suspended particulate matter reaching 1,420 mg/m^3 (measured in a rural area in the Free State).

Carbon dioxide is an asphyxiate that displaces oxygen from the breathing atmosphere. Individuals with cardiac or pulmonary diseases are most susceptible to the effects of carbon dioxide. Carbon monoxide (CO) exposure is associated with various effects, ranging from headache, dizziness, nausea and vomiting to rapid heart beat, shallow breathing and fainting (TOXNET, 2000) These health effects are only likely to occur at extremely high indoor concentrations. Particulate matter may be of variable sizes and the smaller the particle the more likely it is to travel deep into the lungs resulting in adverse health effects. Individuals with asthma, lung and heart disease are most susceptible to the effects of particulates, as are the elderly and young children. Particulates are likely to cause persistent coughs, wheezing and excess phlegm, as well as diseases associated with compounds (such as volatile organic compounds) that can be attached to the particulate matter (US EPA, 1997). Asbestos fibres are known to cause asbestosis and mesothelioma (ATSDR, 2001).

VOCs are released during industrial processes (such as fossil fuel burning) and are also found in vehicle emissions. VOCs include a wide range of individual substances (hydrocarbons, halocarbons and oxygenates), with varying health effects. The health effects of VOCs include mucous membrane irritation, headaches, nausea, organ damage and cancer. Benzene is one of the main VOCs arising from vehicle emissions, and benzene concentrations are often higher in urban areas compared to rural areas, with roadside concentrations being highest (US EPA, 2001; MMU, 2001). The impact of air quality from wind-blown dust emanating from gold mine dumps is localised around the Potchefstroom and Klerksdorp-Orkney-Stilfontein areas. Dust from gold mine dumps and tailings dams contains several toxic substances (e.g. arsenic, cyanide and radioactive substances including Uranium-238 and Radium-226). These can cause adverse effects on human health (such as silicosis) and impact on crops growing on nearby farmland. The increasing number of tailings dams in the Rustenburg area is already posing a similar problem in the platinum producing area of the NW Province.

Un-rehabilitated asbestos mines present significant impacts to the health of the surrounding communities. It has been shown that wind blown asbestos dust causes pulmonary disease, such as asbestosis, lung cancer and mesothelioma (Randeree, 1998). This is a continuous environmental problem, and nearby local communities have been exposed to asbestos for many years. Nearby communities are still exposed to blue asbestos fibres or crocidolite (the most toxic form of asbestos) blown from open pits at the mines. Toxic material can be blown 60 to 100 km in strong winds. Many ex-miners and people living in the adjacent communities have died or are suffering from the abovementioned respiratory diseases. It has been proposed that the communities be relocated from the Pomfret area. The Nchweng asbestos mine, which was rehabilitated in 2001, is located very close to the school and village, posing a serious health threat to the people living in the vicinity (NWDACE, 2002).

Box 6-7: Indoor air-pollution in informal settlement shacks

Unemployment and poverty in the NW Province are major factors affecting the state of the environment. Overcrowding in urban and peri-urban areas, and burgeoning informal settlements where people live in congested dwellings with inadequate ventilation, have a major impact on air quality in these areas and hence human health. Coupled with this is the domestic use of fossil fuels by large numbers of people without access to electricity. Some of the highest air pollution levels have been recorded in similar low-income indoor environments. Indoor SO_2 levels become dangerously high when cooking with coal (up to 5.2 mg/m^3) for one hour, with total suspended particulate matter reaching 1,420 mg/m^3. The World Health Organisation (WHO) states that the minimum levels of total suspended particulate matter for effects on human health to be detectable are 0.180 mg/m^3 over a 24-hour period.

The Provincial mortality rate directly attributable to air pollution (indoor and outdoor) has yet to be quantified. However, children and those already suffering from respiratory diseases living in low-income housing or informal settlements are the most vulnerable.

6.3.3.3. Specific impacts of the mining industry in the platinum belt

The sustained increase in the price of platinum, driven by increased demand as a result of the economic growth of China, coupled with demand driven by the automobile industry where catalytic converters are now a compulsory component of all petrol and diesel driven engines, has seen a massive expansion in mining operations in the Rustenburg area. There has also been an enormous increase in the processing of raw ore into platinum, through the smelting process. The paradox for Rustenburg is that platinum is a key component in ensuring that pollution from motor vehicle emissions are minimized thus contributing to cleaner air globally, yet the platinum smelting process results in unacceptably high sulphur emissions. Various air-borne pollutants are common to the mining and minerals processing industry. These include particulate matter (often containing heavy metals and radioactive substances from gold mine dumps), SO_2, NO_2 and carbon oxides. Many mineral-processing plants, such as platinum and ferrochrome plants, release significant emissions; and where sulphur-containing ores are smelted, sulphur dioxide is also emitted. Chrome processing plants emit Chromium VI, which is produced when chrome is smelted in the presence of oxygen.

Criteria air pollutants may cause various health-related issues, from irritation of the eyes to cardiovascular, respiratory and pulmonary disease. SO_2 primarily affects the mucous membranes in the body (e.g. eyes and nose) and the respiratory system. It may cause tightness of the chest, coughing, wheezing and asthma. SO_2 in the presence of particulate matter can cause and aggravate chronic lung diseases and increase the risk of respiratory disease (TOXNET, 2000). NO_2 primarily has an affect on the respiratory system and may cause shallow breathing, increased heart rate, wheezing, shortness of breath and coughing; it may also have an affect on the immune system (Californian EPA, 1997; Law, 1999). This is a particular concern in the eastern region of the Province (Rustenburg, Brits area) as well as indoors due to coal burning in poorly ventilated dwellings.

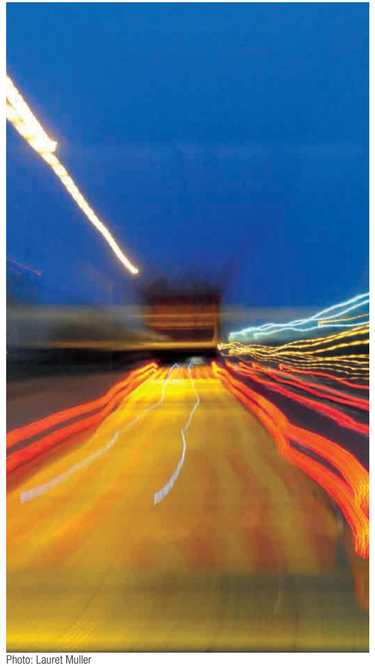
Whether SO_2 from the Gauteng Province impacts on the air quality in the NW Province, largely depends on prevailing winds. As the vast majority of industries are located in the eastern region of the NW Province in the Rustenburg-Brits-Garankuwa area, it is in this region where air pollution emanating from industry is of greatest concern, particularly from the platinum and chrome processing industries. High levels of SO_2 are currently being emitted in this region (in excess of 250 tons/day for Rustenburg). These levels of emissions are impacting on the air quality in the area and the potential for acid rain and acidification of soils and water is high. SO_2 itself is known to be toxic to plants and animals. Levels in Gauteng Province have been known to occasionally exceed biological toxicity thresholds (DEAT, 1999).

The environmentally sensitive areas of Magaliesberg Protected Environment and the Kgaswane Mountain Reserve are also in the vicinity of the platinum mining belt. Residents claim that there has been a significant increase in respiratory diseases and ailments in the area, and that even trees are dying as a result of the high sulphur content in the air. Citrus farmers have also complained that the polluted air is affecting their crops. By installing 'environmentally clean' technology in smoke stacks, the three platinum plants have committed to reducing their SO_2 emissions to less than 20 tons/day and their dust emissions to less than 50mg/Nm^3.

Vanadium pentoxide (V_2O_5), classified as a carcinogen, is mined in the Brits region. There is evidence that this compound has mutagenic properties and may cause eye, nose and throat irritation; respiratory health effects and eczema. Exposure to V_2O_5 is through inhalation. One mine mines both vanadium and chromium in the Brits area, while another also mines chromium in the same area. Chromium VI is a known carcinogen.

Figure 6-2 provides a map of the ambient air hot-spots[7]. A total of five ambient air pollution hotspot areas were identified. Two of the hotspot areas fall within the Bojanala Platinum district, with the first including monitoring points Bojanala 2, Bojanala 3 and Bojanala 4, and the second including point Bojanala 6. One area within the Ngaka Modiri Molema District was identified as a hotspot area covering both monitoring points Central 1 and Central 2. The Dr. Kenneth Kaunda District has two hotspot areas covering monitoring points Southern 1, Southern 2 and Southern 3. Various criteria were considered for selection of these hotspot areas, including:

- Highly industrialised areas;
- Areas with extensive mining operations (including mine tailings impoundments);
- Densely populated areas (more significance was given to areas with likelihood of domestic fuel burning);
- Busy roadways resulting in vehicle tailpipe emissions, and
- Areas with predominantly agricultural activities.



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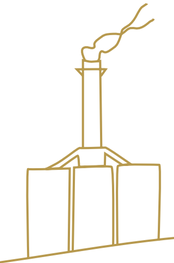

6 Refer to Chapter 2 for a discussion on human health

7 Given the sparse distribution of ambient monitoring stations within the Province all data was included for the purpose of this report. Summary statistics were calculated to highlight the current air quality challenges. Preference was given to the stations with the most current, comprehensive and reliable data. Emphasis was also placed on the stations located within or near to residential areas even though all the stations reflect industry-related monitoring.

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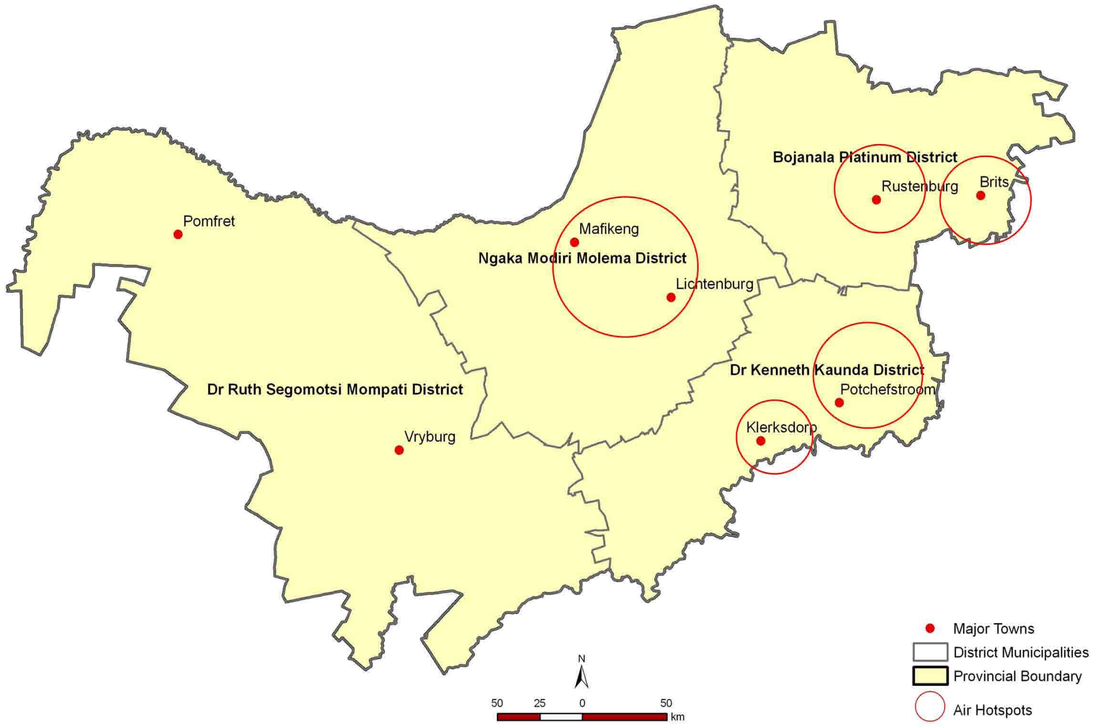


Figure 6-2: Identified air pollution hotspot areas where ambient monitoring stations need to be implemented.

6.4. Climate change[8]

Greenhouse gases are transparent to short wavelength radiation from the sun, but absorb the long wavelength radiation reflected from the earth. This causes an increase in the temperature of the earth's surface. Greenhouse gases include water vapour, CO_2, NH_4, NO_x, O_3 (ozone) and CFCs, and are therefore believed to be responsible for climate change, which includes gradual increases in temperature and increases in the frequencies of extreme events such as droughts and floods (SOA, 2006).

Climate change is an international concern which has resulted in the United Nations Framework Convention on Climate Change (UNFCCC) and the associated Kyoto Protocol, which schedules greenhouse gas emission reductions for 'developed' countries.

South Africa's climate is highly variable, both temporally and spatially. Global warming is expected to contribute further to this variability, and the frequency and intensity of droughts and floods can be expected to worsen. Projected climate changes in South Africa, based on the integration of findings from simulations using a range of climate models, are summarised as follows (Scholes and Biggs 2004; Hewitson, 2005):

- The majority of models indicate a net drying on the western two-thirds of the subcontinent, south of about 10°;
- East coast regions, where topography plays a significant role in rainfall formation are likely to become wetter. The extent to which this wetting extends into the interior is currently uncertain;
- The Western Cape appears to be facing a shorter rainfall season, with the eastern interior portions of the Province likely to experience increased late summer rainfall, and
- Ambient air temperature is predicted to increase across the country with the interior experiencing the greatest increases. Maximum warming for the interior is likely to be in the range of 3°C to 4°C.

6.4.1. Impacts of greenhouse gases

The potential impact of climate change on the health of the South African population has not been modelled, as is the case in other countries such as the USA. Potential indirect health effects anticipated to occur locally have, however, been identified as including (Terblanche, 1994):

- Mortalities and increased incidence of developmental defects, infectious diseases and respiratory diseases due to increased surface temperatures. The likely occurrence of epidemic infectious diseases is related to changes in the distribution of disease vectors and to reduced cellular immunity in humans as a result of UV exposure.
- Increases in ambient air pollution and higher ambient temperatures are likely to result in an increase in O_3 levels, with longer lasting peaks predicted to occur in urban areas early in the day.
- Increased incidence of skin cancer, eye diseases and immuno-suppression due to exposures to higher UV radiation levels (SOE, 2007).

Photo: Lauret Muller

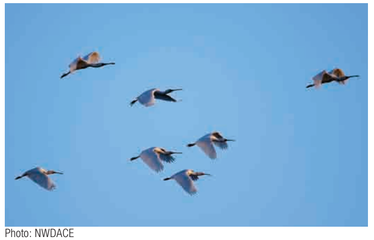


Photo: NWDACE

Indirect effects on human welfare due to global climate change are related to the potential impacts on biodiversity, ecosystems and the availability of agricultural land and water for irrigation. The potential for overcrowding, malnutrition and starvation, allergic diseases, and suffering due to weather extremes has been noted (Terblanche *et.al.,* 1994; SOE, 2007).

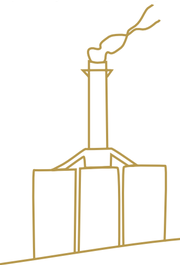
6.4.2. Ozone depletion

The Earth's protective ozone layer is found in the stratosphere (about 15 – 50 km above the earth's surface) and is between 15 and 30km thick. In this layer, O_3 is concentrated to 1 to 10 ppm. Stratospheric ozone is a naturally occurring gas layer that filters the sun's ultraviolet radiation; the depletion of stratospheric ozone is believed to result in more harmful ultra-violet B radiation reaching ground level.

Box 6-8: Ozone depleting substances

O_3 depleting substances, such as CFCs and carbon tetrachloride have almost been completely phased out in South Africa. However, a small amount of legal CFCs are imported and exported to fill asthma inhalers as well as air conditioners and refrigerators manufactured prior to 1996. CFC methyl bromide is still imported and used as a pesticide in the agricultural sector. DEAT is formulating a full phase out plan for these substances (SAO, 2007).

Although stratospheric ozone depletion is a global issue, the impacts of stratospheric ozone depletion are likely to be of considerable significance on a local scale. Such impacts include increased harmful UV-B radiation reaching ground level and associated increases in skin cancer, and cataract and immune system related health risks. UV-B radiation also impacts on vegetation by damaging the photosynthetic pathways and genetic structure of plants.



8 Refer to Chapter 4 for a discussion on the impacts of climate change on vegetation types

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6.5. Conclusion

Sources of atmospheric emissions include both natural and anthropogenically-induced releases. Natural sources include biogenic releases, wind blown dust, veld fires and lightning (inducing NO_x formation). Anthropogenic sources include:

- Industrial and commercial activities, including Scheduled Processes and fuel burning appliance operation by businesses, hospitals and schools;
- Electricity generation by power stations;
- Waste treatment and disposal:
- Emissions from residential sources include household combustion of coal, paraffin, LPG and wood;
- Sources of emissions relating to transport include petrol and diesel driven vehicle tailpipe emissions, vehicle entrained road dust, brake and tyre wear fugitives, and rail and aviation emissions;
- Emissions from mining specifically relate to wind-blown emissions from mine tailings impoundments, and include particulates (TSP, PM10 and PM2.5);
- Agricultural sources include crop residue burning, enteric fermentation and fertiliser and pesticide application;
- Other sources of emissions that should also be considered include tyre burning and fugitive dust from construction and erosion of open areas, and
- Long-Range Transport of Aerosols from biomass burning and industrial emissions.

The air pollution data presented in this Chapter highlights the following air quality challenges:

- Elevated PM10 concentrations are evident from the limited data supplied at the various stations within the NW Province. For all stations where PM10 data were supplied, the proposed SA Standards over a daily average and annual average were exceeded. In general an increase in ambient PM10 concentrations was reflected. The data for PM10 is however inconsistent and more comprehensive records are required to determine trends of PM10.
- Close to industrial sources SO_2 concentrations were high, exceeding the SA Standard for all averaging periods (10-minute, hourly, daily and annual averages). In the residential area of Rustenburg a slight increase in SO_2 concentrations were noted over the past 3 years, whereas a slight decrease was recorded near the industrial zone of Anglo Platinum. The current total SO_2 emissions in the Rustenburg area are approximately 250 tons/day.
- SO_2 concentrations are likely to be high in low income settlements where use is made of coal and wood as energy source.
- Although NO_2 concentrations have not been recorded to date in the NW Province, it is likely to be high close to busy roads and intersections such as the N4 Platinum Highway.
- Hexavalent Chrome is a concern within the NW Province due to the number of Ferro-Chrome smelters located in the area.

Poor air quality may have impacts on many aspects, such as:

- Ecological impacts through fallout and deposition of particulates. High concentrations of pollutants in the atmosphere can cause acid rain, changes in ecological functioning, destruction of flora through tissue death, and formation of ozone in the troposphere.
- Human health impacts include respiratory, pulmonary and cardiovascular symptoms and diseases, due to elevated levels of particulates, oxides of nitrogen and sulphur, CO_2 and VOCs in the atmosphere.
- The increases in greenhouse gas emissions are responsible for changes in climate.
- Depletion of the stratospheric ozone layer results in increased ultraviolet radiation β which causes skin cancer, immune health risks and damage to plant tissues.

6.6. Responses – air quality[9]

Information regarding the status of air quality within the NW Province is limited prohibiting proper management of ambient air quality. The main limitation characterising air quality within the Province is the limited availability of high quality, long duration air pollution monitoring data. The status of the ambient air is required to determine the significance of the impacts on human health and the environment.

Box 6-9: Air Quality Act

National, provincial and local authorities (district and metropolitan municipalities) are responsible to manage air quality under the National Environmental Management: Air Quality Act (Act no 39 of 2004).

6.6.1. Government responses

The availability and dissemination of air quality information is a major obstacle affecting air quality management and control. Very little historic air quality monitoring data is available for the Province, with air quality monitoring historically undertaken by the industries in the region.

The NW Province government will be responsible for ambient air quality monitoring, monitoring of the District Municipalities and development and implementation of a provincial AQMP. An Air Quality Officer will have to be appointed as stipulated under the AQA. One of the major obstacles at Provincial and Local Government levels is capacity in terms of resources, tools and finances for air quality management and control. To date, the Department has established a Provincial Air Quality Forum, with representatives from municipalities and NWDACE, to discuss air quality management issues.

Limited air quality data and information is available in the Province as the measurement of air quality has historically not been prioritised. In addition, current monitoring practices are not standardised and as a result, information is often scattered and fragmented. In addition, insufficient data is collected and collated, with data not routinely transferred into information. Due to the limitations surrounding availability of existing information and appropriate dissemination of this information, air quality information is not readily available to stakeholders. Other sources of information, such as emissions data, are also not easily accessible or available. Emissions from smaller industries are often un-quantified, as it is currently not a legal requirement. As a result, the quantification of total source emissions can be difficult and inaccurate.

6.6.2. Non-government responses

There are two active Non-Governmental Organisations (NGOs) within the NW Province. The NW Ecoforum and Kroondal Ecoforum have been involved in air quality related issues over the past few years. These organisations aim to ensure improvement of the ambient air quality within the region.

The NW Air Pollution Control Forum (NAPCF) comprises of Scheduled Process Certificate holders (22 at present) and was established in 2002. The main objective of the organisation is to share information, facilitate technical discussions and provide feedback on air quality management. From participating industries (ferrochrome, cement, platinum, etc) it has been estimated that there was a 50% and 70% improvement in the control of SO_2 and particulate matter emissions respectively for the period from 2000 up to and including 2004 (NAPCOF, 2007).

6.6.3. Proposed air monitoring network for the NW Province

The major limitation characterising air quality within the province, is the limited availability of high quality, long duration air pollution monitoring data. It is necessary that the status of the ambient air quality is determined to evaluate the significance of the impacts on human health and the environment. As a result, responses are focused on ambient air quality monitoring, and proposes an expansion of the current monitoring network and a tiered approach to start monitoring PM10 and SO_2 first, and thereafter expand the network to cater for the remainder of the criteria pollutants.

6.6.4. Responses

Norms and standards for ambient air quality monitoring are published in SANS 1929: 2005, Ambient Air Quality – Limits for Common Pollutants. These are based on accepted international practice and are accepted as the national norms and standards for ambient air quality monitoring in the National Framework for Air Quality Management. The National Framework provides guidance on the macro- and micro-siting of stations as well as the ideal minimum number of sampling points for fixed measurements.

Table 6-5 shows which indicators are to be monitored within the timeframes stipulated, as and when these should be implemented:

TIER	PM10	SO_2	NO_x	CO	PB	O_3	COMMENT
Rustenburg/Kroondal region							
1	✓	✓	×	×	×	×	Should be measured as a minimum. Background data exists but authorities should have stations in the area for verification purposes.
2	✓	✓	✓	×	✓	×	No background data exists. Lead mainly from vehicles with NOx due to domestic fuel burning and vehicle emissions.
3	✓	✓	✓	✓	✓	✓	No background data exists. Ozone should be measured to determine background concentrations. CO will result from industries, vehicle tailpipes, biomass and domestic fuel burning.
Marikana/Brits region							
1	✓	✓	×	×	×	×	Should be measured as a minimum. Limited background data exists for selected areas. Authorities should have stations in the area for verification purposes.
2	✓	✓	✓	×	✓	×	No background data exists. Lead mainly from vehicles with NOx due to domestic fuel burning and vehicle emissions.
3	✓	✓	✓	✓	✓	✓	No background data exists. Ozone should be measured to determine background concentrations. CO will result from industries, vehicle tailpipes, biomass and domestic fuel burning.
Mafikeng/Lichtenburg region							
1	✓	✓	×	×	×	×	Should be measured as a minimum. No background data exists and authorities should have stations in the area for verification purposes.
2	✓	✓	✓	×	✓	×	No background data exists. Lead mainly from vehicles with NOx due to domestic fuel burning and vehicle emissions.
3	✓	✓	✓	✓	✓	✓	No background data exists. Ozone should be measured to determine background concentrations. CO will result from industries, vehicle tailpipes, biomass and domestic fuel burning.
Klerksdorp region							
1	✓	✓	×	×	×	×	Should be measured as a minimum. No background data exists and authorities should have stations in the area for verification purposes.
2	✓	✓	✓	×	✓	×	No background data exists. Lead mainly from vehicles with NOx due to domestic fuel burning and vehicle emissions.
3	✓	✓	✓	✓	✓	✓	No background data exists. Ozone should be measured to determine background concentrations. CO will result from industries, vehicle tailpipe, biomass and domestic fuel burning.
Potchefstroom region							
1	✓	✓	×	×	×	×	Should be measured as a minimum. No background data exists and authorities should have stations in the area for verification purposes.
2	✓	✓	✓	✓	×	×	No background data exists. Lead mainly from vehicles with NOx due to domestic fuel burning and vehicle emissions.
Vryburg region							
1	✓	×	×	×	×	×	Should be measured as a minimum. No background data exists and authorities should have stations in the area for background monitoring – background levels where no major activities exit.
2	✓	✓	✓	×	×	×	No background data exists and authorities should have stations in the area for background monitoring – background levels where no major activities exit.

Table 6-5: Indicators to be monitored

9 For more detail on responses, refer to Chapter 10.

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Monitoring is proposed in a phased approach as three tiers (timeframes) are to be implemented within the NW Province, increasing per tier until all criteria pollutants are measured at Tier 3. The timeframes allocated to the three tiers coincide with the medium and long-term timeframes stipulated, as follows:

- Tier 1: Current to 2015;
- Tier 2: 2015 to 2025, and
- Tier 3: 2015 to 2025.

6.6.4.1. Continuous ambient air quality monitoring

A continuous ambient air quality monitoring programme needs to be initiated with the purpose of providing continuous, accurate data on pollution concentrations at a specific location. Limitations include spatial coverage, technical skills required for maintenance and calibration as well as the financial implications. Municipalities need to acquire air monitoring equipment and a system to automatically retrieve air quality data from loggers and sensors for the management of remote data acquisition equipment.

As a minimum, any new ambient monitoring station to be installed should measure a range of pollutants and meteorological parameters including:

– PM10, PM2.5, SO_2, NO_x (NO and NO_2), BTEX, CO and O_3, and

– Wind speed, wind direction, temperature, humidity, pressure and rainfall.

Stations should be regularly calibrated, with zero and spans conducted every two weeks and a full dynamic calibration undertaken every three months. All stations should obtain SANAS accreditation to ensure the standardisation of monitoring practices in the region.

6.6.4.2. Data collection and management

The collection, management and dissemination of ambient air quality data and information need to be coordinated and managed as a whole in the Province. Current ambient air quality monitoring practices in the NW Province are fragmented and uncoordinated, since it is primarily done by industry.

The ambient monitoring stations to be implemented by the NW Province should ensure that data is electronically transferred to an on-line, centralised database. The data storage and management system shall have multi-user access to view, collect and validate data, depending on their designated level of access. The software should consist of a database which controls and maintains the integrity of all logger data, as well as user-defined parameters and controls in the system. The data acquisition system should have sufficient data storage capacity to hold historical data.

The data system should be linked to the National Data system currently being developed as part of the South African Air Quality Information System Project (SAAQIS). All ambient monitoring data will be transferred to the electronic database at the South African Weather Services.

Standard reports showing all measurements per interval, maximum and minimum over period and average data shall be made available. All reports should include graphical representation of appropriate information. Other information management interventions include accessibility and dissemination of information through various media forms such as newspaper articles, "Frequently Asked Questions" booklets and the internet.

6.6.4.3. Human resources

For the effective implementation of the air quality monitoring programmes in the NW Province, the following professional appointments are required:

- Air quality Information Officer – Long Term (2015 to 2025). The appointment of a Provincial Air Quality Officer is a requirement of the Air Quality Act, and such as person should be responsible for coordinating matters pertaining to air quality management;
- Atmospheric Scientists – Long Term (2015 to 2025);
- Technicians – Long Term (2015 to 2025); and
- Provincial Air Quality Officer – Medium Term (Current to 2015).

6.6.4.4. Provincial ambient air quality management plan

The objective of the plan will be to provide unambiguous clean air objectives and associated strategies to ensure improvement in the provincial ambient air quality. This must be based on a comprehensive database providing an accurate account of the current status of air quality and air quality management in the province.[10]

The plan will aim to:

- Identify gaps in the existing baseline air quality data;
- Determine if existing ambient air concentrations within the Province are in compliance with legal requirements;
- Identify management requirements for the Province;
- Provide an updated and more accurate baseline characterisation of the air quality within the study area, and
- Develop an Air Quality Management Plan that is linked with the proposed monitoring programme to ensure the ambient air of the Province will be brought into compliance.

Table 6-6 lists indicators were not examined for this Outlook Report; these indicators must be calculated for reporting in the future.

Objective	Indicator	Indicator calculation/data collection
Reduce gas emissions that contribute to green house effect	Carbon dioxide emissions per capita (MDG)	Amount of emitted carbon dioxide / Population
	Mean annual temperature	∑(Morning temperature for the entire year)/365+∑(Evening temperature for the entire year)/365
	Consumption of ozone depleting substances (methyl bromide)	∑(Provincial annual production - exports + imports of controlled substance) * Ozone depleting potential

Table 6-6: Table of indicators not examined

10 Refer to Chapter 10 for more information.

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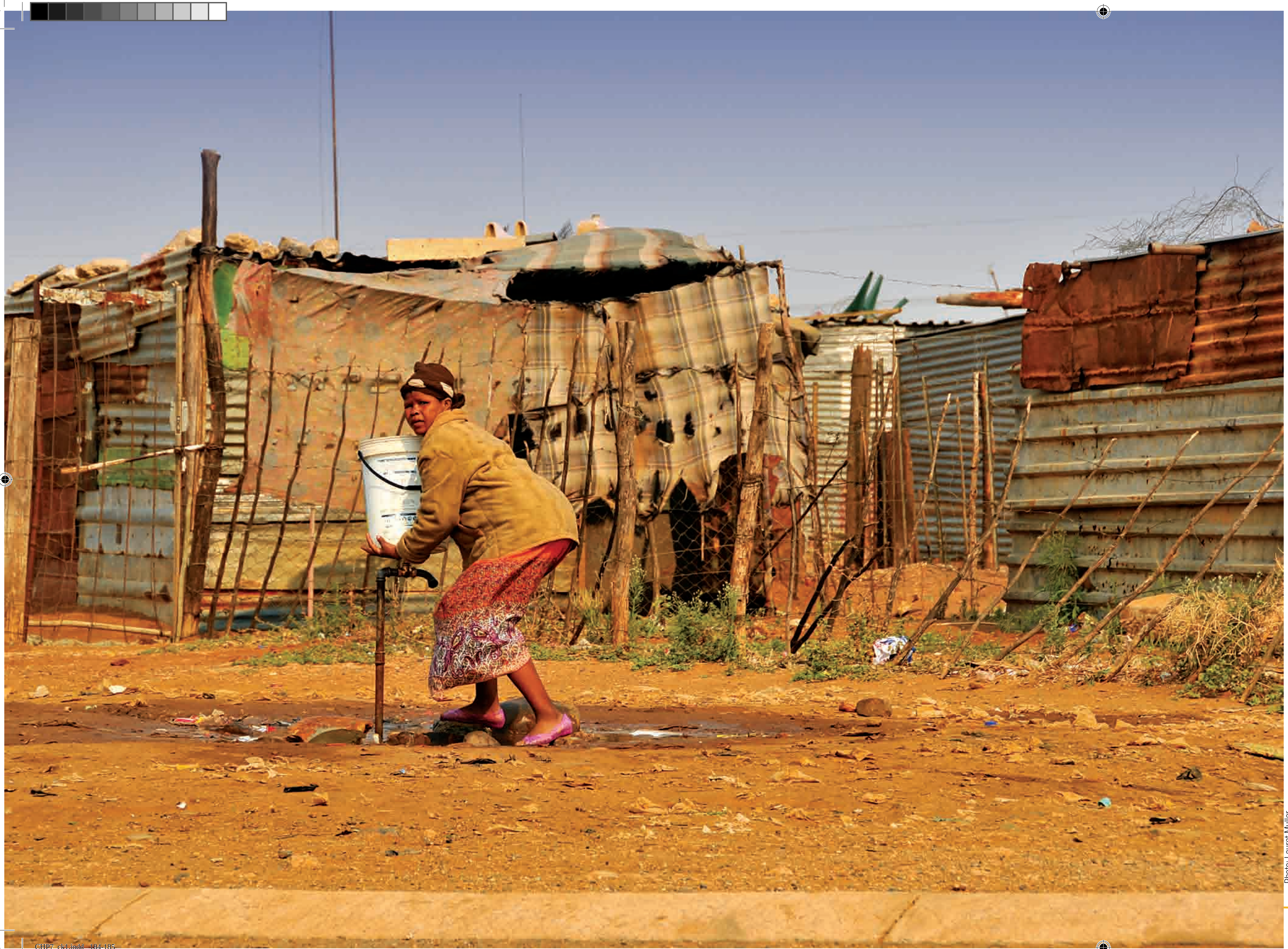

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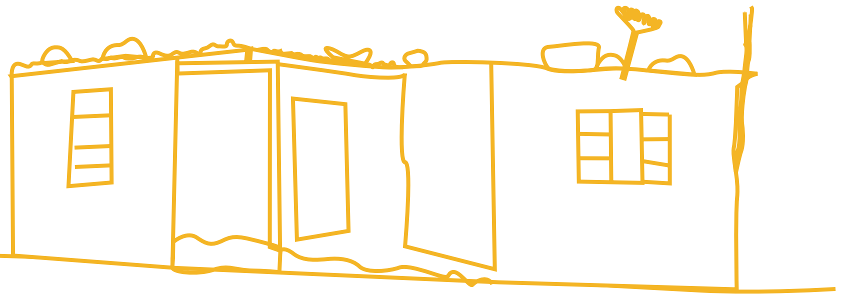
CHAPTER 7

Human settlements and infrastructure



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List of figures

Chemical abbreviations

CaF_2	Calcium Fluoride

Acronyms and abbreviations

EPWP	Expanded Public Works Programme
DEAT	Department of Environmental Affairs and Tourism
DME	Department of Minerals and Energy
DOH	Department of Housing
DWAF	Department of Water Affairs and Forestry
GGP	Gross Geographic Product
Gwh	GiggaWatt hours
HCRW	Health Care Risk Waste
IWMP	Integrated Waste Management Plan
MTEF	Medium Term Expenditure Framework
NEAC	National Electrification Advisory Committee
NW	North West
NWPG	North West Provincial Government
NWPSDF	North West Province Spatial Development Framework
PGDS	Provincial Growth and Development Strategy
RDP	Reconstruction and Development Programme
SDI	Spatial Development Initiative
SMME	Small Medium and Micro Enterprises
TRI	Taxi Retail Installations

Photo: Lauret Muller

Definition of terms

Hazardous waste
Hazardous waste is waste, other than radioactive waste, which is legally defined as hazardous in the state in which it is generated, transported or disposed of. The definition is based on the chemical reactivity or toxic, explosive, corrosive or other characteristics which cause, or are likely to cause, danger to health or to the environment, whether alone or in contact with other waste (DWAF, 2005 Minimum Requirements).

Migration rate
Net migration rate is the difference of immigrants and emigrants of an area in a period of time, divided per 1,000 inhabitants. A positive value represents more people entering the country than leaving it, while a negative value mean more people leaving than entering it.

Urbanisation level
The proportion of the population living in urban areas at a particular point in time.

List of tables

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7.1 Introduction

To many, the environmental consequences of the human-environment relationship are readily apparent in and surrounding human settlements. While human settlements, as systems, are synonymous with access to economic and social opportunities, so too are they defined by their consumption of resources and wasteful outputs into the environment.

Each of the provinces in South Africa is characterized by spatial patterns inherited from the apartheid era. The historical injustices imposed by apartheid on the majority of the population meant that there was limited access to economic and social opportunities in all provinces. This division along racial lines was fundamental in shaping unsustainable settlement patterns in the North West Province and a lack of provision of basic infrastructure including water, sanitation and electricity has contributed to the backlog of human development progress within the province. Settlement patterns within the province are also shaped by the availability of water and land, the proximity to minerals, markets and economic and social opportunities.

In the North West Province, the variability of access to economic and social opportunities is evident when comparing the more sparsely-populated and arid west to the economically-robust eastern region. Settlements in the province are constantly in flux as they are continually being shaped by the forces of migration and urbanisation spurred by the position of the mines within the province, and the proximity to other urban-industrial centres such as Tshwane and Johannesburg.

The human-environment relationship is seldom symbiotic, where human survival and economic ambitions, coupled with dynamic population forces, constantly place pressures on finite resources. This is most true in areas of the province where environmental quality is pitted against the survival needs of the poor. An overview of the human settlement situation and the infrastructure supporting the growth and developmental needs of the province is provided in this Chapter, in order to define the extent of the impact of human settlements on the environment.

7.2 Settlement pressures in the North West Province

7.2.1 Population

As mentioned, the settlement patterns in the NW Province, particularly in smaller settlements, were influenced by the policies of the apartheid government. This resulted in fragmented, displaced, and in many cases unsustainable settlement patterns. According to the Office of the Premier (2007), there were 3.271 million or 7.0 % of the national total population in the North West Province. The population is estimated to be growing at a rate of 1.2% per annum. The Bojanala Platinum District has the densest demographic distribution, while Dr. Ruth Segomotsi Mompati District has the least dense distribution with 1,043 people and 208 people per km^2 respectively. There are a relatively small number of urban centres, the largest of which are Potchefstroom, Klerksdorp, Mafikeng, Brits, Rustenburg and Carltonville, representing the most densely populated areas of the province. Approximately 35% of the population live in urban areas. The most sparsely populated parts of the province include the areas north of the Pilansberg, the northwest of the Dr. Ruth Segomotsi Mompati District, the area between Zeerust and Mafikeng, and also between Vryburg and Mafikeng[1]. Approximately 65% of the population live in rural areas. The rural settlements, informal settlements and traditional villages are generally located on state or tribal land.

Based on the StatsSA Community Survey (2007), there are approximately 911,120 households in the NW Province. As indicated in Figure 7-1, significant household and population growth has occurred in the Bojanala Platinum and Dr. Kenneth Kaunda Districts, which had the most overall growth. A slower growth rate is noted in the Ngaka Modiri Molema District while a decrease in households is evident in the Dr Ruth Segomotsi Mompati District.

The factors contributing to the shift in population across the province are attributed primarily to the urbanisation and migration trends experienced within the province.

7.2.2 Urbanisation

Urbanisation is defined as the movement of people from rural to urban areas and/or the measurement of the proportion of people living in defined urban centres. According to Naude and Krugell (2003), South and Southern Africa has one of the worlds highest urbanization rates, with approximately 70% of the total population expected to live and work in urban areas by 2030. This poses great challenges for planners and development decision makers throughout the country.

Of the 224 settlements within the NW Province, 205 are categorised as either agricultural service centres or traditional rural agricultural centres, which emphasises the province's rural character. According to a report by Stats SA (Migration and Urbanisation in South Africa), the urbanisation level in the Province is 41%, meaning that this percentage of the population were resident in urban areas as calculated from the 2001 population census. The province's urbanisation rate is almost 10% lower than the South African urbanisation rate of 56.3%. As discussed in Chapter 2, the rate of urbanisation in the NW Province has increased steadily over the past ten years. In 2006, urban areas absorbed 11.3% more of the total population of the province than in 1996, and 8.8% more than in 2001.

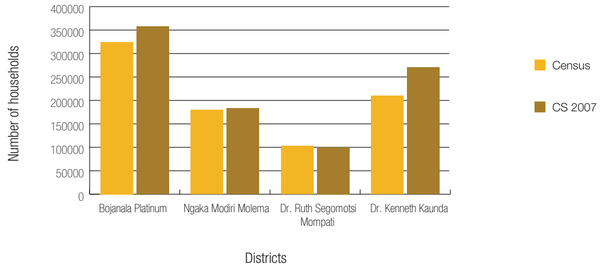

Figure 7-1: Number of households per district (Stats SA Community Survey 2007 / Census 2001)

1 Refer to Chapter 3 for additional information on population growth in relation to land cover

The rate of urbanisation in the province is increasing as a result of a lack of employment opportunities in rural areas. According to most sources, it is largely accepted that the Bojanala Platinum District is the densest and fastest urbanising District in the Province, where platinum mining is the driving forces, spurring urbanisation.

Most urban areas in the North West Province do not have adequate response mechanisms to urbanisation. Urban growth occurs on the periphery of urban areas, thereby perpetuating urban sprawl. This often results in haphazard growth of the urban centre in areas which may be unsuitable for human settlement based on environmental factors. This unplanned, unfocused development exerts pressures on natural resources. No province specific information currently exists with which to quantify the extent of environmental degradation due to urbanisation; however, coupled with the forces of migration, urbanisation has a defining role in environmental quality in the NW Province.

7.2.3 Migration

Migration plays a significant role to in the evolution of human settlements and is simplistically defined as the temporary or permanent movement of a person from his or her home of origin to a new place. Human migration is often a factor of underlying social or environmental problems experienced by individuals and households. The main reason people migrate is to exercise the economic and cultural options provided by their destination. The effects of migration may be experienced, but not limited to the following at source:

- Brain drain of local knowledge to other areas;
- Under-management of local subsistence agriculture or resources, and
- Improved household income due to cash injection sent home by the migrant worker.

The effects of migration as a result of the scale of the phenomenon, are primarily experienced at the new point of settlement and may include, but are not limited to the following:

- Unfocused urban settlement resulting in squatter settlements;
- Lack of service and infrastructure provision;
- Environmental degradation due to pollution of natural resources, and
- Adverse health impacts in humans.

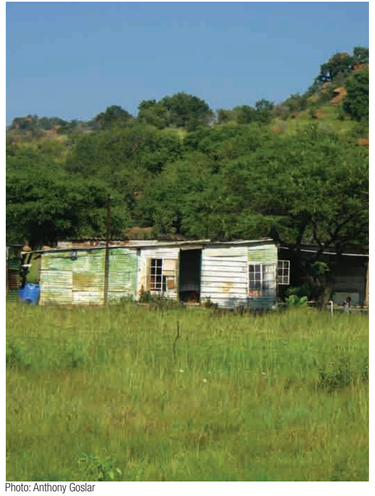

Photo: Anthony Goslar

According to StatsSA's community household survey (2007) the NW Province has a negative migration rate. Estimates for the period of 2001 to 2006 indicate that 219,200 out-migrants migrated to other provinces. An estimated net migration loss of 55,000 people was experienced during this period in the province. The main reason for this negative net migration rate is attributed to the search for employment in other provinces, particularly Gauteng, which received 66 % of the provinces migrants. The total number of in-migrants into the NW Province was 163,700 of which the majority came from Gauteng.

Although most migration events are based on economic and cultural choices, people also migrate as a consequence of severe environmental change. The effects of environmental change on human settlements however, are not covered extensively in this report. In the NW Province, land degradation and the acceleration of soil loss due to unsustainable land use practices are pressures which may place severe future constraints on agriculture[2]. A sudden loss of soil productivity or soil erosion may lead to yield reductions, also contributing to migration decisions. No data exists in the province as to migration decisions made as a result of environmental change, although environmental and climate change could ultimately lead to an increased occurrence in migration events.

7.3 State of settlements

7.3.1 Poverty

Factors such as environmental, cultural, social and economic factors affect the quality of life experienced by the residents of settlements in the province.

As discussed in Chapter 2, one of the key issues affecting human settlement and human vulnerability in the NW Province is poverty. The primary drivers of human vulnerability and poverty[3] are:

- Low levels of employment;
- High population densities leading to settlement problems;
- Household income disparities;
- Low levels of education, and
- High levels of HIV/AIDS.

2 Refer to Chapter 3 for information regarding land use pressures

3 Refer to Chapter 2 for additional information on the status of human vulnerability in the province

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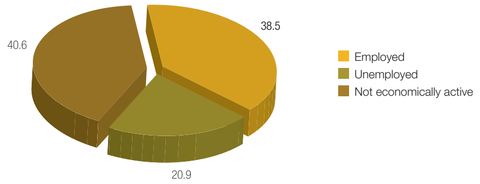

Figure 7-2: Employment in NW Province according to the official definition (StatsSA 2007 Community Survey)

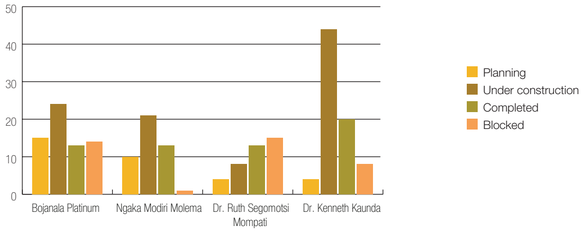

Figure 7-3: Status of housing projects in the NW Province. Department of Developmental Local Government and Housing; Annual Report 2006

7.3.2 Employment

Settlements in the NW Province are strongly defined by economic opportunities in the form of employment. The largest economic contributors to the NW Province's economy are the primary sector activities of mining and agriculture. The mining sector contributes a significant economic share in terms of production and employing approximately 39% of the population within the province.

The state of employment in the province is described in Chapter 2. Important to note here is that according to the StatsSA Community Survey of 2007, over 40 % of the NW Province's population is not considered to be economically active while 21 % of the population is unemployed. This accounts for 61% of the population and infers that only 38.5 % of the population is employed. This is a high unemployment rate by any account. Unemployment among the female economically active population is markedly more than that of males, although the situation in the province seems to be improving.

7.3.3 Shelter and tenure

Access to secure tenure or housing, provides a measure of social security within settlements. Housing provision in the NW Province is primarily influenced by:

- The rate of natural population growth in an area;
- External migration and urbanisation trends;
- Housing affordability issues, and
- Previous and past policy issues related to housing in a particular area.

As mentioned, disjointed urbanisation trends have led to urban sprawl and informal settlements. This has largely been a function of the pre-1994 government, however stark inequalities in the quality of housing structures are still apparent in many areas of the province. Also, the demand for housing as a result of rapid population growth in certain areas often exceeds the delivery rate. Household income and housing affordability also affects access to secure tenure. The more successful the province becomes as the result of a buoyant platinum price, the more people are attracted to the urban areas, and the higher the demand for housing.

According to the StatsSA Community Household Survey, 2007, approximately 54% of households own their dwellings (higher only than Gauteng with 53%), while 22% rent their dwellings.

Government also has an obligation to provide its citizens with secure access to housing. In the NW Province, this role is fulfilled by the Department of Developmental Local Government and Housing. In terms of housing grants for the 2007/8 financial year, the NW Province received R 875.2 m, spent R 785.5 m and delivered in excess of 19,000 housing units.

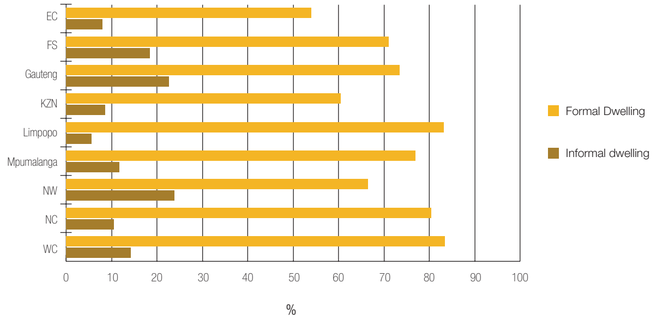

Figure 7-4: Percentage of formal and informal dwellings per Province (StatsSA Community Survey, 2007)

Despite a recorded improved performance in housing provision, the housing backlog increased from 4.7 % in 1996 to 16.3 % in 2006. This represents in excess of 168,000 households waiting for housing (Engineering News, 2008).

Two of the main challenges for housing delivery in the NW Province include the ability of municipalities to manage housing projects and the ability of the service providers appointed by the municipalities to complete housing projects. This often leads to so-called 'blocked' housing projects, which hampers service delivery. In terms of the status of government housing projects in the province, the following trends are noted, as indicated in Figure 7-3.

- The Dr. Kenneth Kaunda District accounts for the most number of projects completed and under construction;
- There were 41 blocked projects of the 249 projects throughout the province during the 2005/2006 period;
- The Ngaka Modiri Molema District has more "blocked" projects than projects under construction;
- The Dr. Ruth Segomotsi Mompati District has the least number of "blocked" projects, and
- The Bojanala Platinum and Dr. Ruth Segomotsi Mompati are the two best performing Districts in terms of project planning.

The definition of secure tenure does not encompass informal settlements, squatters or slums or housing without formal agreement. Figure 7.4 provides a provincial comparison of households categorised as informal. Evident is that the NW Province recorded the highest provincial percentage of households living in informal dwellings (23.8 %) in 2007, followed by Gauteng with 22.7%. NW Province therefore, can be regarded to be the most underperforming province in terms of providing secure tenure in the country.

7.3.4 Transport

In order for human settlements to have access to economic and social opportunities, a transport network which provides adequate mobility must be provided. The ability to access resources is supplied by this network, which is generally determined by or focussed around:

- Improved household incomes;
- The proximity to infrastructure;
- The location in or proximity to urban areas, and
- Efficient government and social delivery mechanisms and participatory local governments.

Development of transport infrastructure favours the eastern part of the NW Province, where population densities and economic activities are the highest. An overview of road, air, rail and public transport infrastructure in the province is detailed hereunder.

Photo: Lauret Muller

7.3.4.1 Roads

Although the NW Province is a landlocked province, an extensive road network connects the major commercial centres of the province to the rest of the country.

There are a total number of 7,140 km paved/surfaced and 16,558 km of gravel/ unpaved roads in the province. The current condition of the paved network is fair, with 13% in very good condition, 29% in good condition, 36% in fair condition, 17% in poor condition and 5% in very poor condition. The potential asset value of the paved network is R15.5 billion at replacement value, current value is however R12 billion (i.e. 77 % of replacement value) due to current road conditions.

The Platinum Highway from Tshwane through Zeerust is part of a highway system that will connect Maputo (Mozambique) on the Indian Ocean to Walvis Bay (Namibia) on the Atlantic.

The Platinum Highway is part of a broader corridor network, which carries important prospects for the future growth of the NW Province's industrial sectors. The project is being hailed as a vital development for the economic future of the Province given that it forms the backbone of the Provinces spatial development initiatives (SDIs).

However, the overall provision of road infrastructure is lower than the national average, and is the second lowest provincial average (NWPSDF).

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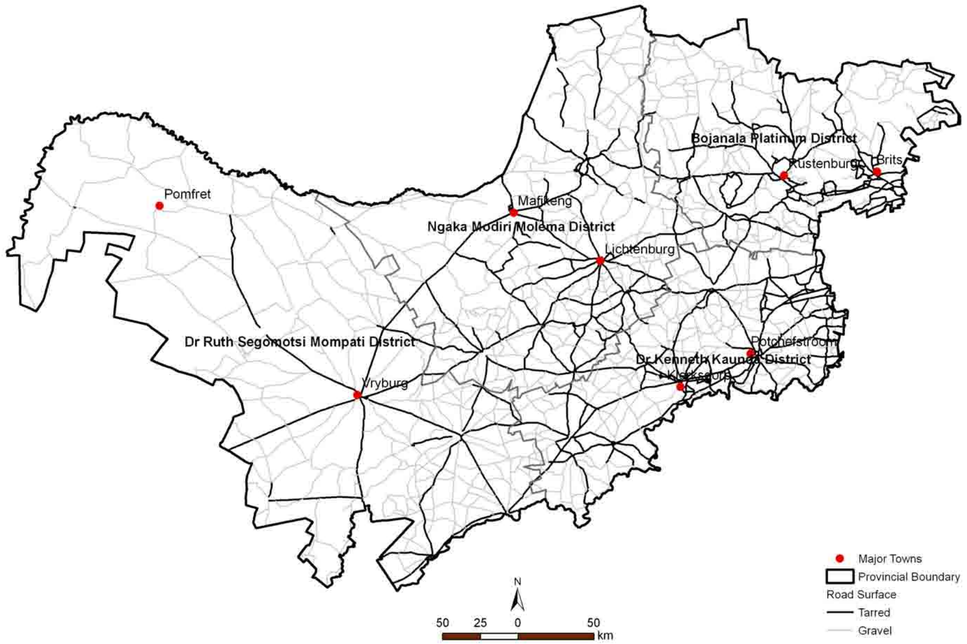

Figure 7-5: Road network in NW Province (National Department of Transport)

7.3.4.1.1 Road maintenance

The deterioration of road infrastructure raises transaction costs and the costs of human mobility in the province.

In terms of paved road maintenance, approximately R112 million is spent annually in the NW Province on daily routine maintenance including grass cutting, road markings, and culvert cleaning. The cost of periodic maintenance of paved roads including resealing and rehabilitation, as well as addressing the paved roads backlog in the province is approximately R1.113 billion per annum.

The state of gravel roads is variable in that 4% of gravel roads are in good condition, 71 % in a fair condition and 25% in a poor condition. Routine maintenance needs are estimated at R 100 million per annum. Every ten years, ten percent of the gravel road network requires re-graveling. In the 2005/2006 financial year, a total of 101.6 km of gravel road were upgraded to paved roads and a total of 140 km of paved roads upgraded. In addition, 36 km of roads were resealed and 85 kilometres rehabilitated. A total of 23 kilometres of road in the farming community of Schweizer-Reneke in Bophirima were re-gravelled, and the Nelson Mandela Drive to the Ramatlabama Border Post was upgraded. The “Thiba Pothole Programme” targeted the Bophirima and Ngaka Modiri Molema Districts with the view to eliminating potholes on the worst affected roads.

The Department of Transport, in partnership with other departments, such as Public Works and Agriculture, continues to contribute to the development projects in Modimong and Modimola. Two hundred and thirty-eight contracts were awarded under the Expanded Public Works Programme (EPWP) throughout the province. The Department’s major goal is to upgrade economic roads that will have a significant impact on the economic development within the Province. Towards the end of the 2006/2007 financial year and over the Medium Term Expenditure

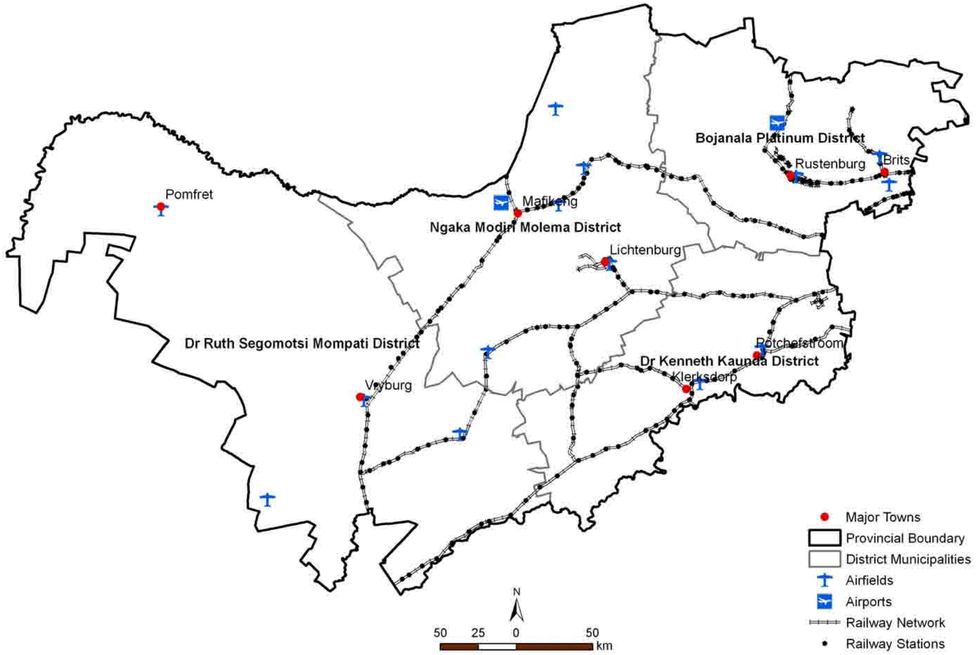

Figure 7-6: Rail and air infrastructure (National Department of Transport)

Framework (MTEF) period, focus on the improvement and planning of the road network will shift towards the Bophirima Region, with the view of bringing about easier mobility in the often neglected remote and rural areas of the province (NW Province Department of Transport, Roads and Community Safety, 2006).

7.3.4.2 Air and rail transport

7.3.4.2.1 Airports

Mafikeng Airport has one of the longest runways in the world and can accommodate the largest commercial aircraft. Operating well below capacity, the airport has great potential as a freight and passenger terminal for international flights and is being developed as an attractive alternative to the heavily used OR Tambo Airport (Johannesburg International). Pilanesberg also has an international airport, servicing primarily the tourism industry for the surrounding areas of Sun City and the Pilanesberg National Game Reserve. Smaller airports and landing strips are located in most of the major towns and cities in the province, providing links to other major destinations in South Africa.

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7.3.4.2.2 Rail

The rail freight system of the NW Province is an important element of the transportation system of the province. There is a large amount of rail freight that moves through the province to destinations within and beyond South African borders.

According to the Freight Transport Data Bank, the cargo rail system consists of four important arterial main line routes and one branch line complex, where over 29 million tonnes of commodities were transported across the NW Province in 2003/2004. The NW Province contributed approximately 7.3 million tonnes of this cargo and received approximately 1.8 million tonnes of freight, mostly in the form of coal and gypsum for industry.

Photo: Anthony Goslar

According to the NWPSDF, there is a lack of internal competition for rail services and compounded with the unavailability of rail-cars for transport of bulk goods, contributes to excessive production costs within the province. This under-utilisation of rail infrastructure has adverse environmental and logistical implications as mining products and other bulk products are transported by roads where the rail-capacity is reached. Commuter rail is poorly developed in the NW Province and rail is the least utilised mode of public transport.

7.3.4.3 Public transport

The development of a public transport system is vital in improving the mobility status of settlements.

According to StatsSA, taxis are the primary source of transportation in the NW Province. 71.5 % of the population make use of taxis, higher than the national average of 60.8 %. This could largely be due to the establishment of co-op owned Taxi Retail Installations (TRIs) which comprise of filling stations and service and repair centres in service of the taxi associations. This has seen the formation of strategic partnerships with property developers where business sites, ideally nearest to taxi ranks, have been secured and which has led to an improved taxi infrastructure to the benefit of commuters.

Despite the positive growth in the taxi industry, the annual rate of increase in the use of private vehicles exceeds that of taxis. This is possibly testament to increased vehicle expenditure in the province. A decreasing trend in bus, train and "other transport" is evident. Approximately 6.3 % of the provinces population still travel on foot to their destinations.

Photo: Mary-Ann Palmer

In terms of safety on the roads, the number of road accidents per 1,000 population in the NW Province in 2005 is almost half that of the national ratio, at 4.7 and 10.1 respectively. The trend indicates an improvement from previous years.

Refer to Chapter 6 for information pertaining to air pollution resulting from tailpipe emissions.

7.4 Essential Infrastructure

Access to essential infrastructure draws parallels with the status of secure tenure in the province. In many areas of the provinces infrastructure is highly developed, in part due to its strong mining and agriculture sectors that have historically demanded an efficient transportation and electrification system. However, where mines or other economic activities are not dominant, infrastructure has suffered, and there are considerable backlogs in meeting basic infrastructure delivery standards. Infrastructure provision underpins growth and development as well as access to services for the betterment of the quality of life throughout the Province

In its 2004 assessment, Project Consolidate (Department of Provincial and Local Government, 2004) found that there were municipalities in the NW Province that were affected by a number of critical service delivery areas including:

- Unimproved water supply;
- Inadequate provision of sanitation and refuse removal;
- Electricity supply to households, and
- Inadequate housing.

There were a number of municipalities that were performing less than 30 % of their assigned powers and functions, and seven of which were performing less than 50 % of their assigned powers and functions. These factors contributed to a backlog in the provision of basic needs to the provinces population. However, the provincial government aims to provide about 35,000 households with basic water services and 70,000 households with sanitation facilities annually. This translates to addressing the backlogs in five years and six years respectively (North West Water Sector Forum, 2006).

Trends regarding the supply of selected basic services are indicated in Table 7-1. There was significant improvement

Service	2001	2003	2004	2005	2006
Access to piped water in yard or distance less than 200 m	437,498	597,356	626,682	624,965	711,910
Access to electricity	695,016	848,562	935,859	873,918	890,400
Access to formal dwellings	859,726	897,023	952,515	821,235	837,900

Table 7-1: Number of people with access to basic services in the NW Province Mid-Term Review, NW Province (2006)

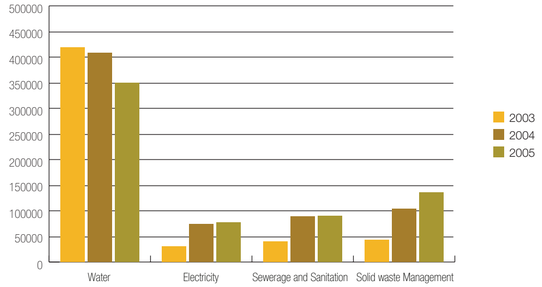

Figure 7-7: Number of households receiving free basic services in NW Province between 2003 and 2005 (Stats SA, Non-financial census of municipalities for year ended 30 June 2005)

in access to piped water. Access to electricity and formal dwellings has however faltered over the period indicated. This information confirms the decline of access to secure tenure, as confirmed in the Stats SA Community Survey 2007 discussed previously.

7.4.1 Free access to basic services

In the NW Province, free access to water far exceeded the free provision of any other basic service (Figure 7-7), for the period 2003 to 2005, albeit at a declining rate to the free provision of electricity, sanitation and solid waste management. Solid waste management showed the most significant growth over this period. In 2005, a total of:

- 350,090 households received free access to water;
- 77,657 households received free access to electricity;
- 90,456 households received free access to sanitation, and
- 135,762 households received free solid waste management.

7.4.2 Water supply

Sustainable access to an improved water source refers to the proportion of the population, urban and rural, who use piped water, public tap, borehole or pump, protected well, protected spring or rainwater for drinking purposes. Improved water sources do not include vendor-provided water, bottled water, tanker trucks or unprotected wells and springs.

According to the Department of Water Affairs and Forestry (DWAF) (2006), approximately 23 % of the province was below the Reconstruction and Development Programme (RDP) water standards in 2005, as shown in Table 7-2. The situation improved to 18 % in 2006 but may be primarily attributed to the alignment with new boundary demarcations. Dr. Kenneth Kaunda indicates the most favourable situation with only 1.1 % of its population below RDP water standards in 2006, while the Bojanala Platinum (7.5 %) and Ngaka Modiri Molema Districts (5.8 %), with their larger populations, did not fare as favourably in 2005.

According to StatsSA (2007), the percentage of households with sustainable access to an improved water source in the NW Province has been steadily increasing from 78 % in 2001 to 97.3 % in 2005, representing a 5.7 % growth rate over this period. This is a positive trend, as it shows that the province has already achieved the Municipal Demarcation goal of halving the proportion of population without sustainable water source. Furthermore, the province is close to achieving the World Health Organisation goal of 100% access to the improved water source.

The situation regarding piped water in the NW Province improved from 86.6 % in 2001 to 89.9 % in 2007, as is evident in Figure 7-7. Dr. Kenneth Kaunda accounts for the most households with access to piped water (97 % in 2007). The most significant growth in access to piped water was seen in the Bojanala Platinum and Ngaka Modiri Molema Districts.

	2005	2006*				
	Estimated Population (March 2005)	Population below RDP Water	% of Population below RDP Water	Estimated Popultion (March 2006)	Population below RDP Water	% of Population below RDP Water
Ngaka Modiri Molema	1, 034, 481	312, 520	30.21	815, 342	199, 956	5.86
Bojanala Platinum	1, 514, 488	366, 300	24.19	1, 270, 363	254, 478	7.46
Dr. Ruth Segomotsi Mompati	517, 056	174, 760	33.8	448, 563	118, 873	3.49
Dr. Kenneth Kaunda	835, 525	67, 544	8.08	876, 012	39, 560	1.16
NW Province	3, 901, 550	921, 123	23.61	3, 410, 280	612, 867	17.97

Table 7-2: Water below RDP standards (DWAF, 2006)

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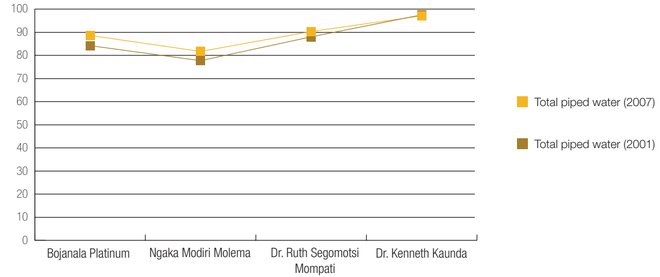

Figure 7-8: Percentage of households with access to piped water (Stats SA Community Household Survey, 2007)

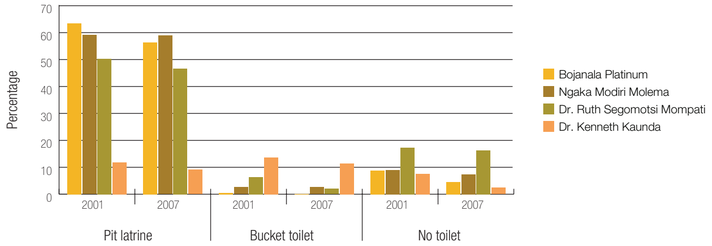

Figure 7-9: Households with access to unimproved toilets (%) (Stats SA Community Household Survey, 2007

7.4.3 Sanitation

The responsible disposal of human waste plays an important role in maintaining environmental quality and curbing the spread of disease. Despite the continued improvement of potable water sources in the province, the supply of adequate sanitation facilities is lagging. As is evident in Table 7-3, a total of 49.8% of the population in the province were below the RDP standards for sanitation. Approximately 1.94 million people were below RDP sanitation levels in 2005, which decreased to 1.37 million in 2006 under the newly demarcated boundaries. Eradication of sanitation backlogs remains a huge challenge in the province.

According to the Stats SA Community Survey, 41.7 % of households in the NW Province still make use of pit latrines, indicating an improvement to the 47,6 % of households making use of pit latrines in 2001. The amount of households with no toilet facilities decreased from 9.6 % in 2001 to 5.8 % in 2007. On a District level, the following trends are noted, as seen in Figure 7-9:

- The overall amount of households with no toilet, bucket toilets and pit latrines has decreased in the NW Province.
- The Dr. Kenneth Kaunda District still accounts for most use of the bucket system (11.4 % in 2007), but has the least number of households with no toilet or a pit latrine.
- The Ngaka Modiri Molema District is the most underperforming District in terms of providing access to improved sanitation.

	2005	2006*				
	Estimated Population (March 2005)	Population below RDP Sanitation	% of Population below RDP Sanitation	Estimated Population (March 2006)	Population below RDP Sanitation	% of Population below RDP Sanitation
Ngaka Modiri Molema	1, 034, 481	566, 663	54.78	815, 342	404, 934	11.87
Bojanala Platinum	1, 514, 488	844, 089	55.73	1, 270, 363	612, 908	17.97
Dr. Ruth Segomotsi Mompati	517, 056	334, 343	64.66	448, 563	182, 917	5.36
Dr. Kenneth Kaunda	835, 525	197, 639	23.65	876, 012	174, 492	5.12
NW Province	3, 901, 550	1, 942, 734	49.79	3, 410, 280	1, 375, 251	40.33

Table 7-3: Sanitation below RDP standards (DWAF, 2006)

7.4.4 Energy consumption

The consumption of energy provides a useful measure of the economic and social status in any given area. Although the NW Province does not generate any electricity, it is the third largest energy consumer in the country, consuming approximately 15% of the grid supply.

The total electricity consumption has steadily increased between 1994 and 1998 to a total of 27,920 Gwh (GigaWatt hours). This is mainly due to the increased energy-intensive mining, industrial and smelting activities in the east of the province.

The distribution of the electrification network draws parallels with supply of other infrastructure in the province, as is evident in Figure 7-11.

From an electrification perspective, there is a total backlog of 178,001 households, 151 schools and 13 clinics in the province (National Electrification Advisory Committee, 2007). There is a delivery target set out in the Provincial Growth and Development to electrify an additional 33,556 households before 2014.

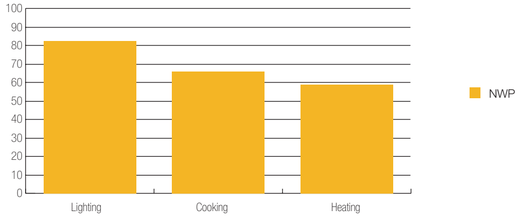

Figure 7-10: Use of electricity in the NW Province (Stats SA 2007 Community Survey)

As shown in Figure 7-10, over 80% of households make use of electricity for lighting purposes in the province, while 65% use electricity for cooking and 59% use electricity for heating purposes. This compares favourably to population census (2001) statistics where 73% of households used electricity for lighting. The rural nature of the province results in large numbers of households contributing to habitat degradation in search of firewood[4]. In 2001 approximately 25% of households used wood for cooking purposes. The burning of wood and coal for cooking inside of dwellings is often associated with adversely affecting human health[5].

4 Refer to Chapter 3

5 Refer to Chapter 6 for information regarding indoor air pollution

Renewable energy

Implementation of renewable energies such as solar energy in the NW Province is ideal as it has high levels of solar radiation. In 1996 a Solar Cooker Programme was initiated in the Province following bi-lateral agreements between the Department of Minerals and Energy (DME) and other parties.

7.4.5 Waste management

The production and consumption patterns of human settlements are responsible for the generation of various waste products. Waste generators in the NW Province consist of municipalities, formal and informal settlements, commerce, industries, hospitals and the agricultural and mining sectors. As Gross Geographic Product (GGP) in the province is highly dependent on the mining sector, it stands to reason that the primary waste output in the province is mining related.

7.4.5.1 General waste

Local authorities are tasked with the responsibility of providing domestic waste collection, handling and disposal services in the NW Province. As is evident in Figure 7-12, the percentage of households where refuse was removed by the local authority or a private company improved from 40.1% in 2001 (last Census) to 54.8% in 2007. However, there was an increase in the percentage of households with no refuse disposal from 7.8% in 2001 to 8.1% in 2007.

Photo:Werner Bentz

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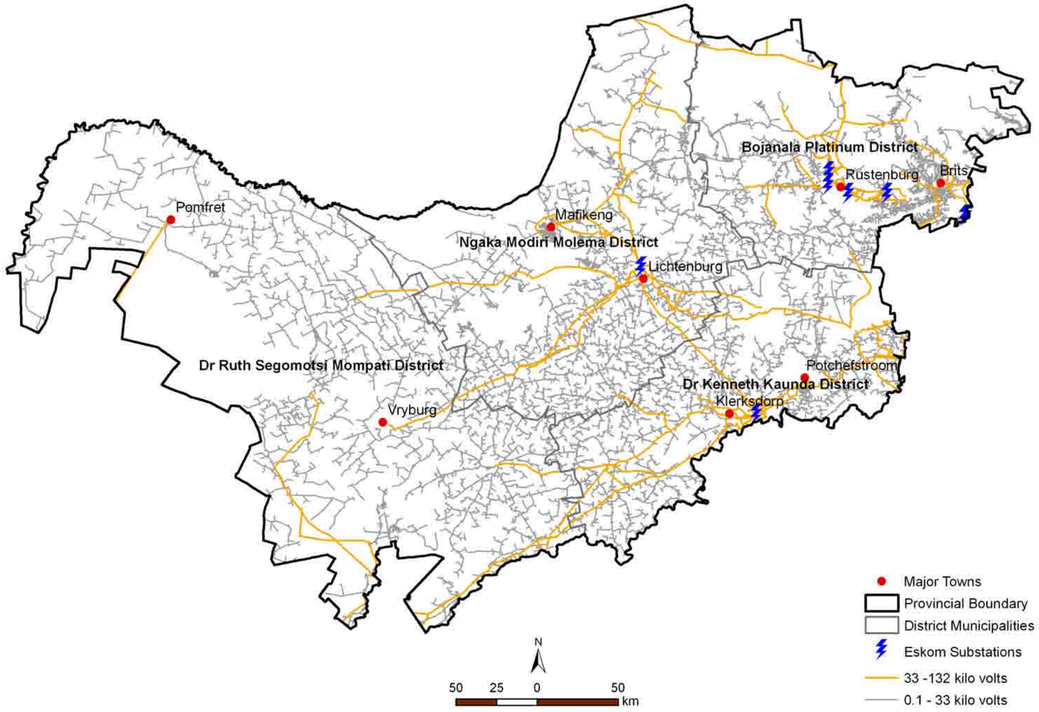

Figure 7-11: Electrification network across NW Province (National Department of Transport)

The following trends are noted at a district municipality level:

- The amount of households in all Districts with no access to refuse disposal increased;
- Access to formal refuse removal in the Bojanala Platinum District more than doubled from 2001 to 2007, and
- The remaining Districts registered minor improvements in the formal waste collection service.

In informal settlements and other under-serviced areas, the dumping of solid wastes (the volume of which is increased by home-based enterprises), is common where waste removal services are not adequate. The burning of wastes on informal communal dumps is also fairly common, contributing to soil, water and air pollution.

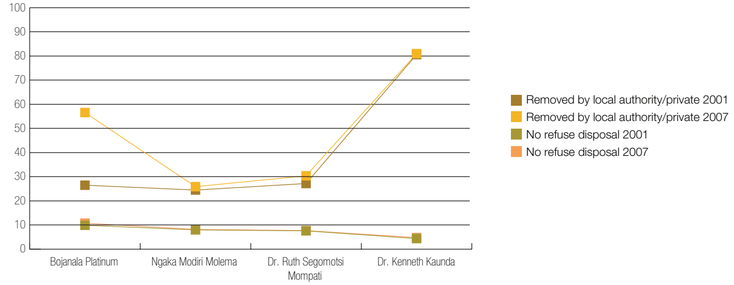

Figure 7-12: Percentage of households with access to refuse removal by District (Stats SA 2007 Community Survey)

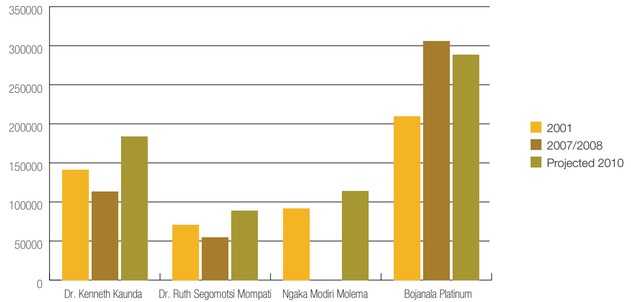

Figure 7-13: Waste generation per District which is landfilled in tonnes per annum (NW Province Integrated Waste Management Plan, 2008)

* This total assumes that the figure for Ngaka Modiri Molema District Municipality stays the same

In terms of waste disposal at landfills, the Bojanala Platinum and Dr. Kaunda Districts account for the majority of waste landfilled in the province (Figure 7-13). Although the Bojanala Platinum District accounts for the most waste produced, it is the only District where a decrease in landfilled waste is projected.

As detailed in Table 7-4, there are 52 waste disposal sites in the province, most of which are situated in the Bojanala Platinum District. Figure 7-14 provides an indication of the distribution of the waste disposal sites throughout the province. Although the province is performing better in terms of waste collection services, many of the landfill sites are not legally permitted to dispose of waste in terms of Section 20(1) of the Environment Conservation Act (Act No. 73 of 1989). Add to this the number of unrecorded communal sites in the province and the potential scale of contamination of soil and surface and groundwater from landfill sites, the impact landfill sites have on the environment becomes more severe.

7.4.5.1.1 Waste recycling

Most current recycling projects are conducted by the private sector or within the informal sector. There are very few municipal general waste recycling initiatives in the province. Similarly, waste minimization schemes are few and waste recycling and re-use initiatives in the province are in an early stage of development. The NW Province, through its Integrated Waste Management Plan (IWMP), aims to compile a register of recycling initiatives within each municipality to be project managed by a facilitator to champion recycling initiatives in their area. The Rustenburg Local Municipality currently has a recycling awareness initiative which is run at schools and which promotes recycling for SMME development.

Where recycling exists, waste volumes recycled in the province are estimated at between 5% and 10% of the general waste produced. Most landfills provide subsistence for waste scavengers who remove recyclable materials from the landfill. This is dangerous and can very often result in injury or fatalities. Very few landfills have formalised recycling centres.

Little or no composting of organic wastes such as garden refuse is being carried out in the province, although pilot projects in Rustenburg are investigating the viability of composting as a business. A number of recycling initiatives for hazardous wastes are in progress, including the following:

- Recycling of used oil;
- Reconditioning and re-use of hazardous material drums;
- Recycling of lead-acid batteries, and
- Recycling of mining and metallurgical waste, and scrap tyres.

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Bojanala Platinum District	Ngaka Modiri Molema District	Dr. Ruth Segomotsi Mompati District	Dr. Kenneth Kaunda District
Kgetlengrivier LM (3 sites)	Ramotshere Moiloa LM (1 site)	Greater Taung LM (3 sites)	Potchefstroom LM (2 sites)
Madibeng LM (4 sites)	Ditsobotla LM (2 sites)	Mamusa LM (2 sites)	Maquassi Hills LM (4 sites)
Moses Kotane LM (4 sites)	Mafikeng LM (1 site)	Lekwa-Teemane LM (3 sites)	Ventersdorp LM (1 site)
Moretele LM (2 sites)	Tswaing LM (2 sites)	Naledi LM (2 sites)	Merafong City LM (2 sites)
Rustenburg LM (10 sites)	Ratlou LM (no sites)	Kagisano LM and Molopo LM (no sites)	Matlosana LM (4 sites)
23 sites	6 sites	10 sites	13 sites

Table 7-4: Number of landfills sites per District and Local Municipality (NW Province Integrated Waste Management Plan, 2008)

Generic waste type	Estimated volume (2005)
Boiler Ash	3 600 tonnes
Empty bags	450 tonnes
Water treatment sludge	81 723 tonnes
Sewage sludge	87 782 tonnes
Tyres (scrap)	339 000 units
Used batteries 98% recovery rate (recycled)	77 000 units
Grease	1 800 Kilolitres
Oil contaminated rags and boxes, etc.	300 tons
Oil filters	65 000 units
Oily sludge	500 Kilolitres
Used oils	4 725 kilolitres (2 700 Kilolitres Recycled)
Fluorescent tubes	180 tonnes

Table 7-5: Generic hazardous waste streams generated in the NW Province (NWP Integrated Waste Management Plan, 2008)

7.4.5.2 Hazardous waste

According to the IWMP (2008), the management of hazardous waste generated by industrial, mining and sometimes domestic activities has not been systematically addressed or planned for in the NW Province. Most of the hazardous waste in NW Province is generated in the Bojanala Platinum District and Dr. Kenneth Kaunda District. This is due to the large mining operations in these two Districts where mining accounts for the majority of the hazardous wastes generated. Brits, Rustenburg, Klerksdorp and Potchefstroom are the major contributors to manufacturing production, contributing between them more than 50% of total manufacturing production.

Management of hazardous wastes is the responsibility of the NW Province although collection, transport and final disposal is undertaken by private companies. The amount of hazardous waste produced is often difficult to quantify or accurately predict due to the fact that there is no registration of generators. This is exacerbated by the fact that disposal sites and treatment facilities are also not required to register and report volumes to the Province.

Table 7-5 below summarises the types and quantities of the major generic hazardous waste streams currently being generated in NW Province.

In most instances, facilities used for the storage of hazardous waste are not permitted or suitably constructed and controlled. The companies storing hazardous wastes are not monitored. There are only a few private contractors who collect and transport hazardous waste in the province. Most of the contractors transporting hazardous waste to Gauteng for processing or disposal are based in Gauteng. The transportation of small volumes of waste over long distances is not economically viable, and hence the hazardous wastes produced in remote areas are not accounted for.

Only a small percentage of the hazardous waste generated in the NW Province is being treated within the province and this is mainly limited to the treatment of effluents discharged to municipal sewers. Some of the companies have their own small on-site effluent-treatment plants. The incineration of medical waste or health care risk waste is practiced in NW Province.

Currently collection, transport and disposal of all hazardous waste is are carried out by the private sector, with little or no provincial or local municipality input into any of these initiatives. There are three facilities that have been permitted to accept hazardous waste:

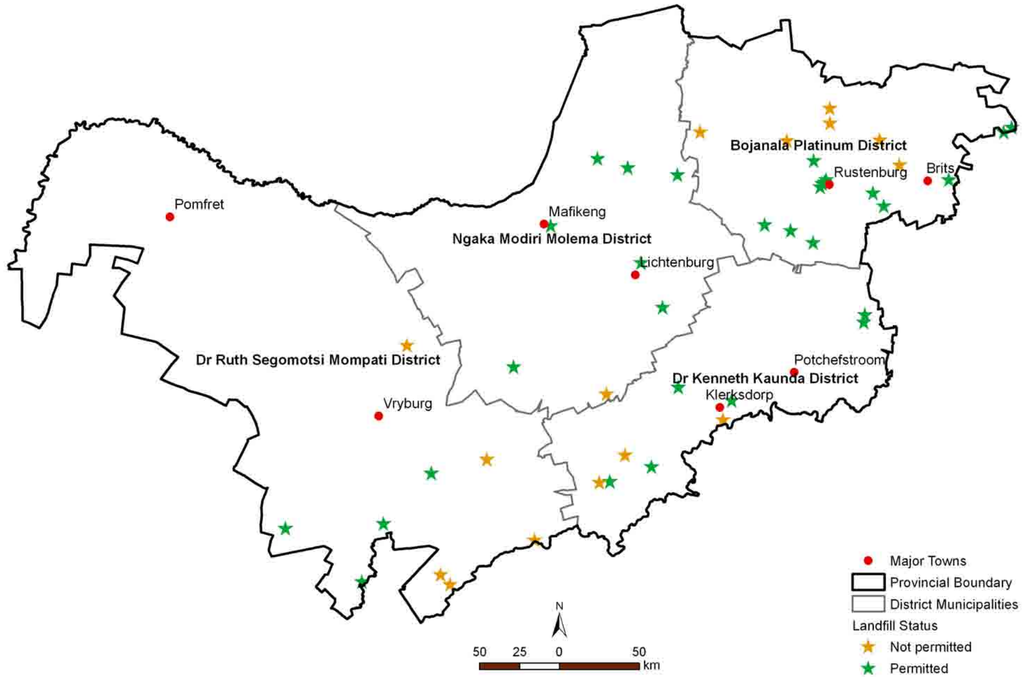

Figure 7-14: Number of landfill sites in NW Province (NWDACE, 2008)

- The new Klerksdorp Regional Waste Disposal Facility, Class GLB- permit for general waste, with a Class H:h permit for two new cells to be constructed;
- NECSA's Pelindaba Class H:H landfill site (Brits) for the disposal of Calcium Fluoride (CaF_2). This site is no longer operational and is in the process of being rehabilitated;
- Kynoch Gypsum Dam in Potchefstroom for the storage of gypsum. The plant has a Class H:H permit but has closed down and the gypsum is being removed by a cement manufacturer. This will continue over the next 20-25 years until all the gypsum is removed, and
- Pholo-Ntle Medical Waste (Mafikeng) has a Class H:H permit for the storage of medical waste. However,their incinerator was never constructed and the company is not operational at present.

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An incinerator and three kilns are operated privately by The Wasteman Group, PPC Slurry and Holcim Dudfield respectively. Approval for the burning of waste in the cement kilns is expected during 2009.

Due to the limitation associated with these private facilities, most companies requiring their hazardous waste to be treated and disposed of off-site, make use of Gauteng based disposal facilities such as the Holfontein H:H Landfill, the Rosslyn GLB+ Landfill, the Rietfontein GLB+ landfill site, and the Thermopower thermal treatment plant in Olifantsfontein.

7.4.5.3. Medical waste

Approximately 1,600 to 2,000 tonnes of health care risk waste (HCRW) is generated annually by medical facilities including government and private hospitals, clinics and nursing homes. The major challenge appears to be the collection of HCRW from the outlying, rural areas. This has been identified as a problem by the Department of Health who are currently busy with a pilot project looking into alternate opportunities and solutions for the storage and collection of the HCRW from rural facilities. An additional problem is the apparent lack of control and enforcement of adequate HCRW management at both private and provincial facilities. Facilities are not properly monitored to ensure that they are legally compliant, and to ensure that they are making use of permitted destruction facilities.

7.4.5.4 Asbestos waste

Un-rehabilitated asbestos mines have impacted in the past and may still be contributing to serious health problems in the province. Wind blown asbestos dust is known to cause a range of pulmonary diseases, including asbestosis and lung cancer. This is a persistent environmental problem, which local communities have been exposed to for decades. The western areas of the province are particularly affected, in areas such as Heuningvlei, Pomfret, Reivilo, Gamopedi and Nchweng. Many ex-miners and people living in the adjacent communities are significantly affected by these respiratory diseases. 60% of the NW Provinces five asbestos mines and 36 dumps have been rehabilitated of which the Heuningvlei and Butte sites are currently being rehabilitated. It is anticipated that the entire rehabilitation process, including dumps and mines, should be completed by about 2010.

Refer to Chapter 6 for further information relating to asbestos mining.

7.5. Responses

Responses by the North West Provincial Government (NWPG) to the pressures exerted on the environment by existing settlements, coupled with the added pressures of migration and urbanisation, exist in the form of government delivery mechanisms such as strategic policies, resolutions and programmes. Although the backlog of housing delivery and associated essential infrastructure within the province is still significant, much has been done to alleviate the vulnerability of the NW Province's population to their environment, simultaneously buffering the environment from poverty associated impacts.

It is however vital that policy makers continue to implement the plans that they have created in order to allow a sustainable integration between human settlements and the environment. The following responses are applicable in this regard and are reflected in Chapter 10.

7.5.1. Department of Local Developmental Government and Housing, Strategic Plan: 2005/2009

The Strategic Plan was compiled in 2005 and incorporates provincial and national priorities, strategic objectives and challenges as well as other focus areas of emerging municipalities. Emphasis is placed on priorities of government and municipalities. The Strategic Plan reflects on the Department of Housings implementation of programmes and projects in order to accelerate local government transformation, service delivery, development, and change in order for democracy to become more meaningful to local communities and people within the NW Province. In May 2007, the MEC for Local Developmental Government and Housing outlined the Department of Housings (DOH) plans for 2007/2008. A major change is that the DOH would take full responsibility for all new housing projects, and allow municipalities to complete existing projects. In the process, the Department committed housing development for a two year period, including more than 39,000 units, with the aim of ensuring provision of projects in identified municipalities in a structured development approach.

7.5.2. Provincial Growth and Development Strategy 2004-2014

Construction and infrastructure has been identified as one of the five pillars of growth in the Provincial Growth and Development Strategy (PGDS). One of the two key goals of the PGDS is to eradicate poverty by wiping out backlogs in basic services, including water and sanitation, within the next ten years.

Photo:NWDACE

7.5.3. Northwest Provincial Water Sector Plan: Five Year Workplan 2007-2012

The Northwest Provincial Water Sector Plan: Five-Year Workplan 2007 to 2012, has the following goals:

- Provide access to basic sustainable services;
- Provide sustainable water services;
- Provide integrated water resource management;
- Implement sustainable water services institutions;

Photo:NWDACE

- Effect inter-governmental relations and sector collaboration, and
- Build a strong provincial water sector (cross cutting issues). Its purposes and functions are to:
- Provide mechanisms to fast-track delivery;
- Set an agenda for collaboration structures;
- Provide a yardstick for organisational accountability;
- Serve as a vehicle to facilitate communication;
- Serve as an agent of transformation, and
- Provide a device to attract extra funding.

Photo:NWDACE

7.5.4. Project Consolidate

Project Consolidate was established in 2004, with the primary focus on service delivery to:

- Recognise progress and achievements made in the first decade of democracy;
- Forge partnerships that will result in a practical improvement in the quality of people's lives at local level, and
- Address remaining challenges.

Project Consolidate identified a number of principal challenges to local government in 2004. These are:

- Policy refinement and clarification;
- Full implementation of existing legislation and policy;
- Attending to the basic service delivery functions, and extending the coverage of these services, and
- Re-examining the way in which national, provincial, and local government are individually and collectively giving effect to the Constitutional mandate given to municipalities.

In addressing these challenges, Project Consolidate focuses on, amongst others:

- Capacity building and human resource development;
- Integrated human settlement development;
- Free basic services, billing systems, and municipal debt;
- Local economic development, job creation, and infrastructure;
- Special intervention in rural and urban nodes, and
- Performance monitoring, evaluation, and communication.

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Issue	Objective	Indicator	Indicator calculation/data collection	Data availability
Road and transport infrastructure	Improve the provision of accessible public transport	Percentage of budget allocated to public transport	Provincial expenditure on public transportation / Provincial budget	1
	Maintain and extend safe and efficient transport infrastructure	Road freight rand value per km of road	Road freight value in Rands/ Tarred road kilometres	2
Transport	Road Transport	Access to road infrastructure	No of villages without access to roads	1
		Storm water management	No of roads with proper storm water drainage	1
	Air Transport	Air travel	No of passenger who travel each year by air	1
		Use of air for freight transport	Air freight rand value per year	1
		Extent of rail infrastructure	Km of rail	1
		Facilities for rail transport	No of loading and offloading stations in the province	2
		Use of rail for freight transport	Rail freight rand value per year	1
Waste management	Reduce waste generation	General waste produced per capita per year	General waste produced (tons) / Population	1
		Provincial waste collection capacity	Volumes of commercial waste recycled through projects	1
		Volume of hazardous waste produced per sector per year	Hazardous waste produced by sector (per sector, in tons) / Total hazardous waste produced (tons)	2
		Volume of liquid waste produced per year	Volume of liquid waste produced (tons)	2
	Ensure appropriate waste disposal	Available landfill sites' lifespan	Available airspace (m^3) / Incoming volume per annum (m^3)	1
		Percentage of general waste correctly disposed through general waste facilities	General waste correctly disposed through waste facilities (municipal and commercial) / Total general waste (municipal and commercial)	2
		Percentage of medical waste correctly disposed	Medical waste correctly disposed/ Total medical waste produced	2
Medical waste		Percentage of hazardous waste correctly disposed through hazardous waste facilities	Hazardous waste correctly disposed through waste facilities / Total hazardous waste	2
	Promote proper waste management practices	Number of recycling projects in the province	Number of recycling projects in the province	1
		Percentage of general waste recycled per year	General waste recycled (municipal and commercial) / Total general waste (municipal and commercial)	1
Nuclear waste	Disposal of Nuclear waste	Amount of nuclear waste produced per annum from Pelindaba and other sources	Volumes of nuclear waste disposed per annum	1
Asbestos waste	Contamination of air with blue fibres	Number of asbestos sites	Extent of rehabilitation and enforcement of asbestos sites	2
Sewage	Capacity of Sewage treatment plants	No of sewage treatment plants	No of sites with sewage treatment, and current as well as planned capacity	2
	Use of sewage for composting	Volume of sewage produced per annum	Volume of sewage produced per annum/capacity of sewage treatment plants vs composting potential of sewage	1
Other waste & recycling	Builder's rubble and other wastes, especially on the peri-urban fringe.	Illegal dumping of builder's rubble	No of incidents of illegal dumping	2
	Domestic recycling efforts	No of domestic recycling projects	Volumes of domestic waste recycled through domestic projects	2
	Commercial – recycling	Recycling of products at Commercial level	No of commercial recycling projects	2
Energy and electricity use	Ensure sustainable energy use	Annual energy consumption per capita	Primary energy production/ Population	1
		Percentage of energy supplied from renewable sources	Production of energy from renewable resources / Primary energy production	1
Living conditions		Percentage of clinics and hospitals without access to electricity	Number of clinics without access to electricity / Number of clinics	1

Table 7-6: Indicator gaps (NWDACE, 2007)

7.6. Conclusion

Human settlements and the essential infrastructure in support of such settlements in the NW Province are in constant flux due to the forces of migration and urbanisation. The growth of the Bojanala Platinum and Dr. Kenneth Kaunda Districts, with their strong economic links, will continue to attract migrants in search of economic and social opportunities, placing increased pressure on the natural and social environment. As is evident from the statistics, extreme disparities do still exist, and this is highlighted by the comparisons of the types of settlements and their respective roles in causing environmental change. The rate of new settlement developments (planned and unplanned) is adversely affecting efforts to eradicate backlogs. The NW Province accounts for largest number of informal households in the country presenting a challenge to the province to supply secure tenure.

Improvements in the provision of housing and infrastructure will alleviate the pressures experienced in the Province, although much still needs to be done to realise the evolution of settlements into sustainable settlements.

7.7. Indicator gaps

The indicators in Table 7-6 have been identified to be reported on in this report. However, insufficient data exists to enable meaningful reporting on these issues. These indicators should be considered when future state of the environment reporting is planned.

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Photo: Laurel Muller

CHAPTER 8

Natural and cultural heritage

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Acronyms and abbreviations

BP	Before Present
DEAT	Department of Environmental Affairs and Tourism
DSSACS	North West Provincial Department of Social Services, Arts, Culture and Sport
Early IA	Early Iron Age
EIA	Environmental Impact Assessment
ESA	Early Stone Age
HIA	Heritage Impact Assessment
IUCN	International Union for the Conservation of Nature and Natural Resources
LIA	Late Iron Age
LSA	Later Stone Age
MSA	Middle Stone Age
NBSAP	National Biodiversity Strategy and Action Plan
NGOs	Non-Governmental Organisations
NHRA	National Heritage Resources Act (Act No. 25 of 1999)
NW	North West
NWPHRA	North West Provincial Heritage Resource Agency
SAHRA	South African Heritage Resource Agency
SANHP	South African Natural Heritage Programme
SESDNW	Support to Environment and Sustainable Development Project in the NW Province
UNESCO	United Nations Educational, Scientific and Cultural Organization
ZAR	Zuid Afrikaansche Republiek

Definition of terms

Tangible resources
Movable or immovable, including objects, features and landscapes, such as graves, forts, battlefields, and archaeological sites, as well as domesticated plants and animals.

Intangible resources
Aspects such as oral history, traditional knowledge and cultural practise and folklore, associated with physical places, not to be confused with various forms of arts and culture.

Photo: NWDACE

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8.1. The value of our heritage

Heritage can be defined as *"the ways in which historical features form frameworks for on-going processes of identity formation in relation to places. Identities are layered into landscapes, framed and informed by previous relationships. Dynamics of absence and presence are also important, as memories are cherished and held on to, narratives created, and relationships negotiated both in terms of what is there, and what is not - such negotiations often involve institutions of state, and raise claims of ownership and belonging, claims of cultural continuity"* (Bienkowski & Harvey, 2005).

Our heritage nurtures, identifies, provides knowledge and inspiration, and is the basis of our cultural life today. We define our heritage by the value we attach to places and artefacts which represents our past, including social injustice, exploitation and degradation of people and their environments. Lessons learnt from our past, if comprehended, should prevent us repeating the mistakes in the future.

8.2. Introduction

The North West (NW) Province has many significant natural and cultural heritage resources, and is representative of South Africa's deep-rooted natural and social history, and cultural diversity. The cultural heritage resources present in the NW Province can be divided into the following two main components:

- Tangible resources which can be either movable or immovable, including objects, features and landscapes, such as graves, forts, battlefields, and archaeological sites, as well as domesticated plants and animals. The main house on Boekenhoutfontein, President Paul Kruger's farm and the Taung child skull are examples of tangible heritage resources within the NW Province, and
- Intangible resources are aspects such as oral history, traditional knowledge and cultural practise and folklore, which are associated with physical places, and are not to be confused with various forms of arts and culture. Although primarily a natural feature, the Pilanesberg National Park contains many places of cultural significance associated with Bakgatla history, such as initiation cleansing sites and schools, execution sites and sacred hills.

Box 8-1: The definition of heritage resources

The National Heritage Resources Act 25 of 1999 (NHRA), which governs heritage management in South Africa, defines the heritage resources of South Africa as physical places and objects that are of cultural significance or other special value for the present community and which for future generations must be considered part of the national estate.

Terms such as cultural significance and value can have different meanings, but the prime reasons for conserving heritage resources today are linked to political and ethical motives. However, more utilitarian reasons, such as the educational and economic potential of conserving heritage, also play a role, and in this respect there is a definite link with education (social upliftment) and tourism.

Heritage resources may include:

- Places, buildings, structures and equipment of cultural significance;
- Places to which oral traditions are attached or which are associated with living heritage;
- Historical settlements and townscapes;
  - Landscapes and natural features of cultural significance;
- Geological sites of scientific or cultural importance;
- Archaeological and palaeontological sites;
- Graves and burial grounds, including -
  - Ancestral graves;
  - Graves of Royalty and traditional leaders;
  - Graves of victims of conflict;
  - Graves of individuals designated by the Minister by notice in the Gazette;
  - Historical graves and cemeteries, and
  - Other human remains which are not covered in terms of the Human Tissue Act, 1983 (Act No. 65 of 1983);
- Sites of significance relating to the history of slavery in South Africa, and
- Movable objects, including -
  - Objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens;
  - Objects to which oral traditions are attached or which are associated with living heritage;
  - Ethnographic art and objects;
  - Military objects;
  - Objects of decorative or fine art;
  - Objects of scientific or technological interest, and
  - Books, records, documents, photographic positives and negatives, graphic, film or video material or sound recordings, excluding those that are public records as defined in Section 1 of the National Archives of South Africa Act 43 of 1996.

Box 8-2: Cultural value and significance

The NHRA recognises a heritage resource to be part of the national estate if it is of cultural significance and value because of:

- Its importance in the community, or pattern of South Africa's history;
- Its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;
- Its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;
- Its importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects;
- Its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;
- Its importance in demonstrating a high degree of creative or technical achievement at a particular period;
- Its strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;
- Its strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa, and
- Sites of significance relating to the history of slavery (or labour) in South Africa.

8.3. Pressures affecting heritage resources

The growth and development of the population is a major driver for change in the Province[1]. This has both positive and negative socio-economic implications for cultural heritage resources. Unfortunately, because of the emphasis on development, vandalism and deliberate degradation or loss of sites for economic gain are a past and current issue of concern.

Urbanisation is also a major issue affecting the conservation of heritage resources, not only in connection with the development of new towns and townships, but also the re-use of existing heritage resources such as historic buildings and villages. Within the heritage management context, pressures on heritage resources as a result of urbanisation are the transformation of land due to an increased waste generation requiring landfill space, the need for development space and the need for infrastructure development.

8.3.1. Key issues affecting heritage resources

Key issues identified which impact on valuable heritages resources within the NW Province include:

- A lack of heritage knowledge and skills;
- The decay of environments around facilities, particularly in old towns and cities;
- The deterioration of existing facilities;
- Competition from other forms of entertainment;
- The neglect of heritage sites and buildings;
- Threats to the security of facilities, visitors and objects;
- A lack of sufficient comparative knowledge about places of heritage significance in areas that traditionally have not been covered through heritage surveys, such as –
  - The western parts of the province;
  - Vacant land;
  - Open spaces around towns;
  - Informal settlements;
  - Old mining sites;
  - Farms;
  - Protected areas, and
  - Old industrial sites.
- A lack of single, GPS-referenced and integrated register of places of heritage significance, and
- A lack of database of current and completed Environmental Impact Assessments (EIAs) and Heritage Impact Assessments (HIAs).

The two overriding issues affecting heritage management in the province that emerged out of the key challenges are:

- Authorisations of development projects without the consideration of sites of heritage significance, and
- A lack of capacity and awareness with regard to heritage management.

8.4. Natural assets that have value – our natural heritage

Biodiversity plays a crucial role in sustainable development and poverty eradication. Conservation areas contribute to job creation and socio-economic upliftment and serve as a foundation for the tourism industry. A shift in focus from a conservation-based approach to a management approach established through the recognition of the contribution of biological resources to food security, science, economy, cultural integrity and well-being, are the result of fundamental changes to the legislative, policy and institutional framework for natural resource management.

The South African Natural Heritage Programme (SANHP) was established by the Department of Environmental Affairs and Tourism (DEAT) in 1985 as an incentive for landowners to conserve unique biodiversity features, in return for which they would receive a certificate recognised by the International Forest Stewardship Council. Such unique sites are defined by the South African Natural Heritage Programme as sites that have *"stands of special plant communities, good examples of aquatic habitats, sensitive catchment areas, habitats of threatened or endangered species, as well as outstanding natural features"*.

8.4.1. Conservation areas

The contribution of conservation areas towards maintaining and conserving biodiversity is incalculable. A traditional approach to conservation is inadequate due to the geographic spread and diversity of South African plant and animal species and 80% of significant biodiversity still lies outside existing protected areas.

Only 2.4% of the Province is formally protected, including national parks, provincial nature reserves, private nature reserves and protected natural environments. This amounts to approximately 283,300 ha. This is not sufficient when considering that South Africa is committed to meeting the World Conservation Union (IUCN) target of 10% of land area being under protection[2].

To achieve conservation, biodiversity priorities have to be integrated with all policies, plans and programmes. This approach has been captured in the National Biodiversity Strategy and Action Plan (NBSAP), launched in June 2006. The NBSAP acts as a guide for the conservation and the management of biodiversity to ensure sustainable and equitable benefits for all communities. The NBSAP focuses on including biodiversity priorities in guidelines and codes of practice, and on measures to encourage sustainable production practices within the production sectors, such as mining and forestry. The NBSAP facilitates the development of the National Biodiversity Framework to ensure an integrated, coordinated and consistent approach to biodiversity management by all spheres of government, non-governmental organisations (NGOs), the private sector, local communities, stakeholders, and the public.

8.4.2. South African World Heritage Sites

In May 1997, South Africa ratified the World Heritage Convention. The World Heritage Convention Act 49 of 1999, grants world heritage status to cultural and natural sites in South Africa. It provides for the adequate protection and conservation of heritage features to promote tourism in a culturally and environmentally responsible way. In terms of this Act, the South African Government has to ensure the legal protection of heritage significant sites, and to develop management plans and institutional structures for periodic monitoring of heritage features.

1 Refer to Chapter 2 for more information on population and human development as a driver

2 Conservation areas are discussed further in Chapter 4

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Box 8-3: South Africa's World Heritage Sites

South Africa has various World Heritage Sites proclaimed by the United Nations Educational, Scientific and Cultural Organization (UNESCO), inlcuding:

- Robben Island;
- The Isimangaliso Wetlands Park;
- The hominid sites at Swartkrans, Sterkfontein and Kromdraai (known as the Cradle of Humankind);
- The Ukhahlamba- Drakensberg Park (a mixed natural and cultural site);
- The Mapungubwe Heritage Site;
- The Cape Floral Kingdom;
- The Taung Fossil Skull Site;
- The Vredefort Dome, and
- The Richtersveld Cultural and Botanical Landscape.

8.4.2.1. World Heritage Sites within the North West Province

Three World Heritage Sites fall within the NW Province:

- The Taung Fossil Skull Site;
- The Vredefort Dome; and
- The Cradle of Humankind.

The Vredefort Dome straddles the Free State and NW Provinces. Formed two billion years ago, it is the world's oldest and third largest (measuring 140km across) meteorite impact site. It is considered one of the Province's prime adventure tourism destinations because of its outstanding geological, archaeological and historical heritage; the Vredefort Dome Conservancy is also renowned for its unique natural beauty. The restored mining village at Venterskroon provides an insight into the pioneering days of gold mining. There are also numerous places where remnants of Iron Age habitation and Anglo-Boer War history can be studied.

In July 2005, the Taung Skull Fossil Site in the province and the Mokopane Valley in Limpopo were included in the world heritage status of Sterkfontein's fossil hominid sites. Now known as "The Cradle of Humankind", it contains one of the world's richest concentrations of hominid fossils, evidence of human evolution over the past 3.5 million years. Located across Gauteng and the NW Province, the fossil sites, captured in a bed of dolomite deposited around 2.5 billion years ago, cover an area of 47,000 ha.

8.4.3. Natural heritage sites within the North West Province

Fourteen national parks and provincial reserves can be found within the NW Province. The Pilanesberg and Madikwe National Parks are administered by the NW Parks and Tourism Board. The Magaliesberg Protected Environment is shared between the NW Province and Gauteng. Only 10 conservancies and several game farms or ranches are registered in the Province and only 6% of the 160,000 ha of land committed to game farming can be classified as proclaimed game farms.

8.5. Cultural heritage – 2 million years of history

The NW Province is host to a small number of declared national and provincial heritage sites that seem to reflect only part of its history. In terms of the NHRA, the following are protected:

- Palaeontological and archaeological places (Stone and Iron Age, rock art);
- All structures and buildings older than 60 years;
- Older burial places;
- Public monuments, and
- Memorials.

Important palaeontological sites in the NW Province include:

- Taung, and
- Gondolin and Haasgat, both national heritage sites occurring in the Brits area.

Figure 8-1 indicates the location of these sites.

The first communities were hunters and gatherers who were able to make tools and weapons from stone, bone and wood. Approximately 2.4 million years Before Present (BP), early hominids known as *Australopithecus africanus* lived at Taung,

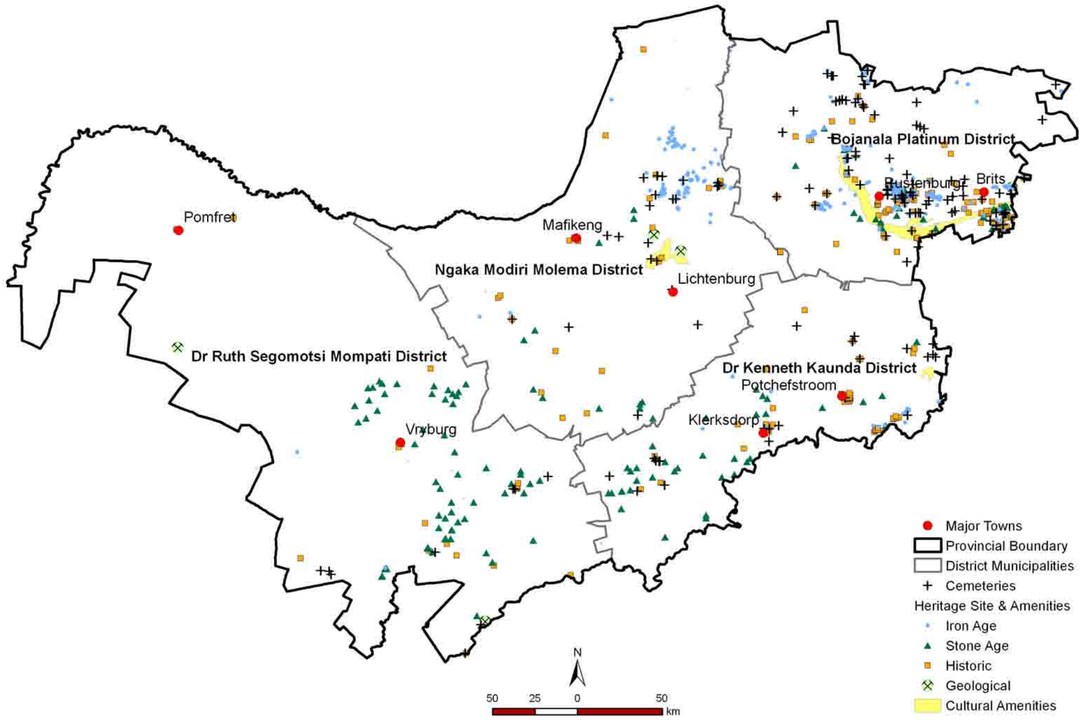

Figure 8-1: Location of known places of heritage significance in North West

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The australopithecines were gradually displaced by another early hominid, *Homo habilis*, and eventually disappeared. *Homo habilis* had evolved into the more advanced *Homo erectus* (also known as *Homo ergaster*) by 1.8 million years BP, which was responsible for the development of large stone cutters and cleavers that collectively constitute the so-called Early Stone Age (ESA). The NW province is so far not known for any major ESA sites.

By 250,000 years BP, the large cleavers and hand axes of the ESA disappeared and were replaced by a larger variety of smaller tools and weapons of diverse shapes and sizes, made by different techniques. This change in technology marks the beginning of the Middle Stone Age (MSA). During the MSA, early humans still settled in the open,

Figure 8-2: The famous skull discovered at the Buxton Limeworks, Taung, in 1924, a national heritage site managed by NW Parks and Tourism Board

along or near water sources but also took shelter in caves. The MSA marks the transition from a more archaic *Homo* (*Homo ergaster*) to anatomically modern humans, *Homo sapiens*. With this physical development the first signs of art, decoration and symbolism began to appear.

The Later Stone Age (LSA), which occurred from about 20,000 years ago, is signalled by a series of technological innovations and social transformations within these early hunter-gatherer societies. The hunting apparatus now included two important innovations, the bow and the link-shaft arrow. The Magaliesberg contains major LSA sites (Jubilee Shelter, Kruger Cave, Silkaatsnek, Xanadu and others), whilst Matlwase near the former Wolmaransstad represent another important LSA site.

The LSA is also associated with the advent of rock art. In Southern Africa, rock paintings are primarily found in hilly and mountainous areas where there are shelters, whilst rock engravings occur in the open on scattered rocks and outcrops. The province is not known for its rock paintings, but has instead one of the largest collections of rock engravings in South Africa, mainly in the south-western Highveld regions (Bosworth and Thaba Sione rock engravings, declared a provincial heritage site).

Most of these engravings are attributed to the Khoisan communities that evolved during the later periods of the LSA.

Figure 8-3: Two of the 559 rock engravings at Thaba Sione south-west of Mafikeng, a national heritage site under the custodianship of the local community

The early farmers, who, among other things, cultivated crops, raised livestock, made ceramic containers (pots), mined ore and smelted metals, occurred in this area between AD 400 and AD 1100 and brought the Early Iron Age (Early IA) to South Africa. They settled in semi-permanent villages. These communities migrated from the lowveld and coastal areas to the higher regions in the interior during the latter part of the Early IA. An important early settlement site with evidence of iron smelting and working is located near Broederstroom (provincial heritage site) in the Brits area. Sites were found within 100m of water, either on a riverbank or at the confluence of streams. The close proximity to streams meant that the sites were often located on alluvial fans. The nutrient rich alluvial soils would have been favoured for agriculture. The availability of floodplains and naturally wetter soils would have been important for the practice of dryland farming.

While there is some evidence that the Early IA continued into the 15th century in the Lowveld, on the escarpment it had ended by AD1100. The Highveld, particularly around Lydenburg, Badfontein, Sekhukhuneland, Roossenekal, and Steelpoort, became active again from the 15th century onwards due to a gradually warmer and wetter climate. From here communities spread to other parts of the Highveld.

This later phase, termed the Late Iron Age (LIA), was accompanied by extensive stonewalled settlements, such as Kaditshwene (potential national heritage site near Zeerust), Molokwane (potential national heritage site east of Rustenburg) and the Olifantspoort Complex near Koster.

Other LIA sites occur in the entire Magaliesberg and the hilly region north-west of Klerksdorp. In 1820 Kaditshwene had more inhabitants than Cape Town.

By the 1700s, with growing trade wealth, economically driven centres of control began to emerge and the NW landscape became an important thoroughfare for both local and foreign traders, although there were far less trade routes than in Limpopo and Mpumalanga. Long distance trade goods such as copper, tin, ivory, furs, rhino horns and salt (mined at the Tswaing Crater) were exchanged for livestock, cloth, glass beads and other European objects, like guns. Tin was mined at Rooiberg, just outside the present-day province, which became an important terminus for a trade route stretching to Musina. Copper was mined at Dwarsberg and iron in the Rustenburg-Brits area.

Sotho-Tswana and Nguni societies, the descendants of the LIA mixed farming communities, found the region already sparsely inhabited by the Late Stone Age (LSA) Khoisan groups, the so-called 'first people'. Most of them were eventually assimilated by LIA communities and only a few managed to survive, such as the Korana and Griqua. From LIA communities, tribal societies emerged, grouped according to their languages. The province became home to western Sotho communities speaking Setswana, such as the Tlhaping, Rolong, Phiring, Fokeng, Kwena, Kgatla, Hurutshe, Taung and Tsatsing tribal communities.

Figure 8-4: Iron Age settlement in the Vredefort Dome World Heritage Site, similar in form but smaller than Kaditshwene and Molokwane

Factors such as population expansion, increasing pressure on natural resources, the emergence of power blocs, attempts to control trade and penetration by Griquas, Korana and white communities from the south-west, resulted in a period of instability in Southern Africa that began in the late 18th century and effectively ended with the settlement of white farmers in the interior. This period, known as the *difaqane* or *Mfecane*, also affected the NW Province, although at a relatively late stage compared to the rest of Southern Africa. Here, the period of instability, beginning in the mid-1820s, was triggered by the incursion of Matabele groups commanded by Mzilikazi. Mzilikazi either displaced or assimilated many residing tribal communities and eventually moved his centre of operations from the Tshwane region to Gabeni and Mosega in the Zeerust area. Continual harassment by Griqua, Korana and Zulu invaders and, in the end, a campaign by a Voortrekker force compelled him to move to the present-day Zimbabwe in the late 1830s, taking a large portion of his community with him. Many of the tribal communities who were displaced by Mzilikazi regrouped and moved back to their former capitals, large settlements such as Kaditshwene, Lattakoe, Taung, Maquassi, Khunwana, Mashow, Lotlhakane, Tsineng, Motito and others.

The *difaqane* coincided with the penetration of the interior of South Africa by white traders, hunters, explorers and missionaries. The first was Hinrich Lichtenstein's journey of 1804-1805, which reached Lattakoe west of Vryburg. They were followed by Cowan, Donovan, Burchell and Campbell and resulted in the establishment of a London Mission Society station near Kuruman in 1817 by James Read. Samuel Broadbent and Thomas Hodgson of the Wesleyan Mission Society established a mission outpost at Leeuwfontein near Wolmaransstad in 1823 (today a heritage site). The journeys by Scoon, McLuckie, Bain, Smith and Hume in the 1820s resulted in increased contact between Mzilikazi and missionaries such as Moffat, Archbell, Lindley and Venable and in 1836 a mission station was established at Mosega.

In 1837 the establishment of a Boer settlement at Klerksdorp marked the beginning of a new phase in the history of the NW Province. The first Voortrekkers to settle in the area were the followers of A H Potgieter. A fortification near Fochville (provincial heritage site) is a memory of this period. The town of Potchefstroom became the new centre of the community and white settlers slowly established themselves in the region. The Trekkers' political fractiousness did not, however, diminish. In 1856, the Lydenburg community seceded from the Zuid Afrikaansche Republiek (ZAR), a development that was symptomatic of the fragility of the wider state. Political instability and racial exclusivity however, co-existed with strong traditions of popular democracy. It was not until 1864 that political unity was achieved among the main Trekker communities in the Transvaal. By that time the Vaal River had been established as the border with the Orange Free State Boer Republic.

Once the Trekkers had established what they saw as their right to the land, they set about distributing it among themselves. The land was demarcated into large farms and title deeds were issued. The initial policy was that all burghers (citizens) were entitled to two farms of 3,000 morgen each (about 6,330 acres or 2,564 hectares) from the State. White newcomers to the Transvaal were quickly granted citizenship and the land that went with it. Farms which were not distributed remained government property and the ZAR, which battled to raise revenue, increasingly fell back on its principal asset – land. Within a short time some white settlers owned numerous farms while others had lost all right to the land.

One important effect of this 'land shortage' was growing pressure on the land of neighbouring African kingdoms and chiefdoms. The land which fell under the sway of Tswana kings and other rulers seemed to offer a solution to a growing social predicament. Initially there was little effect on independent African kingdoms, but there were more immediate consequences for African communities which found themselves subject to Boer control. When the Trekkers settled in the Western Transvaal, the numerous chiefdoms of various sizes and combinations of lineage

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and identity who lived in the area had little option but to bow down before the military superiority of the Boers. Some also welcomed these new powerful neighbours as a potential shield from attack by other aggressors. However, the Trekkers, contrary to the practice in British colonies, did not set aside reserves for African communities. By the early 1850s Boers in the Western Transvaal were laying claim to farms both on the margins and in the core areas of subordinate groups. Africans were expected to pay tax and tribute to local officials and to meet the owners' demands for rent, variously and sometimes simultaneously in cash, kind and labour. These exactions provoked mounting resentment and eventually resulted in armed conflict that began in the early 1850s.

The conflict between Boer and Tswana communities escalated in the 1860s and 1870s when the Korana and Griqua communities became involved and later also the British government. The conflict mainly centred on land claims by various communities. For decades the western border of the Transvaal Boer Republic was not fixed. Only through arbitration (the Keate Arbitration), triggered by the discovery of gold at Tati (1866) and diamonds at Hopetown (1867), was part of the western border finally determined in 1871. Ten years later, the Pretoria Convention fixed the entire western border.

The economy of the Transvaal Boer Republic was essentially based on farming. Land speculation and hunting and development in the Western Transvaal was slow until the discovery of diamonds in Griqualand West and along the lower Vaal River in the late 1860s and gold on the Witwatersrand in the mid-1880s. Towns established by the Boers during this period were Klerksdorp, Potchefstroom, Hartbeesfontein, Rustenburg, Zeerust, Jacobsdal, Lichtenburg, Bloemhof and Christiana. The 1880s and 1890s saw the advent of the first railway line to Klerksdorp (the station is a provincial heritage site), improved roads, expansion of existing towns and establishment of new towns, such as Geysdorp, Ottoshoop, Schweizer-Reneke, Wolmaransstad and Ventersdorp. Important architectural, social and cultural landmarks in many towns are provincial heritage sites, whilst a number of historic farmsteads are also protected.

Figure 8-5: Main house on Boekenhoutfontein, President Paul Kruger's farm in 1873-1900, a provincial heritage site managed by a private hotel group

Figure 8-6: Railway station at Klerksdorp (1897), a provincial heritage site managed by Spoornet

The political history of the western parts of the NW Province, comprising the former Vryburg, Taung and Mafikeng districts, differs from that of the remainder of the province, which used to form part of the Transvaal Boer republic until 1900 and thereafter of the Transvaal Province until the 1990s. Spearheaded by missionaries such as Robert Moffat (who managed a mission station at Kuruman) and David Livingstone, the early colonial history of the region was dominated by missionaries until the 1830s, when groups of Voortrekkers began settling. However, their numbers remained relatively small due to the harsh environment (which made farming difficult) and internal dissent. The region remained an unstable border area known as Bechuanaland, nominally under the control of the British government, but in practice controlled by tribal communities.

The discovery of gold and diamonds stimulated territorial ambitions and eventually led to a dispute as to the ownership of the diamond fields, involving the Transvaal and Orange Free State Boer Republics, the Griquas, the southern Tswana tribes and the Cape Colony. This was resolved in 1871 when the Cape Colony annexed Griqualand West (the Kimberley area).

Figure 8-7: House built by Silas Molema, son of the founder of Mafikeng, in Mafikeng, also occupied by Sol Plaatjie, writer, journalist, politician and first Secretary-General of the ANC. This house is a provincial heritage site (image copyright: S. Balson)

Figure 8-8: Mafikeng Museum commemorating the siege of 1899-1900 (image copyright: S. Balson)

The Pretoria Convention of 1881, through which Britain restored independence to the Transvaal Boer Republic (annexed in 1877), determined the new western border of the Transvaal. Boer pressure on Tswana territories west of the border was renewed and resulted in the establishment of two small Boer republics just west of the border, namely Gosen in 1882 (with Rooigrond as capital) and Stellaland in 1883 (with Vryburg as capital). Through the London Convention of 1884, which revised the Pretoria Convention, the British government decided to declare a protectorate over Bechuanaland south of the Molopo River. A year later a British force occupied this territory, eliminated Stellaland and Gosen and founded the town of Mafikeng. In 1890 the protectorate was enlarged by moving the northern border to the Zambezi, and in 1895 the southern part was transferred to the Cape Colony. The remainder remained a protectorate, governed from Mafikeng, until it became the Republic of Botswana in the 1960s.

The Anglo-Boer War (1899-1902) affected the entire NW Province and left behind a heritage of many battlefields, military cemeteries, fortifications and memorials, a few provincial heritage sites, others protected as graves of victims of conflict. After the war the Transvaal Boer Republic ceased to exist and became a separate British colony, transforming into a province when South Africa became a Union in 1910. The border between the Transvaal and Cape Province remained untouched.

The missionary activities of the London, Wesleyan, Paris, Berlin and Hermannsburg Mission Societies and also the Dutch Reformed Church in the province have left behind a lasting heritage in the form of many mission stations and outposts.

Two other human activities have contributed to the transformation of the landscape of NW and both the creation and destruction of heritage, namely mining and the implementation of the apartheid system.

The exploitation of mineral resources already began in the Early IA, but it was only in the early 1880s that commercial mining took root in the province, starting with the discoveries of gold at Klerksdorp, Hartbeesfontein and Ottoshoop. This was preceded by the advent of alluvial diamond mining along the Vaal River. Platinum mining was established after the discovery of the Merensky Reef in 1924.

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The foundations of the apartheid system were already laid in the 1880s when the republican and colonial governments started demarcating "locations" or reserves on tribal lines for the exclusive occupation by African communities. These formed the nucleus of the "scheduled areas" as determined in the Natives Land Act of 1913. They were enlarged by the addition of "released areas" in 1936. At the same time, legislation for "Non-Europeans" in urban areas created separate townships (also known as locations) for members of African, Coloured and Asian population groups.

From 1948, racial segregation became the basis of the planning of settlement in South Africa. Legislation made it compulsory for people to live only in specific areas that had been proclaimed for people of their race classification. Massive forced removals began in the 1950s amongst the urban populations, when African, Asian and Coloured communities were relocated from the scattered older formal locations and informal settlements to larger townships. Parallel with the government's policies in the urban areas, went a major process of political restructuring in the reserves by developing them as "homelands" based on tribal and language lines. These homelands were created around the areas demarcated in 1913 and 1936. In the NW Province the Tswana Territorial Authority was created in 1961, which was renamed *Bophuthatswana* and became a "self-governing state" in 1972 and "independent" in 1977. Like elsewhere, Bophuthatswana's population was assembled from communities already living in this territory, Africans removed from urban areas, African labour tenants removed from white-owned farms and the people from "black spots" such as farms owned by Africans and communities residing at mission stations. After mining, the policy of forced removals is probably one of the most important factors that contributed towards the destruction of heritage and left behind a legacy of hundreds of forgotten cemeteries and the ruins of villages and homesteads, such as those in Figure 8-10.

Figure 8-10: Graves of African farm workers in the Faan Meintjies Nature Reserve, Klerksdorp

The new political dispensation after 1994 effectively ended apartheid and in a sense, began reversing the migrations brought about by forced removals through a process of land restitution and redistribution. If not carefully planned and managed, this process has the potential to damage and destroy heritage, e.g. by returning historic farmland and mining areas to communities. Under the new Constitution, the four provinces of South Africa were broken up into the current nine, which assimilated the former homelands. The new NW Province was created by merging the western districts of the former Transvaal with the northern Bophuthatswana territories and the Vryheid, Taung and Mafikeng districts of the Cape Province, thereby restoring in a sense a territory that shared a common heritage.

Figure 8-9: Former Bantu Commissioner's office in the Pilanesberg National Park, managed by NW Parks and Tourism Board

Figure 8-11: Intangible heritage – although primarily a natural feature, the Pilanesberg National Park contains many places of cultural significance associated with Bakgatla history, such as initiation cleansing sites and schools, execution sites and sacred hills

Figure 8-12: Many collections of heritage objects in the province are housed in museums

8.5.1. Inventory of heritage sites within the North West Province

The following inventory of heritage significant sites has been included in the NW Environmental Management Series (Series 3) prepared by the NW Provincial Government in 2005:

National Sites	
Taung Skull Fossil Site, Taung	An archaeological site where the "Taung child" skull was discovered in 1924 in a limestone mine. The site also has a large number of other heritage values (see box). An application for World Heritage Site status has been submitted to UNESCO.

Australopithecus africanus was first discovered by Raymond Dart in 1925. He found a beautifully preserved skull of a juvenile, three to four years old. This skull, commonly known as the Taung Child, for Taung South Africa where it was found, is perhaps the best preserved fossil of A. Africanus known.

http://www.geocities.com/capecanaveral/lab/8932/africanus.html

National Sites applied for but not yet declared	
Kaditswene/ Kgaditshwene/ Kgaditwene, Zeerust	The largest Iron Age stone-built city in South Africa. In 1820 this city was larger than Cape Town. It was the manufacturing, trading and cultural capital of the Bahurutshe from before 1600 to 1823. Its economy was based on iron manufacturing.
Thaba Sione, Tshwaing	A well-known rock-engraving site near Khunwana and Kraaipan.
Vlakfontein, Rustenburg	Iron age settlement with about 10.000 inhabitants.
Molokwane, Rustenburg	To the west of Rustenburg lies this Late Iron Age settlement occupied by the Bakwena Bamodimosana tribe between 1650 and 1770. It covers an area of approximately 4 km2.

Table 8-1: Inventory of heritage sites (Environmental Management Series, Series 3)

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Provincial Sites	
Maratiwa, Mafikeng	House built by Silas Molema (son of the founder of Mafikeng) who also built the first school in the area in 1878. Sol. T. Plaatjie, a writer, journalist, politician and First Secretary general of the ANC, occupied the house.
Boekenhoutfontein, Rustenburg	Farm of Paul Kruger, president of the former Transvaal around 1900.
Old Fort & Cemetery, Potchefstroom	The largest and best preserved fort of its period, 1880/81.
Tom Street, Potchestroom	700 oaks line this road.
Stowlands, Lekwa-Teemane	Unusual San rock art sites located some 6 km from town.

Other Sites	
Kgotla of the Barolong Boo Ratshidi, Mafikeng	Mafikeng Tribal Kgotla of Chief Montshiwa has been in use since the 1850's. It contains a monument to Barolong who died in action during the Mafikeng siege of 1899-1900.
Battle of Tigela Site, Mafikeng	31 July 1884 saw the largest battle of the Bechuanaland War between Barolong and the Gosen Boers. 67 Bangwaketse warriors were buried here and it is the only known African military graveyard in NW. The battle resulted in the British colonial intervention and the establishment of the Botswana borders as they are now.
Warren's Fort, Mafikeng	This stonefort built by General Sir Charles Warren in 1885 to protect the Barolong Commandment. Sarel Eloff, towards the end of the Siege of Mafikeng, captured the fort for one day.
Mafikeng Museum, Mafikeng	An old Town hall built in 1902. Impressive steel ceilings, old Town clock and elaborate architectural style.
Concentration camp cemetries, Mafikeng	The cemetries are for those who supported the Boer cause and for the wives of the Boer Commandos who refused to surrender to the British.
Cooke's lake and ponds, Mafikeng	A popular bird lake sanctuary consists of a large lake, which is home to numerous species of wildlife close to the camping and picnic sites at the dam.
Siege graves – Mafikeng cemetery, Mafikeng	The military and civilian graves of the Mafikeng Siege causalities.
Dinokana springs, Zeerust	The springs are an attractive and interesting geological feature.
Mzilikazi's wall, Ditsobotla	This 1 km stonewall was built by Mzilikazi in the 1830's along the Malmani river to act as "hopo" or animal trap.
Bosman's school/ Heimweeberg school, Zeerust	A school built in the 1920,s where the writer HC Bosman taught, lies near Abjaterskop.
Khunwana, Zeerust	The Barolong capital from 1820's to the 1930's and the site of two battles of Difaqane in 1823 and 1832. 6 August 1832, Mzilikazi's Ndebele, thus precipitating the Barolong migrations, attacked the town. Sol Plaatjie based his novel, Mhudi, on this event.

8.6. Tourism – the economic connection

Tourism creates jobs and wealth, resulting in the potential to contribute to economically, environmentally and socially sustainable development. Tourism can contribute to development because:

- There is a minimised impact on natural environmental resources;
- It can be regarded as a direct and powerful motivation for the protection of heritage resources;
- It may result in an increasing consumer commitment to sustainable development principles, and
- It is an economic incentive for conserving natural environments and habitats which might otherwise be allocated to more environmentally damaging land uses.

The initial economic expenditure and the operational cost for the setting up of a tourism industry are low compared to many other forms of industry development. Tourism is one of the few realistic options for development in many areas. It is therefore a priority area for the NW Province with its rich heritage and rural communities.

8.6.1 Number of foreign tourists to the North West Province

SA Tourism's 2004 quarterly reports on foreign tourism to the NW Province shows that 9.5% of all foreign arrivals to South Africa visited the NW Province, equivalent to 633,395 foreign visitors in 2004. NW Province captured 3% of the total bed-nights spent in South Africa (2 million bed-nights), comprised of 1.2 million bed-nights from African visitors, 477,000 bed-nights from European visitors, 198,000 bed-nights from American visitors and 104,000 bed-nights from Asian and Australasian visitors. The most significant increase in bed-nights spent in the NW Province came from American visitors – up almost 200% on the number in 2003, albeit off a low base. There was also an 11.6% increase in the number of bed-nights spent by European visitors in the NW Province, though bed-nights from the Asian and Australasian market were down by 13.8%.

Other Sites	
Setlhare sa Morula, Rustenburg	Place where the meetings used to be held by Kgosi Pilane villagers and sub-chiefs. Also consists of the Chief's kgotla.
Strydom Square, Tshwaing	It comprises of an effigy of General De la Rey and a Heroes' Acre where a number of persons involved in the battles from the surrounding areas were reburied.
Salt pan, Tshwaing	In summer, the pink-coloured saltpan attracts thousands of flamingoes. One of the most awe-inspiring attractions in the Province.
Magistrates building, Ditsobotla	The old Magistrate building was built during 1895.
Manana, Ditsobotla	It hosts Greef Home, which was built in 1875. An old plantation house, home of the pioneer in dry-land farming, colonel H.Du Toit, was erected south of the town in 1910.
Botshabelo (Putfontein), Ditsobotla	The extensive ruins and cemetery of the large BaTloung settlement that was completely destroyed in 1976/1977 when the entire population was forcibly removed to Ramatlabana, can be seen in this place.
Hanging tree, Mamusa	The tree where the Korana used to hang criminals. It is still standing as quiet witness at the foot of the hill.
Rock engravings, Mamusa	Some rock engravings are located just above the Wenzel Dam and on various farms in the area, including Weltevrede, on the road to Vryburg.
Potchefstroom Town Hall, Potchefstroom	A classic Edwardian building that was completed in 1909. Together with the Town hall in Krugersdorp, it is the oldest existing Town Hall in the NW.
Mosque, Potchefstroom	Built in 1925 to accommodate the Indian traders in the town, especially those with business in Potgieter Street. The recent renovation of the Mosque accentuates its distinctive charm.
Klerksdorp Museum, Klerksdorp	Formerly a prison, this sandstone building exhibits early town life, archaeology and social history.
Hendrik Potgieter Road, Klerksdorp	The oldest road in the former Transvaal. The first Voortrekkers settled here in 1837.
Dinkwaneng, Taung	Near the village of Mantestad are some excellent examples of San rock art.
Makwassie Town Hall, Makwassie Hills	A stately sandstone building, which was completed in 1912/1913.
Schoonspruit River Eye, Ventersdorp	The town depends on this water for human consumption. The water level stays constant, even during dry seasons. From here the first mineral water was bottled in South Africa.
Water Mill, Ventersdorp	The mill, running on steam and still running in order. Erected by APC Roscher between 1874 and 1876. Mr Morris and Mr. French helped in 1885 with the mill.
Kinderdam rock engravings, Ventersdorp	Pristine records of life about 1000 years ago.
Tigerkloof Mission, Naledi	The mission school was attended by numerous past and present South African leaders.
Bakerville, Ditsobotla	The town of Bakerville, in the Lichtenburg diamonds fields area. In 1928 the area was home to more than 150,000 diamond diggers. Most of them lived in tents or houses of corrugated iron.

8.6.2. Length of stay of foreign tourists

On average, foreign arrivals to South Africa spent 9 days in the country during 2004, down from an average of 10 days during 2003. Foreign arrivals spent on average 3.1 days in the NW Province in 2004, the same as in 2003. Length of stay of visitors from the Americas in the NW Province, as well as visitors from Europe, increased in 2004 compared to 2003. These visitors also tend to spend longer in the NW Province than other visitors. Visitors to the NW Province are dominated by Botswana (81% of all African visitors to the NW Province), largely as a result of the province's shared borders with that country.

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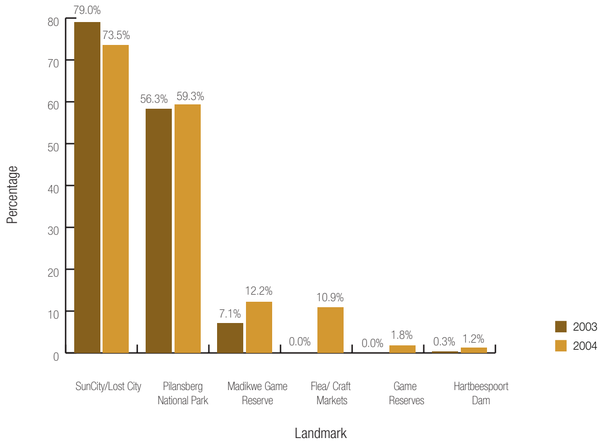

Figure 8-13: Landmarks visited by foreign visitors (2003 / 2004) (SA Tourism / KPMG 2006)

8.6.3. Landmarks visited in the North West Province

The most visited landmarks in the province are Sun City – Lost City, Pilanesberg National Park and Madikwe Game Reserve, followed by flea and craft markets. Hartbeespoort Dam attracts a very small percentage of foreign visitors to the NW Province (Figure 8-13). This could be dramatically improved through the promotion of cultural heritage alongside natural heritage and resorts (such as Sun City), as well as appropriate interpretive signage and better local knowledge of the historical/cultural sites in each District.

The NW Parks and Tourism Board and the affected district and local municipalities have initiated the Heritage Park Development Project. The concept plan for the Heritage Park includes a corridor linking the Pilanesberg and Madikwe Reserves. The NW Province endorsed the project, now being recognized as one of the priority projects within the Provincial Growth and Development Strategy.

8.6.4. Domestic tourism in the North West Province

The 2003 Domestic Study found that 49.3 million domestic overnight trips were taken during August 2002 to July 2003. Of these, the NW Province received 6.24% or 3 million trips, which places it as the seventh most popular destination for domestic visitors. The 2001 study found that the NW Province received 7.9% of domestic trips, which placed it sixth most popular.

8.7. Conclusion

Trends in the conservation of heritage resources are focused on achieving physical protection of resources, making them available and accessible to communities, tourism and other user groups in order to generate wealth. This is a driving force that has emerged since the 2002 State of the Environment Report, as illustrated by the consolidation and expansion of protected areas (of which the Heritage Park linking Madikwe and Pilanesberg is a classic example). Recent initiatives have contributed to the preservation of the provincial heritage resources, the creation of a provincial resource database and focus attention on a number of flagship projects, such as Taung.

Consequently, resource conservation trends need to be properly supported by financial and human resources and infrastructure.

Tourism development, linked to community participation and growth, is one of the main priorities in the NW Province. The natural and cultural heritage resources act as a basis for such developments, as well as being the most obvious and possibly cost effective way for integrating local communities into the growing tourism sector. There is potential for sites of social, political, historical, environmental, recreational and aesthetic importance to bring many more international tourists, and to have a Province that is less dependent upon the Platinum Belt to provide livelihoods.

Tourism development is however, heavily dependent upon the following:

- The global and national marketing of the rich heritage sites in the Province;
- The development of tourism 'hubs' around sites of importance, and linking this to platinum beneficiation (i.e. jewellery);
- The promotion of tourist 'packages' which include all aspects of the unique offering of the NW Province;
- The development and maintenance of a proper database of heritage resources in accordance of Section 39 of the NHRA by the Province to ensure adequate protection and promotion of the resources;
- The addressing of all heritage issues (natural and cultural) in municipal Integrated Development Plans
- The incorporation of heritage management plans into general management plans of protected areas;
- Better liaison and co-operation between the South African Heritage Resources Agency (SAHRA), the NW Provincial Heritage Resource Agency (NWPHRA) and the NW environmental authorities (NWDACE) concerning the implementation of the EIA Regulations;
- The encouragement of Local authorities to develop their own databases of heritage resources, and expertise, in accordance with the provisions of the NHRA, and
- The initiation of a programme to mark heritage places with interpretive signage by the Province and district municipalities.

A positive driving force in the preservation and development of existing known heritage resources is created by subsidies in the development of heritage linked tourism initiatives. This may drive the need for research into the state and possible function of these resources for optimal conservation and utilisation in the Province.

8.8. Reponses

- As stated in Section 8.3, the two overriding issues resulting in the loss of important heritage features and sites and which affects effective heritage management in the Province challenges are:
- The authorisations of development projects without the consideration of sites of heritage significance, and
- A lack of capacity and awareness with regard to heritage management.

As reported in the NW Environmental Management Series (Series 3) (NWPG, 2005), prepared by the NW Provincial Government in 2005, the NW office of the SAHRA together with the NW Provincial Department of Social Services, Arts, Culture and Sport (DSSACS) are proposing to undertake the compilation of a provincial heritage database to record data about all cultural, historical and natural sites and their protection status. The SAHRA North West Office has partnered with the Support to Environment and Sustainable Development Project in the NW Province (SESDNW) to contribute the database component for the province.This will provide valuable data for future planning purposes to ensure the protection and development of heritage significant sites.

As part of the regulated EIA approval process for proposed listed activities, requirements should be set by SAHRA to ensure that the relevant Heritage Impact Assessment, as contemplated in the NHRA, are undertaken, and that any significant heritage sites are recorded, added to the database and appropriately addressed.

Prioritisation of the cultural environment has to be undertaken to initiate a process for the declaration of sites with significant heritage value. The criteria for prioritization can be based on the following:

1. The value of the site in terms of aesthetics, social, cultural and religious value and educational and technological value;
2. Vulnerability, and
3. The state of its current condition and integrity.

Objective	Indicator	Units of measurement/data collection
Support and promote tourism	Revenue generated from natural heritage sites	Sum of revenue generated from natural heritage sites in the North West province
Preserve indigenous knowledge and culture	Number of cultural and historical heritage sites per 100,000 population	Number of cultural and heritage sites * 100,000 / Population

Table 8-2: Indicators for future monitoring

Photo: NWDACE

The starting point of this report on the current state of natural and cultural heritage was based on the indicators identified for the report. The following indicators have been identified to inform this report; however, insufficient data exists to enable meaningful reporting on all the issues. These indicators should be considered when future state of the environment reporting is planned.

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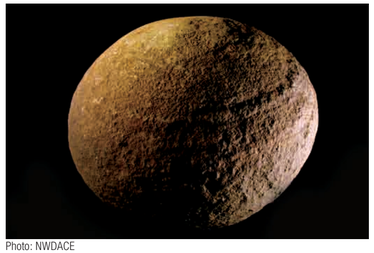

Photo: NWDACE

Photo: Anthony Goslar

Photo: NWDACE

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Photo: SA Tourism

CHAPTER 9

Outlook for the North West Province 2008 - 2025

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Chemical abbreviations

NO_2	Nitrite
NO_3	Nitrate
PM10	Particulate Matter with a diameter of less than 10 nano meters
PM2.5	Particulate Matter with a diameter of less than 2.5 nano meters
PO_4-	Phosphates
SO_2	Sulphur dioxide
TSP	Total Suspended Solids

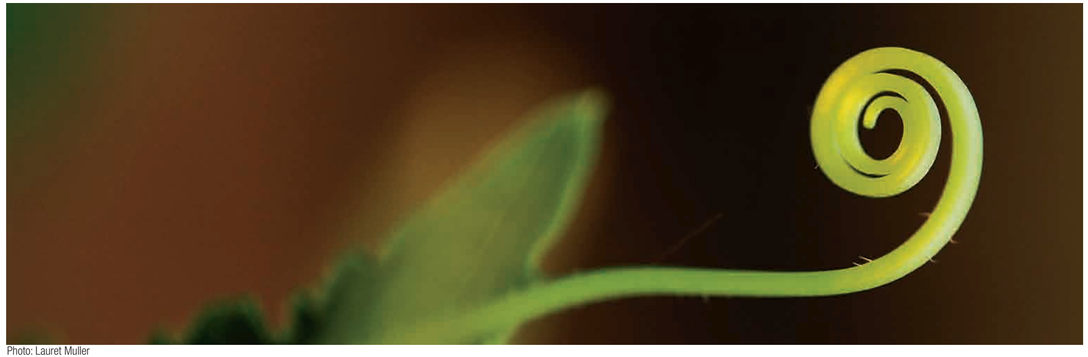

Photo: Lauret Muller

Acronyms and abbreviations

AEO	African Environment Outlook
AIDS	Acquired Immune Deficiency Syndrome
ASGISA	Accelerated and shared Growth Initiative for South Africa
CITES	Convention on International Trade in Endangered Species
DEAT	Department of Environmental Affairs and Tourism
DST	Department of Science and Technology
DWAF	Department of Water Affairs and Forestry
EIA	Environmental Impact Assessment
EIP	Environmental Implementation Plan
EMF	Environmental Management Framework
GDP	Gross Domestic Product
GEO	Global Environment Outlook
GGP	Gross Geographic Product
GVA	Gross Value Added
GMO	Genetically modified organism
HDI	Human Development Index
HIV	Human Immunodeficiency Virus
IUCN	International Union for the Conservation of Nature
NEMA	National Environmental Management Act 107 of 1998
NW	North West
NWPG	North West Provincial Government
PGDS	Provincial Growth and Development Strategy
PPP	Plans, policies and programmes
R&D	Research and Development
RoD	Record of Decision
SADC	Southern African Development Community
SANBI	South African National Biodiversity Institute

Photo: NWDACE

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9.1. Introduction

The effective management of the environment is determined by our knowledge of the expected location and extent of environmental impacts. Predictions on environmental impacts are made utilising an Outlook, which describes potential alternative future scenarios and is based on the key drivers of environmental change within the province. Providing scenarios which describe the way that future events could materialise assists us in identifying environmental and development tools in order to realise the ultimate desired outcomes. Scenarios identify a possible future, rather than a probable one and may be used as a tool to stimulate debate around future events. The outlook for the NW Province uses the current trends of the drivers of environmental change as a departure point, but is however unable to identify the probability of an event.

In compiling this Outlook, three relevant initiatives were reviewed:

- The Africa Environment Outlook (AEO) and United Nations Environmental Programme's (UNEP) Global Environment Outlook (GEO), which defined the following scenarios: 'Market forces', 'Policy reform', 'Fortress world', and 'Great transitions';
- The Southern African Development Community (SADC) Environment Outlook (SADC, IUCN, SARDC & UNEP, 2005) which developed environmental scenarios for the SADC region for the year 2015, which were informed by the Global and Africa Environment Outlook documents of UNEP. Three scenarios were developed, namely 'Market forces', 'Policy reform', and 'Fortress world', and
- The South African Environment Outlook 2005-2028 (Department of Environmental Affairs and Tourism, 2006) which developed environmental scenarios for South Africa for the period 2005 to 2028. Four scenarios were developed, namely 'Skorokoro', 'Going nowhere slowly', 'Ta ta ma chance' and 'Laduma'.

The significant areas of convergence of these reports give credibility to the various outcomes. In general, the 'worst case' scenarios describe governance and economic failure and predict an increase in impacts from large industrial and agricultural enterprises. Table 9-1 provides an overview of the scenarios as described in each of the respective documents.

9.2. Drivers and pressures

The driver-pressure-state-impact-response (DPSIR) framework is a cause and effect framework formulated to describe how human activities ultimately impact upon the environment and what measures can be undertaken to address these impacts[1]. The first two steps in the framework are the Drivers and Pressures[2]. The driving forces refer to the overarching macro-level activities which apply pressure to the environment. Understanding the drivers within the NW Province not only assists us in understanding the main forces placing pressure on the environment, but helps in gaining insight as to what the future pressures on the environment may be, should these drivers strengthen or weaken.

Four key drivers are discussed in this report (UNEP, 2006; DEAT, 2006):

- Demography and human well-being;
- Economic growth;
- Governance, and
- Science and technology.

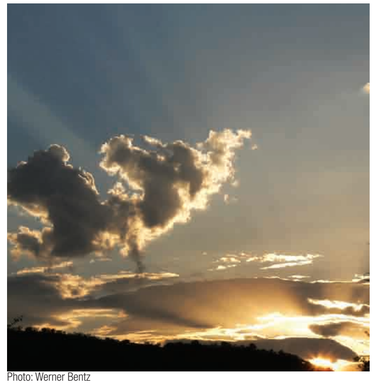

Photo: Werner Bentz

These drivers are also listed as the major overarching drivers for South Africa (DEAT, 2006) and Africa (UNEP, 2006) respectively.

The production and consumption of goods place pressures on the environment as a result of excessive use of environmental resources. The processes of consumption and production therefore exert pressure on the environment and can be categorised as follows (Kristensen, 2004):

- Excessive use of environmental resources;
- Changes in land use, and
- Emissions (chemicals, waste, radiation and noise) to air, water and soil.

Excessive use of environmental resources is strongly linked to economic activities, population growth and human livelihoods, placing an increasing demand on the available finite resources within the province. As demand increases, driven by economic and population growth and coupled with human necessity, pressure is placed on resources, which then begin to deplete and degrade due to over-utilisation.

With increased populations and economic activities, available land is increasingly becoming a scarce resource. Change in land use places pressure on the natural habitats and ecosystems.

Emissions and effluent comprise all chemicals, waste, radiation and noise that are discharged into the air, water and soil. Emissions are typically categorised according to a source-pathway-receptor chain. The source is the activity which releases the pollutant; the pathway is the non-living component of the environment that transmits the pollutant and the receptor is the living component (including humans) that receives or is subjected to the pollutant. While pollutants place pressure on non-living components of the environment, the ultimate effect of this pollution is transferred to living organisms.

1 Refer to the Preamble for further discussion on the DPSIR framework.

2 Refer to Chapter 2 (drivers of environmental change) for a full description of the Drivers in the NW Province.

	Most desirable	Intermediate	Intermediate	Least desirable
Africa Environment Outlook (UNEP, 2006)	**Great transitions**	**Policy reform**	**Market forces**	**Fortress world**
	Focuses on a new sustainability paradigm and values are centred on simplicity and community. Environmental outcomes include greater regional cooperation on key social, economic and environmental issues.	Balance between social and economic development, with a focus on environmental issues. Strong market forces, political fragmentation, and instability stemming from poor quality and vulnerability, causing impact.	Global economic forces have a greater impact on local issues. Due to Africa's weak stance, the continent and its countries are subject to relatively unrestrained exploitation of natural resources and unsustainable social patterns.	Regional and local disparities are fuelled, due to the distribution of wealth between the elites (minority) and the rest of the population, causing a breakdown of law and order. Elites adopt a fortress approach to protecting themselves. The environment is both exploited and unmanaged.
South Africa Environment Outlook (DEAT, 2006)	**Laduma**	**Going nowhere slowly**	**Tata Ma Chance**	**Skorokoro**
	Characterised by people, the economy and the environment moving towards a sustainable future.	There is an understanding of environmental and social issues by the State, and a strong commitment to action through policies and governance, while the global economic environment directly influences the national economy.	Emphasis on economic and industrial growth, while environmental policies remain fragmented and poorly developed with poor capacity for enforcement.	Poor governance and poor economic performance are the major trends in this scenario, which result in decreased social and environmental states, compounded by a lack of economic investment.
Southern Africa Environmental Outlook (SADC et al., 2005)	**Policy reform**	**Market forces**		**Fortress world**
	The focus is on markets and economic growth, facilitated by targeted social and environmental policy and practice, resulting in the private provision of social services. It will gradually reduce air pollution, support land reform and balanced land use, as well as cause greater demand for water and an integrated resource management system.	This scenario focuses on market-driven economic growth, and undervalued biodiversity.	None identified.	Characterised by low growth, limited social and environmental concern, high poverty and inequality, reduced industrial pollution, low farm productivity and high land pressure.

Table 9-1: Comparison between three significant Outlook reports

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9.2.1. Driver 1: Demography and human well-being

The demography and human well-being driver focuses on the human population within the province which is explicitly linked to the livability or state of human settlements and just as closely tied to the effects of poverty.

Key findings with regard to demographics and human well-being as a driver are as follows:

- The population of the province in 2007 was approximately 3.272 million (Office of the Premier, 2007);
- The population is currently growing at a rate of 3.1% per annum, thus increasing the need to meet the food and energy requirements of the people, thus placing more pressure on the land;
- In the period between 1996 and 2005, the population of the NW Province grew by 15% from 3.355 million to 3.858 million people. During 2006, legislative amendments were passed to redefine municipal boundaries to ensure that cross-boundary municipalities are entirely located in one province. With this change, the province's population decreased by 0.484 million people, or 13%;
- The average population density of the province is 28 people per km^2;
- The population is projected to range from 5.5 million people by 2021 (in a low HIV and AIDS scenario) to 4.0 million (in a high HIV and AIDS scenario);
- On average, 40% of all deaths in the NW Province are HIV and AIDS-related;
- The NW Province has a HIV and AIDS prevalence of 31.8% overall, and 29% among pregnant women;
- Life expectancy in 2006 was 50.7 years;
- The infant mortality rate in 2006 was 44 deaths per 1,000 births;
- AIDS orphans comprise almost 3% of the NW Province population;
- When the current prevalence of HIV in pregnant mothers receiving antenatal care is considered, an associated increase in AIDS orphans can be expected;

Photo: Lauret Muller

- In 2007, 646,000 children were receiving care grants. This number is 9.6 times higher than in 2001, and 244 times greater than in 1996, and
- The total number of the NW Province population which received grants in 2007 is 1,001,629 people, accounting for almost one third of the provincial population.

Increased population numbers and a concentration in population densities translate into greater pressures being placed on the environment. This is due to a higher demand and greater competition for resources. Consumption increases the production of wastes which are disposed of into the environment. In order to meet the demand for resources, larger areas of land are altered for activities such as urban infrastructure and agriculture.

The poorest sections of the population typically live in the most fragile, degraded and marginal areas. This is largely the result of previous land policies and the creation of the former homeland areas, with consequent landlessness, overpopulation, overgrazing and increased land degradation in many rural areas. The poor often live in degraded urban environments, in close proximity to waste disposal areas or on sites vulnerable to flooding.

Environmental problems experienced by the poor manifest in the following ways:

- An alienation of people from the land;
- Land degradation caused by overcrowding and unsustainable agricultural practices;
- Lack of access to clean water;
- Health problems caused by air pollution;
- Lack of access to safe and efficient energy sources;
- Exposure to hazardous waste, and
- Exposure to land and water degradation from mining activities.

Similarly, high unemployment levels and widespread poverty, combined with large urban and international demand for certain products, leads to poaching of game, trade in CITES-listed species, and smuggling of protected plant species.

9.2.2. Driver 2: Economic development

The economic development driver refers to activities related to the development of the NW Provincial economy.

The economy is the realized social system of production, exchange, distribution, and consumption of goods and services.

Key findings with regard to economic development as a driver are as follows:

- Gross Domestic Product (GDP), in 2000 prices, has grown from R58 billion in 1996 to more than R72 billion in 2006;
- Since the launch of the Provincial Growth and Development Strategy (PGDS) in 2004, the economic growth per annum consistently outperformed the annual population growth at 3.6% in 2004, 4.9% in 2005 and 4.3% in 2006;
- The real Gross Geographic Product (GGP) growth rate in the province increased significantly between 2001 and 2005 from 0.9% in 2001 to 5.1% in 2005;
- The GGP per capita was R22,506 in 2006, up from R21,947 in 2004 and R20,813 in 2001;
- The diversity of the NW Province's economy has ranged between 45.6 and 54.4 in the Tress Index for the period 1996 to 2004, and ranks as the fifth most diverse economy in South Africa;
- The largest sectors in the NW economy are mining and community and government services;
- The mining sector contributed to 41.5% to the NW Province's Gross Value Added (GVA) in 2004, up by 10.9% from 1996. The mining sector has become increasingly important in the NW Province's economy, contributing R54,821 million in 2006 at 2007 prices (Office of the Premier, 2007);
- The mining sector employed a total of 135,682 people in the province in 2004 (NWPG, 2004);
- The community and government services sector contributed 24.9% to the NW Province's GVA in 2004 down by 4.7% from 1996, contributing R16.3 million in 2006, up from R12.2 in 2001 (at 2007 prices) (Office of the Premier, 2007). The sector is the largest employer, accounting for 22.7% of employment in the province (NWPG, 2004);
- The unemployment rate in the NW (expanded definition) is estimated to be 48%, the third highest in the country behind the Eastern Cape and the Northern Province (PPT, 2005);
- The total estimated number of unemployed persons in the NW Province in 2007 was approximately 57, 000;
- The NW Province has the lowest number of people over the age of 20 in the country (5.9%) who have received a higher education (PPT, 2005);
- The province has a literacy rate of only 54.3%. Approximately 44.7% of people 20 years and older were functionally illiterate in 2003, and
- More than 60% of urban households earn less than R1,500 per month. In addition, more than 80% of all households in most districts earn less than R3,500 per month.

Economic activities such as mining and agriculture place pressure on the environment through the use of environmental resources, changes in land use and the discharge of emissions and effluent. Economic growth is however necessary for providing for the livelihoods of the people. Balances and trade-offs are therefore necessary in addressing the pressures of these activities on the environment.

The government has placed a high premium on economic growth in order to promote employment and to improve service delivery. To give effect to this policy, the Accelerated and Shared Growth Initiative for South Africa (ASGISA) in 2006[3] was initiated with the ultimate aim of halving unemployment by 2012.

Many environmental resources have not been priced or adequately valued through the market. This is particularly true in the case of waste and pollution which only recently commanded serious consideration in economic analysis. Thus, the initiatives that support ASGISA will have environmental consequences which will need careful monitoring.

9.2.3. Driver 3: Governance

Governance refers to the mechanisms used to ensure that institutions' or organisations' constituents follow its established processes and policies. An effective governance strategy implements systems to monitor and record compliance with the agreed policies, and provides for corrective action in cases of non-compliance.

3 ASGISA was launched by Deputy President Phumzile Mlambo-Ngcuka in February 2006 to address six "binding constraints on growth". ASGISA's objectives could be achieved if the economy grew at an average rate of 4.5% in the period to 2009, and by an average of 6% from 2010 to 2014.

The following is relevant to governance as a driver:

- The Government of South Africa is divided in three democratically elected spheres:
  - (i) national;
  - (ii) provincial, and
  - (iii) local municipal government.
- The provincial and local level policies are guided by the national policies and legislation, or regulatory frameworks;
- The Constitution of the Republic of South Africa Act 108 of 1996 is the supreme law of South Africa. Any law or conduct inconsistent with it is invalid and obligations imposed by it must be fulfilled. It is also the starting point in determining the responsibilities for the administration of environmental law, as it sets out the framework for the legislative and executive branches of government;
- The legislative authority of a province is vested in its provincial legislature, which has the power to pass legislation for its province in respect of certain provisions;
- The Provincial Legislature may also assign any of its legislative powers to a municipality within its area of jurisdiction;
- NWDACE currently has the mandate, in terms of the National Environmental Management Act 107 of 1998 (NEMA), to administer the following:
  - Environmental Impact Assessments (EIA) in accordance with Regulation 385 promulgated in terms of NEMA;

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- Strategic Environmental Assessments (SEA) to assess the environmental implications of a proposed strategic decision, policy, plan, programme, piece of legislation or major plan;
- Environmental Management Frameworks, and
- Environmental Implementation Plans (EIP), which are a requirement for all provincial departments aimed at aiding integrated decision-making and planning.

- The uncertainties with regard to the parameters of the powers and functions of NWDACE are affecting the Departments attempt to establish cooperative governance;

- More than 432 EIA Record of Decisions (RoDs) were issued in the annual reporting cycle of 2006/2007, including township developments, telecommunication infrastructure, roads, and water supply infrastructure;

- The province has also started building capacity for environmental compliance and enforcement monitoring. At least 77 operations have been inspected by NWDACE for RoD compliance in the annual reporting cycle of 2006/2007. Two environmental emergency incident investigations and 35 general duty of care breaches have been identified by NWDACE and legal directives issued for further monitoring;

- NWDACE has undertaken six SEA's within the province. It has however been found that these are not taken into consideration in the decision making process. In response to this, NWDACE is currently investigating the viability of conducting Environmental Management Frameworks (EMF) instead of SEAs. EMFs have legal standing in terms of NEMA, and therefore provide for the enforcement of the implementation of the recommendations contained therein, and

- The NW Province 2006/07 Environmental Implementation Plan (EIP) Annual Report is the fourth and the most recent annual report in terms of the first edition of the NW Province EIP, which was gazetted in April 2003. The NW Province has commenced with the process of compiling the second edition of the Environmental Implementation and Management Plan and it is expected to be finalised at the end of 2008.

Human activities are increasingly impacting on the environment and affecting its ability to provide services in support of human well-being. Timely and reliable environmental information and scientific knowledge are needed to mitigate and adapt to environmental change. Information is required for action at national and regional levels, for mainstreaming environmental concerns into sectoral activities, and for implementing and monitoring multilateral environmental agreements and the development goals and objectives for sustainable development (Governing Council of the United Nations Environment Programme, 2006).

Effective environmental governance within the province enables the identification of issues, the development of suitable responses and the monitoring of compliance which provides uniform national norms and standards and/or which is necessary to uphold the environmental agenda.

9.2.4. Driver 4: Science and technology

Science and technology drivers relate to the long-term economic sustainability of the NW Province. Recent research suggests that in order to achieve long-term economic growth, innovation and organised responses are essential (Buys *et al.*, 2004).

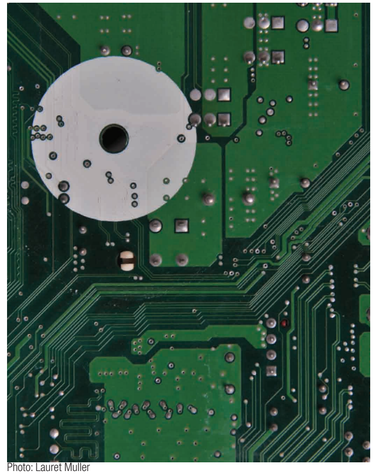

Photo: Lauret Muller

The following is relevant to science and technology as a driver:

- Science and technology do not necessarily equate to innovation. Innovation, built upon science and technology, is the transfer of the science and technology into market capital (NACI, 2004);

- The extent to which science and technology may act as a driver is based on the following concepts (NACI, 2004):

  - **Absorptive capacity** which refers to "the ability to absorb new knowledge and adapt imported technologies". This capacity is essential for emerging economies to catch up with developed economies;
  - **Research and Development (R&D) supply** which is important not only to generate new knowledge but also to act as a mechanism to absorb it;
  - **Diffusion and linkages** measure how many users, other than the innovator, are utilising the technology. This essentially justifies the R&D expenditure, and
  - **Innovation demand (market pull)** which refers to the applicability of this technology for the market.

- Science and technology are of fundamental importance in pulling the NW Province out of an economy built primarily on first, second and third dynasty activities into economic dynasties that return higher yields for capital investment;

- The ability to absorb new ideas and adopt new technologies is fundamentally linked to poverty, education and human well-being. It is imperative that the population is involved in tertiary and life-long educational activities in order to be able to participate in the knowledge economy;

- A primary requirement to create the ability to absorb technology is proper services and infrastructure. The province's progress towards this is measured by the Human Development Index (HDI). As discussed in the first driver, the HDI for the province in 2005 was 0.54;

- The University of the NW has 3 campuses: Mafikeng, Potchefstroom and the Vaal Triangle. In 2004 24,000 people had a university degree or higher. The province is currently tackling secondary education as 322,000 people have received no education at all (NWPG, 2004);

- Based on the HDI and the education figures, the NW Province is in an unfavourable position for the necessary absorption capacity to handle new technology and innovation, unless the expertise migrates into the province;

- Provincial expenditure on R&D has remained below 5% for the period 2004 to 2008. The majority of expenditure has been allocated to professional fees. It is unclear whether this is towards professionals within the province or from outside provinces;

- Information on the diffusion and linkages of information is currently scarce for the province as there are no figures available for: the number of internet users; internet sites being accessed; training; ISO 9000 registrations; or on internet accessibility and usage;

- The market pull or innovation demand in the NW Province is difficult to quantify;

- Information on the availability of venture capital and protection for patents within the NW Province is not available, and

- The South African Department of Science and Technology (DST) provides tax incentives for R&D (DST, 2008).

The NW Provinces has opportunities for R&D in the mining and agricultural sectors. The opportunities include the development of technologies for the better extraction of minerals and management of mining wastes. It is however difficult and costly to retrospectively apply technology to activities not included in the original design. Of particular applicability are cleaner technologies for the control of pollutants. Within the field of agriculture, opportunities exist around genetically modified organisms (GMOs), bio-fuels and organic farming techniques.

Science and technology produces innovative solutions to economic issues. As a driver, it can therefore reduce or increase pressures on the environment based on the type of solution being proposed. For instance, innovative solutions could be proposed for treating effluent prior to its discharge into a river. This would reduce the pressures of pollution on the environment. However, a new technology could be introduced to cost-effectively mine platinum reserves at deeper levels, increasing the quantity of mining wastes in the east of the province.

It is argued as a criticism against the concept of carrying capacity that *"necessity is the mother of invention"* (Boserup, 1965) and therefore science and technology do not drive environment change but are rather a response to the former three drivers discussed in this chapter. With the recent and growing green revolution taking place around the planet, scientists and engineers are applying themselves more fervently to innovate in a manner which limits environmental impacts. However, this innovation will always have to be translated into market value and therefore faces the dual challenge of decreasing impacts on the environment while increasing profit margins.

9.3. Overview of the state of the environment

This section presents the status quo of the environment for the NW Province as discussed in Chapters 3 to 9. It assumes that all drivers will influence the environment as they have in the past, and that no additional issues will exert pressure on the system. This perspective provides a baseline or reference for the scenarios to follow.

Photo: Werner Bentz

9.3.1. Land use and transformation

9.3.1.1. State - land use

The state of land-use can be summarized as follows:

- The NW Province covers approximately 11.6 million ha of which 9.6 million ha (81.1%) is agricultural land;

- Agricultural land can further be subdivided into approximately 3.4 million ha (34.9%) of arable land, 5.4 million ha (56.3%) of veld and 764, 500 ha (7.9%) of conservation land;

- Approximately 54% of the surface area of the province has been transformed by agriculture;

- Most of the mining activity is in the eastern and southern regions. Alluvial diamond mining still occurs in ancient river beds within the Harts River catchment and some rivers in the central and southern regions, and

- Diamonds are also mined at Lichtenburg, Koster, Christiana and Bloemhof, while the Klerksdorp-Orkney-Stilfontein-Hartbeestfontein (KOSH) area is renowned for its gold mines.

9.3.1.2. State – degradation

The state of land-use degradation can be summarized as follows:

- In the Bojanala Platinum District, approximately 17% of the land is susceptible to desertification. The contributing factors for the susceptibility is ascribed to the following:
  - overstocking and poor legal services in combating overstocking;
  - erratic rainfall and drought patterns;
  - poor farm planning;
  - lack of land ownership;

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- communal farming controls;
- regular veld fires (more than once per season) resulting in the following:
  - Grass species in the area are predominantly that of pioneer species;
  - Soil compaction, especially around watering points;
  - Walkways, and
  - Increased water runoff.

- Bush encroachment has increased in excess of 30% since 2002, where Sickle Bush (*Dichrostachys cinerea*), Black Wattle (*Acacia mearnsii*) and Bluegum (*spp. Eucalyptus*) make up the dominant encroaching species;
- Erosion occurs in 71% of the municipal areas of the province. The most important forms of soil degradation in croplands are:
  - Sheet erosion;
  - A loss of topsoil, and
  - Rill, gully and donga erosion.
- The NW Province is listed fourth out of the nine provinces in terms of the collective degradation index and fifth in terms of the soil and veld degradation indices.

9.3.1.3. Impacts

Increased growth of the agricultural and mining sector, specifically the Platinum Belt, increases the utilisation of natural resources resulting in:

- Soil erosion;
- Sterilisation of arable land;
- Bush encroachment, and
- Soil and veld degradation.

9.3.2. Air quality and climate change

9.3.2.1. State

Sources of atmospheric emissions include both natural and anthropogenically-induced releases. Natural sources include biogenic releases, wind blown dust, veld fires and lightning (inducing NO_x formation). Anthropogenic sources include:

- Industrial and commercial activities, including Scheduled Processes (as listed under the Atmospheric Pollution Prevention Act 45 of 1965) and fuel burning appliances operated by businesses, hospitals and schools;
- Electricity generation by power stations;
- Waste treatment and disposal;
- Emissions from residential sources including household combustion of coal, paraffin, Liquefied Petroleum Gas (LPG) and wood;
- Sources of emissions relating to transport including petrol and diesel driven vehicle tailpipe emissions, vehicle entrained road dust, brake and tyre wear fugitives, and rail and aviation emissions;
- Emissions from mining specifically relating to wind-blown emissions from mine tailings impoundments, including particulates (TSP, PM10 and PM2.5);
- Agricultural sources including crop residue burning, enteric fermentation and fertiliser and pesticide application;
- Other sources of emissions that should also be considered include tyre burning and fugitive dust from construction and erosion of open areas, and
- Long-range transport of aerosols from biomass burning and industrial emissions.

The air pollution data presented in this Chapter highlights the following air quality challenges:

- Elevated PM10 concentrations are evident from the limited data supplied at the various stations within the NW Province. For all stations where PM10 data were supplied, the proposed South African Standards over a daily average and an annual average were exceeded. In general, an increase in ambient PM10 concentrations was reflected. The data for PM10 is however inconsistent and more comprehensive records are required to determine trends of PM10.
- Close to industrial sources, SO_2 concentrations were high, exceeding the South African Standard for all averaging periods (10-minute, hourly, daily and annual averages). In the residential area of Rustenburg, a slight increase in SO_2 concentrations was noted over the past 3 years, whereas a slight decrease was recorded near the industrial zone of Anglo Platinum. The current total SO_2 emissions in the Rustenburg area is approximately 250 tonnes/day.
- Sulphur dioxide (SO_2) concentrations are likely to be high in low income settlements where use is made of coal and wood as an energy source.
- Although NO_2 concentrations have not been recorded to date in the NW Province, it is likely to be high close to busy roads and intersections such as the N4 Platinum Highway.
- Hexavalent Chrome is a concern within the NW Province due to the number of Ferro-Chrome smelters situated in the area.

9.3.2.2. Impacts

Poor air quality may have impacts on many aspects, such as:

- Ecological Impacts through fallout and deposition of particulates. High concentrations of pollutants in the atmosphere can cause acid rain, changes in ecological functioning, destruction of flora through tissue death, and formation of ozone in the troposphere;
- Human health impacts include respiratory, pulmonary and cardiovascular symptoms and diseases, due to elevated levels of particulates, oxides of nitrogen and sulphur, carbon dioxide and volatile organic carbons in the atmosphere;
- The increases in greenhouse gas emissions are responsible for changes in climate, and
- Depletion of the stratospheric ozone layer results in increased ultraviolet radiation, which causes skin cancer, immune health risks and damage to plant tissues.

9.3.3. Water resources and aquatic ecosystems

9.3.3.1. State of water availability

The state of water availability can be summarised as follows:

- Groundwater:
  - It has been reported that groundwater resources are currently considerable.
- Surface water:
  - The Crocodile West – Marico Water Management Area (WMA 3) borders on Botswana to the north-west, and includes two major river systems: the Crocodile and Groot Marico, which give rise to the Limpopo River at their confluence;
  - The water resources of the Crocodile West – Marico WMA support major economic activities of the WMA and a population of approximately five million people, with the largest proportionate contribution to the national economy, generating almost a third of the country's GDP;
  - The WMA is highly altered by catchment development, with economic activity dominated by urban areas and industrial complexes of northern Johannesburg, Midrand and Tshwane, and with platinum mining north-east of Rustenburg;
  - Extensive irrigation activities occur along the major rivers, with game and livestock farming occurring in other parts of the WMA;
  - The state of the water resources in the NW Province is characterized by an overall scarcity of water resources as many surface water systems are non-perennial;
  - The amount of available surface water decreases from east to west in the NW Province, with significantly higher flows in the east. The converse is true for the Crocodile West River that is growing on an annual basis due to the discharge of treated waste water from the Johannesburg Northern Sewage works, and
  - The quantity of the water in the NW Province is affected by the following:
    - Abstraction of groundwater from dolomitic compartments which has an effect on the quantity flowing from dolomitic eyes;
    - Construction of dams and reservoirs result in changes from the riverine to lacustrine systems, and
    - Inter-basin transfers of water from different catchments have major quantity ramifications for the rivers.
- Aquatic ecosystems:
  - The NW Province is part of the western plateau of the plateau wetland group which has the greatest concentration of pans in the country. These are mostly endorheic pans (i.e. closed wetlands with no outlet) which have an average size of 8 hectares (ha) (from a total of 636 pans located in the Western Plateau). Several of these pans in the NW Province are located on the watershed between the Vaal and the Limpopo river systems and on the Ghaap Plateau, and the remainder are located in the area drained by the Harts River system, and
  - There are approximately 40 major wetland areas within the NW Province (NWDACE, 2007). They comprise riverine wetlands, dolomitic eyes, palustrine wetlands and endorheic wetlands or pans of which Barbers Pan, a RAMSAR site, is the NW Province's largest.

9.3.3.2. State of demand for water

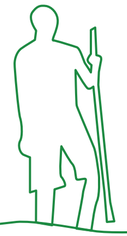
Demand for water can be divided into 2 categories:

- Water for basic human needs:
  - Rising population numbers and the increasing wealth and standards of living exert a burden on water resources. The tendency to migrate to urban areas has resulted in a gradual increase in the demand for water for the following:
    - Basic services;
    - Basic sanitation;
    - Access to free water, and
    - Services to institutions.
  - Challenges include:
    - Availability of infrastructure;
    - Inadequacy of the existing infrastructure to provide free basic water;
    - Limited capacity in some Water Service Areas;
    - Ineffective metering and billing systems, and
    - Indigent registration.
- Water for economic activities:
  - Mining (primary sector) requires high volumes of water for production and disposal of waste products. Mining at depths below dolomitic aquifers cannot be conducted safely;
  - Irrigation for agriculture (primary sector) is the single highest water consumer in the NW Province. Effective irrigation requires a constant supply of water and arable soil;
  - Irrigation of agricultural land over dolomitic areas where groundwater is extracted for irrigation. Water use for irrigation is unmanaged and as a result is often wasteful of the resource, and
  - Tourism (tertiary sector) requires reticulated water and sanitation services. It is a cause of pollution in dams due to recreational uses of water resources, however results in positive generation of revenue in the province.

9.3.3.3. State of water quality

The state of water quality in the province is summarised as follows:

- Groundwater:
  - The water quality was found to be reasonable in most parts of the NW Province with average major ion concentrations being within drinking water quality limits for more than 60% of the groundwater samples;
  - There were regions of high Total Dissolved Solids concentrations as a result of natural causes and human impacts;
  - Nitrates, from human activity and naturally occurring inorganic nitrate, exceeded DWAF Water Quality Guidelines;
  - The high fluoride concentrations in groundwater are limited to small areas underlain by fluoride-rich rocks and are associated with the Bushveld Complex, and



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- High sulphate concentrations are associated with acid mine drainage, some emanating from the dolomite springs were associated with the goldmines from the far West Rand.

- Surface water:

  - Rivers
    - All the secondary drainage areas had electrical conductivity averages below the target DWAF guideline, while the nitrates and nitrites (NO_3 and NO_2) exceeded the DWAF guideline in parts of the drainage area. The average fluoride levels and phosphate levels were below the DWAF guidelines, and
    - Faecal coliforms are not monitored at most of the rivers and the data available showed the sites exceeded the DWAF guideline; this could result in the risk of gastrointestinal illnesses.

  - Dams
    - The trend established in the dams' water quality data was that there was a slight increase in the variables between 2002 and the current data;
    - There was a decrease in total alkalinity of between five and 50 mg/l in the Vaalkop, Roodekopjes, Kosterrivier, Swartruggens and Rietspruit Dams, and
    - There is an indication of eutrophication in 8 out of the 15 dams for which Chl-a is measured.

9.3.3.4. Impacts on groundwater

Human activities impacting on the quantity and availability of groundwater include:

- An increase in stormwater runoff, which minimises seepage of water back into the groundwater, preventing recharge, usually as a result of rapid urbanisation;
- Abstraction from boreholes for drinking water and central pivots for irrigation of crops, and
- Dewatering of the dolomitic compartments for mining activities.

Human activities that directly impact on the water quality of the water resource include:

- Pollution from return flows and surface waters which infiltrate and percolate into the groundwater;
- Poor sanitation provision in rural areas and cemeteries results in seepage into the groundwater, and
- Long-term domestic consumption of groundwater with high nitrate concentration may pose serious health threats for babies and young children.

9.3.3.5. Impacts on surface water

Impacts on surface water have a knock-on effect on the habitat integrity and aquatic biodiversity. The enrichment of surface water and eutrophication (Chlorophyll-a of 200 µg/L) results in the formation of algal scums, proliferation of macropytes and the formation of incubation sites for potentially toxic algae, as observed on the surface of the shallow Bospoort Dam and Hartbeespoort Dam.

Photo: Lauret Muller

Photo: Lauret Muller

The total water reconciliation shows a negative balance (deficit) of water, which will have an impact on potential development (base and high scenario) for the year 2025 as reflected in the National Environment Outlook (2007). Currently the reserve for the Crocodile West – Marico Catchment is being determined and this will provide accurate values in terms of the water quantity in the catchment and subsequently the total surface water resources for the NW Province.
The potential water quantity impacts include:

- The construction of dams and reservoirs result in changes from the riverine to lacustrine systems, and
- Inter-basin transfers of water from different catchments have major quantity ramifications for the rivers.

9.3.3.6. Impacts of poor water quality

In summary, the following impacts of poor water quality have been identified:

- Nitrites caused by on-site sanitation, wastewater treatment facilities, the fertilizer industry and in agricultural practices have a negative impact on water quality and can result in eutrophication in water bodies, such as dams characterized by high algal blooms. This effect results in the scavenging of oxygen, depriving other life forms such as fish of oxygen, resulting in fish deaths. Thus, data obtained through regular monitoring should be interrogated and compared to the baseline prior to impact as well as against the DWAF guidelines for the specific water uses;
- Phosphates (PO_4^-) in water have a similar effect to nitrites causing algal blooms;
- Faecal coliforms occur as a result of the impact of poor sanitation and non-compliance of wastewater treatment facilities to DWAF guidelines for wastewater discharge. At high levels, faecal coliform counts can result in the outbreak of water-borne diseases such as cholera;
- Radionucleids from chemicals used in mining activities can have adverse health effects on humans and other water users;
- Electrical conductivity in water is an indication of high salts resulting from industrial and mining activities where effluent discharged does not meet DWAF standards;
- The presence of high levels of heavy metals in the water resources can result from mining and industrial activities where discharge standards are not met. The impacts of heavy metals also include bioaccumulation in fish and plants and transference through the food chain. Other heavy metals are considered carcinogens, and
- Other indicators of concern will be determined from the type of activities taking place in the study area (such as effects of chrome as a result of chrome mining).

Photo: Lauret Muller

9.3.3.7. Impact on aquatic ecosystems

The following impacts on aquatic ecosystems were identified:

- Mining:
  - Dumping of waste material into wetlands;
  - Compacting of wetland soils by heavy duty vehicles;
  - Diversion of water courses from natural flow patterns, and
  - Possible contamination of water courses through discharge of point source pollution;
- Agriculture:
  - Ploughing and planting in wetland areas;
  - Isolation of pans or depressions by ploughing around the pan, thus cutting off corridors for biotic movement, and
  - Overgrazing of grassland and wetland vegetation leading to gully erosion.
- Other:
  - Uncontrolled veld fires.

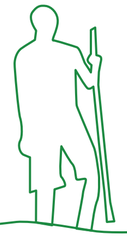
9.3.4. Biodiversity and ecosystem health

9.3.4.1. State

The status-quo of biodiversity and ecosystem health in the province is summarised below:

Photo: SA Tourism

- Sixty-one of a total of 435 vegetation types for South Africa have been recorded in the NW Province, 12 are found wholly or primarily (i.e. more than 75%) within the NW Province;
- 29.4% of the province is transformed, 21% of which is due to cultivation. Other activities that affect transformation are erosion features, landfills and feedlots, urbanisation, infrastructure development, sports fields and golf courses, and mining;
- Subsistence and commercial over-harvesting of indigenous plants are causing various species to become threatened with extinction locally and even nationally;
- There are 71 invasive plant species recorded in the NW Province. Of those, 30 are considered to be 'major invaders' that are well established and have already had a substantial impact on natural ecosystems. 41 are 'emerging invaders' that have attributes and habitat suitable to increase in range in the next few decades. It is anticipated that 20% of the NW Province has a high suitability for the invasion by alien plants. These areas are situated on the eastern to north-eastern portions of the province;
- Of the ecosystems in NW Province, 42% are threatened (that is, those classified as vulnerable, endangered, and critically endangered). These lie primarily within the central to eastern parts of the province. The area covered by these ecosystems includes 56% of the land area of the NW Province. Of these:
  - 8 terrestrial ecosystems (20%) are endangered, most of which are in the southern to south-eastern parts of the province affected by extensive cultivation, and
  - 9 terrestrial ecosystems (22%) are vulnerable, most of which are in the central to eastern parts of the province and affected by cultivation and degradation (Mucina, Rutherford and Powrie, 2005).
- The rivers of the Kalahari Basin drain to the north-west and westwards, constituting the main drainage from the western parts of NW Province. The rivers of this basin are classified as Least Threatened. The rivers within the remaining basins are classified as either Endangered or Critically Endangered;
- In accordance with the Threatened Species Programme of the South African National Biodiversity Institute (SANBI), it has been determined that there are eight plant taxa that are now threatened in the NW



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Province, of which two are Endangered, and six are Vulnerable according to the IUCN;

- Large mammals that are threatened in the province are currently only found in National Parks or other conservation areas, and it is neither practical nor beneficial to re-introduce them into unprotected natural areas. However, urgent conservation attention needs to be directed towards the threatened small mammals in the province;
- In the NW Province, there are many ridges and koppies that provide suitable habitat for the Southern African Python (classified as Vulnerable) which is declining due to hunting practices;
- The Giant Bullfrog, which occurs in parts of the NW Province is classified as Near Threatened and is declining due to habitat destruction;
- The large number of bird species in the NW Province that are either Near Threatened or Vulnerable is cause for concern due to the fact that this reflects degradation in the types of habitats that they require for breeding and foraging;
- Very little information exists on the status of butterflies in South Africa, and therefore NW Province. SANBI is currently overseeing the process of re-assessing the Lepidoptera of the entire country, so that the information can be used to determine how to ensure adequate conservation of threatened species, and
- The three fish species on the Red Data List are all endemic to parts of river systems that occur in the NW Province. The conservation status of these species reflects the poor condition of these rivers.

9.3.4.2. Impacts

Impaired ecosystem health can lead to reduced goods and services that they provide, resulting in costs to social and economic systems. Over-exploitation eventually leads to a loss of diversity and deterioration of ecosystem health, which can reduce services that ecosystems provide. The potential impacts of loss of biodiversity and compromised ecosystem function in the NW Province are likely to be:

- Extinction or economic extinction of useful species;
- Decreased carrying capacity for domestic livestock;
- Soil erosion;
- Loss in quantity and quality of water resources, and
- Ecosystem instability.

The potential outcomes within vulnerable rural communities are mainly poverty, famine, disease and threatened food security.

9.3.5. Human settlements and infrastructure

9.3.5.1. State

The attraction of employment opportunities and the social improvements created with the advance of the economic situation is a major pull factor to largely rural settlements of the NW Province. 61% of the province lives in rural areas and underdevelopment in such areas has led to increased incidents of migration and urbanisation around the larger economic centres within NW Province and Gauteng. An estimated net migration loss of 55,000 people was experienced between 2001 and 2006 which has contributed to the negative migration rate in the province. The greatest exchange of migration, both in and out of the Province, is with Gauteng.

Migration from the rural areas contributes to rapid urbanisation around the economic hubs of the province. Provision and access to secure tenure is proving to be one of the major challenges, and according to StatsSA (2007), the NW Province had the highest number of informal settlements than any other province in the country, as almost one quarter (23.8%) of the households are regarded to be informal. This is a testament to the large backlog of housing which still needs to be addressed.

Human settlements require a level of basic services to support their existence and determine their level of sustainability. The following trends are relevant to the provision of essential services and infrastructure in the NW Province:

- Household access to piped water improved from 86.6% in 2001 to 89.9% in 2007. The most significant growth in access to piped water was seen in the Bojanala Platinum and Ngaka Modiri Molema Districts;
- A large number of households (41.7%) still make use of a pit latrine which, although still high indicates an improvement to the 47.6% of households using pit latrines in 2001. The use of the bucket toilet system has improved from 5.1% in 2001 to 4.2% in 2007 while the amount of households with no toilet facilities decreased from 9.6% in 2001 to 5.8% in 2007;
- Over 80% of households use electricity for lighting purposes in the NW Province, while 65% use electricity for cooking and 59% use electricity for heating, and
- The percentage of households where refuse was removed by the local authority or a private company improved from 40.1% in 2001 to 54.8% in 2007. However, there was an increase in the percentage of households with no refuse disposal from 7.8% in 2001 to 8.1% in 2007, largely as a result of the growth in informal settlements.

9.3.5.2. Impacts

The impacts of human settlement on the environment are severe when combined with the impacts of poverty and the failure to provide for the population's basic needs. Human settlements generally will not react to environmental degradation when they are struggling to maintain their daily survival needs.

Human settlements, constantly in flux through the forces of migration and urbanisation, result in:

- Pressures placed on natural resources supporting urban settlements in terms of air, water and land use;
- Pollution of natural resources including air, water and soil;
- Concentrated waste outputs compromising the assimilative capacity of the environment, with implications to human health;
- Underdevelopment of rural areas;
- Lack of secure tenure and essential services in urban areas, and
- Pressure on authorities to respond to socio-economic pressures.

9.3.6. Natural and cultural heritage

The following key findings were made regarding natural and cultural heritage within the NW Province:

- The total size of formally protected areas, including national parks, provincial nature reserves, private nature reserves and protected environments, is 283,308 ha which amounts to approximately 2.4% of the province;
- The NW Province has 14 national parks and provincial reserves within its borders. The most well known are the Pilanesberg and Madikwe National Parks, which are administered by the NW Parks and Tourism Board;
- The province shares the Magaliesberg Protected Environment with Gauteng;
- There are 10 registered conservancies and several game farms or ranches in the province. A total area of about 1,171,332 ha of land is committed to game farming, and
- Three World Heritage Sites fall within the NW Province, including:

Photo: SA Tourism

  - The Taung Fossil Skull Site (completely);
  - The Vredefort Dome (partially); and
  - The Cradle of Humankind (partially).

An inventory of significant heritage sites has been included in the NW Environmental Management Series (Series 3), and is presented in Chapter 8 of the report.

In terms of the tourism sector, the following is relevant:

- SA Tourism's 2004 quarterly reports on foreign tourism to the NW Province show that 9.5% of all foreign arrivals to South Africa visited the NW Province, equivalent to 633,395 foreign visitors during 2004;
- NW captured 3% of the total bed-nights spent in South Africa (2 million bed-nights), where the most significant increase in bed-nights spent is from American visitors, and
- The most visited landmarks in the NW Province are Sun City / Lost City, Pilanesberg National Park and Madikwe Game Reserve, followed by flea / craft markets. Hartbeespoort Dam attracts a very small percentage of foreign visitors to the NW Province.

9.3.6.1. Impacts

Key issues identified which impact on valuable heritages

Photo: SA Tourism

Photo: Mary-Ann Palmer

resources within the NW Province includes:

- A lack of heritage knowledge and skills;
- The decay of environments around facilities, particularly in old towns and cities;
- The deterioration of existing facilities;
- Competition from other forms of entertainment;
- The neglect of heritage sites and buildings;
- Threats to the security of facilities, visitors and objects;
- A lack of sufficient comparative knowledge about places of heritage significance in areas that traditionally have not been covered through heritage surveys, including the western parts of the province, vacant land, open spaces around towns, informal settlements, old mining sites, farms, protected areas and old industrial sites, and
- A lack of single, GPS (Global Positioning System) -referenced and integrated register of places of heritage significance.

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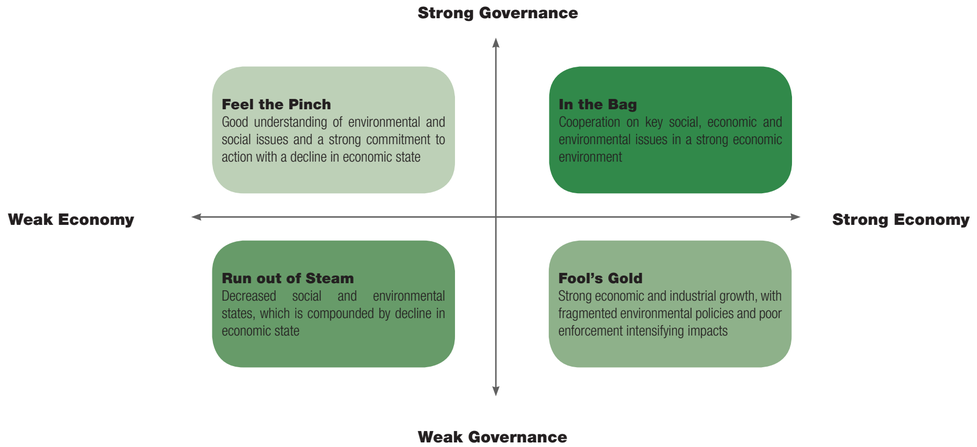

Figure 9-1: Four scenarios of the NW Province

The two overriding issues affecting heritage management in the province that emerge out of the key challenges are:

- Authorisations of development projects without the consideration of sites of heritage significance, and
- A lack of capacity and awareness with regard to heritage management.

9.4. Future scenarios for the North West Province

The compilation of an environment outlook for the NW Province is being undertaken utilising scenario planning. Scenario planning is a technique developed by Herman Kahn in the 1950's (Ratcliff, 2002).

The purpose of undertaking scenario planning in environmental reporting is to inform decision makers of possible alternative futures. These futures are presented to assist in making current decisions and actions towards the environment. Scenario building is therefore based around strategic thinking to inform strategic decision making (Ratcliff, 2002). Scenarios are not a prediction of the future but rather 'what if' stories that portray the future in a certain context.

The scenario planning for NW Province is founded on the current state of the environment trends that are detailed in Chapters 1 to 9 (and summarised in the previous section) of this report, and are based on the data that was available and on the opinion of professionals. The scenario timeframe was chosen to coincide with that of the South African Environment Outlook (DEAT, 2006), which is 2025.

The planning is based on the identification of the key drivers that affect environmental change, as agreed in a workshop with the Steering Committee Members, and later with stakeholders. To capture the main drivers that influence outcomes, 'Governance' and 'Economy' were selected as the axes for a two-by-two scenario matrix, as illustrated below in Figure 9-1. These two drivers were selected as they are opposing driving forces within the province.

Based on the above scenarios, the context for possible futures in the NW Province have been provided, thereby enabling anticipatory responses which inform the future development of plans, policies and programmes.

9.5. Four scenarios - four possible futures

The four scenarios represented in Figure 9-1 represent alternative futures based on the two opposing drivers of both economic development and governance.

9.5.1. Scenario 1: In the bag

This scenario describes the NW Province in a situation where the economy is prosperous and governance is comprehensive and effective.

- The NW Province GGP has grown steadily to the point where the province is in a position to provide all relevant built and social infrastructures. Diversification within the economy towards innovation and knowledge has meant that long term economic growth and development is firmly set for the province in the knowledge economy. New opportunities for the population, built upon the foundation of basic services, have helped to address high unemployment figures and consequently, poverty and the large wealth gap;
- The capacity and awareness across the various spheres of government has been developed to ensure sustainable development as a central theme. Previous impacts on the environment caused by various economic sectors and poor social conditions have been remediated. The government works as a collective group towards effective land use management, pollution control and resources management. The NW Province is heralded as a province which has utilised available resources in a responsible manner resulting in a favourable quality of life for the residents;
- The government and industry largely work in cooperation towards a sustainable future. As far as possible, government operates in a manner that enhances the economy within, while businesses appreciate their social responsibilities and manage the triple bottom line. Business and government are involved in long-term programmes for the social upliftment of the poor and disadvantaged. Strong leadership is taken and a collective responsibility for major social issues such as the increased number of AIDS orphans;
- A sense of excitement and passion for the NW Province prevails. Natural and cultural history are protected and celebrated as the roots of the success of the province. This has been facilitated through sound environmental management. Initiative is applied, in partnership between business and government, providing leadership in environmental management. As a result, a local awareness and initiatives to safeguard the natural environment are undertaken by many citizens;
- The relics of poor land management and pollution have been removed. The technology applied in addressing these solutions is exported, stimulating the economy and promoting further research and development into fields such as biomimicry and cleaner development, and
- Eighty percent of the goals of the PGDS have been met through the implementation of programmes which took socio-economic objectives into account: thus, the poverty gap is significantly reduced. Human vulnerability declines and civil society is increasingly more aware of the environmental impact and consequences of their actions. All these developments create a situation where there is greater capacity to improve environmental governance systems. In particular, policies addressing energy use and alternative/renewable energy are effectively implemented.

9.5.2. Scenario 2: Fool's gold

This scenario describes the NW Province in a situation where the economy is prosperous however governance is weak and ineffective.

- The economy strengthens with a higher GGP for the province. There are gains within employment, however unemployment remains worryingly high. Confidence in the sustainability of the economy is uncertain due to the imbalance between economic growth and employment;
- Government has a large workforce funded by the high tax base. Departments are however notoriously unreliable and ineffective. No accountability is provided by government, who are accountable to themselves. Government attempts to use business and industry to fulfil and complete their mandate and fail to fulfil the promises they make to their constituents. Corruption ensues in government, as there is little regulation, enforcement or compliance. Officials make use of their power in government to run their private businesses, profiting from the economy;
- The poor are unable to break out of the poverty gap because they are unable to develop skills due to government's failure to provide the necessary platforms. Policies by government to address these issues are too little, too late and ineffective due to an apathetic workforce. As a result, the poor remain largely reliant on the environment for their livelihoods, however they are able to create some type of income in the informal sector. Crime levels are relatively high due to poverty and a general disillusionment with government;
- The environment undergoes degradation due to a high incidence of pollution. The government fails to control pollution adequately and only addresses issues of high priority which cannot go unnoticed and unaddressed. The poor remain vulnerable and reliant on the environment for their livelihoods. Job seekers migrate to areas such as cities and mines to seek employment. Large informal settlements are established around these areas. Basic services are however slow or non-existent due to poor service delivery, and
- Regulation and compliance is inconsistent and weakly carried out. Little follow-up is made on findings of studies and reports. Environmental management is stated as an insignificant issue relative to other more "pressing" issues that government must attend to.

Over the long term, the lack of governance results in unsustainable development and the degradation of the environmental resources.

9.5.3. Scenario 3: Feel the pinch

This scenario describes the NW Province in a situation where the economy is weak, however governance is strong and effective.

- The economy of the NW Province has experienced a decline in total GGP. Businesses and industry are struggling to function under tight margins which threaten the livelihoods of the residents. The depressed economy has resulted in high unemployment rates and vulnerable communities;
- With a weak economy, the government has stepped up efforts to address access to basic services and resources providing for the fundamental needs of the people. Even though the economy is depressed, the higher levels of education means that the population is more empowered to address this. Poverty however forces people to migrate to other economic centres to generate an income, resulting in a 'brain drain';
- The tax base has decreased due to the depressed economy. The government therefore has limited resources to enforce regulation and compliance. They are continually under pressure to generate an environment which will attract new business, even at the expense of sustainable development, in an attempt to kick-start the economy. While the government is aware of the pollution, changes in land use and excessive use of resources, there is little that can be done.

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Business and industry often lack the capital for better environmental practice and people are reliant on the natural environment for their basic necessities. They are unable to afford the services which have been installed for them;

- The long term sustainability of the province is threatened by the lack of income in the province. The support provided by the government however ensures that a an acceptable level of environmental management is practiced, as far as possible, within the limitations of the budgetary constraints, and
- Over the long term, the weak economy results in unsustainable development and the degradation of environmental resources.

9.5.4. Scenario 4: Run out of steam

This scenario describes the NW Province in a situation where the economy declines and governance becomes largely ineffective.

- The economy of the NW Province slowly declines resulting in lower GGP and GDP per capita. Business and industry close down due to poor performance, leaving relics of a once promising economy. Unemployment increases, with a larger number of people living below the poverty line. The wealth gap increases, with a small pocket of people controlling resources;
- Government is unable to fulfil its basic functions. Regulation and compliance are meaningless and merely bureaucratic red tape. The widespread pillaging of resources begins with a select few benefiting. Resources are exported in raw form from the province, with little to no economic benefit to the people. The economy of the province shrinks considerably and is controlled by a small select few;
- Pollution becomes widespread and harmful to both the environment and people as a result of a lack of funding for environmental remediation and pollution control. No responsibility is taken by government and widespread corruption is practiced in an attempt to keep issues quiet. Rumours of intimidation by industry and government of isolated rural communities are persistent. A game of 'finger pointing' persists between different responsible parties, resulting in a discontent population. The poor are reliant on the surrounding environment for their survival and are therefore highly vulnerable. The environment has degraded and continues to do so due to the reliance of a large portion of the population on the land and continual pollution. Important natural habitats and ecosystems are lost to agriculture and pollution, and
- Reports are persistently spread through the press of the suffering of the poor and mismanagement of their resources. Aid organisations are constantly involved in the province attempting to address malnutrition and disease, particularly of the high proportion of the population with HIV and AIDS. Mortality is high and the value people place on life falls due to their own poor quality of life. Social injustice within the province culminates in civil unrest, with demonstrations by communities and a high incidence of organised crime and militia who threaten business and local populations. The police force is under-resourced and insufficiently trained to address crime within the province, resulting in widespread anarchy. Educated and skilled labour emigrates from the province to safer environments.

9.6. Conclusion

The NW Province is currently in a scenario of favourable economic growth, with an increase in the Provincial GDP between 1995 and 2006. The growth has been driven by the mining sector, which has increased its dominance of the provincial economy. The second largest sector of community and government services is mostly funded by the allocation of government funds.

Government has taken positive steps towards increasing capacity and governance. A variety of initiatives have been undertaken since the 2002 State of the Environment Report (SoER) and more data is available on the current SoE than during the compilation of the 2002 SoER. On the whole, infrastructure in the province has improved, however the NW Province has the largest number of informal households of all the provinces in South Africa.

While economic growth has taken place, it has been disproportionate, with the number of people living below the poverty line increasing from 44% in 1996 to 53% in 2006. The province has made grants available to the poor, with over one million beneficiaries being allocated a grant. The extent and increase in poverty, and level of informal settlements means that the pressure placed on the environment by the demography and human-well-being driver has increased over the past decade.

The current pressure of economic development and governance on the water resources cannot confidently be determined due to limited data on the state and trends of water quality and availability as well as aquatic ecosystems. While there is an indication that air emissions from industrial and mining polluters have reduced, the air quality still remains poor.

With an economy so heavily reliant on mining, the NW Province could be prone to the "resource curse" (Sachs & Warner, 1995). The curse refers to mineral wealthy developing countries that are unable to translate their mineral wealth into economic performance. This is primarily due to the pressure on these governments to spend mineral revenues on current consumption needs rather than to reinvest revenues. The path to sustainability requires a rule to ensure that revenues from mineral wealth are reinvested to sustain economic development in the future. This concept is known as Hartwick's rule (Lange and Wright, 2002). Similar examples of following this rule are:

- Dubai who is spending revenue generated from its oil reserves on building a tourism hotspot;
- Saudi Arabia who has spent revenue generated from its oil reserves on equity purchases;
- Botswana who has a sustainability budget index (SBI) to ensure that non-investment spending does not exceed the revenue generated from minerals, and
- Royal Bafokeng Nation who has established Royal Bafokeng Holdings to invest the profits from mines on their property into other investment portfolios.

Of the four given scenarios, only scenario 1, 'In the bag', tells a story of longer-term sustainability. Based on current trends, the fool's gold scenario is being played out in the province. In order to achieve sustainability, a robust economy, progressive and practical environmental policies and laws, social equity and innovation, and good governance are required. This seems like a tall order, but is achievable if all the relevant parties work together towards securing our future.

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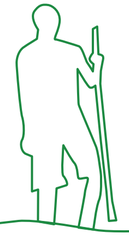

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Photo: Gill Ledger

CHAPTER 10

Taking Action

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Photo: Mary-Ann Palmer

Photo: Lizelle Prosch

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Acronyms and abbreviations

CASP	Comprehensive Agricultural Support Programme
DME	Department of Minerals and Energy
DDLGH	Department of Developmental Local Government and Housing
DE	Department of Education
DH	Department of Health
DPW	Department of Public Works
DSD	Department of Social Development
DWAF	Department of Water Affairs and Forestry
EIA	Environmental Impact Assessment
IEM	Integrated Environmental Management
GDP	Gross Domestic Product
LCP	Land Care Programme
NHRA	National Heritage Resources Act 25 of 1999
NW	North West
NWDACE	North West Department Agriculture, Conservation and Environment
NWDSD	North West Department of Social Development
NWDSAC	North West Department of Sport, Arts and Culture
NWPG	North West Provincial Government
NWPHRA	North West Provincial Heritage Resources Agency
NWP&TB	North West Parks and Tourism Board
RoD	Record of Decision
SAAQIS	South African Air Quality Information System Project
SAHRA	South African Heritage Resources Agency
SANAS	South African National Accreditation System
SANBI	South African National Biodiversity Institute
SMME	Small, Micro and Medium Enterprises
ToPS	Threatened or Protected Species
WfWP	Working for Water Programme

Chemical abbreviations

CO	Carbon monoxide
NO	Nitrous oxide
NO_2	Nitrous Dioxide
O_3	Ozone
PM10	Particulate Matter with a diameter of less than 10 nano meters
SO_2	Sulphur dioxide

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10.1. Introduction

The "Best Case – In the Bag" Scenario represents sustainability within the North West (NW) Province. To achieve sustainability, a strong economy, progressive and practical environmental policies and laws, social equity and innovation are required.

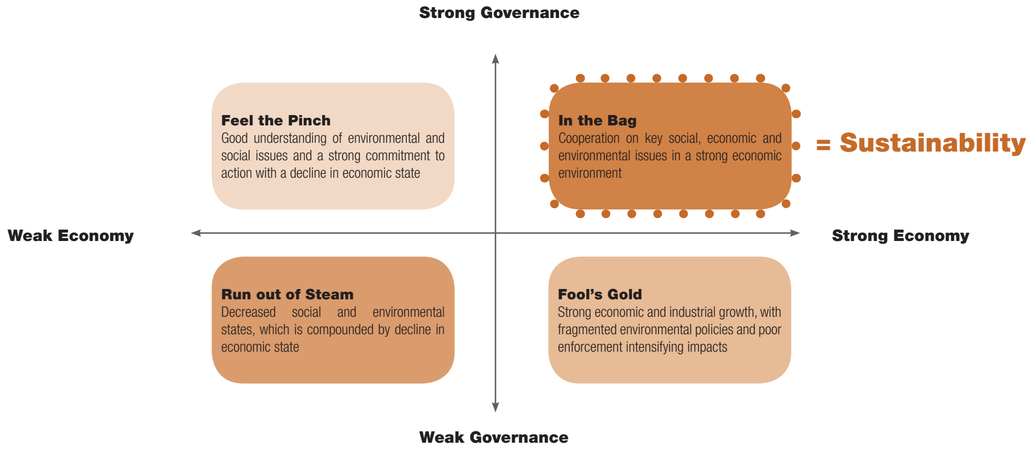

Figure 10-1: "Best Case – In the Bag" Scenario represents Sustainability

Based on an analysis of the current state of the environment within the province, and through an understanding of the drivers and the resultant pressures, environmental issues that need to be addressed in order to progress towards a sustainable future have been identified. Currently, the increasing population numbers and the high growth in the mining and agricultural sectors have led to a rapid increase in demand for natural resources, thus increasing the pressures exerted on the receiving environment.

Effective environmental governance within the province will facilitate the identification of issues, the development of suitable responses, the enforcement of legislation and the monitoring of compliance. This will enable the NW province to align itself with the uniform national norms and standards necessary to uphold the environmental agenda. Though various provincial initiatives have been embarked on to ensure effective environmental governance, the specific responses detailed in this chapter have been developed based on the findings of this report, to facilitate and inform current and future plans, programmes and policies.

The proposed responses outlined are prioritised and the provincial departments that will be responsible for the initiatives are indicated.

The prioritisation is indicated as follows:

High:	Urgent action is required; initiation within 12 months; implementation within 24 months.
Medium:	Initiation within 24 months; implementation within 48 months.
Low:	Initiation within 48 months; implementation within 60 months.

The proposed responses have not been developed to replace current provincial initiates but rather to supplement and compliment current plans, programmes and policies and the continued implementation and management of these current initiatives is regarded as a significant contributor to the objective of achieving sustainability.

The development of responses also recognises the environmental management actions and activities as identified in terms of the second edition of the NW Province Environmental Implementation Plan (EIP 2nd Edition). This plan was prepared by the province in compliance with Chapter 3 of the National Environmental Management Act 107 of 1998 (NEMA) as statutory instrument to coordinate environmental policies, plans, programmes and decisions of local government and various provincial departments that exercise functions that may affect the environment or are entrusted with powers and duties aimed at the achievement, promotion and protection of a sustainable environment. It also gives effects to the principle of co-operative governance in terms of Chapter 3 of the Constitution. The identified environmental management actions and activities are included as current initiatives identified for implementation.

10.2. Land use and transformation

Agricultural and mining activities are the major contributors to land transformation within the NW Province. Agriculture amounts to approximately 20% of land use within the province, and accordingly the focus of responses to this sector is on plans and policies promoting sustainable agricultural resources management.

Mining is the largest economic contributor to the Gross Domestic Product (GDP) of the NW Province; however, it has the smallest footprint of each of the identified land uses, totalling only 0.4%. Responses focus on remediation of current impacts and mitigation of future impacts that may arise as a result of mining activities.

1.2.1.1. Current initiatives

The Department of Developmental Local Government and Housing (DDLGH), with the support of the SESDNW project, is currently in the process of developing a provincial Land Use Management Bill. The final document has been completed and will be submitted to provincial legislature for gazetting after which public review of the said document will commence. The objective of the Bill is to promote the use of land that are socially and economically beneficial, ecologically sustainable and which assists in the conservation of the environment and cultural heritage of the North West Province by:

- Establishing integrated and efficient planning and decision-making systems for land use management based on co-operative government principles;
- Establishing mechanisms for provincial support to, and monitoring and oversight of, municipalities in respect of planning and managing the use of land, and
- Facilitating the integration of environmental and heritage impact assessment processes with land use planning processes and other decision-making processes affecting the use of land.

The following actions and initiatives have been identified in the second edition of the provincial EIP.

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Proposed plans for implementation	Responsibility	Timeframe
Land Use Management		
Alignment of strategic and municipal plans to the PGDS and PSDF.	☐ Office of the Premier ☐ DDLGH ☐ Municipalities ☐ NWDACE ☐ DWAF	June 2009
DACE must participate in the DWAF process to develop Resource Management Plans for dams	☐ NWDACE ☐ DWAF	On going
DACE and municipalities must develop and implement Environmental Management Frameworks (EMFs) together with the SDFs to ensure environmental issues are addressed in spatial planning.	☐ DDLGH ☐ Municipalities ☐ NWDACE	At least four EMFs for the period 2008 – 2012
Development of a provincial Land Use Management Bill to ensure sustainable development and the consideration of environmental issues in land use management	☐ Office of the Premier ☐ NWDACE ☐ DDLGH	June 2009
Ensure that SDFs consider areas of critical biodiversity and sensitive environments.	☐ NWDACE ☐ Municipalities ☐ DDLGH	March 2009
Compliance with EIA Regulations and Biodiversity Management Act	☐ All relevant department and municipalities	Ongoing
DACE and municipalities must implement the NW Environmental Toolkit that was developed to support the IDP process	☐ NWDACE ☐ Municipalities	Workshops on the Environmental Toolkit to be conducted December 2008 and implementation ongoing
Participation of sector departments and municipalities in the NW Provincial Development Planning Forum to align and coordinate actions related to land use management.	☐ All relevant sector Departments ☐ Municipalities	Quarterly
Public Property Development		
Ensure compliance to EIA Regulations by all relevant departments.	☐ NWDACE ☐ DPW ☐ DH ☐ DE ☐ DSD	Ongoing
Development of guidelines for the integration of environmental issues (e.g. energy and water efficiency, waste and recycling) into property development, management and maintenance.	☐ NWDACE ☐ DPW ☐ Municipalities	March 2009
Participation of relevant departments in the Provincial Environmental Forum where environmental issues are being discussed	☐ NWDACE ☐ DPW ☐ DH ☐ DE ☐ DSD	Ongoing
Housing Development		
Integrated planning for housing and township development must be incorporated into IDPs through the SDF's.	☐ Municipalities ☐ DDLGH	March 2009
Enforce compliance to EIA regulations and NEMA principles.	☐ NWDACE	Ongoing
Land Reform		
Environmental opportunities and limitations must be considered before people are being relocated to land in order to determine possibility of sustainable livelihood for communities to be resettled	☐ NWDACE ☐ DLA ☐ Municipalities	Ongoing
Environmental Services of DACE should be represented on the Provincial State Land Disposal Committee and on the Provincial Project Approval Committee	☐ NWDACE	Ongoing

Table 10-1: Land use management actions proposed in the EIP (2nd Edition)

10.2.2. Agriculture

10.2.2.1. Current initiatives

There are currently three major agriculturally-related project-based interventions utilised by government to promote poverty eradication through sustainable development, including:

- The Working for Water Programme (WfWP) initiated by the Department of Water Affairs and Forestry (DWAF) which aims to eradicate alien plant species that deplete available surface and ground water, impair biodiversity, and contribute to the danger of runaway fires;
- The LandCare Programme (LCP) initiated by the National Department of Agriculture – which aims to mobilise the general public to take up their responsibility of a "duty of care", and
- The Comprehensive Agricultural Support Programme (CASP) initiated by the National Department of Agriculture. The aim of this programme is to provide support to the targeted beneficiaries of land reform as well as producers who have acquired land through private means and are, for example, engaged in value-adding enterprises.

The Land Reform Programme has also need initiated which provides an innovative framework for delivery and collaboration on land reform and agricultural support to accelerate the rate and sustainability of transformation through aligned and joint action between stakeholders.

Other programmes includes:

- The Anti Stock Theft Programme was conceptualized after rising levels of livestock theft were recorded in the province. Since its inception, stock theft levels have decreased to very low levels per annum, compared to 4% in 2003 (Polity.org.za, 2008).
- Poverty relief programmes at Modimong and Modimola initiated by North West Provincial Government (NWPG) focuses on poverty alleviation through food security, skills development or transfer and food production.

The NWDACE Agricultural Extension Services Division provides professional agricultural support to farmers in the province to ensure sustainable management of agricultural resources and development, as well as ensuring the meaningful contribution to the economy of the province. The department is also responsible for implementing the above programmes and have made significant progress towards the goals and objectives as set out above.

The following actions and initiatives have been identified in the second edition of the provincial EIP.

Proposed plans for implementation	Responsibility	Timeframe
Agricultural Development		
Implementation of sustainable farming practices	☐ NWDACE	Ongoing
Agricultural sector must involve Environmental Services of DACE in development of Agricultural Master Plan	☐ NWDACE	Ongoing
Environmental Services of DACE and municipalities to be involve in planning agricultural projects (community and strategic level)	☐ DACE ☐ Municipalities	Ongoing
Compliance wit EIA Regulations	☐ NWDACE	Ongoing
DACE to participate in the Agricultural PGDS Working Group	☐ NWDACE	Ongoing
Implementation of national guidelines and standards on Aquaculture	☐ NWDACE ☐ Municipalities ☐ DWAF	Ongoing

Table 10-2: Agricultural management actions proposed in the EIP (2nd Edition)

10.2.2.2. Proposed responses

A Provincial Land Degradation Monitoring Programme must be developed, and must include the establishment of monitoring committees at a district level. This will facilitate the ongoing monitoring of soil and veld degradation in order to ensure that short term remedial measures can be identified and implemented.

A State Grant Initiative must be developed in order to facilitate agri-business development in the province. The purpose of this initiative is to ensure the beneficiation of small and medium scale communal farmers and to optimise, through stimulating economic growth, the contribution of the agricultural sector to the Provincial GDP. As part of this process, a project must be initiated for the implementation of an Agricultural Resources Management Training programme, intended specifically for subsistence farmers in both the communal and commercial farming sectors of the Province, in order to ensure the application of sustainable agricultural land use practices.

The following actions and initiatives have been identified in the second edition of the provincial EIP.

Initiative 1:	Provincial Land Degradation Monitoring Programme
Priority:	High
Responsibility:	Department Agriculture, Conservation & Environment

Initiative 2:	State Grant and Training Initiative
Priority:	Medium
Responsibility:	Department Agriculture, Conservation & Environment

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Proposed plans for implementation	Responsibility	Timeframe
Mining and Industrial Development		
DACE, DME, DWAF & Municipalities to participate in Regional Mineral Development and Environmental Committee meetings	☐ DME ☐ Municipalities ☐ NWDACE ☐ DWAF	Ongoing
Small-scale mining operators must be monitored regularly to check compliance to licenses and environmental management issues	☐ DME ☐ Municipalities ☐ NWDACE ☐ DWAF	Ongoing
DME must be represented on provincial forums where environmental issues are being discussed	☐ DME	Ongoing
DME together with DACE and municipalities, must participate in the NW Air Quality Management Forum	☐ DME ☐ Municipalities ☐ NWDACE	Ongoing
DACE must implement provincial ambient monitoring programmes to monitor the impact of mines and industry on natural resources	☐ NWDACE	March 2010 and Ongoing
Municipal and provincial Air Quality management Plans must be developed and implemented as per national guidelines	☐ NWDACE ☐ Municipalities	March 2009
Compliance with EIA Regulations and Biodiversity Management Act	☐ All relevant departments and municipalities	Ongoing

Table 10-3: Mining management actions proposed in the EIP (2nd Edition)

10.2.3. Mining

10.2.3.1. Current initiatives

The following programmes have already been identified and initiated at the provincial level to contribute to the growth in the mining sectors:

- ☐ Mining Supplier Park – an initiative coordinated by Invest North West to establish an agreement between active mining houses in the province to manage and support Small, Micro and Medium Enterprises (SMME) suppliers to the mining industry.
- ☐ Platinum beneficiation projects are currently being implemented through the establishment of a trust and a company registered to beneficiate platinum into jewellery products. A business park where offices and jewellery centres will be built and further agreements between the province and Canada will also be finalized to complete a Platinum Theme Park. The Business Incubation Centre, which is located at Orbit College near Rustenburg, is already operational.
- ☐ Granite Beneficiation Project - South Africa has vast amounts of waste granite material that could be used in small scale beneficiation, and further beneficiation of raw blocks could be carried out by means of cobbling, production of colour reconstituted products and through secondary and tertiary cutting of raw blocks. An operational granite beneficiation project is located in Bethanie, approximately 13 km south of Brits.

10.2.3.2. Proposed responses

The extent of current soil degradation caused by mining activities must be determined and areas requiring remediation must be identified and prioritised. This initiative must be a collaborate effort between the Department of Minerals and Energy (DME), NW Department of Agriculture Conservation and Environment (NWDACE) and the mining houses operational within the province.

10.3. Biodiversity

Habitat destruction may occur either directly, when land transformation takes place for human needs such as agriculture and urbanisation, or indirectly, for example by pollution, alien infestation (including introduced pathogens) or a change in a critical component of the ecosystem.

Plants and animal species are negatively impacted on and lost mainly through:

- ☐ Exploitation for use such as food or timber, and
- ☐ The extermination of perceived problem species.

Laws pertaining to the conservation of biodiversity can be grouped as follows:

- ☐ Protecting species from exploitation;
- ☐ Safeguarding habitats that are threatened by destruction, and
- ☐ Controlling processes that harm or destroy ecosystems or habitats (such as pollution).

Photo: Anuschka Barac

Initiative 3:	Remediation of closed mines
Priority:	Medium
Responsibility:	Provincial Department Agriculture, Conservation & Environment & National Department of Minerals and Energy and relevant mining houses

10.3.1.1. Current initiatives

The following provincial initiatives have been embarked upon in order to address the identified issues:

- ☐ A collaborative effort between the NWDACE and the South African National Biodiversity Institute (SANBI) to develop a biodiversity conservation strategy and action plan for the province, of which the provincial Biodiversity Assessment has already been completed. This assessment produced a map of Critical Biodiversity Areas in the province and has been incorporated in the compilation of the second Provincial Spatial Development Framework (PSDF) to be published by the end of 2008. This initiative is a first step to ensure that development will be guided so as not to destroy the biodiversity and sensitive habitats in the province;

Initiative 4:	North West Protected Areas Expansion Strategy
Priority:	High
Responsibility:	North West Parks & Tourism Board, Provincial Department Agriculture, Conservation & Environment & South African National Biodiversity Institute

- ☐ Through the support of the SESDNW project, a Biodiversity Information Management System (BIMS) was developed for the province;
- ☐ The National Grasslands Biodiversity Programme,developed and managed by SANBI, is a programme developed to conserve biodiversity within the grasslands biome;
- ☐ The consolidation of the pre-1994 provincial nature conservation legislation into a single North West Biodiversity Conservation Act and Regulations (still to be promulgated), in the context of co-operative governance and in order to avoid duplication with existing national legislation;
- ☐ The province has participated in the development of the National Protected Areas Expansion Strategy and will now develop a provincial one based on the Critical Biodiversity Areas to ensure protection of threatened species and habitats.

The following actions and initiatives have been identified in the second edition of the provincial EIP.

Proposed plans for implementation	Responsibility	Timeframe
Biodiversity		
Ensure that critical biodiversity areas, threatened ecosystems, ecological corridors and other features such as wetlands and ridges are incorporated in provincial and municipal SDFs	☐ DWAF ☐ Municipalities ☐ NWDACE ☐ NWP&TB	March 2009 and Ongoing
Development and implementation of provincial biodiversity conservation plan	☐ NWDACE	March 2009
NWP&TB must submit Park management plans to DACE for inputs and approval, as required in terms of the Protected Areas Act.	☐ NWP&TB ☐ NWDACE	Ongoing
NWP&TB and DACE must establish a Management forum to discuss and agree on issues of common interest.	☐ NWDACE ☐ NWP&TB	March 2009
NWP&TB and DACE must establish Provincial wild life forum		
Biomonitoring programmes must be implemented by DACE to determine quotas for resource use	☐ NWDACE	Ongoing
Implementation of scientifically established quotas for resources use.	☐ NWDACE ☐ Municipalities ☐ NWP&TB	Ongoing
Compliance with EIA Regulations and Biodiversity Management Act	☐ NWDACE ☐ Municipalities ☐ NWP&TB ☐ DWAF	Ongoing
☐ Participation in Pilanesberg, Madikwe Heritage park steering committee. ☐ Participation in Provincial Wild Life forum ☐ Participation in People and Parks Forum ☐ Participation in Protected Areas Expansion programme ☐ Participation in SAWHCC: South African World Heritage Convention Committee. ☐ Provincial weed invader plant forum	☐ DWAF ☐ Municipalities ☐ NWDACE ☐ NWP&TB	Ongoing
Establishment of nurseries (Medicinal plants) and protection of indigenous trees as declared by the Filed and Forest Act	☐ DWAF	Ongoing
Tourism		
Management of tourism activities must be addressed in the Park Management Plans	☐ NWDACE ☐ NWP&TB	March 2009
NWP&TB and DACE must establish a Management forum to discuss and agree on issues of common interest.	☐ NWDACE ☐ NWP&TB	March 2009
Bio-monitoring programmes must be implemented to inform quotas for resource use	☐ NWDACE ☐ NWP&TB	March 2009

Table 10-4: Biodiversity and tourism actions proposed in the EIP (2nd Edition)

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10.3.1.2. Proposed responses

Impacts relating to the loss and destruction of biodiversity due to the extensive harvesting of woody vegetation for fuel, as well as hunting of fauna and medicinal plants for traditional use and food, have not been addressed in the Province. Unrestricted land clearing activities, related to informal settlements and subsistence farming, are causing the destruction and fragmentation of habitats. The following initiatives should therefore be undertaken to facilitate the management of these identified issues:

- A Conservation and Sustainable Use of Medicinal Plants Project with the objective to:
  - Determine the extent and purpose of harvesting and trade of medicinal plants within the Province;
  - Agree, with Traditional Healers, on sustainable harvesting and trading practices, and
  - Train communities to engender an understanding of the value of conservation and sustainable harvesting.
- Agreements must be reached with other relevant provincial departments to monitor and report on land clearing caused by informal settlement and subsistence farming activities.
- Ensure implementation of Biodiversity Monitoring Programmes to populate the provincial BIMS that will support decision-making and reporting by authorities.

Based on the outcomes of the biodiversity database and the development of a provincial conservation plan, areas suitable for protection and inclusion in existing park and reserves must be identified. The project must be extended to the prioritisation of protection of such sites based on sensitivity and whether the site can be regarded as irreplaceable.

10.4. Water resources and aquatic ecosystems

Development and expansion of industry and mining within the NW Province, as well as the growth of communities in both urban and informal settlements, place a demand on the available water supply. These have impacts on water availability and water quality, which in turn have an impact on water users, both human and ecological. As impacts on the water resource and the water user are interrelated, responses are focused on the sustainable supply of suitable quality water for communities, industry and natural ecosystems, as well as on the quality of such resources.

Water quality monitoring provides an understanding of the patterns and trends in the condition of water resources as a result of natural change or anthropogenic impacts, as well as a tool to evaluate the effectiveness of management practices. Figure 10-2 below illustrates the generic water quality monitoring process.

Initiative 5:	Conservation and Sustainable Use of Medicinal Plants Project
Priority:	Low
Responsibility:	Provincial Department Agriculture, Conservation & Environment & South African National Biodiversity Institute

Initiative 6:	Implementation of Biodiversity Monitoring Programmes
Priority:	High
Responsibility:	North West Parks & Tourism Board, Provincial Department Agriculture, Conservation & Environment & South African National Biodiversity Institute

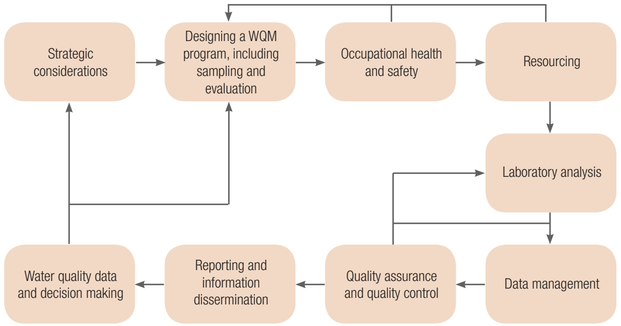

Figure 10-2: Water Quality Monitoring Process (Water Quality Monitoring Toolkit)

10.4.1.1. Current initiatives

The NW Province is currently implementing the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP) through the initiation of the River Health Programme. Another current initiative is the implementation of the "Harties metsi a me" programme to remediate the excessive algal blooms and subsequent eutrophication at Hartebeespoort Dam. The programme was initiated by DWAF and includes a number of activities to improve the water conditions in and around the dam (DWAF, 2008):

- Development of a Resource Management Plan to ensure sustainable management of the dam;
- Investigation of the recreational use of the dam and management of such activities;
- Removal of the algal bloom and disposal of removed matter;
- Removal of the sediment and investigation of the uses of the removed material;
- Re-establishment of the fish population and investigation of the potential for job creation;
- Restoration of riparian vegetation for the purpose of establishing habitat for aquatic species;
- Consideration of alternative, sustainable methods for water treatment;
- Rehabilitation of wetlands as well as establishment of artificial wetlands upstream of the dam basin created to assist with water cleansing, and
- Continual monitoring of water quality in the dam to ensure that the rehabilitation programme is effective.

The programme is currently being implemented by Rand Water.

10.4.1.2. Proposed responses

Gaps in current water monitoring practises have been identified and as a result, it is proposed that a provincial water monitoring programme be initiated. The minimum monitoring requirements for each water resource are provided to ensure that monitoring programmes are sufficient to provide information on the state of water availability, supply and quality within the province, as well as to determine changes in water resources due to natural causes or anthropogenic impacts. The monitoring programme must include the following:

- Dams: Regular monitoring of Chl-a to determine the dam's fitness for use (non-contact recreational use).
- Rivers: Regular monitoring and recording of nitrites, phosphate, conductivity, faecal coliforms, fluoride, toxicity and radionucleids.
- Groundwater: Frequent (i.e. twice per annum) monitoring of nitrites, phosphate, conductivity, faecal coliforms, fluoride, toxicity and radionucleids. There is a need to reconcile future supply and demand imbalances with regard to groundwater and surface water resources.
- Wetlands: Use of a standardised protocol for wetland determination and delineation. The DWAF Water Quality Guidelines set out specific indicators. If these are monitored on a regular basis and data is recorded, trends can be formulated and the state and Outlook of wetlands can be determined.
- Demand management: There is a need to invest in improving practices, technology, and capacity in water demand management.
- Water re-use: Opportunities available for the re-use of wastewater need to be explored by application of appropriate treatment technology and quality control. Further inter-basin transfer potential needs to be explored.
- Invasive alien vegetation: The working for water programmes need to be enhanced in order to address the control of alien vegetation, particularly in the NW Province where groundwater resource availability is at risk.
- Surface water resource development: There is a need for surface water resource development. However, this requires intensive capital investment.
- Economic and population growth: The increased mining activities and population growth should be monitored and managed in order to minimize the potential for water resource variables and indicator compounds to reach unacceptable concentrations.

Limitations of a province-wide water quality monitoring programme include spatial coverage, technical skills required for maintenance and calibration as well as the financial implications. Municipalities should thus consider obtaining monitoring equipment, data collection, analysis and reporting, as well as take into consideration human resource requirements.

Initiative 7:	Provincial Water Monitoring Programme
Priority:	High
Responsibility:	Provincial Department Agriculture, Conservation & Environment & Department of Water Affairs and Forestry

10.5. Air Quality

The major limitation characterising air quality within the province is the limited availability of high quality, long duration air pollution monitoring data. It is thus necessary that the status of the ambient air quality is determined in order to evaluate the significance of the impacts on human health and the environment. As a result, these responses are focused on ambient air quality monitoring, and proposes an expansion of the current monitoring network and a tiered approach to start monitoring particulate matter (PM10) and sulphur dioxide (SO_2) first, and thereafter expand the network to cater for the remainder of the criteria pollutants.

10.5.1. Current initiatives

The following current programmes have been initiated:

- NWDACE, through the support of the SESDNW project and in cooperation with the local municipalities, has established 7 ambient air quality monitoring stations in the province. The stations were commissioned and operational at the end October 2008.
- A Provincial Air Quality Management Plan is also currently being developed and will be completed by the end of 2008.
- A Municipal Air Quality Officer's Forum was established and meets quarterly. The purpose of this forum is to share experience and to build capacity for technical expertise.
- Capacity building within and training of municipalities in terms of the Air Quality Information System is an ongoing initiative.

Box 10-1: South African Air Quality Information System Project

SAAQIS is being developed under the auspices of a task team comprising members from the Department of Environmental Affairs and Tourism (DEAT) and the South African Weather Service. The broad purpose of SAAQIS is to provide stakeholders with access to accurate, relevant, current and complete information pertaining to national air and atmospheric quality in order to facilitate informed decision-making with respect to South African ambient air quality objectives.

A continuous ambient air quality monitoring programme has been initiated with the specific purpose of providing continuous, accurate data on pollution concentrations at a specific location. The stations will capture meteorological data and will measure four pollutants of concern including; SO_2, O_3, NO_2 and particulate matter.

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Limitations of this programme include; spatial coverage, technical skills required for maintenance and calibration as well as the financial implications of maintaining such a programme. Municipalities further need to acquire air monitoring equipment and a system to automatically retrieve air quality data from loggers and sensors for the management of remote data acquisition equipment.

10.5.2. Proposed responses

10.5.2.1. Norms and standards

Norms and standards for ambient air quality monitoring are published in SANS 1929: 2005, Ambient air quality – Limits for common pollutants. These are based on acknowledged international practice and are accepted as the national norms and standards for ambient air quality monitoring in the national framework. The national framework provides guidance on the macro and micro siting of stations as well as the ideal minimum number of sampling points for fixed measurements. The NW Province is awaiting the national standards to be implemented prior to determining whether more stringent standards should be developed to address air quality concerns in the province. This proposed initiative is earmarked for instigation in September 2009.

10.5.2.2. Continuous ambient air quality monitoring

As a minimum, any new ambient monitoring station to be installed should measure a range of pollutants and meteorological parameters including:

- PM10, PM2.5, SO_2, nitrous oxides (NO and NO_2), BTEX, carbon monoxide (CO) and ozone (O_3), and
- Wind speed, wind direction, temperature, humidity, pressure and rainfall.

10.5.2.3. Data collection and management

The collection, management and dissemination of ambient air quality data and information needs to be coordinated and managed as a whole. Current ambient air quality monitoring practices in the NW Province are fragmented and uncoordinated, as it is primarily currently undertaken by industry.
Data from the ambient monitoring stations, including municipal and privately owned stations, should be electronically transferred to an on-line, centralised database. The data storage and management system should have multi-user access to view, collect and validate data, depending on their designated level of access. The software should consist of a database which controls and maintains the integrity of all logger data, as well as user-defined parameters and controls in the system. The data acquisition system should have sufficient data storage capacity to hold historical data.

The data system should be linked to the National Data System currently being developed as part of the South African Air Quality Information System Project (SAAQIS). All ambient monitoring data must be transferred to the electronic database at the South African Weather Services.

Standard reports showing all measurements per interval, maximum and minimum over period and average data should be made available. All reports should include graphical representation of appropriate information. Other information management interventions include accessibility and dissemination of information through various media forms such as newspaper articles, Frequently Asked Questions booklets, and the internet.

The objective of the plan will be to provide clear clean air objectives and associated strategies to ensure improvement in the provincial ambient air quality. This must be based on a comprehensive database providing an accurate account of the current status of air quality and air quality management in the province.

The plan will aim to:

- Identify gaps in the existing baseline air quality data;
- Determine if existing ambient air concentrations within the Province are in compliance with legal requirements;
- Identify management requirements for the Province;
- Provide an updated and more accurate baseline characterisation of the air quality within the study area, and
- Develop an Air Quality Management Plan that is linked with the proposed monitoring programme to ensure the ambient air of the Province will be brought into compliance.

Initiative 8:	Management and the Continual Evaluation of Air Quality Monitoring Programme
Priority:	High
Responsibility:	Provincial Department Agriculture, Conservation & Environment, Department of Environmental Affairs and Tourism and relevant District and Local Municipality

10.5.2.4. Controlled Emitters, Fuels and Priority Areas

In terms of the National Air Quality Act 39 of 2004 (AQA) the province should declare:

- Controlled emitters - means any appliance or activity which results in atmospheric emissions which through ambient concentrations, bioaccumulation, deposition or in any other way, present a threat to health or the environment;
- Controlled fuels – means a substance or mixture of substances which, when used as a fuel in a combustion process, result in atmospheric emissions which through ambient concentrations, bioaccumulation, deposition or in any other way, present a threat to health or the environment, and
- Priority areas - means an area where ambient air quality standards are being, or may be, exceeded in the area, or any other situation exists which is causing, or may cause, a significant negative impact on air quality in the area; and the area requires specific air quality management action to rectify the situation.

Initiative 9:	Identification and Management of Controlled Emitters, Fuels and Priority Areas
Priority:	High
Responsibility:	Provincial Department Agriculture, Conservation & Environment, Department of Environmental Affairs and Tourism and relevant District and Local Municipality

Priority areas within the province have been identified and include:

- Rustenburg Local Municipality;
- Madibeng Local Municipality, and
- Klerksdorp, Stilfontein and Potchefstroom Areas.

10.5.2.5. Climate Change

The NW Province does not currently have any climate change policies, programmes or plans in place. It is important for the Province to identify sources of greenhouse gases in order to enable the formulation of appropriate management measures.

Initiative 10:	Climate Change Strategy
Priority:	Medium
Responsibility:	Provincial Department Agriculture, Conservation & Environment, Department of Environmental Affairs and Tourism and relevant District and Local Municipality

10.6. Human settlements

Responses by the North West Provincial Government to pressures exerted on the environment by existing settlements, coupled with the pressures of migration and urbanisation, include strategic policies, resolutions and programmes.

10.6.1. Current initiatives

Although the backlog of housing delivery and associated essential infrastructure within the province is still significant, much has been done to alleviate the vulnerability of the NW Province's population to their environment, simultaneously buffering the environment from poverty-related impacts.

10.6.1.1. Department of Developmental Local Government and Housing – Strategic Plan: 2005/2009

The Strategic Plan reflects the DDLGH's implementation of programmes and projects to accelerate local government transformation, service delivery, development, and change, in order for democracy to become more meaningful to local communities and people within the NW Province. In the DDLGH's housing projects for 2007/2008, the DDLGH will take full responsibility for all new housing projects, and will allow municipalities to complete existing projects. In the process, the DDLGH has committed to providing more that 39,000 houses within a two year period, with the aim of ensuring a massive roll-out of projects in identified municipalities in a structured development approach.

10.6.1.2. Provincial Growth and Development Strategy 2004-2014

One of the two key goals of the Provincial Growth and Development Strategy (NWGDS) is to eradicate poverty by wiping out backlogs in basic services, including water and sanitation, within the next ten years.

10.6.1.3. Provincial Spatial Development Framework

The revision of the 2005 North West Spatial Development Framework (NWSDF) has been undertaken with objectives to:

- Provide a spatial interpretation of the NWGDS as well as the National Spatial Development Perspective (NSDP) to guide future land use and development;
- Draft a policy for the overall spatial distribution of development which will:
  - Indicate desired or undesired utilisation of space in a particular area;
  - Identify areas where strategic intervention is required, and
  - Indicate priority areas where public sector intervention is required.
- Respond to spatial implications and synergies arising form other development strategies and policies and ensure co-ordination;
- Provide a framework for planning for district and local municipalities to co-ordinate and facilitate their planning and provide appropriate support (a framework for more detailed land use planning);
- Take into consideration the new demarcation of municipal and provincial borders;
- Address environmental considerations in development planning, and
- Focus on user friendliness of the material.

It will be table at the provincial executive committee for adoption and implementation.

Initiative 11:	Monitoring Strategy
Priority:	Medium
Responsibility:	Provincial Department Agriculture, Conservation & Environment, Department of Economic Development & Tourism, Department Developmental Local Government and Housing and Department of Social Development as well as relevant District and Local Municipality

Photo: Mary-Ann Palmer

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10.6.1.4. North West Provincial Water Sector Plan: Five Year Workplan 2007-2012

The functions of the North West Provincial Water Sector Plan: Five-Year Workplan 2007-2012 are to:

- Provide mechanisms to fast-track delivery;
- Set an agenda for collaboration structures;
- Provide a yardstick for organisational accountability;
- Serve as a vehicle to facilitate communication;
- Serve as an agent of transformation, and
- Provide a device to attract extra funding.

10.6.1.5. Project Consolidate

Project Consolidate was established in 2004 and focuses on, amongst others:

- Capacity building and human resource development;
- Integrated human settlement development;
- Free basic services, billing systems, and municipal debt;
- Local economic development, job creation, and infrastructure;
- Special intervention in rural and urban nodes, and
- Performance monitoring, evaluation, and communication.

The following actions and initiatives have been identified in the second edition of the provincial EIP.

Photo:NWDACE

Proposed plans for implementation	Responsibility	Timeframe
Roads infrastructure		
Compliance with EIA Regulations	☐ NWDACE ☐ DTR & CS	Ongoing
☐ Participation in the Provincial Development Planning Forum ☐ Participation in the Municipal IDP Forum ☐ Participation in the North West 2010 Committee ☐ Participation in Provincial Environmental Forum	☐ Municipalities ☐ DTR & CS ☐ NWDACE ☐ DME	Ongoing
☐ Planning process must ensure that SDFs consider impacts of linear structures ☐ Alignment of the road infrastructure plan, integrated transport and other relevant plans, strategies and IDP's to the PGDS and PSDF.	☐ Municipalities ☐ DTR & CS NWDACE ☐ DME	Ongoing March 2009
Waste and Health Care Waste		
DACE to monitor compliance with the provincial Integrated Waste Management Plan (IWMP)	☐ NWDACE ☐ Municipalities	Ongoing
DACE must implement provincial ambient monitoring programme to monitor the impact of landfill sites on natural resources	☐ NWDACE	March 2009
DACE must establish a provincial Waste Management Forum where municipalities are represented on and meet on regular basis	☐ NWDACE ☐ Municipalities	March 2009
Compliance with EIA Regulations	☐ NWDACE ☐ DH	Ongoing
Compliance with other relevant waste minimum standards	☐ Municipalities ☐ DH ☐ DEAT / DWAF ☐ NWDACE	Ongoing
Municipal Bulk Infrastructure		
DWAF to support the municipalities to develop water services plan (covering ground water)	☐ Municipalities ☐ DWAF	March 2009
Municipal Bulk Infrastructure Plan to be aligned with SDF's	☐ Municipalities	Ongoing

Table 10-5: Infrastructure management actions proposed in the EIP (2nd Edition)

10.6.2. Response

Current programmes include the provision of housing, water, sanitation and infrastructure. Provincial and / or local government need to develop a strategy for monitoring the above responses, in order to determine the effectiveness of plans implemented, and whether additional policies or plans should be developed.

The province must establish a forum to continuously monitor and review the alignment of development goals and objectives of the municipal and provincial planning initiatives.

Initiative 12:	Alignment of development goals and objectives
Priority:	High
Responsibility:	Provincial Department Agriculture, Conservation & Environment and Department Developmental Local Government and Housing , Local and District Municipalities

10.7. Cultural and natural heritage

The major issues resulting in the loss of important heritage features and sites and which affect effective heritage management are:

- Authorisation of development projects without the consideration of sites of heritage significance;
- A lack of capacity and awareness with regard to heritage management, and
- The prioritisation of tourism development without the proper consideration of conservation requirements.

There is potential for sites of social, political, historical, natural, recreational and aesthetic importance to attract many more international tourists, and to have a Province that is less dependent upon the Platinum Belt to provide livelihoods. Tourism is heavily dependent upon the following:

- Global and national marketing of the rich heritage sites in the province;
- Developing tourism 'hubs' around sites of importance, and linking this to platinum beneficiation (i.e. jewellery);
- Promoting, branding and marketing tourist 'packages' which include all aspects of the unique offerings of NW Province;
- The province developing and maintaining a proper database of heritage resources in accordance with the requirements of Section 39 of the National Heritage Resources Act 25 of 1999 (NHRA), so that such resources can be adequately protected and promoted;
- All heritage issues (i.e. natural and cultural) must be properly addressed in provincial and municipal planning, and
- The incorporation of heritage management plans into general management plans of protected areas.

There must be better liaison and co-operation between the South African Heritage Resources Agency (SAHRA), the NW Provincial Heritage Resource Agency (NWPHRA) and the NW environmental authorities (NWDACE) concerning the implementation of the Environmental Impact Assessment (EIA) Regulations. Local authorities should be encouraged to develop their own databases of heritage resources, and expertise, in accordance with the provisions of the NHRA.

10.7.1. Current initiatives

The NW office of the SAHRA together with the NW Provincial Department of Sport, Arts and Culture are proposing to undertake the compilation of a provincial heritage database to record data relating to all cultural, historical and natural sites within the province, and their protection status. This will provide valuable data for future planning purposes, in order to ensure the protection and development of heritage significant sites.

10.7.2. Response

As part of the regulated Environmental Impact Assessment (EIA) approval process for proposed listed activities, requirements should be set with SAHRA to ensure that the relevant Heritage Impact Assessment (HIA), as contemplated in the NHRA, are undertaken, and that any significant heritage sites are appropriately recorded and adequately addressed.

Prioritisation of the heritage sites must be undertaken in order to initiate a process for the declaration of sites with significant heritage value. The criteria for prioritization may be based on the following:

- The value of the site in terms of its aesthetic, social, cultural and religious value and educational and technological value;
- Vulnerability, and
- The state of its current condition and integrity.

The protection and management of heritage sites within the province should be in compliance with the provisions of the World Heritage Convention Act, the National Environmental Management: Protected Areas Act 57 of 2003 (NEMPA) and the National Environmental Management: Biodiversity Act 10 of 2004 (NEMBA). The province must during this implementation of this initiative should also recognise and ensure alignment with the activities undertaken by SANBI in terms of the Protected Area Expansion Strategy (PAES).

The Taung Skull Site and the Cradle of Humankind are heritage resources shared between different provinces. The management thereof should thus be a collaborative effort and the province must initiate the establishment of a cooperative management agreement for these sites.

Photo: Anuschka Barac

Initiative 13:	Heritage Impact Assessment as part of Environmental Impact Assessment.
Priority:	High
Responsibility:	Provincial Department Agriculture, Conservation & Environment

Initiative 14:	Heritage Site Declaration
Priority:	Low
Responsibility:	Provincial Department Agriculture, Conservation & Environment and South African Heritage Resource Agency

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10.8. Proposed general responses

The following general responses are proposed to ensure effective environmental governance.

10.8.1. Training and monitoring

Environmental management cannot be effective without awareness and training of representatives on government and community levels: *we cannot manage and conserve that which we do not understand and value.*

Training programmes on current initiatives must be continued and training instigated at the implementation of any new plan, programmes and policies.

The management of environmental resources requires the collection and analysis of data in order to determine the state thereof and to compare changes over time. This can only be achieved through the systematic and regular monitoring of the state of the environment. Information management and reporting is essential for the accurate interpretation of data to establish trends. A management system will also provide accessible information to enable decision making.

Enforcement and compliance monitoring is necessary for the successful management of environmental resources. While the current and proposed plans, policies and programmes may provide the framework for the NW Province to work towards achieving sustainability, it cannot be achieved without the effective enforcement thereof and subsequent monitoring of compliance thereto.

The following actions and initiatives have also been identified in the second edition of the provincial EIP.

Initiative 15: Training Programme

Priority: High

Responsibility: Provincial Department Agriculture, Conservation & Environment

Initiative 16: Environmental Monitoring Programme

Priority: High

Responsibility: Provincial Department Agriculture, Conservation & Environment

Initiative 17: Enforcement and Compliance Monitoring

Priority: High

Responsibility: Provincial Department Agriculture, Conservation & Environment

Proposed plans for implementation	Responsibility	Timeframe
Capacity Building and Empowerment		
Establishment of Provincial Environmental Forums where all sector departments and municipalities can discuss environmental issues.	☐ NWDACE ☐ DE ☐ Municipalities	March 2009
Regular awareness campaigns on environmental issues.	☐ NWDACE ☐ DE ☐ Municipalities	Ongoing

Table 10-6: Capacity building and empowerment actions proposed in the EIP (2nd Edition)

10.8.2. Disaster Management

Environmental disasters refer to natural events which may impact or disrupt communities and cause environmental loss. Disaster management is a proactive preparation to enable intervention to manage the disruption and impact of such events. As part of the provincial EIP, management actions have been identified and are set out in Table 10-7.

Photo: Lauret Muller

Proposed plans for implementation	Responsibility	Timeframe
Disaster management		
Environmental issues and EIA requirements to be included in the development of Risk and Disaster Management Plan, as well as Drought Management Plan.	☐ NWDACE ☐ DWAF ☐ Municipalities	Ongoing
Environmental Services (DACE) and DWAF to form part of municipal teams when attending to spillages and pollution incidents	☐ NWDACE ☐ DWAF ☐ Municipalities	March 2009
Environmental services must participate in the provincial Disaster Management Forum.	☐ NWDACE ☐ DDLGH	Ongoing
Implementation of National Veld and Forest Fire Act, 1998 (e.g. establishment of Fire Protection Associations)	☐ NWDACE ☐ DWAF ☐ Municipalities	Ongoing
Implementation of Disaster Management Act	☐ NWDACE ☐ DWAF ☐ Municipalities ☐ DDLGH	Ongoing

Table 10-7: Disaster management actions proposed in the EIP (2nd Edition)

Photo: Anuschka Barac

10.9. Conclusion

Various initiatives are already underway to resolve some of the environmental issues identified throughout this report. However, based on the analysis of the current state of the environment, as well as the current trends within the province, 17 additional initiatives are proposed. These proposed initiatives have been prioritised and the responsible governing bodies for their implementation identified.

The starting point of this report on the current state of the environment was based on the indicators identified for the purposes of the development of the report. The following indicators were identified at the commencement of the project, but have not been reported on herein as insufficient data exists to enable meaningful reporting on all the issues. These indicators should thus be considered when future state of the environment reporting is planned.

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Objective	Indicator
Monitor land degradation	Proportion of land affected by desertification
	Soil Degradation Index
	Veld Degradation Index
	Combined Degradation Index
Monitor soil quality due to agricultural practices to prevent low crop yields	Soil Quality Standards enforced
Monitor permanent loss of soil to prevent land degradation	Loss of top soil through run-off
To determine land available for housing and Industrial development	Rate of development in all zoning categories
To protect cultural relevant sites and recreation sites of cultural/historic significance	Change in land use
Monitor urban sprawl	Demand for housing and other urban developments
Ensure reasonable land redistribution practices	Recipients of land claims and reform process and use of recipient land
Monitor rapid urbanization	Rezoning applications vs provision of services
Avoid flooding of developments and damages related thereto	Development within the 1 in 100 year floodline or close to water courses, wetlands; no buffer zones
Monitor implementation of SDI Plans	Adherence to SDI plans and development nodes
Determination of the extent of sterilized land resulting from petrochemical, agrichemical and heavy metal contamination	No of sites where soil contamination has been investigated
Ensure land rehabilitation	Percentage of wetlands rehabilitated out of degraded wetland areas that require rehabilitation
	Percentage of land rehabilitated out of the total land area that require rehabilitation
Ensure sustainable utilization of land	Agricultural land productivity vs. potential productivity
	Change of land use from agricultural to hard development (consideration of agricultural land area
	Arable land area per capita (m^2)
	Settlement, grazing and arable land area as a percentage of total area
	Average gross residential density in urban areas
	Area with organic farming as a percentage of total arable land area.
	N, P and L losses from agricultural land
	Veld condition score
	Accumulation of heavy metals in agricultural top soil
Ensure the management of natural habitat	Proportion of land affected by desertification, Soil/ veld/ land degradation index/ veld condition scores/ changes of land use
Land degradation	Proportion of land affected by desertification, Soil/ land degradation index/ Percentage of land rehabilitation out of degraded lands/ veld condition scores/ changes of land use
Soil erosion, alien plants & animals	Percentage of land affected by alien and invasive species/ Budgetary allocation for alien eradication programmes
Land rehabilitation	Percentage of land rehabilitation out of degraded lands/ changes of land use
Urban sprawl	Number of EIA applications/ Changes of land use

Table 10-8: Land use and transformation indicators

Photo: Anuschka Barac

Photo: Anuschka Barac

Objective	Indicator
Promote integrated environmental management and compliance	Number of environmental impact assessments approved per district per year
	Expenditure on environmental management as a percentage of budget
	Percentage of EIA ROD compliance monitoring conducted per year
	Percentage of pollution and waste compliance investigated per year
	Number of compliance notices/directives/interdicts issued per year for the companies that do not have permits
Promote Integrated Environmental Management & Compliance	Immediate and clear identification of ecological sensitive areas, preventing significant damage to sensitive areas
Amend requirements for biodiversity investigations for new developments	Increase the existing knowledge of biodiversity of the region
Compliance monitoring of EIA ROD	Ensuring proper protection for the natural environment
	Percentage of IDP's that include Integrated Environmental Management (IEM)
Species Diversity	Prevent the loss of T&P species
	Increase existing knowledge of biodiversity
Loss of species	Prevent/ determine the loss of species
Status of invasive plants & species	Control the spread of alien and invasive plants/ animals into areas of natural habitat, particularly wetlands
Protection of sensitive ecosystems & habitat	Provide clear and detailed guidelines for biodiversity assessments as part of EIA investigations
Enforcement of environmental legislation	Enforce terms presented in ROD for maximum protection of the environment
Status of known protected habitats	Provide protection for sensitive ecosystems
Identification and declaration of additional protected areas	Provide protection for sensitive ecosystems

Table 10-9: Biodiversity and ecosystem health indicators

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Photo: Anuschka Barac

Photo: Anuschka Barac

Objective	Indicator
Freshwater Ecosystem Integrity	Provide protection for areas of surface water
Identification of sensitive habitats	Provide protection for areas of high slopes
Identification of sensitive habitats	Provide protection for areas of unique biodiversity attributes
Ensure protection of ecologically sensitive areas	Protected areas as a percentage of the total area (MDG)
	Percentage of representative vegetation types and other sensitive eco-systems under formal protection
Protect natural heritage sites	Status of natural heritage sites (international, national, provincial)
	Percentage of budget allocated to the protection of natural heritage sites
Natural heritage sites	Number of natural heritage sites
Identification of Biodiversity Sensitive Areas	Provide protection for areas of floristic/ faunal endemism, high biodiversity, areas known to be ecologically sensitive, rd localities
Public awareness of environmental importance	Increase knowledge of environmental importance/ sustainable utilisation
Promote environmental education and awareness	Number of schools implement awareness/education programmes
The pet trade (CITES).	Introduction of non endemic species as pets that cause pressure
Sensitive areas need proper identification	Designate limited development areas.
Conservation outside of officially designated areas needs better regulation – i.e. ridges, wetlands.	Loss of other tourism opportunities
Management of the Protected Areas.	Only local/provincial conservation areas are managed and monitored
Veld Fires	Contributes to habitat pressure
Non-endemic fauna such as bears, tigers, etc. being brought into the area.	Displacement of other animals causing pressure (see permitting office for information).
	Hybrids i.e. white springboks or golden wildebeest which are being bred on game farms to attract tourists. These are a threat to biodiversity.
"Canned lion hunting"	With the increase in game farms and the associated hunting, an increase in lion breeding and numbers has occurred. A big game farm can have up to 200 lions.

Objective	Indicator
Promote wise use of water resources	Allocation of water use in relation to the reserve determination of catchments
	Ratio of water demand vs. water reserves level
	Mean annual rainfall
	Ratio of surface water consumption per capita vs. surface water resources per capita
	Percentage where DWAF guidelines are exceeded for nitrites in surface water
	Percentage where DWAF guidelines are exceeded for total phosphate in surface water
	Percentage where DWAF guidelines are exceeded for conductivity in surface water
	Percentage where DWAF guidelines for faecal coliforms in surface water
	Percentage where DWAF guidelines are exceeded for fluoride in surface water
	Surface water radioactivity in selected rivers
Groundwater extraction	Dependence on groundwater
Ensure ground water quality	Ground water toxicity
	Percentage where DWAF guidelines are exceeded for nitrites in ground water
	Percentage where DWAF guidelines are exceeded for total phosphate in surface water
	Percentage where DWAF guidelines are exceeded for conductivity in ground water
	Percentage where DWAF guidelines for faecal coliforms in ground water
	Percentage where DWAF guidelines are exceeded for fluoride in ground water
	Ground water radio-activity in selected underground rivers and compartments
	Ratio of ground water consumption per capita vs. ground water resources per capita
	Total surface water resources per capita
Ensure wetlands water quality	Wetland status and function
Ensure water quality in dams	Total underground water resources per capita

Table 10-10: Water Resources and aquatic ecosystems indicators

Objective	Indicator
Reduce gas emissions that contribute to green house effect	Carbon dioxide emissions per capita (MDG)
	Mean annual temperature
	Consumption of ozone depleting substances (methyl bromide)

Table 10-11: Air quality and climate change indicators

Photo: Lauret Muller

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Objective	Indicator
Reduce waste generation	General waste produced per capita per year
	Provincial waste collection capacity
	Volume of hazardous waste produced per sector per year
	Volume of liquid waste produced per year
Ensure appropriate waste disposal	Available landfill sites' lifespan
	Percentage of general waste correctly disposed through general waste facilities
	Percentage of medical waste correctly disposed
	Percentage of hazardous waste correctly disposed through hazardous waste facilities
Promote proper waste management practices	Number of recycling projects in the province
	Percentage of general waste recycled per year
Disposal of Nuclear waste	Amount of nuclear waste produced per annum from Pelindaba and other sources
Contamination of air with blue fibres	Number of asbestos sites
Capacity of Sewage treatment plants	No of sewage treatment plants
Use of sewage for composting	Volume of sewage produced per annum
Builder's rubble and other wastes, especially on the peri-urban fringe.	Illegal dumping of builder's rubble
Domestic recycling efforts	No of domestic recycling projects
Commercial – recycling	Recycling of products at Commercial level
Ensure sustainable energy use	Annual energy consumption per capita
	Percentage of energy supplied from renewable sources

Table 10-12: Human settlement and infrastructure indicators

Photo: Anuschka Barac

Photo: Mary-Ann Palmer

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