Limpopo Provincial Government

Department of Economic Development, Environment and Tourism

Limpopo Environment Outlook Report 2016

Acknowledgements

LEDET Core Project Management Team

Maluleke MT, Malungani T and Dr Steenkamp K

Steering Committee Members

Chavalala WN, Dali MR, Gafane M, Kolani L, Maako P, Mabada HD, Malala RE, Mampye A, Maselela T, Maboshego LM, Mthombeni RV, Mudau NR, Mudau MD, Munyai NE, Manoko MA, Mokgenie SH, Mokgobu TS, Mootanane RK, Nchabeleng KG, Netshikovhela E, Peeha T, Tjebane MA, Ramulondi H, Ramusi J, Van Rooyen T and Zikalala KN

Specialist Contributors

Dr Odendaal F, Dr Mclean B, Murray M, Sanchez Piña A, Van der Merwe J, Van Staden S

Specialist Reviewers

Prof Hanks J, Mondlane M, Van der Merwe J

List of Public Workshops

Workshops	Location	Date
Mopani and Vhembe Districts Workshop	Giyani	30 November 2015
Capricorn and Sekhukhune Districts Workshop	Polokwane	01 December 2015
Waterberg District Workshop	Modimolle	03 December 2015
Capricorn District Workshop	Polokwane	15 February 2016
Sekhukhune District Workshop	Groblersdal	16 February 2016
Mopani District Workshop	Giyani	17 February 2016
Vhembe District Workshop	Thohoyandou	18 February 2016

Stakeholders at Meetings

Anyegeni BF, Baloyi MD, Baloyi P, Baloyi O, Chavalala WN, Bamuza MA, Boshomane M, Chuene CL, Chula MJ, de Jager A, de Klerk A, Dima MB, Dimba I, Egan V, Erasmus N, Faber M, Greep BF, Heymans J, Hoaeane, Hlongwane T, Hlungwani YI, Joubert K, Kgaabi L, Kgafane FT, Klassen W, Kobe T, Koemire MS, Koopedi OR, Kruger J, Kubyana MJ, le Roux A, Ledwaba SS, Lekganyane MA, Lekgou C, Lekoana MA, Leo KE, Leope MP, Leshabane PS, Lesufi MA, Letsoalo A, Mabila F, Mabitsela LE, Mabunye NA, Machethe LP, Madadzhe N, Mahapa MS, Mailula NK, Maja F, Makananise TB, Makgoka P, Makhomisani N, Makhubele NJ, Makhubele S, Makhukho SS, Makunamisha N, Malange A, Maleta T, Maluleke MT, Maluleke V, Maluleke MD, Malungani T, Mamida S, Manyala T, Manyaga LA, Manyatsha K, Maputla D, Marakalala T, Mareda T, Maritz J, Marulane RW, Mashaba XG, Mashala L, Mashego R, Mashila D, Mashiloane RD, Masikhwa V, Masindi M, Mathabala JM, Mathebula AM, Mathe TH, Mathobo T, Mathomu CN, Matloga SR, Maud K, Mbadaliga TH, Mbedzi RI, Mdi N, Mdugozi B, Mefa NZ, Mkhabela S, Mkwashu LF, Mlambo MT, Moeng E, Mogalakwana M, Mokgehle SH, Mokghalane PB, Mokgokong KR, Mokgotho C, Mokobi J, Mogoane E, Mokoena TL, Molepo ME, Moloto KK, Molteno N, Mongwe V, Morema T, Moshoeu ML, Mostert J, Motha KJ, Mothapo SW, Mothato W, Mphahlele T, Mphatheleni M, Mukwevho MN, Munyangane S, Musetsho N, Mushiana M, Ndivho T, Ndou N, Ndou FH, Ndou I, Ndwamato CT, Nefale T, Neluvhola SG, Netshidzixhe T, Netshisavhulu NS, Netshivhangani M, Nevhutanda AS, Nevhuthalu NS, Ngobeni M, Ngobeni R, Nkanyana M, Nkwinika C, Nthanyi S, Nthlane LA, Phahlane MN, Pheeha M, Pilusa B, Ramakonya SJ, Ramaphosa NT, Rambuda VS, Rampfumedzi M, Ramukosi M, Ramulongo K, Ramusi J, Ramutla NA, Rangwoto M, Ranku M, Raphunga TV, Ratovhowani C, Ratshikhopha KP, Rodgers S, Rogers M, Sadiki SS, Sedikila P, Sehlapelo MA, Serope LC, Sigoba M, Singo N, Sinyegwe TE, Shabangu PA, Somanje MJ, Snyman J, Steenkamp K, Tema T, Thabethe V, Thilivha T, Thivhafuni P, Thuba MC, Tiba S, Tlouane K, Tovhakale L, Tshitwamulomoni T, Tshuketana MM, Tshuketena TL, Universal Greening Organisation, Van Wetten A and Zikalala KN

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About the Limpopo Environment Outlook Report

The Limpopo Environment Outlook Report comprises five chapters, as described below and illustrated in Figure 1.

Chapter 1 presents an **Introduction** that explains what Environment Outlook Reporting is and what the purpose and use of an Environment Outlook Report is. It also presents a concise overview of the profile of the Limpopo Province.

Chapter 2 explores the major **Environmental Themes** and comprises the following sections: Climate Change, Land and Transformation, Water Resources, Biodiversity and Ecosystem Health, Waste Management, Energy, and Air Quality and Atmosphere.

Chapter 3 describes **The Human Dimension** and comprises the following sections: Environmental Governance, Economics and Human Settlements.

Chapter 4 presents the **Conclusion**, which consolidates and integrates the key findings from Chapters 2 and 3. Trends are reiterated, Key Challenges are identified, Linkages are explained and Scenarios are presented.

Chapter 5 proposes a set of **Recommendations**. These recommendations comprise responses that are of critical importance to ensuring a more sustainable future for Limpopo Province and its people, and for South Africa.

Abbreviations and Acronyms

%	Percent
°C	Degrees Celsius
ADU	Animal Demographic Unit
AEL	Atmospheric Emission Licence
AOP	Annual Operational Plan
AQMP	Air Quality Management Plan
ARC	Agricultural Research Council
BirdLifeSA	Birdlife South Africa
BGIS	Biographical Geographic Information System
BP	Bioregional Plan
BR	Biosphere Reserve
CBA	Critical Biodiversity Area
CFC	Chlorofluorocarbon
CMA	Catchment Management Agency
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_{2eq}	Carbon Dioxide Equivalent
CoGHSTA	Department of Co-operative Governance, Human Settlements and Traditional Affairs
COP	Conference of Parties
CSIR	Council for Scientific and Industrial Research
CSP	Climate Support Programme
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DM	District Municipality
DoE	Department of Energy
DPSIR	Driver-Pressure-State-Impact-Response
DRDLR	Department of Rural Development and Land Reform
DST	Department of Science and Technology
DTI	Department of Trade and Industry
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	Electrical Conductivity
EI	Emissions Inventory
EIA	Environmental Impact Assessment
EMI	Environmental Management Inspector
EMP	Ecological Management Plan
ESA	Ecological Support Area
EXCO	Executive Council of the Limpopo Provincial Government
FAO	Food and Agricultural Organisation
FAOUN	Food and Agricultural Organisation for the United Nations
FGD	Flue Gas Desulphurisation
FMD	Foot and Mouth Disease
GDP	Gross Domestic Product
GDPR	Gross Domestic Product Regionally
GGP	Gross Geographic Product
GHG	Greenhouse Gas
GIS	Geographic Information System
GoSA	Government of South Africa
GTI	GeoTerra Image (Pty) Ltd
GVA	Gross Value Added
GWh	Gigawatt Hour
H_2S	Hydrogen Sulphide
ha	Hectares
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
HSRC	Human Sciences Research Council
IARC	International Agency for Research on Cancer
IBA	Important Birding Area
ICT	Information Communication Technology
IDP	Integrated Development Plan
IES	Income Expenditure Survey
INDC	Intended National Determined Contribution
IPAP	Industrial Policy Action Plan

IPCC	International Panel on Climate Change
IRPTS	Integrated Rapid Public Transport System
IUCN	International Union for Conservation of Nature
IWMP	Integrated Waste Management Plan
IWT	Illegal Wildlife Trade
km	Kilometre
km^2	Square Kilometre
KNP	Kruger National Park
kWh	Kilowatt Hour
LBPTC	Limpopo Basin Permanent Technical Committee
LCPv2	Limpopo Conservation Plan: Version 2
LDA	Limpopo Department of Agriculture
LDP	Limpopo Development Plan
LED	Local Economic Development
LEDET	Limpopo Department of Economic Development, Environment and Tourism
LEGDP	Limpopo Employment, Growth and Development Plan
LEO	Limpopo Environment Outlook
LGEP	Limpopo Green Economy Plan
LM	Local Municipality
LPAES	Limpopo Protected Area Expansion Strategy
LPG	Limpopo Provincial Government
LRP	Land Restitution Programme
LSDF	Limpopo Province Spatial Development Framework
lsu	Large Stock Unit
m^2	Square Metre
m^3	Cubic Metre
MEC	Member of the Executive Council
mm	Millimetre
MoU	Memorandum of Understanding
mt	Metric Ton
MWh	Megawatt Hour
NAAQS	National Ambient Air Quality Standards
NAEIS	National Atmospheric Emissions Inventory System
NATMAP	National Transport Master Plan
NDA	National Development Agency
NDA	National Department of Agriculture
NDP	National Development Plan
NEMA	National Environmental Management Act, Act No. 107 of 1998
NEMAQA	National Environmental Management: Air Quality Act, Act No. 39 of 2004
NEMBA	National Environmental Management: Biodiversity Act, Act No. 10 of 2004
NEMPA	National Environmental Management: Protected Areas Act, Act No. 57 of 2003
NEMWA	National Environmental Management: Waste Act, Act No. 59 of 2008
NGO	Non-Governmental Organisation
NGP	New Growth Path
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxide
NPC	National Planning Commission
NSWR	National State of Water Resources
NWA	National Water Act, Act No. 36 of 1998
NW READ	North West Department of Rural, Environment and Agricultural Development
O_2	Oxygen
O_3	Ozone
PA	Protected Area
PAH	Polycyclic Aromatic Hydrocarbon
PAMP	Protected Area Management Plan
PAN	Protected Areas Network
PES	Present Ecological State
PGDS	Provincial Growth and Development Strategy
PM	Particulate Material
PM_{10}, $PM_{2.5}$	Particulate Material with an Aerodynamic Diameter Inferior to 10 and 2.5 µm
PRECIS	National Herbarium Pretoria Computerised Information System
PV	Photovoltaic
QDS	Quarter Degree Square
RD	Respiratory Disease
R&D	Research and Development

RDP	Reconstruction and Development Programme
RE	Renewable Energy
REC	Recommended Ecological Category
REIPPP	Renewable Energy Independent Power Producer Procurement Programme
RHP	River Health Programme
SAAQIS	South African Air Quality Information System
SABAP	Southern African Bird Atlas Project
SACN	South African Cities Network
SADC	Southern African Development Community
SAEMIZ	South African Energy Metallurgical Industrial Zone
SAHGCA	South African Hunters and Game Conservation Association
SALGA	South Africa Local Government Association
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks Board
SANS	South African National Standard
SAPIA	Southern African Plant Invaders Atlas
SAWS	South African Weather Service
SDA	Strategic Development Area
SDF	Spatial Development Framework
SET	Science, Engineering and Technology
SEZ	Special Economic Zone
SIP	Special Infrastructure Programme
SMME	Small, Medium and Micro Enterprise
SO_2	Sulphur Dioxide
SOER	State of Environment Report
SPI	Standardised Precipitation Index
SPLUMA	Spatial Planning and Land Use Management Act, Act No. 16 of 2013
TB	Tuberculosis
TFCA	Transfrontier Conservation Area
tpa	Tons per Annum
TSP	Total Suspended Particulate
StatsSA	Statistics South Africa
UGEP	Utilisable Groundwater Exploitation Potential
UN	United Nations
UNDESA	United Nations Department of Environmental and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNICEF	United Nations Children's Emergency Fund
VOC	Volatile Organic Carbon
WBPA	Waterberg-Bojanala Priority Area
WEEE	Waste Electrical and Electronic Equipment
WEF	World Economic Forum
WESSA	Wildlife and Environment Society of South Africa
WfW	Working for Water
WHO	World Health Organization
WHS	World Heritage Site
WIS	Waste Information System
WMA	Water Management Area
WRC	Water Research Commission
WUL	Water Use Licence
WWTW	Wastewater Treatment Works
ZLED	Zero Liquid Effluent Discharge

1 Introduction

1.1 What is the Limpopo Environment Outlook Report?

The Limpopo Environment Outlook (LEO) Report is a *snapshot* at this point in time of the environment and the people of Limpopo Province. The LEO Report provides a summary of the current state and future prospects of the environment. It demonstrates how the state or condition of the environment impacts on the well-being of people, and how appropriate responses can improve the overall state or condition of the environment to the benefit of the people who depend on the natural resources in the Province for their survival and well-being.

The purpose of the LEO Report is to make people more aware of the environment and to enable them to understand that there is a deep interconnectedness between people and the environment. It showcases multiple interactions between people and the environment, and demonstrates how these interactions can be negative or positive. The LEO Report highlights trends in resource use that should inform decision-making and future planning to ensure a more sustainable future for the people of Limpopo.

Recent amendments to the National Environmental Management Act[1], hereafter referred to as 'NEMA', require the compilation of Environment Outlook Reports as a mandatory obligation for national and provincial spheres of Government. The result has been various Environment Outlook Reports for South Africa, championed by the National Department of Environmental Affairs (DEA). The LEO Report is a direct result of this requirement. Limpopo is also the first province to compile an Environment Outlook Report under the new national directive.

The LEO Report follows on from the Limpopo Province State of Environment Report (Limpopo SOER), which was undertaken in phases, with Phase 1 completed in 2004 and Phase 2 completed in 2006. The previous SOER also led to the further development of the GAP Tool, a geospatial planning tool, which contains socio-economic and environmental information for Limpopo. Ultimately, the LEO Report, together with similar initiatives from other provinces, will become part of the larger South African initiative to work towards a more sustainable future for the people of South Africa and, ultimately, for the people of the world, ensuring global sustainability.

There is a growing global awareness and recognition of the importance of the environment and the protection of ecosystems to secure our future through the responsible use of natural resources. Informed by this view, a great need exists for integrated spatial planning and development that is focused on the establishment of a green economy and the promotion of a green agenda.

Green economy action planning and performance monitoring have become critically important for Limpopo. With the Limpopo Green Economy Plan (LGEP) in place and the Green Municipalities Competition active, the time has come to encourage private sector participation in the green economy further. The LEO Report provides relevant information and recommendations in this regard.

Finally, the LEO Report is a key governance tool that guides future planning and informs decision-making by all role-players, to ensure sustainable development, create liveable urban and rural settlements, and improve the quality of life, and the well-being, of the people of Limpopo.

1.2 What is the purpose of the Limpopo Environment Outlook Report?

The LEO Report provides a moment to take stock of and assess the current state or condition of the environment, in general, and environmental resources, in particular. It identifies and assesses environmental issues and challenges, determines the condition and trends, and identifies priority environmental challenges and trends in resource use. It evaluates the effectiveness of

[1] The National Environmental Management Act is Act No. 107 of 1998 and is included under the National Environmental Management Laws Second Amendment (Act No. 30 of 2013).

environmental policies, strategies, plans, programmes, projects and actions that are in place. It also looks into the future and presents appropriate responses to improve the *status quo*. It highlights how a range of interrelated measures may either enhance or undermine the environmental resilience of Limpopo. This resilience is a critical component of climate change adaptation. Without the necessary preparedness, the ability of the people and the economy of Limpopo to navigate changes and unpredictability in the environment will be fatally impaired.

According to the draft directive, issued in terms of the National Environmental Management Laws Second Amendment, Act No. 30 of 2013, the objectives of the Environment Outlook Report are to:

- Provide objective, accurate and scientifically credible information about the condition and prospects of the environment;
- Increase stakeholder awareness and understanding of the state or condition of the environment, trends, causes and consequences;
- Facilitate the measurement of progress toward achieving environmental standards and targets;
- Provide early warnings in terms of environmental degradation;
- Make recommendations and influence the strengthening of environmental policies and programmes, aimed at the remediation of environmental degradation; and
- Provide a foundation for improved decision-making at all levels.
- The environmental reporting process enhances the quality, accessibility and relevance of information to enable decision-makers to adopt an integrated and long-term perspective and response for the wise use of natural resources and for improving the quality of life, and well-being, of the people of Limpopo into the future.

Scientifically sound, and rooted in pervasive participation by a range of parties and people from all walks of life, the LEO Report is credible and timely. It contains information relevant to policy formulation and implementation, and recommends actions that can be taken in the short- and medium term that will ensure sustainability in the longer term.

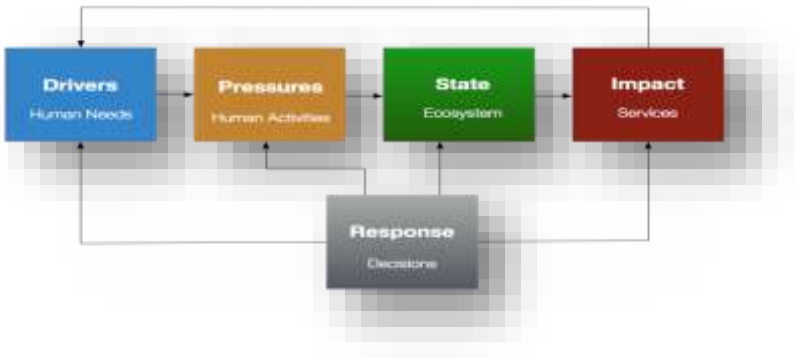
1.3 How was the Limpopo Environment Outlook Report compiled?

The study required that a complex set of interconnected and interdependent issues and responses be explored. The balance between the environment and people was investigated and the overarching methodological framework proposed was the Driver-Pressure-State-Impact-Response (DPSIR) Framework, as recommended in the directive from the DEA.

The LEO Report was compiled together with stakeholders in Limpopo and included the participation of the Project Steering Committee under the auspices of the Limpopo Department of Economic Development, Environment and Tourism (LEDET). Key stakeholder meetings, working groups and public consultation meetings were also conducted. Specialists provided inputs into the reports, which were placed for comment during the project.

The DPSIR Framework

The dynamic Driver-Pressure-State-Impact-Response (DPSIR) Framework is used to assess the current state and future prospects of the environment in Limpopo.



Within the DPSIR Framework, human activities and external forces (the drivers) are seen as producing pressures that can induce changes (impacts) in the state of the biophysical and socio-economic environments and thus in the state of the environment. Society then responds to changes in pressure, or state, with policies and programmes intended to prevent, reduce, or mitigate, pressures and their impacts. These responses in turn produce new pressures. Additional to the simple causal flow from drivers to responses are the dynamic relationships between all five aspects of the Framework.

Drivers (human induced or natural): These are primary agents or driving forces that cause environmental change and determine the extent to which human activities influence the environment. Drivers may also be underlying natural, socio-economic and political agents of change; that is, population growth and the need for increased consumption, for example.

Pressures (actual human activities): Pressures result from the driving forces and relate to the use of natural resources. Pressures act directly on the environment to cause environmental change; that is, mining, agriculture, transportation and energy production, for example.

State: This is the condition of the environment that results from the pressures. The state can be observed in various themes, such as the extent of cultivation, extent of degraded land and level of air pollution.

Impacts: These are consequences or impacts of the state on the environment and sustainability. The impacts are either positive or negative and reflect changes to environmental, economic or social systems, such as the fragmentation of natural habitat that reduces the productivity of ecosystems.

Responses: These are actions taken to mitigate/prevent negative environmental impacts, address damage or protect natural resources, such as improved monitoring and compliance.

1.4 What process was followed?

In order to determine the state or condition of the environment, it was necessary to identify broad themes of environmental issues. Guided by the standard set of themes in the national directive, the themes identified and used in this report are climate change, land and transformation, water resources, biodiversity and ecosystem health, waste management, energy, air quality and atmosphere, environmental governance, economics and human settlements.

It was necessary to have a set of common measurements that help to quantify, monitor and report on the environmental changes within each of these themes. For this reason indicators were chosen that were relevant to the 10 environmental themes. The selection of indicators[2] was guided by the review of international, national and local indicators, including those developed by LEDET in 2004 and 2006.

[2] Refer to the *Indicators Report, March 2016*, for more detail on how the list of indicators was identified.

Data on each indicator was assessed[3] and analysed in order to determine trends. It is important to note that indicators provide a glimpse of a situation at a particular point in time. They do not tell the full story. Trends, on the other hand, allow for conclusions to be drawn over time. Unfortunately rigorous data is not always available; yet, trends in a broader sense can often be detected through anecdotal data and extrapolations.

Drivers of environmental trends, specific pressures, states, impacts and responses were then identified, and their connections and linkages researched, often with specialist input and through talking to a range of stakeholders across the Province. These drivers, pressures, states, impacts and responses can be readily positioned across themes. The DPSIR Framework is integral to the reporting process.

1.5 Gaps and Limitations

In compiling the LEO Report, the following gaps and limitations were identified:

- As in most applied research, there were time constraints. Combined with the vast scope of factors that affected the environment, this meant that an in-depth investigation of all aspects was not always possible, although all available information was sourced.

- Variability in the quality, accuracy and level of confidence in available data is recognised and data was sourced from all available and accessible sources. Secondary source material was used where direct evidence was not available or dependable.

- The available information was not always reliable, consistent or comparable. Discrepancies were sometimes found in the statistics and projections provided by Statistics South Africa (StatsSA), national, provincial and Local Government departments, and external sources. Some key issues have also not been adequately addressed because of a lack of sufficient data.

While the above constraints sometimes affected minor details, the major trends presented in the LEO Report and the messages they bring are clear. Their magnitude and the timescales in which they occur bring an indisputable imperative and responsibility to respond in a timely manner.

1.6 Limpopo Province Profile

Limpopo is located in the north-eastern part of South Africa. The name is taken from the Limpopo River, which flows along the north-western and north-eastern boundaries of the Province. Limpopo shares its northern boundaries with three countries: Botswana, Zimbabwe and Mozambique, as illustrated in Figure 1 below. For this reason, the Province serves as a critical link between South Africa and Sub-Saharan Africa, accessed via nine border posts. The southern boundaries are shared with the Mpumalanga, Gauteng and the North West provinces of South Africa. The main transport route to the north is the N1.

Figure 1: Geographical location of Limpopo Province

[3] Refer to the *Indicators Implementation and Maintenance Catalogue, March 2016*, for more detail on how each indicator was assessed.

Limpopo is approximately 125 754 square kilometres (km^2) in extent (StatsSA, 2011) and represents 10.3% of South Africa's land area. It is the fifth largest of South Africa's nine provinces. Limpopo comprises five district municipalities (DMs), as illustrated in Figure 2 below. Capricorn, Sekhukhune, Mopani, Waterberg and Vhembe DMs are made up of 25 Local Municipalities (LMs).

Polokwane is the capital city of Limpopo, as illustrated in Figure 2. It is located centrally in the Province. Further north is Makhado and in the extreme north is Musina. Mokopane and Bela-Bela, with its popular mineral water baths, are located south-west of Polokwane. Other important towns in Limpopo include the major mining centres of Phalaborwa and Thabazimbi and the major agricultural centre of Tzaneen.

Figure 2: District municipalities and major urban centres in Limpopo Province

The vision in the Limpopo Development Plan (LDP) states that development in the Province aims "*to eliminate poverty, reduce inequality and improve the quality of life of the citizens of Limpopo, as visualised in the National Development Plan [NDP]*" (LPG, 2015). Development is further guided by key planning documents, which include the Limpopo Province Spatial Development Framework (LSDF) and the LGEP.

The population of Limpopo is just over 5.4 million (StatsSA, 2011) and represents 10.4% of the population of South Africa. Sepedi is the dominant language spoken in Limpopo, followed by Xitsonga and Tshivenda. However, in the Vhembe district, Tshivenda is the dominant language, followed by Xitsonga (StatsSA, 2011). There has been a steady increase in employment in Limpopo (up until 2011), with 29% of the workforce being formally employed. More than half (52%) of the population is unemployed (StatsSA, 2011).

Limpopo receives rain in summer and experiences hot summers. Winters are mild and mostly frost free. The northern and eastern parts of Limpopo have particularly subtropical climates. The Province is rich in natural resources. The eastern portion of the Province forms part of the Kruger National Park (KNP). The Mapungubwe National Park lies in the extreme north of the Province and is a World Heritage Site (WHS). Limpopo is home to three biosphere reserves: the Waterberg, Kruger to Canyons, and Vhembe Biosphere Reserves, as well as 43 Provincial Nature Reserves.

Limpopo lies within the Savanna and Grassland Biomes. The Province is home to three national centres of endemism: the Sekhukhune Centre, the Soutpansberg Centre and the Wolkberg Centre.

The top three (of nine) National Biodiversity Conservation Priority Areas are found in Limpopo. National Conservation Priority 1 is the North-eastern Escarpment; National Conservation Priority 2 is Sekhukhune Centre of Endemism; and National Conservation Priority 3 is the Waterberg DM Wet Grasslands.


Figure 3: Biodiversity resources in Limpopo Province

Limpopo is rich in mineral deposits and, therefore, has a well-developed mining industry, which contributes 36% to the economy of the Province. Mineral assets include platinum group metals, iron ore, chromium, coal, diamonds, antimony, phosphate, copper, gold, emeralds, scheekte, magnetite, vermiculite, silicon and mica. Fifty-five percent (55%) of the untapped coal resources in South Africa are found in Limpopo.

Limpopo, being the *breadbasket* of South Africa with its wide variety of crops and livestock farming, is a major contributor to the South African agricultural sector. The major commercial horticultural crops in Limpopo include sunflower, citrus, wheat, maize, soya beans, potatoes, tomatoes, mangoes, avocado, lucerne and macadamias.

1.7 Drivers and Pressures

The environment is made up of a complex set of components and interactions that are in a constant state of flux. There is a need for sustainable growth that allows for the use of natural resources without compromising the livelihoods of future generations.

Environmental change occurs as a result of *forcing* by primary agents or *drivers*. Drivers can be either natural forces, such as climate change, or human-induced forces, such as economic development or population growth. Pressures describe specific activities or interactions between humans and the environment that result from the broader driving forces. Pressures can be both positive and negative.

There are five primary drivers of change: human settlements, climate change, governance, water, and energy production and consumption. All these drivers put increased pressures on environmental resources, if the drivers are not positive towards or supportive of the protection of the ecosystem and the goods and services it provides.

1.7.1 Human Settlements

The main human-induced drivers of environmental change are population and economic growth. As population numbers increase, there is an increased demand for goods and services. In order to meet increased demand and supply there is an increased demand on natural resources. This results in environmental change. The driving force of population increase and economic growth extends beyond the boundaries of the Province.

Limpopo's population of 5.4 million is increasing at a rate of 0.82%, which is a relatively low rate compared to other provinces. However, Limpopo is the poorest province in South Africa (StatsSA, 2011) and 63.8% of the population lives below the poverty line. This means that households are heavily reliant on the natural environment for resources, such as wood for energy use. Human activities cause environmental degradation when natural systems can no longer support these demands. The heavy reliance on the natural environment is further exacerbated by the lack of infrastructure in Limpopo.

1.7.2 Climate Change

Climate change is a major driver of environmental change in Limpopo Province, South Africa and globally. When talking about climate, reference is made to the long-term average weather patterns of a given region (that is, temperature, pressure and precipitation). In this context, 'climate change' refers to perceived increases in the long-term average temperature of the Earth's climate system. This temperature increase alters typical processes in the hydrological cycles and modifies the air and ocean currents. As a consequence, social, biological and ecological systems are also affected. This poses a serious threat to food supply, health, the availability of water resources and economic growth.

The understanding of climate change has been growing and today scientists are 95% certain that the perceived increases in global temperature are mostly caused by the concentration of Greenhouse Gases[4] (GHGs) in the atmosphere (IPCC, 2014). Solar radiation penetrates the Earth, warming its surface. However, only a fraction of this radiation is returned back to space, as most of it is trapped by the accumulation of these GHGs. The trapped radiation is reflected back to heat up the surface of the Earth and increases temperatures, similar to the functioning of a greenhouse. Most of the GHGs are present naturally in the atmosphere in small proportions. However, since the industrial revolution their concentration has risen notably. This rise has primarily been linked to the combustion of fossil fuels, driven by the demand for energy, goods and services, and to the conversion of natural ecosystems for intensive land use.

The energy sector in South Africa is responsible for about 89% of the natural emissions of Carbon Dioxide (CO_2), mainly from energy industries (57%), transportation (9%), and manufacturing and construction (9%) (DEA, 2014). Limpopo is one of the most vulnerable provinces in South Africa in terms of resilience and the capacity to adapt to climate change.

1.7.3 Governance

Governance is a driver of changing environmental conditions. Poor governance can lead to environmental degradation, depletion of essential resources, the failing of essential ecosystem services and loss of biodiversity. Good governance, on the other hand, can promote integrated development, ensure sustainable use of natural resources and provide well-targeted environmental protection.

Overarching policy can also drive the changing state of the environment. Policy goals that prioritise economic growth and short-term economic benefit over balanced sustainable development can have a negative impact on environmental health and, therefore, on the ability of ecosystems to provide valuable goods and services over the long term. Ecotourism, game ranching and hunting industries represent driving forces that may result in positive or negative environmental change, depending on the approach taken.

Insufficient awareness of the value of the environment and of the adverse impacts that diminishing natural goods and services have on development, the impact of declining environmental health on the people and the lack of political will to respond accordingly represent negative driving forces. These drivers can translate into pressures that have a direct impact on the state of the environment, such as lower budgetary allocations to environmental management, poor decision-making, staffing shortages and insufficient skills in critical functions, such as environmental compliance and enforcement, research and development, and conservation.

A rise in environmental crimes and a move towards harder criminal activity driven by increasing demands for wildlife products both in South Africa and internationally constitute a key threat to Limpopo's environment and to the opportunities available through responsible tourism

[4] The primary GHGs in the Earth's atmosphere are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), chlorofluorocarbons (CFCs) and water vapour (H_2O). A GHG is any gaseous compound in the atmosphere that is capable of absorbing infrared radiation, in this way trapping and holding heat in the atmosphere. By increasing the heat in the atmosphere, GHGs are responsible for the greenhouse effect, which ultimately leads to global warming. The most significant GHGs are water vapour (H_2O), carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).

development. Other environmental pressures in the Province include the need for greater energy supply in the form of fuel and electricity production, intensification of the amount and rate of resource consumption and pollution in various forms (air pollution, solid waste and effluent discharge), and unsustainable harvesting and extraction of both renewable and non-renewable resources.

1.7.4 Water

Demand for and use of water in Limpopo are increasing owing to population growth, growing demand for water for sanitation, water services, agriculture, mining activities and urbanisation. Added to these drivers is the issue of climate change as increasing temperatures, erratic rainfall and drought increasingly influence water scarcity in Limpopo.

Common activities that place pressure on the water resources in Limpopo include increased abstraction of water (from both ground and surface sources) beyond the ecological reserve, the construction of infrastructure and modification of river channels and the contamination of freshwater in watercourses.

Commercial mining is a major contributor to the Limpopo economy, as well as being a driver of environmental degradation in the Province. The heavy reliance on water and the pollution that is caused by mining activities result in increased pressure on the water resources in Limpopo.

1.7.5 Energy Production and Consumption

Energy generation and consumption are important drivers in Limpopo. The influence of these factors extends beyond the boundaries of the Province because the Province has large mineral industry and power-generation facilities in place to contribute to the economic growth requirements of South Africa.

Other factors, such as urbanisation levels, population age, household size, transport systems and ambient temperature, also influence not only the amount of energy required but also the patterns of consumption. Consumption patterns (the amount of energy and efficiency of use of such energy) ultimately determine the overall impact on the environment through the various pressures.

Figure 4: Large-scale commercial agriculture and mining activity in Limpopo Province

The activities in the Province that drive energy consumption comprise coal power stations, industry (including mining), transportation and residential land use. The amount of energy that is consumed is related to efficiency of use and this, in turn, depends on the technology of the applications. The nature of this energy consumption determines whether there is room for improvement in energy carriers or energy efficiency.

1.8 How is all of this connected?

Within the environment, complex interactions occur between living (plants, animals, organisms and humans) and non-living elements. These elements do not exist in isolation and together form an intricate ecosystem in which people also play an important role. If one part of the environment is affected (either negatively or positively), adjustments, changes and reactions occur in other parts. Understanding and identifying the state of the environment, therefore, call for an understanding not only of the state, impact and responses within each thematic chapter in this report but also of the linkages between the different themes.

The drivers and pressures are also linked, as are impacts and responses. For example, economic growth drives mining activity, which has a strong link to socio-economic welfare. Mining activity puts pressure on both land and water resources, which results in negative impacts. Similarly, responses to these outcomes are multiple and cross-cutting, and can have both positive and negative effects.

The LEO Report is designed to elucidate the relationships and interactions and to assist the political decision-makers, as well as all other parties that are in a position to change the drivers and stem negative pressures, to discover the appropriate responses and act accordingly – while there is still time.

1.9 References

DEA. 2014. *GHG National Inventory Report South Africa 2000-2010.* Department of Environmental Affairs, GIZ, Pretoria.

IPCC. 2014. *Climate Change 2014 Synthesis Report – Summary for Policymakers*. Intergovernmental Panel for Climate Change.

Limpopo Provincial Government (LPG). 2015. *Limpopo Development Plan (LDP) 2015 – 2019.*

Statistics South Africa (StatsSA). 2011. *Census 2011 Community Profiles*.

2 Environmental Themes

2.1 Climate Change

2.1.1 Introduction

Climate change is a global phenomenon with wide ramifications that are bound to have increasingly profound impacts on nature and human life on the Planet. It is here to stay. It is also cross-cutting, with many interlinked effects that we are only beginning to understand. Climate change is treated as the first of the environmental themes, so that the reader can bear in mind these interlinkages as the reader reads through the rest of the document.

Africa is one of the most vulnerable continents to climate change because of multiple stresses and low adaptive capacity. The Southern African Region is prone to the occurrence of droughts and floods (Meadows, 2006) and Limpopo Province is no exception. The main concerns in Limpopo are increased water stress, higher temperatures and a reduction in agricultural activity and production, which affect food security and cause malnutrition. Limpopo is likely the most vulnerable province in South Africa in terms of resilience to climate change.

During the last five decades, the mean average temperature in South Africa has increased by 1.5 times that of the observed global average of 0.65 degrees Celsius (°C). Maximum and minimum temperatures have increased across South Africa and rainfall has shown high inter-annual variability. There are fewer rain days almost everywhere in South Africa than before, especially during the autumn months (DEA, 2013). Limpopo is particularly vulnerable to climate change, especially in the northern and southern regions (DRDLR, 2016). Extreme climate events and the low adaptive capacity of Limpopo are placing pressure on vulnerable communities and ecosystems. It should be noted that climate change has a cross-cutting effect and influences all aspects of the environment and (because of the close reliance of people on the environment) human life itself.

The indicators used to assess climate change in Limpopo are described in Table 1 below.

Table 1: Indicators used in the assessment of Climate Change in Limpopo Province

INDICATORS	DESCRIPTIONS AND COMMENTS
Rain	Annual rainfall for different stations across the Limpopo Province
Temperature	Average minimum and maximum temperature across Limpopo
Evaporation	Potential evapotranspiration
Disturbance regimes: flood, drought and fire	Standardised Precipitation Index (SPI) comparison Area burned per year
Carbon footprint	Estimated carbon dioxide (CO_2) emissions per type of source

Four climatic regions can be distinguished in Limpopo Province:

a The subtropical plateau, a flat, elevated interior area hot and dry with winter rain;
b The moderate eastern plateau with warm to hot and rainy summers, and cold dry winters;
c The escarpment region with colder weather because of the altitude and rain all year around; and
d The subtropical Lowveld region, of hot-rainy summers and warm-dry winters, also known as the South African Bushveld.

2.1.2 State

Climate change is becoming increasingly apparent in Limpopo. The usual manifestations of climate change are evident in the long-term changes in weather patterns, such as rainfall or temperature.

2.1.2.1 Rainfall

Typical rainfall for Limpopo ranges from 200 millimetres (mm) in the hot dry areas to 1 500 mm in the higher rainfall areas. Most precipitation occurs between October and April. Rainfall in Limpopo varies significantly over the years. There has been a perceptible decrease in the total rainfall on much of the eastern part of Southern Africa, including most of the Limpopo River Basin (Malherbe *et al.*, 2012). This can have serious impacts on the water balance of the region, which affect the largely rural population dependent on rainfall for subsistence agriculture.

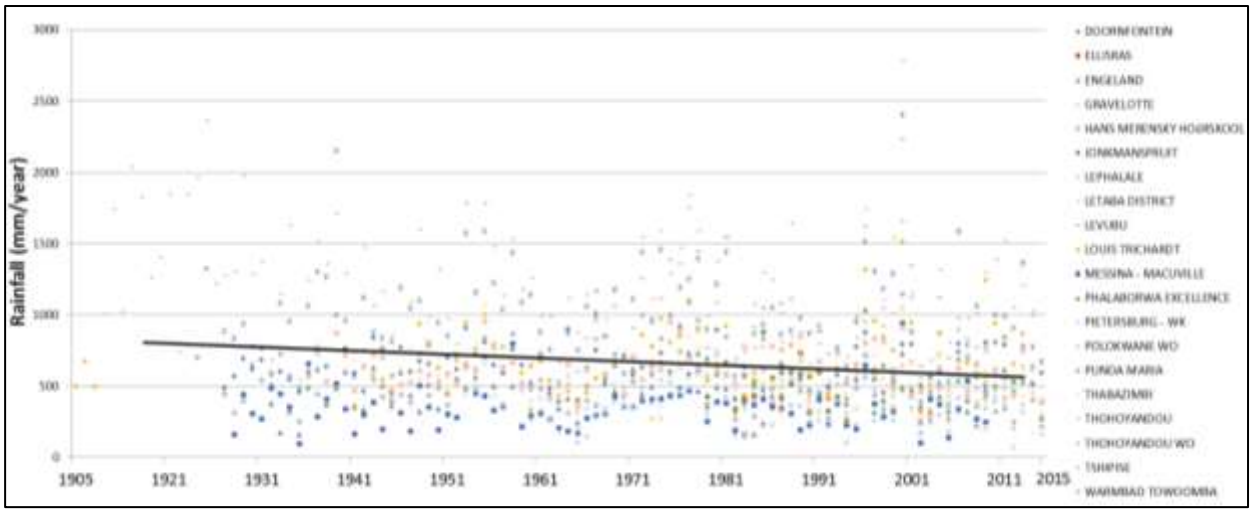
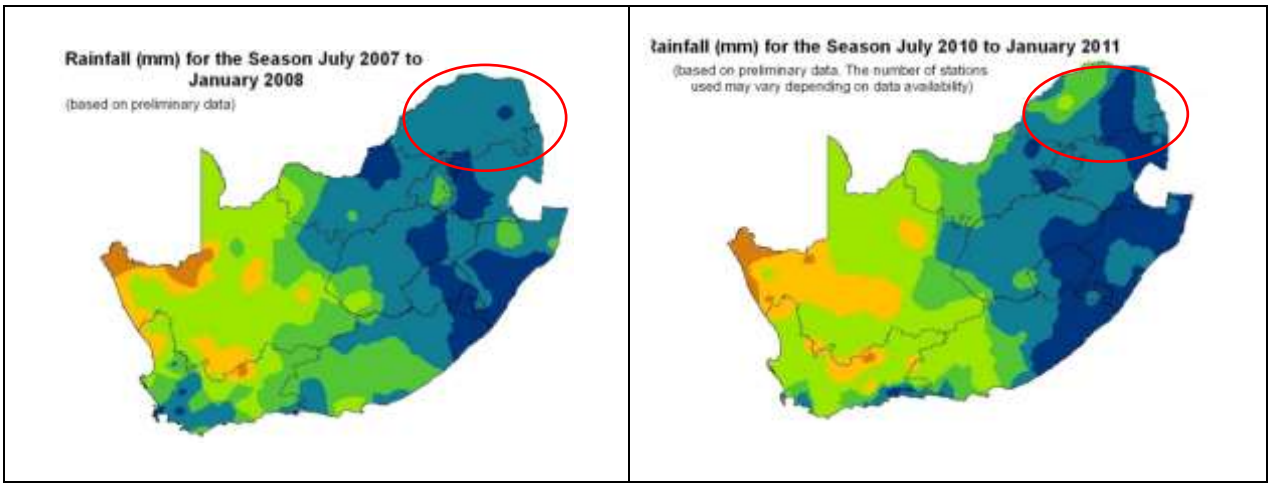


Figure 1: Annual rainfall in Limpopo Province (SAWS, 2013)

Figure 1 shows the annual rainfall for the period 1905 to 2015 as recorded at different stations across the four Limpopo Climatic Zones. Inter-annual variations are observed as expected, and a decreasing trend is seen. A comparison of rainfall for the season July to January for three different periods presents a notable reduction in the rainfall over Limpopo and the rest of South Africa (Figure 2).



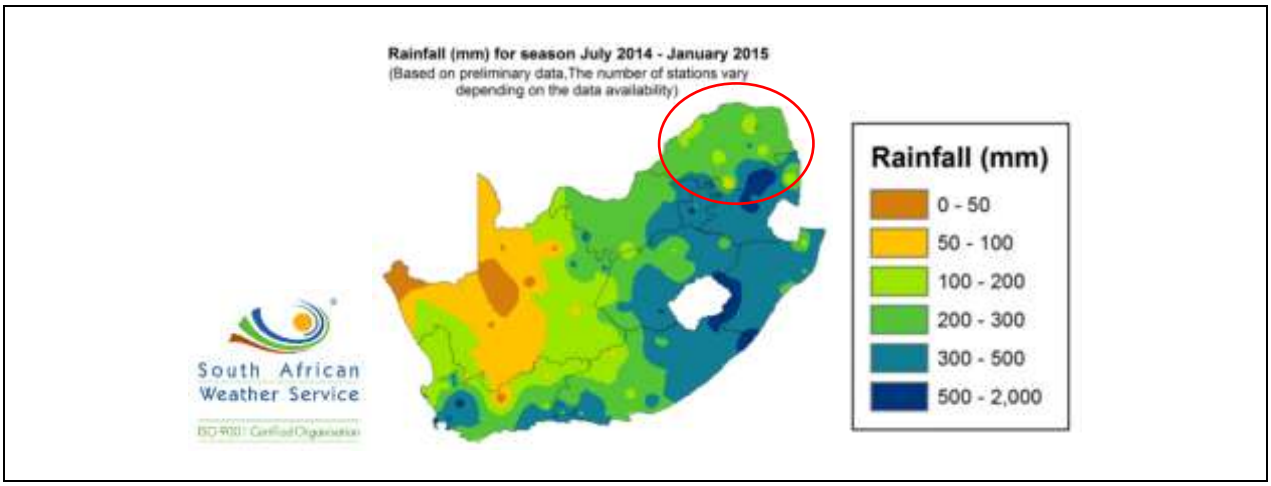


Figure 2: Rainfall for South Africa in millimetres for the season July 2007 – January 2008 (top left), July 2010 – January 2011 (top right) and July 2014 – January 2015 (bottom) (SAWS, 2015c)

2.1.2.2 Temperature

Evidence from the temperature observations indicates a strong warming trend across Limpopo. This has already manifested itself over Southern Africa (Kruger & Shongwe, 2004). Projected increases in air temperatures for South Africa are likely to be higher over the interior and lower over the coast (DST, 2010).

Average annual minimum and maximum temperatures for the last 80 years across Limpopo are illustrated in Figure 3. The increasing trend is recognisable, with the average minimum and average maximum increase in temperature since 1935 at 1.5°C and 0.6°C respectively.

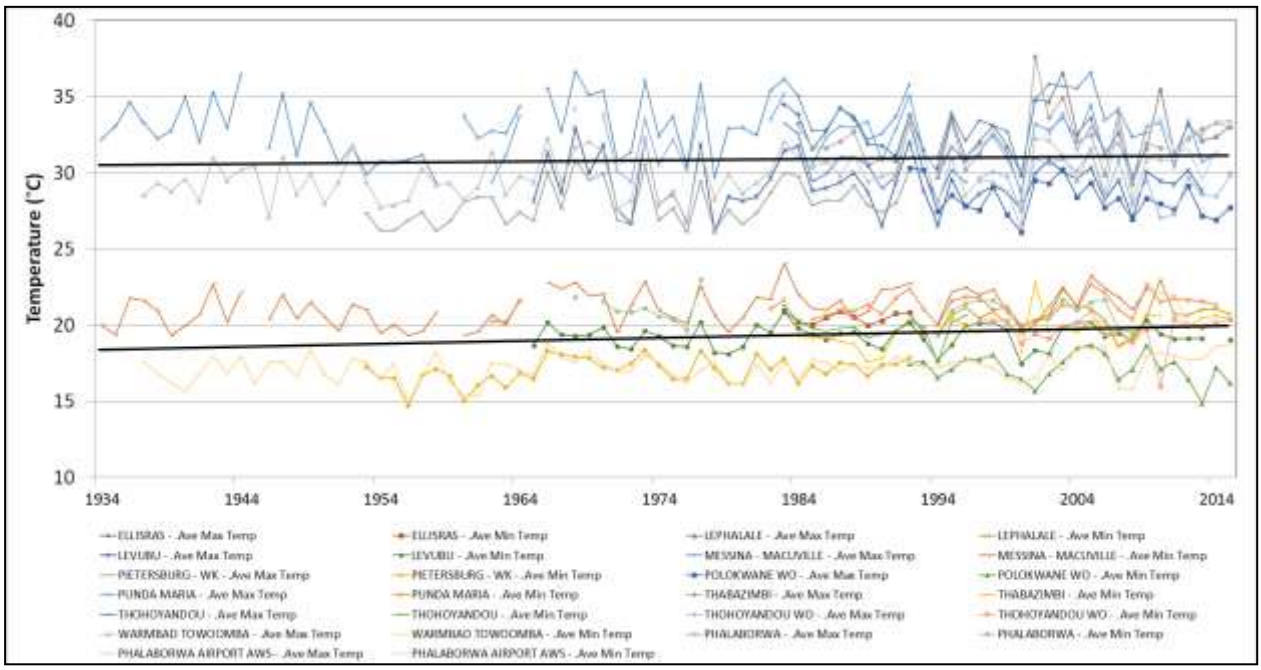


Figure 3: Average minimum and maximum annual temperature in Limpopo Province since 1935 (SAWS, 2015a)

2.1.2.3 Evaporation

High levels of evaporation mean that the soil dries up quickly, which reduces the amount of water available for plant uptake. This results in crops being more prone to drought. Dry land subsistence farming is generally not viable, given the variable rainfall, high evaporation and high evapotranspiration. Evaporation is highest during the rainfall season and it significantly reduces effective rainfall, runoff, soil infiltration and groundwater recharge. The evaporative demand in Limpopo ranges from about 2 mm to 5 mm per day.

Figure 4 presents the calculated potential evapotranspiration for the month of September 2015. Calculations are based on measured temperature, humidity, wind and solar radiation data.

Potential evapotranspiration remains high for Limpopo, especially in the western regions. The projected increase in temperature will partially offset any increase in rainfall, owing to an increase in potential evaporation of about 5% per 1°C (Schulze, 2010), which translates into less water available for use in the future.

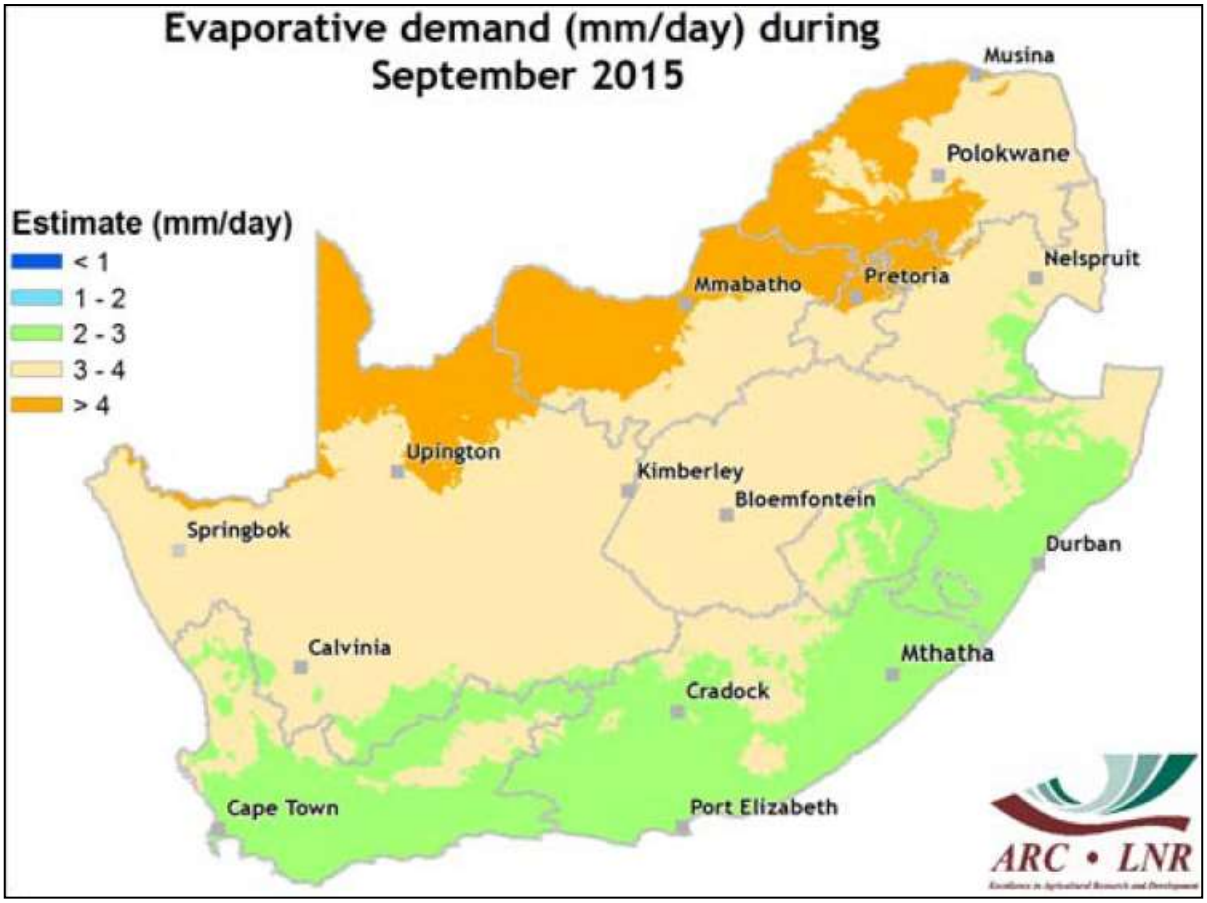


Figure 4: Evaporative demand (millimetres per day) across South Africa during September 2015 (ARC, 2015)

2.1.2.4 Disturbance Regimes

The increase in extreme weather events may be at least partially attributed to the significant increase in surface temperatures over the region. Such an increase would be favourable to the occurrence of heat convection and convective rainfall. For South Africa, high impact weather events, such as heat-wave days and high-fire-danger days, are consistently projected to increase drastically in their frequency of occurrence (Engelbrecht *et al*., 2015). Reference is made in the following subsections to some events, such as drought, floods and fires, although quantification of such is undertaken post event only, as events cannot be predicted. Record keeping and trend observations of events are important for monitoring and managing resilience to climate variability and extreme weather events in terms of disaster management.

2.1.2.5 Drought

Drought is considered one of the most complex and least understood of all natural hazards and affects more people than any other hazard. It is also the natural disaster in Southern Africa with the greatest economic, social and environmental impacts (Buckland, Eele & Mugwara, 2000). It is believed that at least 60% of Sub-Saharan Africa is vulnerable to drought and probably 30% is highly vulnerable. Extreme drought in the Limpopo River Basin is a regular phenomenon and has been recorded for more than a century at intervals of 10 to 20 years. The periodicity of droughts is not necessarily predictable (FAO, 2004).

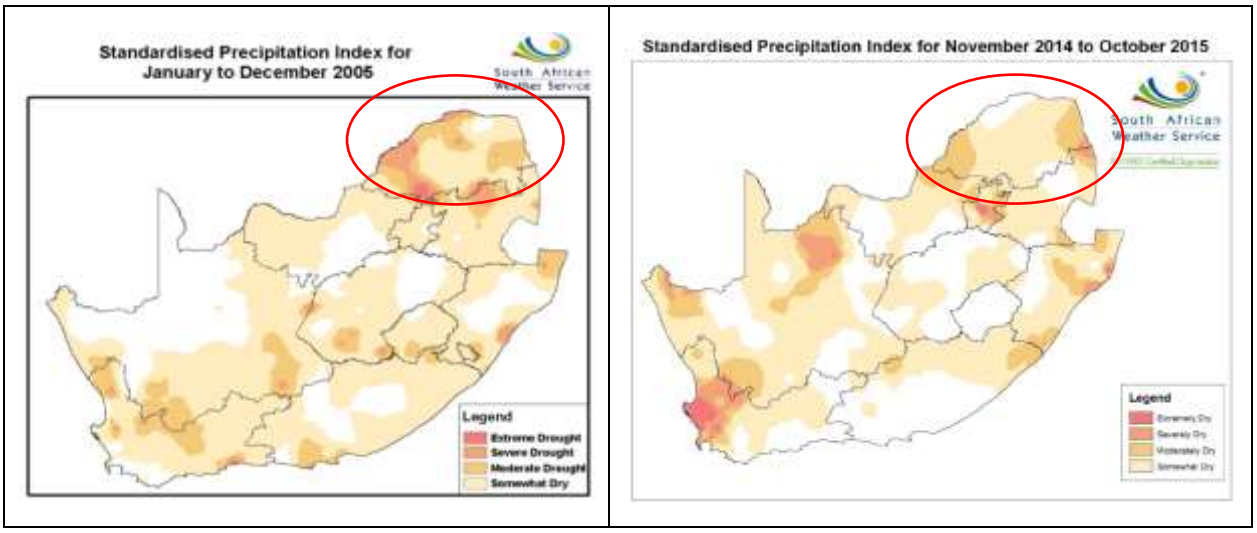


Figure 5: Standardised Precipitation Index for South Africa for period January-December 2005 (left) and November 2014-October 2015 (right) (SAWS, 2015b)

Defining and monitoring drought are difficult tasks, owing to its diverse geographical and temporal distribution. On the basis of rainfall events, the Standard Precipitation Index (SPI) is the most common tool used to investigate drought. The SPI gives the deviation of rainfall events in a selected time scale from the long-term mean. An example of an SPI calculated for South Africa is illustrated in Figure 5 above.

2.1.2.6 Floods

Short duration-intense rainfalls result in floods that can potentially cause serious problems for urban infrastructure (for example, dams, bridges and stormwater systems), population of informal settlements located in and near to floodplains, and agriculture. The impacts of and economic losses from extreme events are such that focus on climate change analysis of extreme events rather than changes in climatic means is recommended by some studies (Von Storch & Zwiers, 1988). The global risk platform[5] indicates the average economic loss for a country caused by disasters. The estimated amount for South Africa during the period 2005 to 2014 was of 118 million United States Dollars. Thirty percent (30%) of this amount is due to flood events and 20% from storm events.

Disaster Management Plans

According to the Limpopo Disaster Management Framework of 2007, Disaster Management is a functional area of concurrent competence of National and Provincial Legislature, in terms of Part A of Schedule 4 of the Constitution of the Republic of South Africa (LPG, 2007).

Sections 28 and 43 of the Disaster Management Act, Act No. 57 of 2002, prescribe that provinces and municipalities must establish and implement a disaster management framework, while sections 29 and 43 of the same Act also compel provinces and municipalities to establish disaster management centres.

The Limpopo Provincial Disaster Management Framework is to guide the development and implementation of the disaster management function in Limpopo.

[5] http://www.preventionweb.net/countries/zaf/data/

The projected change in the frequency of extreme rainfall events is defined as 20 mm of rain falling within 24 hours over an area of 1 x 1 metre[6] (Engelbrecht *et al.*, 2012). Recent information regarding changes in extreme rainfall events and heavy daily rainfall in Limpopo and South Africa is limited. Higher rainfall projections with less rainfall days indicate that the possibility of severe rain events may increase (CSIR, 2010).

2.1.2.7 Fires

Other serious impacts brought about by drought and aggravated by strong winds are the devastating veld fires, which occur naturally (for example, as a result of lightning strikes) and as a result of human activity. Both of these types of veld fire destroy large areas of grass and place pressure on grazing. Commercial timber and orchards are also prone to damage at such times (SAWS, 2015d). The Waterberg and Mopani District Municipalities (DMs) are particularly susceptible to experiencing fires in grassland, bushland and woodlands areas, especially during the months of July to September. Figure 6 illustrates the total annual burned area in Limpopo for the period 2001 to 2007 as recorded from satellite images. Veld fires also contribute significantly to Greenhouse Gas (GHG) emissions.

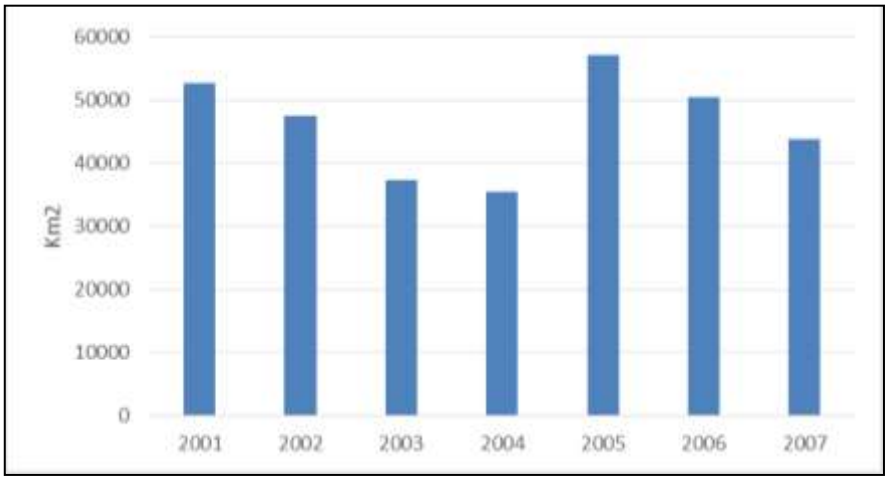


Figure 6: Total annual area burned in Limpopo Province, 2001 – 2007 (NASA)

2.1.2.8 Carbon Footprint

A carbon footprint is the total amount of GHG emissions produced (directly or indirectly) by human activities. Carbon footprint is usually expressed in equivalent tons of carbon dioxide (tCO_{2eq}).

The latest published national GHG inventory for South Africa was conducted for the period 2000 to 2010 and found energy generation as the main contributor to national emissions of GHG (78%) (DEA, 2014). This inventory is developed at national level and does not indicate emissions per province. To date, no published GHG inventory exists for Limpopo.

For the development of this document, an estimation of GHG emissions for Limpopo was made on the basis of available information from different sources. The summary is presented in Table 2 (refer overleaf). Similar to national results, power generation is the main contributor to the CO_{2eq} emissions in Limpopo.

2.1.2.9 Carbon Sequestration

'Carbon sequestration' refers to the process in which CO_2 is captured from the atmosphere or anthropogenic activities, such as power generation and power placed into long-term storage. Plants play a role in carbon sequestration through the process of photosynthesis, where CO_2 is absorbed by plant leaves from the atmosphere and broken down into the two elements carbon and oxygen (O_2). The O_2 is released back into the atmosphere, while the carbon is used for plant

[6] 1 square metre (1 m^2)

growth and is, therefore, stored in the stems, roots and leaves of the plant. During winter or once a plant dies some of the carbon stored within the plant is broken down and stored in the soil.

A carbon sink is anything that absorbs more carbon than it releases, whilst a carbon source is anything that releases more carbon than it absorbs. Forests, soils, oceans and the atmosphere all store carbon and this carbon moves between them in a continuous cycle. The Kyoto Protocol, the international communities' main instrument for halting global warming, suggests that the absorption of CO_2 by trees and the soil is just as valid a means to achieve emission reduction commitments as cutting CO_2 emissions from fossil fuels (Sinkswatch, 2016).

An assessment was recently undertaken by the Department of Environmental Affairs (DEA) to quantify and describe the terrestrial carbon sinks[7] in South Africa (DEA, 2015). A conclusive report has resulted, which identifies the carbon stocks and fluxes across the country. The results and the associated error calculations allow realistic planning of future steps. The report aims to provide input to the national communications to the United Nations Framework Convention on Climate Change.

COP 21

At the Paris climate conference (Conference of Parties (COP) 21) held in December 2015, 195 countries adopted the first-ever universal, legally binding global climate deal. The agreement will be effected in 2020. The Paris Agreement is a bridge between today's policies and climate-neutrality before the end of the century.

Governments agreed to a long-term goal of keeping the increase in global average temperature to **well below 2°C above** pre-industrial levels; to aim to limit the increase to **1.5°C**, since this would significantly reduce risks and the impacts of climate change; on the need for **global emissions to peak as soon as possible,** recognising that this will take longer for developing countries; and to undertake **rapid reductions thereafter** in accordance with the best available science.

Before and during the Paris Conference, countries submitted comprehensive **national climate action plans**. These are not yet enough to keep global warming below 2°C, but the agreement traces the way to achieving this target.

Table 2 describes the estimated carbon dioxide equivalent (CO_{2eq}) for Limpopo Province, including the various sources of emissions.

Table 2: Estimated carbon dioxide equivalent (CO_{2eq}) emissions for Limpopo Province

SOURCE OF EMISSIONS	CARBON DIOXIDE EQUIVALENT (tpa)	PERCENTAGE TOTAL	SOURCE OF INFORMATION
Power generation (excluding Medupi[8])	25 000 000	82%	*Eskom[9] (2011)*
Small boilers	1 564 928	5.1%	*Limpopo Air Quality Management Plan (AQMP)* (LEDET, 2013)
Liquid fuels (excluding traffic)	1 229 001	4.0%	*Limpopo AQMP* (LEDET, 2013)
Agriculture – game	951 176	3.1%	(Du Toit, Van Niekerk & Meissner, 2013)
Biomass (veld fires)	715 367	2.3%	*Limpopo AQMP* (LEDET, 2013)
Traffic	578 214	1.9%	*Limpopo AQMP* (LEDET,2013)
Sanitation	178 964	0.6%	*Limpopo AQMP* (LEDET, 2013)
Agricultural – small stock	126 865	0.4%	(Du Toit, Van Niekerk & Meissner, 2013)
Brickworks	82 309	0.3%	*Limpopo AQMP (LEDET, 2013)*
Fertiliser manufacturing	43 305	0.1%	*Limpopo AQMP (LEDET, 2013)*
Solid waste	Not available	-	
Residential wood/coal	Not available	-	
Estimate Total Limpopo	30 470 130		
Estimate national emissions 2010	518 239 000		
Provincial % of national	5.9%		

[7] Medupi CO2 emissions expected = 0.75 tons per Megawatt hour (MWh) (about 32 million tons once fully operational).
[8] http://www.eskom.co.za/OurCompany/SustainableDevelopment/ClimateChangeCOP17/Documents/Air_quality_and_climate_change.pdf. This figure is only for the stations in Limpopo Province.
[9] When this information was made available the data for December was not included.

2.1.3 Impacts

Vulnerability caused by climate change typically depends on two factors: exposure and sensitivity to climate stress and the capacity to deal with the effects of that stress (Eakin & Luers, 2006).

South Africa's most recent *index of vulnerability to climate change* of the local municipalities is presented in Figure 7 (Turpie & Visser, 2012).

This vulnerability index was calculated taking into account two sets of variables: the climate-related potential impacts (for example, flood frequency, change in temperature, water stress) and the adaptive capacity (for example, infrastructure, governance).

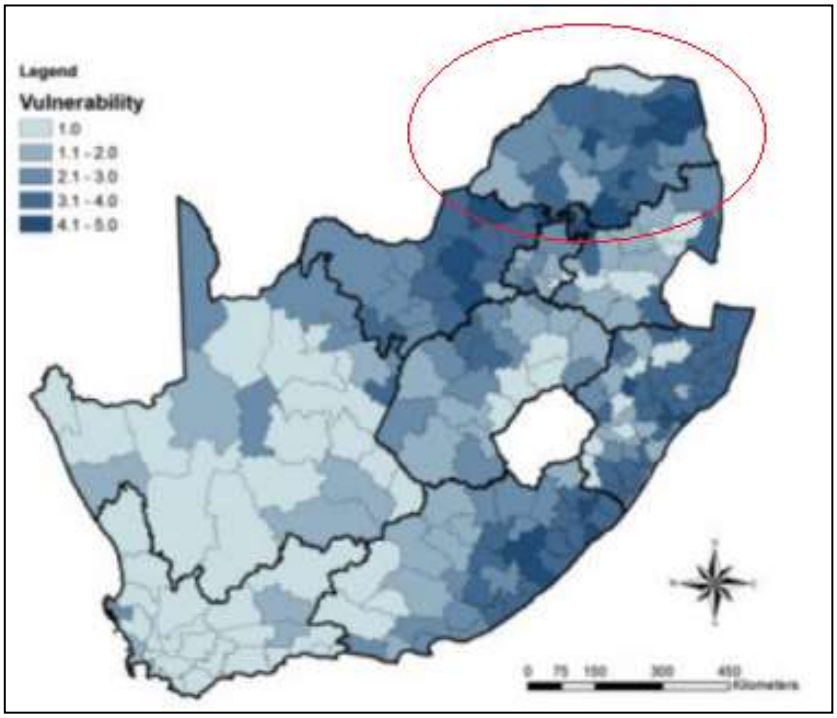


Figure 7: Index value of vulnerability[10] to climate change for municipalities across South Africa (Turpie & Visser, 2012)

The results place the municipalities of Limpopo in a highly vulnerable situation, particularly in zones corresponding to former homeland areas. Seven municipalities in Limpopo – Ephraim Mogale, Elias Motsoaledi and Fetakgomo in the Sekhukhune DM; Greater Giyani and Greater Letaba in the Mopani DM; Thulamela in the Vhembe DM; and Aganang in the Capricorn DM – are found on the list of the 20 municipalities that have been declared *highly vulnerable*. Limpopo is followed in number by the Eastern Cape Province, with five municipalities on the list. As the key areas that relate to this poor performance, the DMs have identified the need for improved governance, deforestation, waste management systems and infrastructure, among others (DEA, 2015c).

An important step towards building an adequate climate adaptation strategy for Limpopo is to identify the key areas of vulnerability, or conduct a Vulnerability Assessment. The current assessment reveals that the sectors in Limpopo that display greater climate change vulnerability, in relative terms, are agriculture, rural livelihoods and settlements, terrestrial and aquatic ecosystems, water supply, public health and safety, and disaster management (DEA, 2015b). A summary of the assessment is presented in Table 3 (refer overleaf).

[10] The higher the vulnerability score, the greater the vulnerability.

Table 3: Summary of climate vulnerability assessment for Limpopo Province[11]

SECTOR	SUBSECTOR	SENSITIVITY	EXPOSURE	RISK	ADAPTIVE CAPACITY	VULNERABILITY
Ecosystems	Aquatic (rivers, lakes, wetlands)	High	High	High	Low	High
	Terrestrial (biodiversity, forests, invasive species)	Medium	High	High	Low	High
Livelihoods	Rural	High	High	High	Low	High
	Urban	Medium	Medium	Low/Medium	Medium	Low/Medium
Economic Activity	Agriculture / Farming	High	High	High	Low	Medium/High
	Tourism	High	High	Medium	Low	Medium
	Extractives	Medium	High	Low/Medium	Low	Medium
Infrastructure and Utilities	Water Supply	High	High	High	Low	High
	Energy Supply	Medium	Medium	Medium	Low	Medium
	Transportation	Low	Medium	Medium	Low	Low/Medium
Public Health and Safety	Human Health (diseases etc.)	High	Medium/High	Medium/High	Low	High
	Extreme Weather / Disasters (wild fires, floods, drought)	High	Medium/High	Medium/High	Low	High

The findings of the assessment on climate change have yielded important information that has implications for the future planning of Limpopo. A summary of the climate change trends is presented in Table 4 below.

Table 4: Summary of climate change trends in Limpopo Province

INDICATORS	QUANTIFICATIONS	TRENDS
Rain	Overall decrease in rainfall across all climatic zones of Limpopo	Variable/Declining
Temperature	Increase in annual maximum/minimum average temperature	Increasing
Evaporation	High potential evapotranspiration across Limpopo: greater than 3 mm per day	Increasing
Disturbance regimes	Flood/Drought: No available reports on number of events per year. Differences in geographical extension, duration, severity, and the like, make it difficult to *quantify* these elements with a comparative purpose. Fire: Variable	Uncertain[12]
Carbon footprint	Estimated CO_2eq: 30 470 130 tpa	Uncertain[13]

It is clear from Table 4 that the average temperatures are increasing and this in itself has significant and cross-cutting implications for development, the management of ecosystems and human well-being.

[11] This information was in draft form at the time of publishing the LEO 2016 Report.
[12] Not enough information to draw a trend.
[13] Not enough information to draw a trend.

2.1.4 Responses

2.1.4.1 National Response

The national response to climate change involves two approaches: the mitigation approach, by reducing GHG emissions, and the adaptation response, which involves preparing to deal with the climate change impacts. Mitigation plans are outlined in the National Climate Change Response White Paper, which presents the target of reducing 34% and 42% of the Business as Usual GHG emissions by 2020 and 2025 respectively. Other mitigation initiatives include the development of renewable energy projects through the Renewable Energy Independent Power Producer Procurement Programme (REIPPP), the Energy Efficiency Strategy and the Solar Water Heater Rebate Programme.

Intended Nationally Determined Contributions (INDCs)

Countries across the globe committed themselves to creating a new international climate agreement by the conclusion of the United Nations Framework Convention on Climate Change Conference of the Parties (COP21) in Paris in December 2015. In preparation, countries have agreed to publicly outline what post-2020 climate actions they intend to take under a new international agreement, known as their Intended Nationally Determined Contributions (INDCs). The INDCs will largely determine whether the world achieves an ambitious 2015 agreement and is put on a path toward a low-carbon, climate-resilient future (WRI, 2016).

On 25 September 2015, South Africa submitted its Intended Nationally Determined Contribution (INDC), which includes the target of reducing its GHG emissions to between 398 and 614 metric tons (mt) of CO_{2eq} over the period 2025 to 2030.

Regarding adaption strategies, the efforts from the National Government include the development of the Long-Term Adaptation Scenarios and Climate Change Vulnerability Assessment (DEA, 2013) to ensure that food, water and energy security and infrastructure are not negatively impacted by climate change. As for the implementation of high climate change adaptation projects, the South African National Biodiversity Institute (SANBI) has selected two areas for these projects, of which one will be in the Mopani District of Limpopo.

2.1.4.2 Provincial Response

In terms of provincial response, identification of the needs for and intentions of shifting towards a green, low carbon economy were stated in the Limpopo Employment, Growth and Development Plan of 2009-2014. The first official step is presented in 2011, with the Limpopo Green Economy Plan: Climate Change Response. This document highlights the advantages that Limpopo has in implementing a green economy and defines short-, medium- and long-term interventions in 10 key focus areas. The goals focus on job generation, improvement of environmental quality, and creation of conditions for green growth and different production patterns.

In 2013, the Climate Change Response Tool for Municipalities in Limpopo exposed the vulnerability of each of the municipalities, identified critical issues related to climate change for each one of them and appointed a responsible person for action. Currently, Limpopo is completing the Provincial Climate Change Vulnerability Assessment and Adaptation Strategies Project, which started in January 2015. This project aims to assess the sensitivity and vulnerability of the different systems in Limpopo and the adaptation capacity that these systems have for facing climate change and its potential impacts. Conclusions of this project are expected mid-2016. However, preliminary results have been included in this chapter, where possible.

2.1.4.3 Adaptation

Limpopo is perhaps the province that is most vulnerable to climate change in South Africa. Besides expecting a high increase in temperatures, strong variations in rainfall patterns and greater frequency of extreme events, Limpopo is also very susceptible as it already faces multiple pressures from poverty, inadequate housing and poor access to services, to name a few. Observed data indicates increases in temperatures and variations in rainfall across Limpopo and it could be said (considering historical metrological data) that Limpopo is already experiencing the effects of climate change. The consequences of experienced extreme

weather events between 2014 and 2015 are exposing the lack of preparation of Limpopo to handle climate variations.

Notable efforts have been made by the Limpopo Provincial Government in the development of a framework and strategies to address mitigation and adaptation. However, the lack of appropriate changes in governance limits improved resilience. It is expected that the biggest challenge that mitigation and adaptation plans face will be integration and effective implementation at local municipal level.

Recorded changes in rainfall, temperature, evaporation and GHGs are indicators for monitoring climate change. Additionally, Limpopo should be able to display the efficiency of mitigation and adaptation efforts. Therefore, a quantification of carbon footprint and a vulnerability assessment are recommended to be included in further reviews of the state of the environment. A rough estimation of GHG emissions presents power generation as the biggest source of emissions in Limpopo. Agriculture, rural settlements, aquatic ecosystems and water supply are the sectors that are most vulnerable to climate change. Public health and disaster management are also threatened in the medium term. Further recommendations include the following:

- Continued awareness raising and education among all stakeholders and levels of government regarding the implications of climate change;
- Implementation of climate adaptation measures at the local municipal level;
- Incorporation of climate change information into future spatial planning processes; and
- Implementation of actions through the Integrated Development Plan (IDP) mechanisms to put in place mitigation measures that improve resilience to climate change.

2.1.5 References

Agricultural Research Council (ARC). 2015. *Umlindi (September edition)*. Pretoria: Agricultural Research Council - Institute for Soil, Climate and Water.

Buckland, R., Eele, G. & Mugwara, R. 2000. *Humanitarian crises and natural disasters: a SADC perspective*. London: European Association of Development Research.

CSIR. 2010. *A climate change handbook for the North-Eastern South Africa.* Pretoria: Climate Change Research Group.

DEA. 2011. White Paper on the National Climate Change Response. Pretoria: Department of Environmental Affairs.

DEA. 2015. *2012 South Africa Environment Outlook*. Pretoria: Department of Environmental Affairs.

DEA. 2015. *Climate Support Program (CSP) Vulnerability Assessment*. Department of Environmental Affairs, GIZ.

DEA. 2015. *Climate Support Programme (CSP) climate change adaptation strategies. Adaptation Strategies for the Limpopo Province*. Department of Environmental Affairs, GIZ.

DEA. 2014. *GHG National Inventory Report South Africa 2000-2010.* Pretoria: Department of Environmental Affairs, GIZ.

DEA. 2013. *Long Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa. Climate Trends and Scenarios for South Africa.* Pretoria: Department of Environmental Affairs.

Department of Rural Development and Land Reform (DRDLR). 2016. Limpopo Province Spatial Development Framework (LSDF). Prepared by Plan Associates, Pretoria.

DST. 2010. *South African Risk and Vulnerability Atlas.* www.rvatlas.org: Department of Science and Technology.

du Toit, C., Meissner, H. & van Niekerk, W. 2013. Direct greenhouse gas emissions of the game industry in South Africa. *South African Journal of Animal Science, 43* (3).

du Toit, C., van Niekerk, W. & Meissner, H. 2013. Direct greenhouse gas emissions of the South African small stock sectors. *South African Journal of Animal Science, 43* (3).

Eakin, H. & Luers, A. 2006. Assessing the vulnerability of social-environmental systems. *Annual Review of Environment and Resources, 31*, 365-394.

Engelbrecht, C., Engelbrecht, F. & Dyson, L. 2012. High-resolution model-projected changes in mid-tropospheric closed-lows and extreme rainfall events over southern Africa. *International Journal of Climatology, 33* (1), 173-187.

Engelbrecht, F., Adegoke, J., Bopape, M.-J., Naidoo, M., Garland, R., Thatcher, M. *et al.* 2015. Projections of rapidly rising surface temperatures over Africa under low mitigation. *Environmental Research Letters*.

FAO. 2004. *Drought impact mitigation and prevention in the Limpopo River Basin: a situation analysis.* Rome: Food and Agriculture Organization of the United Nations.

IPCC. 2014. *Cimate Change 2014 Synthesis Report - Summary for Policymakers.*Intergovernmental Panel for Climate Change.

Kruger, A. & Shongwe, S. 2004. Temperature trends in South Africa: 1960-2003. *International Journal of Climatology* (15), 1929-1945.

LEDET. 2013. Provincial Air Quality Management Plan. Limpopo Department of Economic Development, Environment and Tourism, Polokwane.

Limpopo Provincial Government (LPG). 2015. Limpopo Disaster Management Framework of 2007.

Malherbe, J., Engelbrecht, F. & Landman, W. 2012. Projected changes in tropical cyclone climatology and landfall in the Southwest Indian Ocean region under enhanced anthropogenic forcing.

Meadows, M. 2006. Global change and southern Africa. *Geographical* (44), 135-145.

NASA. (n.d.). *Moderate Resolution Imaging Spectroradiometer (MODIS)*. Retrieved 10 03, 2015, from https://earthdata.nasa.gov/earth-observation-data/near-real-time/download-nrt-data/modis-nrt.

SAWS. 2015. *Annual rainfall, min/max temperature*. Pretoria: South African Weather Services.

SAWS. 2015. *Drought monitoring – October*. Pretoria: South African Weather Services.

SAWS. 2015. *Historical Rain Maps*. Retrieved 11 30, 2015, from http://www.weathersa.co.za/climate/historical-rain-maps.

SAWS. 2015. *What kind of droughts does South Africa experience?* Retrieved 11 30, 2015, from http://www.weathersa.co.za/learning/climate-questions/36-what-kind-of-droughts-does-south-africa-experience.

Schulze, R. 2010. *Atlas of climate change and the South African agricultural sector: a 2010 perspective*. Pretoria: Department of Agriculture, Forestry and Fisheries.

Sinkswatch. 2016. *Carbon Sinks 101*. Retrieved 22 03 2016, from http://www.sinkswatch.org/campaign/carbon-sinks-101.

Turpie, J. & Visser, M. 2012. The impact of climate change on South Africa's rural areas. In *Technical Report: Submission for the 2013/14 Division of Revenue - For an Equitable Sharing of National Revenue* (pp. 127-220). Midrand: Financial and Fiscal Commission.

Von Storch, H. & Zwiers, F. 1988. Recurrence analysis of climate sensitivity experiments. *Journal of Climatology* (1), 157–171.

World Resources Institute (WRI). 2016. *What is an INDC?* Retrieved 23 03 2016, from http://www.wri.org/indc-definition.

WDI. (2011). *The World Bank data*. Retrieved 11 14, 2015, from http://data.worldbank.org/indicator/EN.ATM.CO2E.KT/countries?order=wbapi_data_value_2011%20wbapi_data_value%20wbapi_data_value-first&sort=desc&display=default.

2.2 Land and Transformation

2.2.1 Introduction

Land is the basis for many life-support systems and supports the production of biomass that provides food, fodder, fibre and fuel for human and animal use. Land is an essential natural resource in other respects. It enables ecological functions, such as the provision of biological habitats and gene reserves for plants, animals and micro-organisms; climate regulation; provision of raw materials and minerals for human use; regulation of water quality and quantity (flow and storage); control of waste and pollution through the receiving, filtering and transformation of nutrients and hazardous compounds; provision of a physical basis for human settlements and industry; and storage and protection of the cultural history of humankind.

South Africa's historical background places land resources under tremendous political, socio-economic and environmental pressure. All these pressures emanate from past inequitable land distribution and ownership, spatial variability in land management and unsustainable land use practices (DEA, 2012b).

Land in South Africa has enormous economic, social and environmental value. A large proportion of the land surface in South Africa is, however, susceptible to degradation, partly because of its own fragile ecological attributes that make the land less suitable for intensive farming and partly because of a history of poor land management up until now. Land degradation means a decrease in productivity. Land productivity is intricately linked to social, political and environmental issues. Degradation of land is perceived to be particularly severe in communal areas and poses a serious threat to the sustained supply of ecosystem services and, therefore, to household food security, rural livelihoods and biodiversity (DEAT, 2006).

Humanity has a direct effect on the landscape it finds itself in. Human activities can either support or exceed the sustainable use of land. The spatial distribution of population and population density constitute the primary driver that shapes the function and form of land in Limpopo. The indicators that are used to assess land and transformation are presented in Table 1 below.

Table 1: Indicators used in the assessment of Land and Transformation in Limpopo Province

INDICATORS	DISCUSSION
Extent of natural land cover	Highly relevant to grazing capacity. Spatial analysis and data are required for district identification and monitoring.
Spatial analysis of afforestation	Low relevance due to small areas in Limpopo.
Spatial analysis of deforestation	Small forest land and large areas of woodland coverage in Limpopo.
Extent of degraded and transformed land	This is the focus of provincial land management.
Extent of agricultural areas	High relevance, particularly regarding food security monitoring.
Extent of urban areas	Any denuded area around informal housing.
Extent of mining	Mining represents small land cover, but is an important economic driver in Limpopo.
Change in land use	Changes in various categories of land use in Limpopo.
Grazing capacity	Guide to sustainable livestock holding levels or capacity.
Livestock carrying rate	Measures the current stocking rate and is critical for monitoring and controlling stocking levels.

2.2.2 State

2.2.2.1 Extent of Land Cover and Land Use

Limpopo is the fifth-largest province in South Africa. It is similar in size to the Free State and Western Cape provinces and comprises 10.6% of the total land area of South Africa. Figure 1 below illustrates the land cover per province in South Africa.

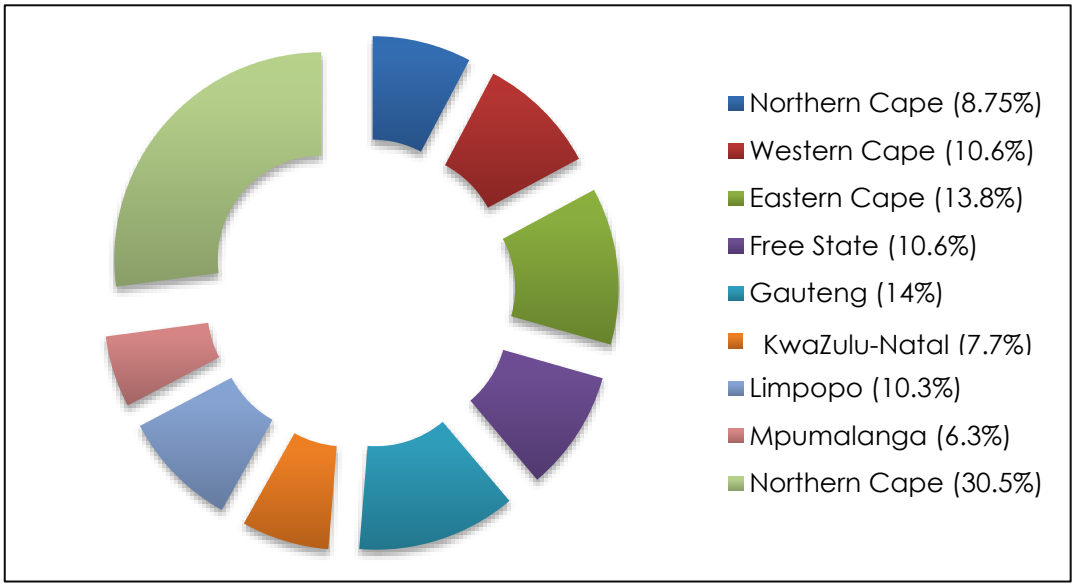


Figure 1: South Africa provincial land area comparison (StatsSA, 2011)

Land use is defined as the sequence of operations carried out with the purpose of obtaining goods and services from the land. Land use can be characterised by the actual goods and services obtained, as well as by the particular management interventions undertaken by the land users (DEA, 2012b). The Spatial Planning and Land Use Management Act (SPLUMA), Act No. 16 of 2013, is administered by the Department of Rural Development and Land Reform (DRDLR) and provides a national directive for land-use planning. SPLUMA, Schedule 2, provides definitions for legislated land use purposes and provides a reference for local and regional planning. Land usage in Limpopo has two overriding features. The first feature is the diverse agricultural profile of Limpopo owing to distinct climatic regions, which are the:

- Arid Lowveld region;
- Semi-arid Middleveld region;
- Highveld region; and
- Escarpment region.

The second feature is that agriculture takes place on 90% (11.3 million hectares (ha)) of the 12.6 million ha of land area in Limpopo. Agricultural land comprises 2 934 commercial farmers, who use 68% of the land area, and 300 000 small farmers, who use the remaining 22% of the land. The small farmers (largely subsistence farmers under communal tenure land) tend to operate on a low input/low output basis. Commercial farms represent a higher level of capital investment and technology usage than small farms. As a result, they have correspondingly greater productivity.

Satellite remote sensing from 2014 indicates the following changes regarding provincial land coverage over a 20-year period since 1994 (refer to Figure 2):

- Three categories (woodlands/open bush, grasslands and thicket/dense bush) account for 79% of land cover. This area and low shrub land account for Limpopo's grazing land use (grazing accounts for 81% of land cover, or 10.2 million ha);

- Total agriculture cropping coverage in 2014 was 1.3 million ha or 10.5% of the total area (of which 30% was subsistence cropping);

- Other larger land-cover areas include a remarkable 470 000 ha of bare land (meaning land devoid of any vegetation), with additional degraded land, accounting for 3.8% of the total area; and

- There are also 47 000 ha of wetland and 46 000 ha of indigenous forest.

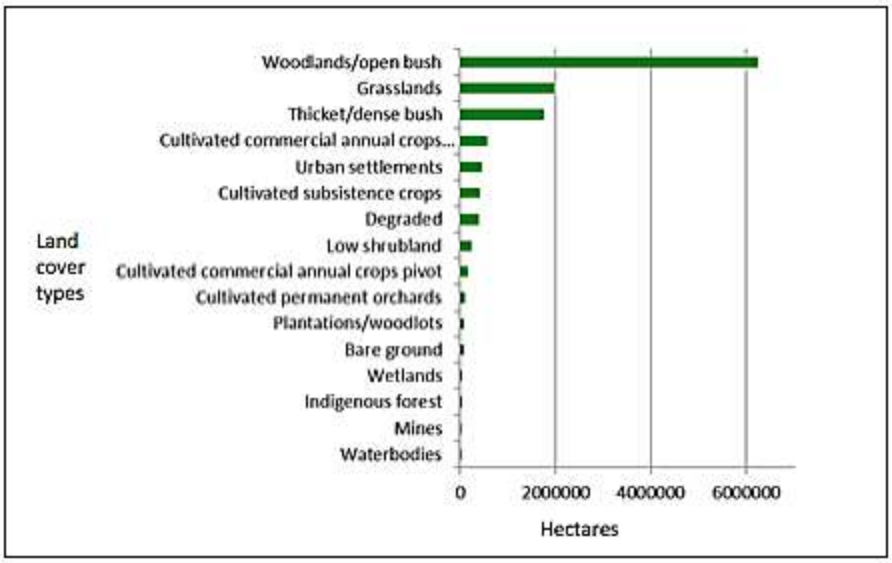


Figure 2: Land-cover types in Limpopo Province (hectares) (GeoTerraImage, 2014)

According to the Limpopo Province Spatial Development Framework (LSDF), the larger part of Limpopo is classified as having either *moderate to high*, or *low to moderate* agricultural potential (DRDLR, 2016). Limited pockets of *high to very high* land capability are found around Thabazimbi, Makhado/Thohoyandou, Tzaneen and Groblersdal (Springbok Flats). The majority of land under jurisdiction of traditional authorities is not very suitable for agriculture, owing to the mountainous nature of the terrain, dry climate and the spatial structure of multiple, scattered, rural villages. The Limpopo Department of Agriculture (LDA) recorded that, based on the characteristics of the soils, the climate and topography, the land capacity categorisation in Limpopo (DRDLR, 2016) can be summarised as follows:

- 50.1% suitable for grazing;
- 37.7% suitable for arable farming; and
- 12.2% suitable for wildlife only.

2.2.2.2 Agriculture

Land and agricultural production have been highlighted as critical for economic growth and poverty reduction (DEA, 2012b), and for food security. According to the Limpopo Development Plan (LDP) 2015 to 2019, the action plan for agricultural production and job creation in Limpopo includes the three competitive clusters recommended as part of the job creation and economic development strategy. These clusters are focused on horticulture, meat production and forestry (LPG, 2015).

Since 1993, the total number of commercial farms in Limpopo has decreased from 5 053 to 2 934 farms. This is most likely the result of a combination of factors, including decreasing farm economics, land restitution and increased security risks on farms. Such a decrease in the number of commercial farms and resultant increase in the farm sizes is a general national feature in the agricultural sector. The LDA used a combination of remote sensing and field surveys and reported a higher total farmland area of 11 321 098 ha in 2012 (LDA, 2012). Agricultural activities in Limpopo are illustrated in Figure 3.

Figure 3: Location of agricultural activities in Limpopo Province (DRDLR, 2016)

Small farmers in Limpopo, of which, as mentioned, there are 300 000, account for 99% of the farmers. However, these small farmers use no more than 30% of the land in Limpopo. It is expected that there will be continued and increased socio-political pressure to address the lack of access to land in the short term. Land use (existing and potential) on communal and commercial agricultural land in Limpopo is illustrated in Figure 4. Farmland dominates the land use, followed by grazing land and arable land.

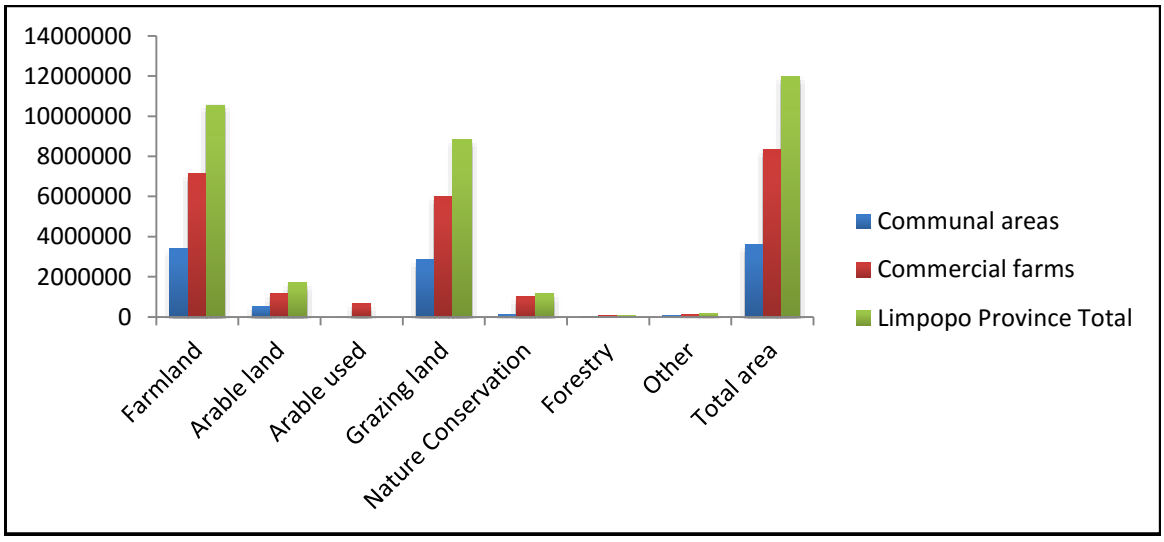


Figure 4: Area of communal and commercial farming land in Limpopo Province (hectares)

Limpopo has, historically, been known for high value horticultural production in the commercial agriculture sector, with 21% of farms used for horticulture (StatsSA, 2007). Horticultural farming is followed by livestock farming. This is reflected in the value of Provincial output by type of produce. Figure 5 illustrates the value of agricultural types for 2002 and 2007, while Figure 6 illustrates the proportionate contribution to gross farm income in Limpopo.

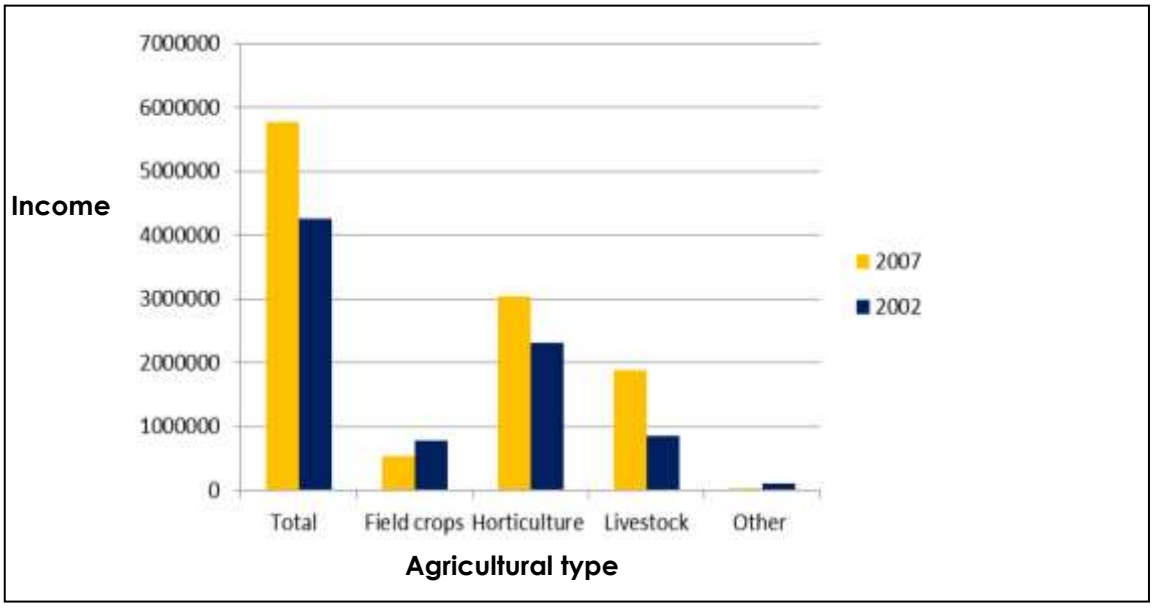


Figure 5: Value of gross income per agriculture type (R'000) in Limpopo Province 2002/2007 (StatsSA, 2002; StatsSA, 2007)

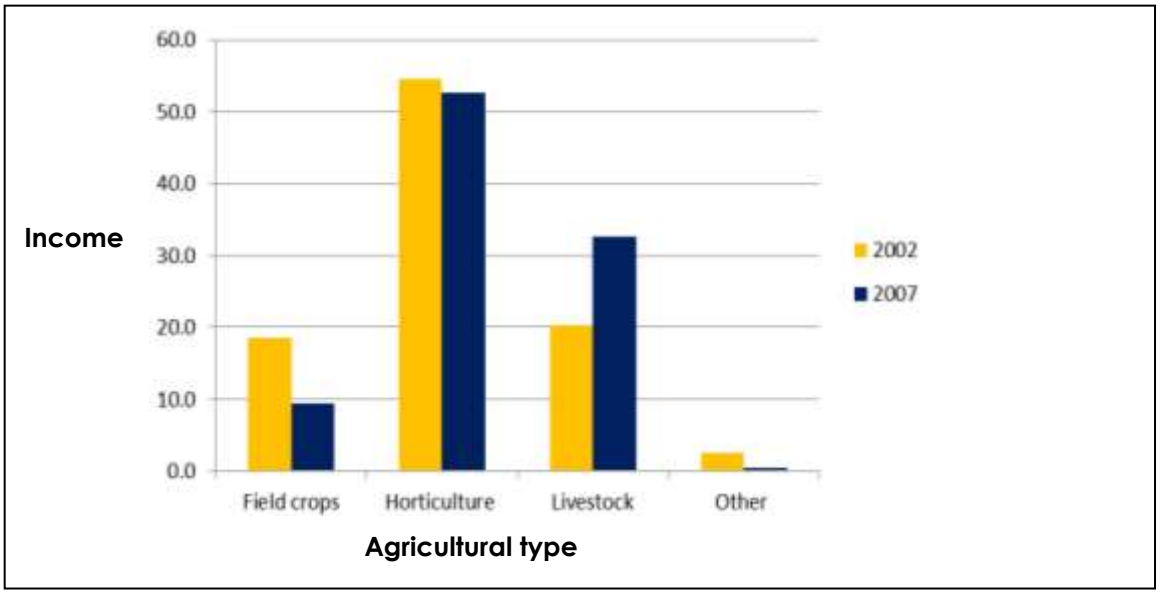


Figure 6: Proportionate contribution to gross farm income in Limpopo Province (percentage) 2002/2007 (StatsSA, 2002; StatsSA, 2007)

While the value of horticultural output remains high and important, it is livestock production that has shown the greatest growth in Limpopo. This is attributed to the increased prominence of game farming in Limpopo.

Cropping

Limpopo has a broad suite of crop farming enterprises. Figure 7 below illustrates the diversity of cropping produce, which includes 11 commodities (sunflower, citrus, wheat, maize, soya beans, potatoes, tomatoes, mangoes, avocado, lucerne and macadamias) that account for 87% of cropped area.

Cropping in Limpopo

Macadamias, avocado, mangoes, citrus and lucerne are essentially capital-intensive crops, which means that production only reaches full output in differing annual periods after the establishment year. These commodities are, therefore, relatively capital intensive and, with economic uncertainty and low confidence in the commercial farm sector, further growth in these sectors will be determined by the latest climate change predictions. Wheat, produced in winter, is essentially an irrigated crop in Limpopo. It is mainly grown in a rotation of summer crops where the second crop is essential for economic returns on high irrigation capital costs. With the currently weak economic outlook nationally, which is likely to result in upward pressure on interest rates, low commercial farming confidence and tighter irrigation, administration will likely contain the expansion of irrigation. However, with the recent drought experienced in South Africa, farmers may resort to expanding irrigation schemes or may deploy other climate start technologies to adapt to the change in climate.

The potentially arable commercial land (1 169 742 ha) and arable area usage (including woodlots and plantations) in Limpopo has decreased by 5% over the last 14 years to 923 000 ha (GeoTerraImage, 2014). At this stage only less productive land remains available. This fact, together with the multiple uncertainties currently facing South African commercial farming, such as climate change and the strained provincial irrigation system, indicates that cropping is unlikely to expand significantly to support traditional crops. Its composition will depend on price outlooks for field crop commodities and on how these commodities fit into crop rotation. Maize is likely to be an exception.

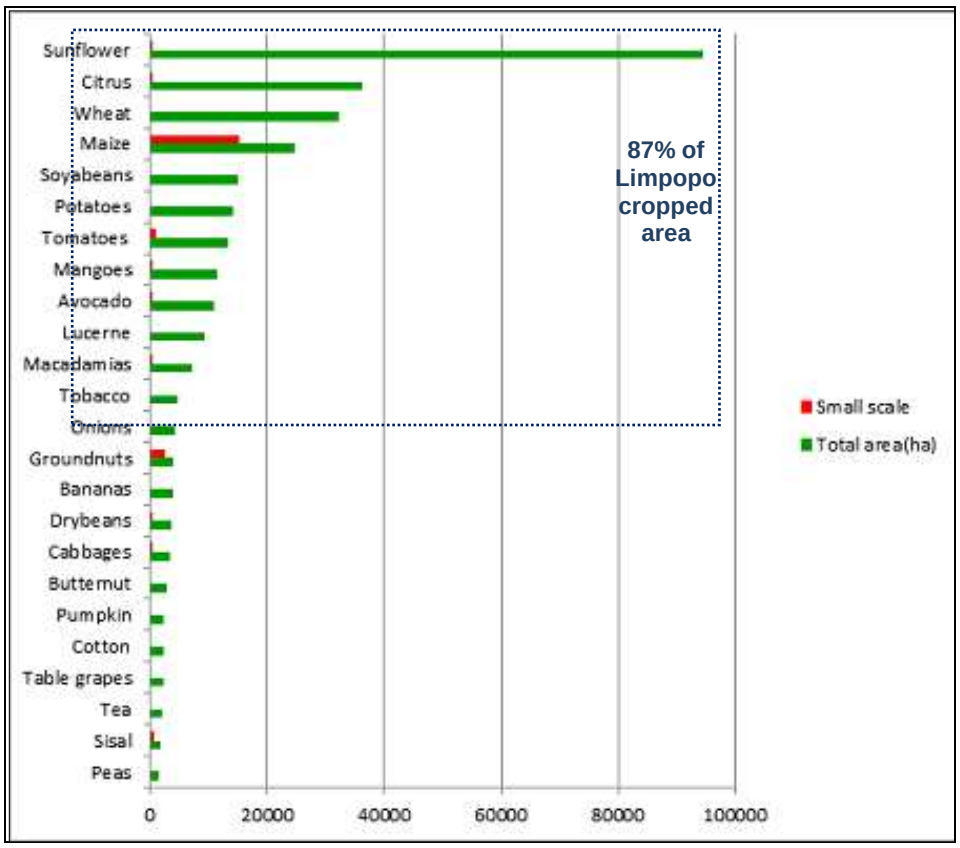


Figure 7: Cropped area (hectares) in Limpopo Province 2011/2012 (LDA, 2012)

Agriculture contributes 60% to 70% of the total consumption of water in Limpopo. It contributes 3% of the Gross Domestic Product (GDP) in the Province. The importance of agriculture should not only be based on GDP share alone, but should be regarded in the broader context of national food security and employment.

Livestock

The land in Limpopo is under pressure from grazing and is susceptible to overgrazing. The pressure lies mainly within the distribution of communal rangelands and, specifically, in the steeply sloping areas adjacent to the escarpment. Commercial herds have decreased since the 1990s. This might be a reflection of a significant swing that has taken place in the national red meat production sector since 1994, where some 85% of beef in South Africa is now feedlot finished. As Limpopo is not a leading maize supplier, the Province might have become more of a supplier of feedlot material than a supplier of grass-finished beef. Feedlot economics favour the transport of animals to maize supplies, rather than the more expensive cost of bringing grain to the animals.

Added to that, spectacular growth in game farming, by organisations such as the South African Hunters and Game Conservation Association (SAHGCA), further illustrates the decline in commercial cattle farming. Although statistics are difficult to access, it is noted that game would have to compete with livestock for grass resources.

Livestock numbers for Limpopo are illustrated in Figure 8 below. The figure illustrates how the cattle population has decreased since 1996 to an apparent constant level of just over one million since 2012. This decrease has occurred, despite beef cattle being a traditional pillar of agriculture in Limpopo.

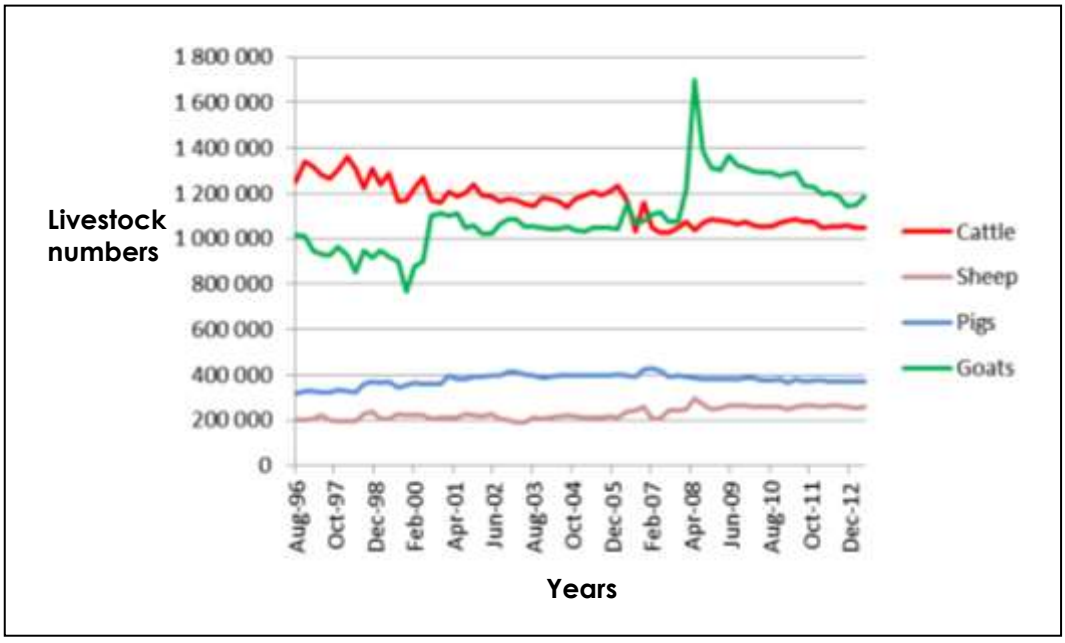


Figure 8: Livestock numbers in Limpopo Province 1996-2012

The split between small farmers and large commercial ownership of cattle is unknown, but the indications are that 20% of rural households own cattle and that 75% of these households have small herds of one to ten head (StatsSA, 2011). Similarly, 24% of cattle-owning households recorded herds of 11 to 100 in size. Besides being the main source of income, cattle are also viewed as an intrinsic measure of wealth in communities in Limpopo (Kgaphola *et al*., 2014). These figures imply that a high proportion of cattle ownership and grazing takes place in areas of communal land tenure, a figure that could be as high as 40% of the total cattle owned.

A study on Foot and Mouth Disease (FMD) was recently undertaken in the *red line zone* in Limpopo, where FMD is a main challenge for livestock farming. The study revealed that livestock farmers are aware of FMD and the government policies that restrict the movement of livestock during an outbreak. The study also indicated that livestock farmers do not regard FMD as a problem, but as a disease that they can control and prevent. The study also revealed that

livestock farmers depend largely on livestock keeping as their main source of income, despite the vulnerability of their livestock to FMD (Kgaphola *et al*., 2014).

What is also of particular concern is the significant increase in the goat population in Limpopo from 2000 to 2008. If unmanaged, goats can have a notoriously negative environmental impact through the short- to medium-term transformation of grazing biomes. Seventeen percent (17%) of rural households own goats, of which 75% own flocks of one to ten (StatsSA, 2011). Most of the goats are kept in the communal grazing areas in Limpopo. Unlike commercial livestock production, which is managed for intensive profit purposes, the majority of smallholder livestock is held under a different production system. This is a complex socio-economic system that largely reflects cultural and economic values. In addition, communal herds and flocks, which graze on communal land, present a difficulty in resource protection, owing to socio-cultural pressures, which show results in significant overgrazing.

Game Farming

Game farming has shown a spectacular growth in Limpopo over the last two decades, although official statistics are difficult to obtain. It is reported that 50% of South Africa's 9 000 game farms are situated in Limpopo and about 80% of the hunting in South Africa takes place in the Province (Van der Merwe *et al*., 2014). Reasons for this are political stability, species availability and ease of access from Gauteng (Van der Merwe *et al*., 2014).

> *"…. in 2006/2007 each foreign leisure hunter spent about R122 000. This was roughly 14 times more than that spent by the average foreign tourist arriving in South Africa by air."*
> (Dr Herman Els, SAHGCA)

It is noted that some game does compete with livestock for grazing resources. Game farming contributes positively to food security, if managed sustainably. However, game farming is a competing land use for different types of agriculture, in this way impacting on land use for crops vital also for food security.

In 2010, hunters spent an estimated total of R1.5 billion on licences and permits, travel, supplies and services directly connected to hunting in Limpopo (Van der Merwe *et al.*, 2014). This value approximately equates to the total value of Limpopo agriculture in the previous decade.

2.2.2.3 Human Settlements

Human settlements and population size are expanding in South Africa, as elsewhere on the continent. Related concerns include the deterioration in quality and reliability of energy services available to the poor as a whole and, particularly, to the growing population moving into urban areas. Population densities in these areas make people vulnerable and expose them to health risks, owing to limited access to cleaner energy in particular (DEA, 2012b), as well as other basic services.

Limpopo has an average population density of 43.5 people per km^2 (people/km^2) and currently supports a total population of 5 506 633 (IHS Global Insight, 2014). There are vast differences in district population densities, ranging from 14.4 people/km^2 in the Waterberg District to 80.3 people/km^2 in the Sekhukhune District. Densities tend to differentiate, due to differing sizes of urban centres, employment opportunities generated, land tenure and general natural resource capacity. Over time, there is an increase in population density in the Province, owing to population growth. In turn, changes in population density also affect the character and distribution of agricultural land.

Human population numbers and density directly affect the rate of land transformation, while social and economic factors, such as residential density, population age profiles, socio-economic welfare and cultural affiliation, can have an individual, or collective, effect on land transformation.

2.2.2.4 Mining

Most provinces have a dominant sector that provides the largest share of economic output. Just as the financial services sector makes up over 25% of economic output for Gauteng, mining provides the leading role in Limpopo's economy, with a contribution that exceeds 28% of the Provincial GDP.

Limpopo mines a wide variety of minerals, which include the largest diamond and copper mine in South Africa, the biggest open-pit platinum mine in the country and the biggest vermiculite mine in the world. Currently, 78 mines operate in Limpopo, with an additional 91 mines being planned for the future. Additionally, approximately 400 prospecting and mining licences have been granted. Furthermore, Limpopo has 41% of South Africa's platinum group metals, 90% of South Africa's red-granite resources and approximately 50% of South Arica's coal reserves. Antimony, a highly strategic mineral found in large quantities in China, is another of Limpopo's major assets. The larger mining operations in Limpopo include diamonds, coal and platinum group metals deposits, which, between them, account for approximately 80% of the mineral revenue of Limpopo. The main drivers of the mining sector include the future prospects of these mineral commodities. Figure 9 illustrates the mineral deposits in Limpopo, according to the LSDF.

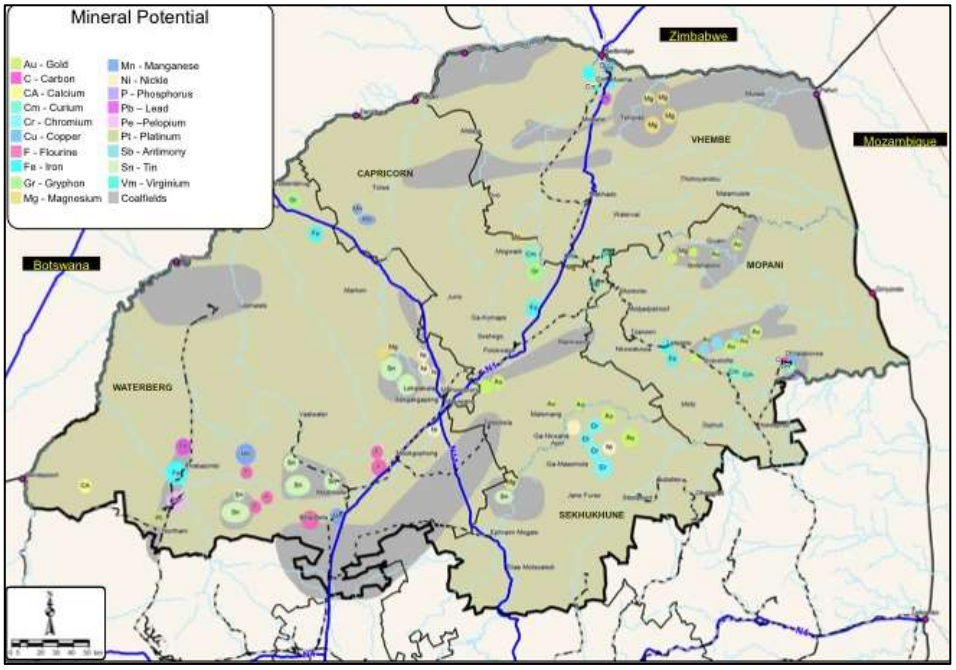


Figure 9: Mineral potential in Limpopo Province (DRDLR, 2016)

Despite the potential for the growth of mining in Limpopo, future expansion will largely depend on the state of the national and world economies, the international outlook for mineral commodities, and internal sector challenges of rising mining costs, available and committed investment levels, labour issues, ensuring a greener economy, and rising hopes and expectations of some communities for a better life related to mineral resource extraction. It seems certain (particularly from coal agreements with Eskom at least and from Provincial Government's commitment to promoting foreign and domestic investment) that the mining sector will continue to account for a substantial share of the Provincial economy.

2.2.2.5 Grazing Capacity and Livestock-carrying Rate

No spatial breakdown is available at the District Municipality (DM) level for livestock statistics or for farmed wildlife. Therefore, it is extremely difficult to calculate existing stocking rates by livestock or vegetation type accurately. Table 2 and Table 3 (refer overleaf) provide estimates using various inputs, including existing stock numbers for Limpopo according to the National Department of Agriculture (NDA) and land cover estimates (GeoTerraImage, 2014).

Table 2: Estimated stocking rates for Limpopo Province

LIVESTOCK	LIVESTOCK NUMBERS		GRAZING AVAILABILITY (ha)		
	STOCK NUMBERS	LSU EQUIVALENT	NDA STATS	GEOTERRA	VEGETATION TYPE
Cattle	1 057 989	1 057 989		6 32 109	Woodlands/open bush
Sheep	258 996	43 166		244 122	Low shrubland
Goats	1 143 393	190 566		1 967 671	Grasslands
TOTAL		1 291 721	8 847 848	8 443 902	
Probable average livestock stocking rate (ha/lsu)			6.8	6.5	

Table 2 illustrates that the current probable average stocking rates in Limpopo fall into a high average range of 6.5 to 6.8 ha/large stock unit (lsu).

This estimated current stocking rate does not take wildlife into account, noting that game competes with domestic stock for grazing resources. The probable average stocking rate indicates that Limpopo is thus heavily overstocked. The estimated stocking rates are far greater than the NDA recommendations for Limpopo, which provide a guideline of an average grazing capacity of between 9 and 15 ha/lsu for Limpopo.

Table 3 below illustrates the difference in grazing pressure that is being placed on the land by small farmers (4.7 ha/lsu) and commercial farmers (8.7 ha/lsu). Small farmers have higher numbers of livestock within smaller areas of land than commercial farmers do. This grazing pressure caused by overstocking results directly in land degradation.

Table 3: Livestock numbers and probable stocking by farmer type[14] for Limpopo Province

LIVESTOCK	STOCK NUMBERS	LSU EQUIVALENT	SMALL FARMERS	COMMERCIAL FARMERS
Cattle	1 057 989	1 057 989	423 196	634 793
Sheep	258 996	43 166	8 633	34 533
Goats	1 143 393	190 566	171 509	19 057
Total (lsu)		1 291 721	603 338	688 383
Grazing availability (ha)			2 863 818	5 984 030
Probable stocking rate (ha/lsu)			4.7	8.7

2.2.2.6 Land Reform

Historically, the land reform process has focused on three areas: restitution, land tenure reform and land redistribution. The predominant land reform programme that has been implemented in Limpopo since the establishment of the land reform programme under the DRDLR has been the Land Restitution Programme (LRP).

As of March 2014, the DRDLR has indicated that a total of 4 038 land claims have been settled, since the start of the restitution programme. A further 2 815 land claims are considered unsettled. With the enactment of the Restitution of Land Rights Amendment Act, Act No. 15 of 2014, it is anticipated that a significant number of new land claims will be launched in Limpopo, particularly on Provincial Nature Reserves and State Land. A map of current land claims in Limpopo, according to the LSDF, is illustrated in Figure 10.

Although progress has been made, the LRP in Limpopo has not yet significantly delivered land to beneficiary groups, households or individuals, with 355 projects being recorded to date.

[14] Calculated from various sources (small farmer ownership of livestock assumed as: cattle 40%; sheep 33%; goats 85%).

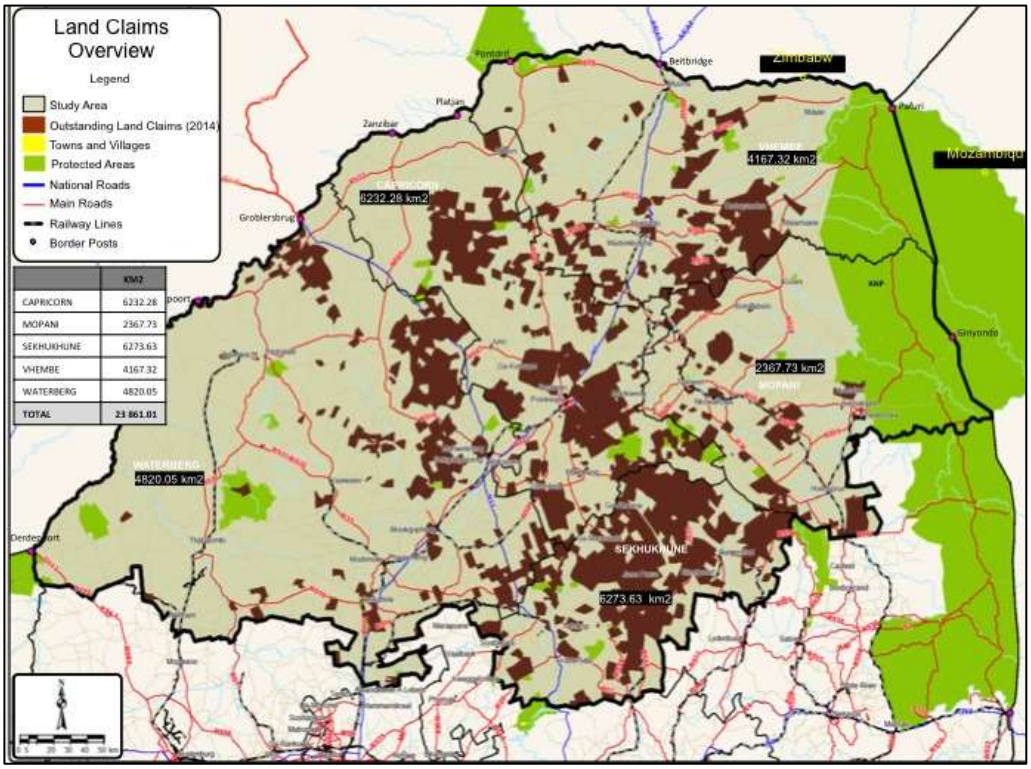


Figure 10: Land claims in Limpopo Province (DRDLR, 2016)

2.2.3 Impacts

Between 1996 and 2014 there was a noticeable change in land cover, as illustrated in Figure 11 (refer overleaf). Of concern is the conversion of grassland to mainly woodlands/open bush and perhaps even thicket areas. The value of grasslands to the livestock sector is great. Over the 18-year period reviewed (1996 to 2014), grassland in Limpopo has decreased by 778 000 ha. This is most likely due to overgrazing, change in land use, human settlement increases, the proliferation of invasive species and bush encroachment.

If the transformation of the grassland area in Limpopo has decreased grazing capacity from 2.5 ha/lsu/year to 5 ha/lsu/year, this would mean that there would be a need to de-stock by 155 600 lsu (probably equivalent to 12% of the Provincial herd) to accommodate the grassland carrying capacity. At a current lsu value of R8 500, this change in land cover equates to a Provincial natural capital loss that is worth some R1.3 billion.

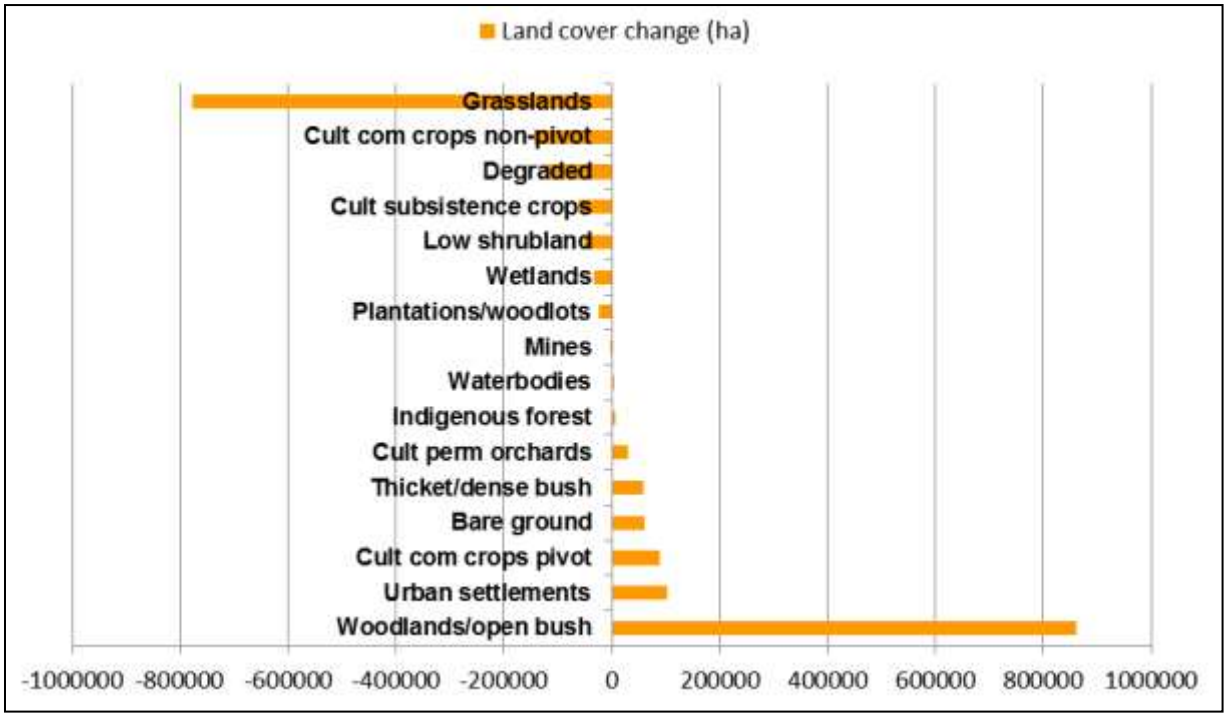


Figure 11: Land cover type change in Limpopo Province, 1996-2014 (hectares) (GeoTerraImage, 2014)

2.2.3.1 Land Degradation

Land degradation continues to threaten land in Limpopo, which reflects a national challenge. The local resource base, on which rural communal livelihoods depend for food security, is threatened. Land degradation is caused by a combination of factors, which include unemployment, poverty and an absence or failure of land use regulation. Land cover or vegetation loss is human induced and/or naturally occurring. The causes span from fire, floods, droughts, natural competition, wildlife grazing, clearing and harvesting to ground and nutrient disturbance. Erosion, biomass harvesting, grazing pressure and competing ecosystem disturbances, such as the invasion by introduced species and pollution from poisoning, are also significant factors that affect land cover (DEA, 2012b).

The communal grazing areas in Limpopo are of great concern as these areas are under severe pressure, due mainly to overstocking and resulting in degradation. Land degradation restricts the productive and regenerative capacity of the land. The pressure, however, is not restricted to overstocking, but also includes population increase and climate change.

2.2.3.2 Erosion

Over 70% of the South African land surface has been intensely affected by various types of soil erosion. Still, the most influential factor in land degradation is poor agricultural or farming methods and land husbandry, by both commercial and subsistence farmers (DEA, 2012b).

Repeated crop failure and subsequent abandonment of less marginal lands also have important consequences for soil erosion and land degradation. It is, therefore, reasonable to expect that persistent and prolonged soil erosion processes are affecting the vegetation that can survive in an area and its rate of growth. Several natural processes, such as running water or blowing winds, also trigger and exacerbate erosion processes. Soil erosion also results in loss of soil productivity, increased suspended sediments in water bodies and sedimentation in reservoirs, which consequently affect freshwater ecosystems (DEA, 2012b).

2.2.3.3 Deforestation

'Deforestation' refers to the loss of trees. The problem of deforestation is that the environmental significance of and ecological function played by trees and/or other types of vegetation are also lost in the process. South Africa's forests are threatened by a combination of factors, which

include agricultural expansion, commercial harvesting, increased firewood collection, inappropriate land and tree tenure regimes, heavy livestock grazing, and accelerated urbanisation and industrialisation (DAFF, 2011).

2.2.3.4 Mining

Although the mining footprint in Limpopo covers approximately 0.2% of the total area of Limpopo and has remained fairly constant over the last 24 years, other related resource demands, such as water demand, rapid development and provision of services, result in broader environmental degradation around, and linked to, mining areas. Required infrastructure, services, waste management facilities and built environment growth all thus increase the ecological footprint of mining, in this way contributing to environmental pressures that cannot be measured by the area transformed alone. Moreover, mining requires water usage (often in places where access to water resources is scarce) and is also shown to degrade air quality in Limpopo. The area of influence of mining is thus far larger than the footprint alone and the cumulative impacts are long-lasting and in many cases irreversible.

2.2.3.5 Land Reform

The DRDLR's Minister has noted that there are an unacceptably high number of underproductive, or abandoned, land reform projects from both restitution and redistribution. Hence, the DRDLR has committed itself to a recapitalisation programme to revitalise these unsuccessful projects. The abandoned agricultural lands on restituted land place pressure on natural resources, such as water, soils, grasslands and trees, with significant negative impacts related to fire wood collection and over-grazing. These impacts, in turn, lead to increased soil erosion and water pollution. These factors also increase the spread of alien invasive species, uncontrolled burning and illegal poaching and the destruction of key infrastructure, such as dams, weirs and canals. Inadequate post-settlement support, therefore, can lead to the serious deterioration of local habitats and the loss of natural resources, particularly water and fertile soils when land is not managed properly.

The political and social pressures on general land reform are such that many more land and tenure movements can be expected. Although it is accepted that such transfer of land ownership is essential, the viability and productive use of land over the medium- to long term remain a key consideration.

From the results of the assessment some strong trends in the transformation of land are evident. Table 4 summarises the trends observed in the assessment of land and transformation.

Table 4: Summary of findings for land and transformation in Limpopo Province

INDICATORS	TRENDS
Extent of natural land cover	Decreasing
Spatial analysis of afforestation	Stable
Spatial analysis of deforestation	Stable
Extent of degradation and transformed land[15]	Increasing
Extent of agricultural areas	Increasing
Extent of urban areas (human settlements)	Increasing
Extent of mining	Increasing
Change in land use	Increasing
Grazing capacity	Stable
Livestock carrying rate	Stable

[15] This trend is informed by GeoTerra statistics on bare land and bush encroachment (GeoTerraImage, 2014).

2.2.4 Responses

South Africa is beginning to experience the impacts of climate change, as described in Chapter 2.1: Climate Change. Increasing awareness of the future likely impacts, linked to climate change, has led to individual Provincial responses across South Africa, including Limpopo. The Limpopo Green Economy Plan (LGEP) was an important first step for the Limpopo Provincial Government in this regard. Major sectors and their comparative vulnerability are identified, which has led to the devising of general strategies such as climate change coping mechanisms.

Five major sectors were identified as being prone to climate change. Sector strategies were developed for each of them:

- Agriculture;
- Livelihoods and Settlements (both Rural and Urban);
- Ecosystems (Terrestrial and Aquatic);
- Water Supply; and
- Human Health.

The responses to the implementation plans are now up to each of the sectors involved, with both the Provincial and National Government providing support to strengthen mechanisms to make Limpopo more climate resilient. Specific land-use pressure points that would be exacerbated by climate change have been identified. Recommendations for their mitigation are made below.

2.2.4.1 Overgrazing and Grazing Capacity

The following recommendations that pertain to overgrazing and grazing capacity in Limpopo are proposed:

- The extent of veld type areas should be updated more frequently at a higher level of detail;
- The carrying capacities should be established by type and state of veld; and
- A control mechanism should be implemented to balance stock with sustainable grazing resources. Communal grazing pressure needs to be alleviated.

2.2.4.2 Cropping

The following recommendations pertaining to cropping in Limpopo are proposed:

- Small-farmer cropping requires an intensive inter-departmental programme to expand small farmers as an entrepreneurial option (including rain water harvesting and land access). The small farmer base probably forms the largest existing platform for Small, Medium and Micro Enterprises (SMMEs).
- Far more effective support should be provided to SMMEs, in light of employment challenges and food security needs.

2.2.4.3 Spatial Information, Monitoring and Control

The following recommendations pertaining to spatial information, monitoring and control in Limpopo are proposed:

- Livestock census numbers should be established on a spatial basis that relates to veld-type groups. This would not be easy, but perhaps could be established from veterinary records, or sample surveys. Census data should also be reviewed more regularly. Furthermore, spatial game census data is also required for the same purpose. Carrying rates for identified veld types should be continuously monitored and strong remedial strategies should be implemented where necessary.

- Numerous national attempts to control livestock populations in communal areas have been undertaken in South Africa, yet the sector and production system remain resilient because of their socio-cultural depth (research has also shown that this low input-low output production system actually serves a number of rural household needs and as a result represents a logical economic choice). However, particularly from an environmental point of view, stocking density has to be addressed, even if it means acquiring more land for livestock holding under the communal system. This would be difficult and would take not only political courage but sensitive and participative determination on the part of all stakeholders.

- The small-farmer-cropping concern is a more predictive one (where, with the current adverse economic outlook, expanding population pressures and a key need to expand employment opportunity, more and more rural households will have to consider cropping to survive if nothing else). This will lead to land transformation but, particularly, if more marginal cropping land was used, degradation would be serious. Yet, small-farmer cropping is also an opportunity area for entrepreneurial growth as it already operates from a large base and is deserving of a more thorough and intensive support programme, including access to suitable land.

2.2.5 References

Agricultural Research Council (ARC). 2007. *A Strategy for the Limpopo Department: Hydrological analysis*. Report for Limpopo Department of Agriculture. Report: GW/A/2007/01.

AgriSeta. 2010. *Sector Analysis Agriculture.* Prepared for Department of Higher Education and Training. Unpublished Report.

Association of Agricultural Economists (AAAEs) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa, 19-23 September 2010.

Department of Agriculture (Directorate of Spatial Information Services). 2012. *The mapping of Agricultural Commodity Production in Limpopo Province.*

Department of Agriculture, Forestry and Fisheries (DAFF). 2011. *State of Forest Report*. Pretoria: Department of Agriculture, Forestry and Fisheries.

Department of Agriculture, Forestry and Fisheries (DAFF). 2015. *Abstract of Agricultural Statistics 2013*.

Department of Environmental Affairs (DEA). 2012a. *South Africa Environmental Outlook*. Part 2: Chapter 11: Climate Change.

Department of Environmental Affairs (DEA). 2012b. *South Africa Environmental Outlook*. Part 2: Chapter 6: Land.

Department of Environmental Affairs and Tourism (DEAT). 2006. *South Africa Environmental Outlook*. A report on the state of the environment. Part 2: Chapter 4: Land, Department of Environmental Affairs and Tourism, Pretoria.

Department of Rural Development and Land Reform (DRDLR). 2016. *Limpopo Province Spatial Development Framework* (LSDF) February 2016. Prepared by Plan Associates, Pretoria.

GeoTerraImage. 2014. *1990 – 2013/14 South African National Land-Cover Change.*

IHS Global Insight. 2014. *Regional eXplorer*. Sourced from LEDET.

Jacobs, P., PhD. 2012. *Effect of climate change on resource-poor small farmers.* Volume 10, Number 3. HSRC Review: HSRC.

Kgaphola, T., Letsoalo, E., Khangale, R., Siaga, R., Ramoroka, H. & Mulaudzi, R. 2014. *Livelihood Strategies of Livestock Farmers in the Foot & Mouth Disease Red Line Zones: A Case of Livestock Farmers in Vhembe District.*

Limpopo Department of Agriculture (LDA). 2012. *The mapping of Agricultural Commodity Production in Limpopo Province*. Polokwane: Department of Agriculture.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2015. *Climate Support Programme* (CSP). Climate Change Adaptation Strategies.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2013a. *Limpopo Conservation Plan version 2.*

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2013b. *Limpopo Green Economy and Climate Change Response*. Prepared by Dr Antoaneta Letsoalo.

Limpopo Department of Finance and Economic Development. 2004. *Limpopo State of the Environment Report*. Prepared by Africon and Environomics Joint Venture. Polokwane: Limpopo Department of Finance and Economic Development.

Limpopo Provincial Government (LPG). 2015. *Limpopo Development Plan (LDP) 2015 – 2019.*

Maponya, P. & Mpandeli. S. 2012. Climate change adaptation strategies used by Limpopo Province farmers in South Africa. *Journal of Agricultural Science*, 4 (12). ISSN 1916-9752.

Mayson, D. 2003. *Evaluating land and agrarian reform in South Africa*. Occasional Paper Series No. 7: Joint Ventures. Cape Town: University of the Western Cape and Surplus People Project.

Meliko, M.O., Phinea, K.C. & Oni, S.A., 2010. *The Efficiency of Small-Scale Agriculture in Limpopo Province of South Africa.*

Ngwenyama, B. 2009. Developing a new grazing capacity map. *PositionIT*. March 2009.

Statistics South Africa (StatsSA). 2002. *Census of Commercial Agriculture*. Report 11-02-01. Internet material accessed 16.03.2016: https://www.statssa.gov.za/publications/Report-11-02-01/CorrectedReport-11-02-01.pdf.

Statistics South Africa (StatsSA). 2006. *Survey of Large Scale Agriculture 2005 (Preliminary)*. Internet material accessed 16.03.2016:*http://www.nda.agric.za/docs/statsinfo/P110112005.pdf*.

Statistics South Africa (StatsSA). 2007. *Census of Commercial Agriculture*. Internet material accessed 16.03.2016: *http://www.nda.agric.za/docs/statsinfo/P110112005.pdf*.

Statistics South Africa (StatsSA). 2011. *Agricultural Surveys 2008 and 2009 (Preliminary)*. Internet material accessed 16.03.2016: *http://www.statssa.gov.za/publications/P1101/P11012009.pdf*.

Statistics South Africa (StatsSA). 2012. *Agricultural Survey 2012* (Preliminary). Internet material accessed 16.03.2016: http://www.statssa.gov.za/publications/P1101/P11012012.pdf.

The National Planning Commission (NPC). 2010. *The National Development Plan 2030*. Prepared for the Presidency of South Africa.

Van der Merwe, P. & Saayman, M. 2014. Determining the economic value of game farm tourism. *Koedoe* 46 (2), 103–112, Pretoria. ISSN 0075-6458.

Water Research Commission (WRC). 2004. Unpublished report. *Smallholder Irrigation and Agricultural Development in the Olifants River Basin of Limpopo Province: Management Transfer, Productivity, Profitability and Food Security Issues.*

2.3 Water Resources

2.3.1 Introduction

Good quality freshwater resources and functioning wetland and aquatic ecosystems are vital for the functioning of the Earth. Water is important in geomorphological processes, such as erosion. It also plays an essential role in the physiological process of all living organisms and defines the distribution of vegetation types, ecosystems, and faunal and floral communities. Water resources also play a role in the distribution of human settlement, as humans too rely on water for drinking and other domestic use. Internationally, 783 million people do not have access to clean and safe water and 37% of those people live in Sub-Saharan Africa (WHO/UNICEF, 2010).

Many industries rely on a steady supply of water. This is particularly applicable to the mining and agricultural sectors in Limpopo Province. Aquatic ecosystems provide numerous goods and services, including, among others, the ability of wetlands to purify water, buffer and attenuate flooding, regulate stream flow and control geomorphological processes. There is increasing recognition of the potential to generate electrical energy through hydroelectric schemes. The ground and surface water environments of most watercourses are intrinsically linked, as several rivers within the Limpopo catchment originate from subterranean sources. The quality and quantity of groundwater resources have a direct bearing on the quality and quantity of most surface water resources, and *vice versa*.

As a water-scarce province, Limpopo faces significant challenges regarding water resources. The National State of Water Resources, captured from July to September 2014 (DWS, 2014), indicates that nationally the risks to health from consumption of contaminated drinking water are highest in Limpopo. The indicators presented in Table 1 below were used to assess the water resources in Limpopo.

Table 1: Indicators used in the assessment of Water Resources in Limpopo Province

INDICATORS	DESCRIPTIONS
Water resources per capita	Volume of water available per person per year as an estimate of the total present and future population and the availability of water.
Water supply and demand	The difference in supply and demand (including the demand for ecosystem maintenance) will indicate if there is a surplus or deficit in the water resources.
Comparison of natural *versus* current river flows	Alterations in the flows of rivers resulting from anthropogenic and climate-driven factors can inform/identify focus locations and future investment in management strategies and allocations of the water resource.
Groundwater quantity	If water quality parameters exceed the national guidelines for use this is indicative of an impact on the resource, which makes it unfit for use and requires attention. Quantification of surface and groundwater can be used to indicate if there is a surplus or deficit in the surface water resources and trends can inform the management of demand.
Groundwater quality	
Surface water quality Surface water quantity	
Health of the rivers	Localised impacts on rivers allow for informed decision-making on the pressures being placed on the rivers within each catchment and can assist in identifying specific polluters and sources of impact.
Number and locality of pollution disaster events	Information on regions that are most prone to pollution incidents.
Capacity and water quality of dams in Limpopo	Differences in the volume of water present in the reservoirs over time and space will indicate usage patterns, available abstraction volumes and potential shortfalls. If water quality parameters exceed the national guidelines recommended for ecosystems in the reservoirs this is indicative of an impact on the resource, which makes it unfit for use and requires attention.

2.3.2 State

The South African National Water Act (NWA), Act No. 36 of 1998, provides the legal framework in the country for the effective and sustainable management of water resources. Central to this Act is the recognition that water is a scarce and precious resource that belongs to all the people of South Africa (DWAF, 1998). In order to manage pressures more effectively, Water Management Areas (WMAs) were developed to facilitate appropriate situational management

of water resources in Limpopo. A WMA is defined as an area established as a management unit in the National Water Resource Strategy, within which a Catchment Management Agency (CMA)[16] manages the protection, use, development, conservation and control of water resources (DWAF, 1999). Four WMAs exist in Limpopo Province (Figure 1):

- Limpopo WMA;
- Luvuvhu and Letaba WMA;
- Crocodile (West) and Marico WMA; and
- Olifants WMA.

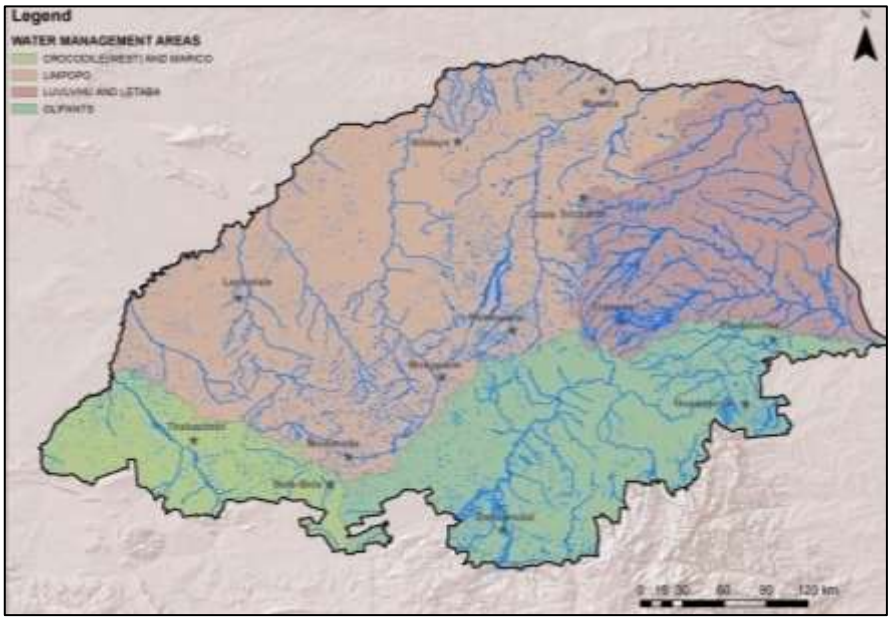


Figure 1: Water Management Areas in Limpopo Province according to the 2011 Fresh Water Ecosystem Priority Areas Database (SANBI, 2015)

Collectively the registered use or licensed use of water[17] in Limpopo is 17% of the total registered use in South Africa (DWS, 2014); however, there are still instances of unregistered use. The Olifants WMA uses the greatest amount of water in the Province (7%), followed by the Crocodile (West) and Marico WMA (5%), the Limpopo WMA (4%), and the Luvuvhu and Letaba WMA (3%).

In 2014, the dominant pressure on water resources in the Province was agricultural irrigation, which accounted for 63%, 66%, and 71% of the registered use in the Luvuvhu and Letaba, Crocodile (West) and Marico, and Limpopo WMAs respectively (refer to Figure 2). Furthermore, the WMAs with the greatest registered use allocated for mining activities (more than 5%) across South Africa were the Crocodile (West) and Marico WMA and the Olifants WMA, where respectively 5% and 23% of registered use in the WMAs was allocated to mining activities.

[16] A Catchment Management Agency (CMA) is a statutory body established by a government notice. A CMA has a governing board that is appointed by the Minister. This board must represent all stakeholders (including current and potential user groups) and their interests in the WMA. The area of operation of a CMA is a defined WMA (DWAF, 1998).

[17] As per the NWA, it is a requirement that all water users who are using stipulated surface and groundwater quantities for aquaculture, irrigation, watering livestock, industrial, mining, power generation, recreation, urban and water supply service must register their water use. Water Use Licences (WULs) are applied for by water users whose activities are regulated in the NWA.

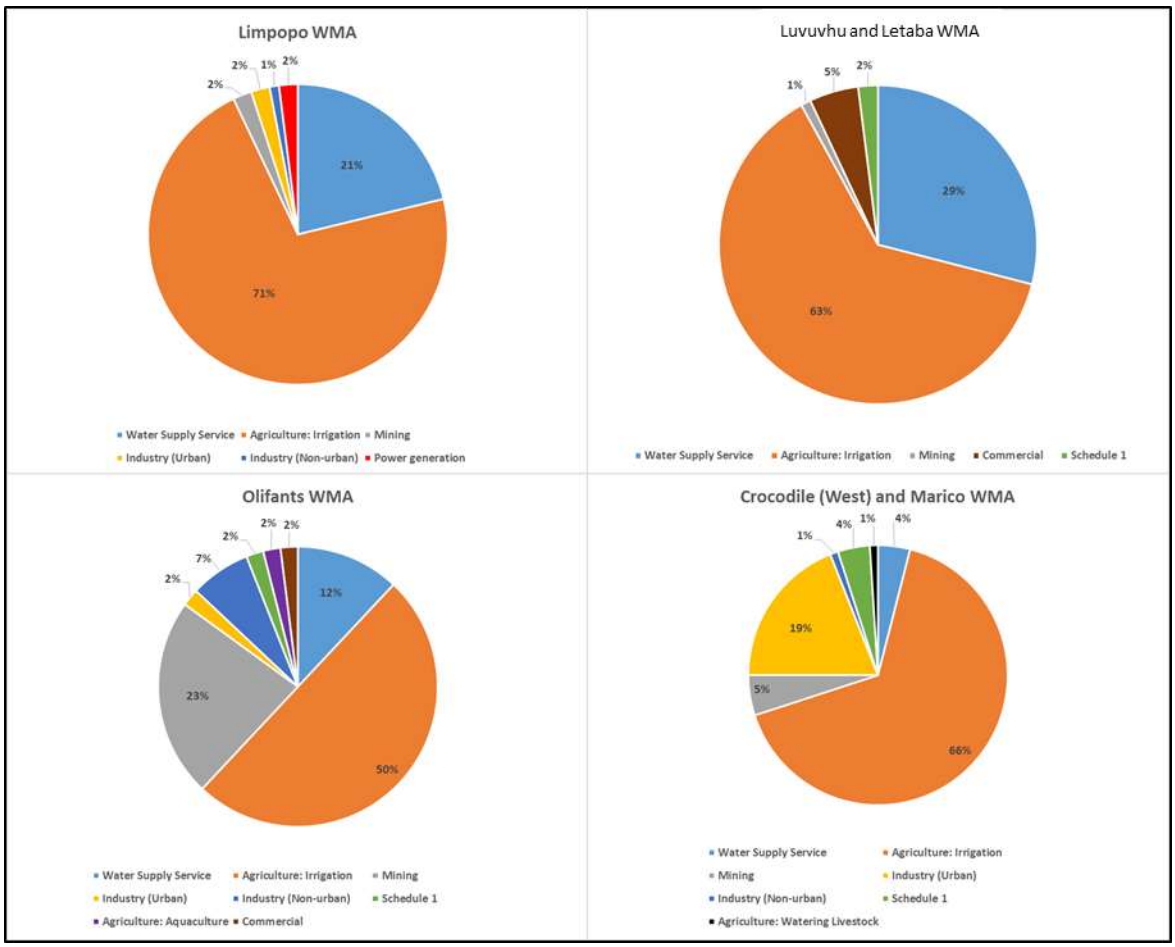


Figure 2: Registered water use per Water Management Area[18] in Limpopo Province (DWS, 2014)

Pressure on and restriction of the use of water in the agriculture and mining sectors are likely to increase, as the available and renewable supply of water in Limpopo is unlikely to meet demand in the future (refer to Figure 3 overleaf). The current available water supply is almost fully allocated. This will necessitate the supplementation of sources in the near future, by means of inter-basin transfers, since the only other alternative resource to surface water is groundwater, but low recharge rates are of concern and may limit the viability of this resource.

Unsustainable use and/or any impairment to the quality of groundwater resources will have severe consequences for human welfare where people are directly dependent on groundwater (such as in dispersed rural communities), and for aquatic ecosystems with significant hydrological linkages to the groundwater environment.

[18] NWA Schedule 1 activities are very small users of water where a licence is not required.

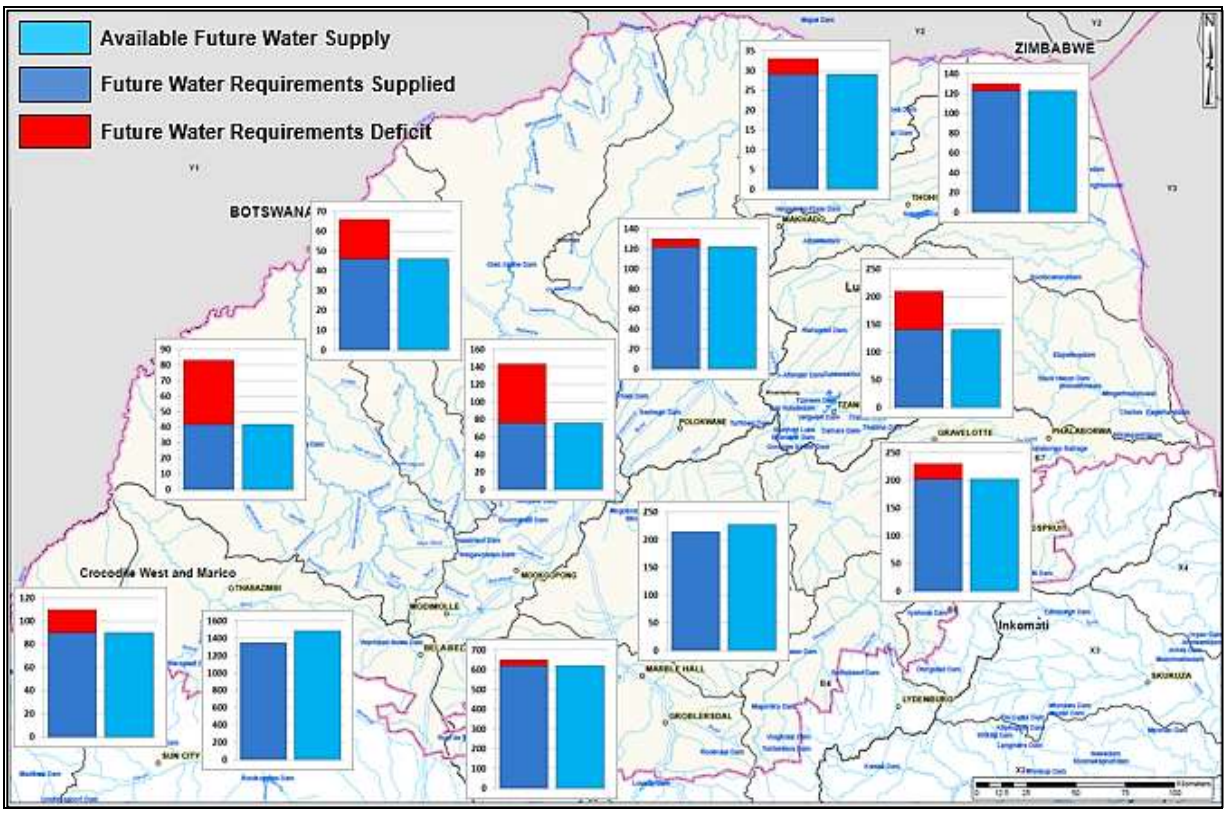


Figure 3: Available and future supply and demand of water in Limpopo Province (DWS, 2012)

The pressure placed on the water supply (refer to Figure 3 above) has impacts on the state of the environment, and on economic growth. For example, the high volume of water used for irrigation and mining in Limpopo will likely place additional pressures on water resources and lead to conflict between these sectors in terms of growth in the future. Therefore, the allocation of water to these two sectors will likely be subject to trade-offs[19] that might be determined by provincial Gross Domestic Product (GDP) allocations and socio-economic opportunities.

While mining and quarrying contributes 26% of the GDP of the Province, and agriculture, forestry and fishing only contributes 2.2% (StatsSA, 2015), agriculture is sustainable, supports significantly more numbers of employees and is key to livelihoods in many rural areas. Additionally, when considering trade-offs between the supplying of water to different sectors, other deciding factors, such as impacts on water quality from each sector, should be considered, as should the holistic management of water resources in the Province.

Four key factors determine the availability of water in the Province: climate, population numbers (and their associated water use), the nature of the economic activities taking place and upstream impoundments outside of the Province or South Africa, which lead to the loss of yield in the Province. The rainfall pattern in the Province is varied, with the northern portion classified as arid and receiving only between 201 and 400 millimetres (mm) per square metre (m^2) per annum. Apart from this, the majority of the Province is semi-arid, receiving between 401 and 600 mm per m^2 per annum. A relatively limited extent of the western and eastern portion of the Province receives between 801 and 1 000 mm per m^2 per annum, while a smaller portion in the east receives over 1 000 mm per m^2 per annum. These zones are respectively classified as dry-sub-humid and humid (FAOUN, 2005). Overall, this relatively low rainfall creates a naturally water-stressed region.

In 2000, it was calculated that 1 220 m^2 was allocated per person per annum and this figure is anticipated to decrease to 1 077 m^2 per person per annum by 2025. At these levels, the Limpopo River catchment can be considered water stressed, which indicates that frequent

[19] It is interesting to note that the water allocated for agricultural purposes is being transferred to the mining sector in the Lephalale area. Mines are purchasing water use rights from farmers to secure adequate water for their operations (Limpopo Environment Outlook Project Steering Committee Meeting, February 2016).

seasonal water supply and quality problems can occur and are accentuated by occasional droughts (Alemaw, 2008; SADC-HDR, 1999).

The Limpopo Province Spatial Development Framework (LSDF) highlights the issue of the Province being particularly vulnerable to climate change, especially its northern and eastern regions. An analysis of the Province's water risk is presented in Figure 4. This analysis shows that the southern parts of the Waterberg District are highly stressed with regard to the demand on and availability of water. The central, southern and eastern parts of the Province, including parts of the Capricorn District Municipality (DM), the Sekhukhune DM and the Mopani DM, are under medium stress (DRDLR, 2016).

A steady increase in the population, coupled with significant potential growth in the mining and industrial sectors and significant water use by the agricultural sector, will result in the need for increased abstraction of water and the need to upgrade water supply and wastewater-related infrastructure. In water-stressed areas, groundwater resources are relied on to alleviate some of the pressure on the surface water resources. This creates the potential for an imbalance between the rate of utilisation and the maintenance of sustainable yields. Use and quality of groundwater resources are monitored and regulated by the Department of Water and Sanitation (DWS).

The pollution of resources from both natural and anthropogenic sources, such as mining, industry, agricultural return flows and domestic wastewater, is also a cause for concern. Furthermore, as the sources for many rivers within this Province, such as the Crocodile River and Olifants River, and the major tributaries feeding them are located in other provinces or neighbouring countries, cross-border co-operation in pollution control is considered essential. The DWS monitors both ground and surface water quality through various monitoring points in surface water features and at boreholes. Water pollution is also managed at a Water Use Licence (WUL) level.

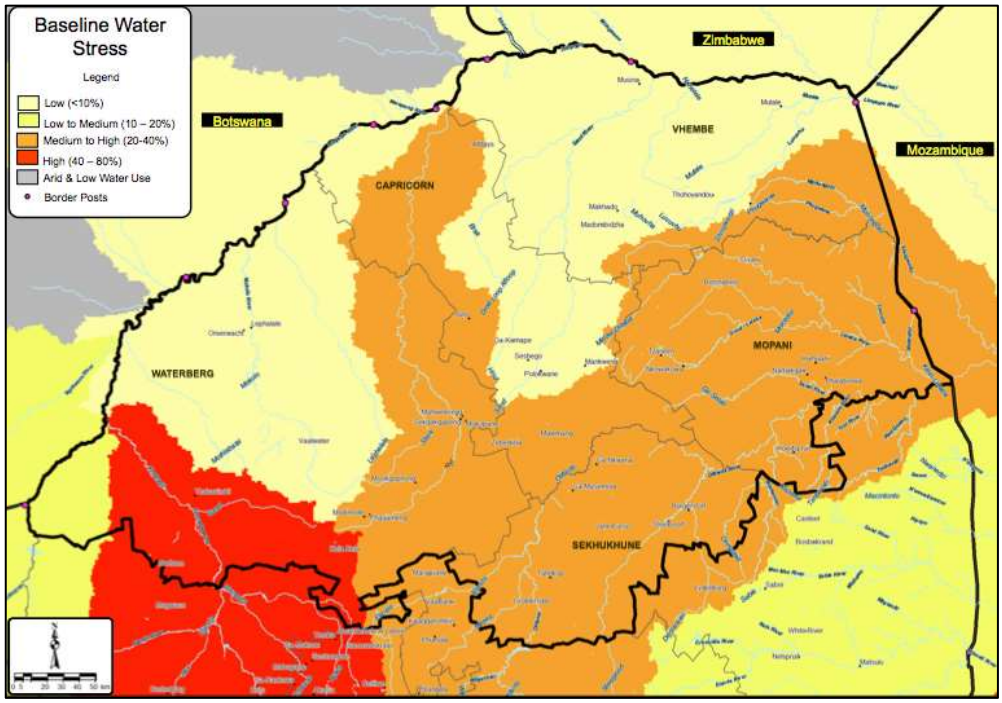


Figure 4: Baseline water stress within Limpopo Province (DRDLR, 2016)

During stakeholder engagement, water resources were identified as a major issue and it was agreed by stakeholders that improved water resource management should be regarded as a priority for the Province. This is illustrated in the outcomes of an issues-identification process, which was conducted during stakeholder meetings across the Province. The issues are presented in Figure 5.

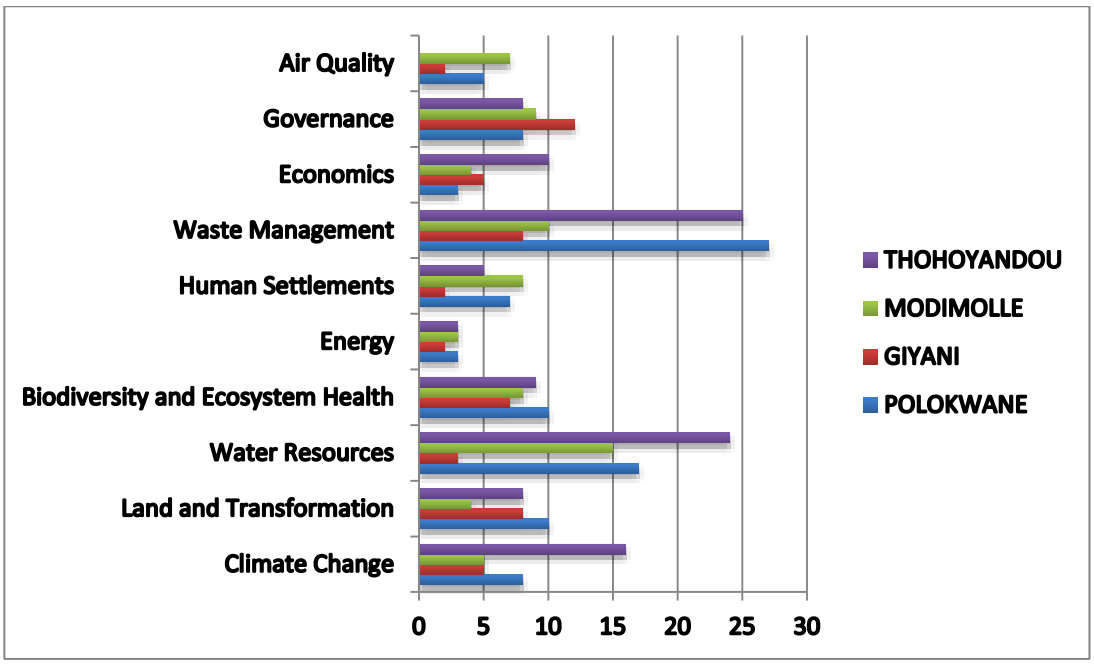


Figure 5: Environmental issues identified in stakeholder meetings and workshops in Limpopo Province

2.3.3 Impacts

Water resources play a vital role in aquatic ecosystems and are integral in supporting population growth and economic development, and the health and well-being of individuals. Key water resource concerns in the Province include (LEDET, 2013):

- Disproportionate distribution of water resources (the agricultural sector consumes 62% of the total water resource);
- Expense of inter-basin water transfers – the cost recovery of water services serves as a barrier to access to safe water by poverty-stricken people;
- Ageing water infrastructure and limited access – costly to maintain infrastructure;
- Lack of access to clean water;
- Inadequate supply of good quality water;
- Conflict and competition arising from water scarcity;
- Insufficient water resources available for new developments; and
- Contamination of water resources arising from malfunctioning and over-capacitated Wastewater Treatment Works (WWTWs) as a result of inadequate maintenance and investment in wastewater treatment. The 2011 Green Drop Report revealed that inadequately treated sewage is being discharged into the environment by approximately 96% of the WWTWs (WRC, 2011).

The impacts from domestic use, agricultural use, mining use, other industries and urbanisation on water resources that are the basis of the key water concerns in the Province can be grouped into the following categories:

- Over-abstraction of water resources;
- Contamination of water resources;
- Degradation of aquatic ecosystems; and
- Interrelated and cumulative impacts.

2.3.3.1 Over-abstraction of Water Resources

Water resources are stored in (among others) rivers, dams, wetlands and groundwater – all of which are subject to impacts from over-abstraction. The demand for water in Limpopo has drastically increased over the last decade, placing pressures on the resources available. The Limpopo River lies in the most downstream portion of the catchment and, therefore, indicates catchment-wide changes in abstraction. Decreases in the average monthly discharge of the Limpopo River over time indicate that approximately 25% more water is being utilised from the catchment than in 1952. Figure 6 illustrates the results from the Chokwe metering station in Mozambique.

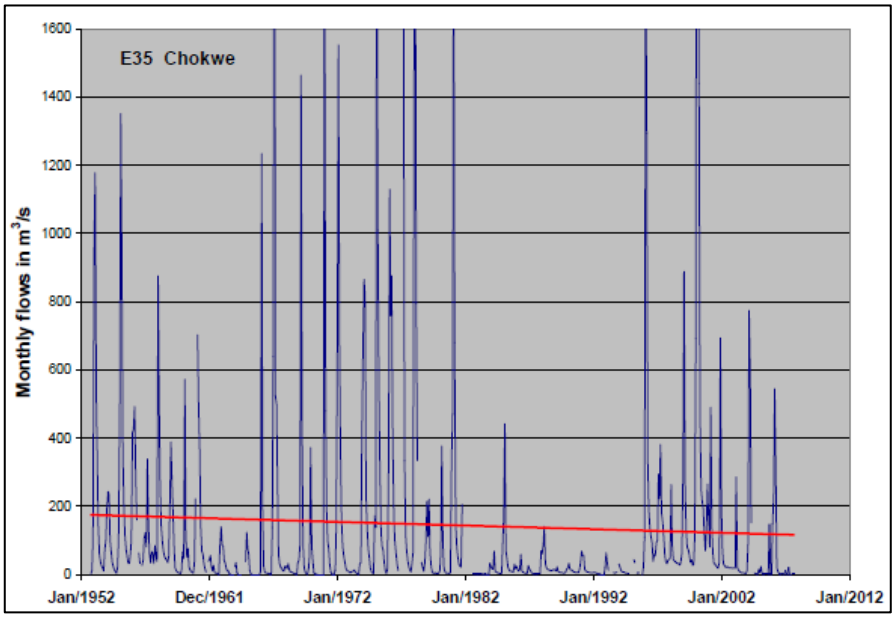


Figure 6: Decreasing trend in discharge of the Limpopo River downstream of Limpopo Province (LBPTC, 2010)

Additionally, the State of Dams Monitoring Program (DWS, 2015a) indicates that between October 2014 and October 2015 the volume of water stored in dams in Limpopo decreased by 13%. Specifically, the storage of water in the Limpopo and Luvuvhu and Letaba WMAs decreased by approximately 20%, and by 11% in the Olifants and Crocodile (West) and Marico WMAs. The data shows the impacts of a drought/extended dry season (BD, 2015) and highlights that, under future drought conditions, the available water supply in the Luvuvhu and Letaba WMA will be the most vulnerable.

The most recent scientific estimates (DWA, 2010) indicate that an estimated 2 020 million m^3 of utilisable groundwater exploitation potential (UGEP) is available to Limpopo, based on the WMAs located in the Province. This constitutes 19.5% of the renewable and available groundwater in South Africa. The dominant use of groundwater, throughout all the Limpopo WMAs, is irrigation, with rural and municipal (domestic) use being secondary (DWA, 2010). In 2014, Limpopo Province reported that in general 67% of groundwater levels monitored are currently higher than the same period in the previous year and in comparison to historical levels the current groundwater levels are well above the level of concern, despite increasing demands for water (DWS, 2014). From this, it can be seen that quantity of available and renewable groundwater in the Province is not currently a constraint, although surface water quantity may be.

This data implies that, although over-utilisation of surface water is taking place in the Province, groundwater resources may be a viable alternative resource to enable further economic growth (if abstracted sustainably), and that consideration should be given to utilising groundwater resources to reduce the impacts on surface water throughout the Province and in the Limpopo WMA in particular.

2.3.3.2 Contamination (Microbial and Toxicant) of Water Resources

Surface water quality is an issue in the Province, owing to both point-source and diffuse pollution. Point sources include mining, domestic and industrial effluents, whereas non-point sources include agriculture and stormwater runoff. The National State of Water Resources (NSWR) Quarterly Report of July to September, 2014, indicates that the major water quality problems facing the country are eutrophication[20], faecal pollution and salinisation (DWS, 2014).

Excessive inputs of nitrates and phosphates into waterbodies and watercourses contaminate the drinking water for both humans and animals, and also lead to a general deterioration of the state of the waterbodies through eutrophication. This is especially problematic where people do not have access to piped potable water and are reliant on water from boreholes and watercourses. While population growth is a driver of eutrophication, the dominant pressures of population growth that result in eutrophication of waterbodies are primarily the overuse of fertilisers in the agricultural industry, the contamination of water resources with polluted urban runoff and the discharge of ineffectively treated sewage effluent from over-capacitated or malfunctioning WWTWs.

Limited data is available on the eutrophication potential or trophic status of watercourses within the Province and reporting largely focuses on dams. The trophic status of all of the reservoirs in the Province reported by the National Eutrophication Monitoring Program (DWS, 2015b) were oligotrophic[21]; therefore, eutrophic[22] conditions at these dams are unlikely to be impairing the water stored therein and sufficient dilution of agricultural return flows is considered to have taken place (refer to Table 2).

Table 2: The eutrophication and trophic status of reservoirs in Limpopo Province between the summer and winter periods of 2014/2015 (DWS, 2015b)

DESIGNATION	EUTROPHICATION POTENTIAL	TROPHIC STATUS	EUTROPHICATION POTENTIAL	TROPHIC STATUS
Dams	Summer (2014-10-01 to 2015-03-31)		Winter (2015-04-01 to 2015-09-30)	
Mokolo	Negligible	Oligotrophic	Negligible	Oligotrophic
Glen Alpine	Moderate	Oligotrophic	Serious	Oligotrophic
Luphephe	Moderate	Oligotrophic	Serious	Oligotrophic
Nzhelele	Negligible	Oligotrophic	Negligible	Oligotrophic
Nwanedi (Nwanedzi)	Moderate	Oligotrophic	Negligible	Oligotrophic
Vondo	Moderate	Oligotrophic	Negligible	Oligotrophic
Tzaneen	Moderate	Oligotrophic	N/A	N/A
Magoebaskloof	Moderate	Oligotrophic	N/A	N/A
Middle Letaba	Moderate	Oligotrophic	Negligible	Oligotrophic
Modjadji	Negligible	Oligotrophic	N/A	N/A
Nsami	Significant	Oligotrophic	Negligible	Oligotrophic

The malfunctioning and overloading of WWTWs (WRC, 2011), and the use of pit latrines (which is common in rural areas) can introduce faecal pollution in the river system in addition to having other water quality impacts. According to the NSWR (DWS, 2014), all of the WMAs in Limpopo, with the exception of the Olifants WMA, experience poor or unacceptable faecal contamination. The Crocodile (West) and Marico WMA reported the greatest number of points of unacceptable *E. coli* counts, which were largely concentrated on the provincial Gauteng border, where the water quality at Kwaguqa was considered to be seriously impacted by *E. coli*. Furthermore, the number of monitoring points is not congruent with the number of surface water

[20] Eutrophication is observed as the bloom of algae in water that results from high levels of nutrients. Such nutrients are typically nitrates and phosphates that originate from fertilisers, detergents and untreated sewage.

[21] Oligotrophic ecosystems are characterised by moderate species diversity, low productivity, rapid nutrient cycling and no nuisance growth of aquatic plants or the presence of blue-green algal blooms (DWAF, 1996). Oligotrophic systems are considered to have good, largely anthropogenically unimpaired, water qualities.

[22] Eutrophic ecosystems are characterised by low species diversity, high productivity, a prevalence of nuisance growth of aquatic plants, and algal blooms may include species that are toxic to people, livestock and wildlife (DWAF, 1996). Although eutrophication can occur naturally, anthropogenic impairment or contamination of watercourses is frequently a key driver.

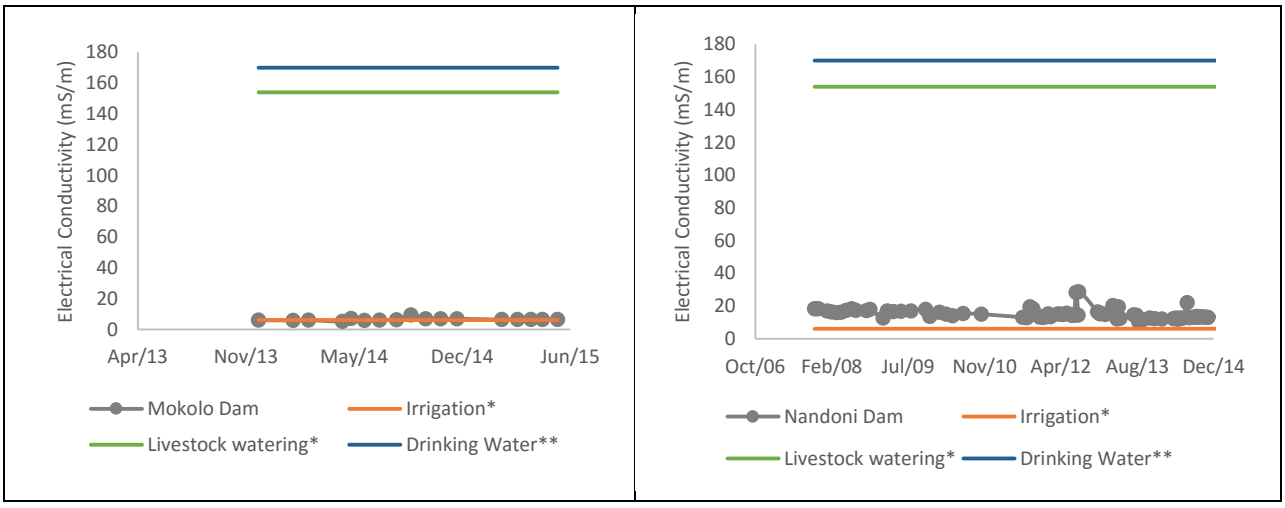
resources. This means that the impacts of faecal contamination on water resources in the Province may be significantly underestimated.

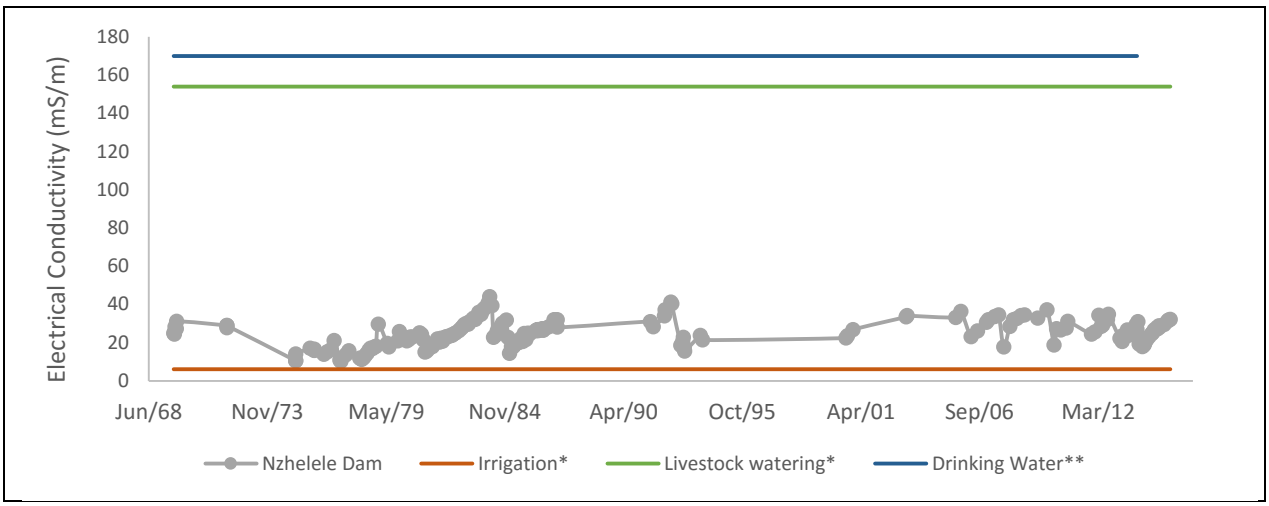
It was reported that nationally the risks from consumption of contaminated drinking water were highest in Limpopo Province, and within the Crocodile (West) and Marico WMA (DWS, 2014). This was attributed to the number of untreated water sources that were reported. Therefore, impacts on water resources from faecal coliform should be considered a management priority.

Agricultural runoff, which is rich in nutrients, and water pollution from mining activities significantly increase salinity in surface water courses (where salinity is indicated by Electrical Conductivity (EC) measurements). Elevated salinity poses a hazard for the environment, including biota. It can also destroy the structure of soils and those affected soils may reduce crop yields. Exposure to high salinity frequently results in depletion of biotic reservoirs by reducing the fecundity of aquatic organisms.

Temporally, the EC of three reservoirs in the Province has remained largely unchanged (refer to Figure 7). Additionally, the concentrations of sulphate and chloride have remained largely consistent, despite a large increase in the number of WWTWs and mining operations in the Province. While it should be noted that the present EC in the Nandoni and Nzhelele Dams exceeds the recommended South African National Standard (SANS 241) Drinking Water Guidelines (DWS, 2015c), it is likely that the EC of the reservoir is naturally non-compliant. The EC at Nzhelele Dam illustrates this in particular, as it has not significantly changed since 1969. On the basis of the DWAF (1996) guidelines, the water in these reservoirs is suitable for irrigation and livestock watering in terms of the EC sulphate and chloride content.

The EC of surface water points monitored by the DWS (DWS, 2014) indicates that all WMAs in Limpopo show ideal or good water quality conditions, with the highest salinity occurring at monitoring points in the Crocodile (West) and Marico WMA. However, the number of monitoring points in the Province is not congruent with the number of water resources. Therefore, the water quality of some resources (specifically rivers of low stream order that are most sensitive to contaminants) was likely not reported. The impact of EC on the water resources of the Province can largely be considered to be of least concern. However, future water scarcity in the Province, as well as an increase in economic and mining activity, poses a significant threat to the current state of the surface water resources.





*DWAF (1996)
**DWS (2015c)

Figure 7: Electrical conductivity at Mokolo (top left), Nandoni (top right) and Nzhelele Dam (bottom) in Limpopo Province (DWS, 2016)

2.3.3.3 Degradation of Aquatic Ecosystems

The over-utilisation and contamination of water have resulted in the degradation of the physical extent and ecological integrity of watercourses in Limpopo. Additionally, the creation of dams and diversion of water have also resulted in a shift in many river systems from perennial to seasonal to ephemeral. Most rivers have lost parts of their flow regime that are essential for maintaining unmodified and natural conditions (WRC, 2011), and the water that remains in ecosystems has been under increasing strain from pollution as well.

The impacts on aquatic ecosystems include a loss of species abundance and diversity, including sensitive and protected species, and a reduction in toxicant assimilation and flood remediation, as well as the transferral of species, which may become pests, into other ecosystems beyond their natural occurrence. Rivers in Limpopo have also become highly incised and eroded as a result of changes in flows, sand mining, artificial diversion (refer to Figure 8 below), urbanisation and overgrazing (WRC, 2001).

Figure 8: Artificial sand channels divert the flow of the Limpopo River towards the South African border (van Staden, 2015)

The greatest impact on water resources in the region occurs within the Crocodile (West) and Marico WMA, where the river is in a largely modified condition[23] (DWS, 2014). Rivers in the Limpopo and Olifants WMAs are also in a moderately modified state[24], and only rivers in the Luvuvhu-Letaba WMA are in a largely natural condition.[25] In addition to the abovementioned impacts, invasive and alien fish and vegetation have contributed to the impairment of these river ecosystems. *Oreochromisniloticus* (Nile tilapia) proves to be the greatest threat to the indigenous fish stocks and encroaches on systems linked to the Limpopo River. This is also aided by illegal introductions of this species as anglers target it. *Oreochromisniloticus* both displaces and hybridises with the indigenous *Oreochromismossambicus* and the gene pool of the indigenous fish is threatened (WRC, 2001). Alien plants that are present in riparian zones and pose a significant threat in Limpopo include *Eucalyptus* spp., *Lantana camara, Morusalba, Chromolaenaodorata, Senna didmobotrya, Populus*spp. *Sesbaniapunicea* and *Melia azedarach* while *Eichhorniacrassipes* and *Azollafilliculoides* are aquatic alien invasive plants that pose a significant threat. Working for Water (WfW) staff estimate that invading plants nationwide currently consume 3.3 billion cubic metres of water per year beyond the requirements of indigenous plants (DEA, 2016).

2.3.3.4 Interrelated and Cumulative Impacts

Cumulative impacts on water resources can result from a combination of physical, biological and chemical pressures; therefore, the impacts from pressures should be considered interrelated and not assessed and managed in an isolated way. For instance, the over-abstraction of water can lower the amount of available water in river ecosystems, which not only compounds the impacts of contaminants (as a result of a reduced dilution potential) but can also result in a degradation of wetland ecosystems that leads to less toxicant assimilation as well. This can then lead to a lack of access to clean water.

Table 3 lists the trends related to water resources identified in Limpopo Province. The DWS prepares Annual and Quarterly National Water Resources Status Reports to monitor and report water resource trends at a national level that relate to the indicators in Table 3 below. These reports provide the latest trends. Provincially, these trends should be monitored to obtain a precise and current state of trends in water resources.

Table 3: Summary of findings regarding water resources in Limpopo Province

INDICATORS	CURRENT STATE/TRENDS
Water resources per capita	Decreasing
Water supply and demand	Increasing
Groundwater quantity and quality	Uncertain
Surface water quality	Decreasing
River health	Decreasing
Disaster events resulting in pollution	Uncertain
Dam trophic status	Uncertain

2.3.4 Responses

The sustainable use of water resources is dependent on informed decision-making and management. The key pillar of this is the extent, efficacy and integration of water resource monitoring programmes. One of the major current monitoring programmes in the Province is the River Health Programme (RHP). The RHP categorises the integrity of a particular point or section of a river within the greater catchment and is relatively site specific, enabling the assessor to identify local and area-specific impacts. The results of applying the biological and habitat indices during a river survey provide the context for determining the degree of ecological modification at the monitoring site. The degree of modification observed at a particular site

[23] A large loss of natural habitat, biota and basic ecosystem function has occurred (DWS, 2014).
[24] There has been a loss and change of natural habitat and biota but basic ecosystem function still occurs (DWS, 2014).
[25] Small changes in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged (DWS, 2014).

translates into the Present Ecological State (PES). In order to put the PES in context, it is important to have an idea of what is desirable and what is not.

An understanding of the ecological state of a river should provide resource managers with directions for making decisions and implementing management actions. If localised impacts on rivers in Limpopo are identified, a realistic Recommended Ecological Category (REC) for each river section is allocated. This will aid in the decision-making process at a higher level where decisions that allow impacts on a particular river are identified. It will also allow for informed decision-making about the pressures being placed on the rivers within each catchment in Limpopo. If a decline in PES is observed at a particular monitoring point, specific polluters and sources of impact will become evident and suitable mitigation measures can be put in place.

Outcomes of the RHP in Limpopo indicate that the priority responses needed for the Limpopo WMAs include:

- Wetland protection and rehabilitation in the areas of the headwaters of these rivers;
- Control of alien plants, especially in riparian zones, in all catchments;
- Control of effluent and mining-related seepage in the upper reaches of the Olifants catchment; and
- Release from storage dams on the basis of ecological flow requirements, especially in the Olifants catchment.

The use of water in the major economic sectors of mining and agriculture in Limpopo highlights the importance of implementing management responses to ensure the availability of water resources of a good quality in the future. The Overview of Water Resources Availability and Utilisation in Limpopo (DWAF, 2003) and the Limpopo Green Economy Plan (LEDET, 2013) have identified that the focus of future management in the catchments should be directed towards a more efficient, beneficial and equitable use of the water resources currently available. They identify mechanisms and ways to manage water resources sustainably for the future in Limpopo as including:

- Water conservation and demand management, especially in terms of limiting losses and improving usage efficiency;
- A review of irrigation water budgets, water allocation mechanisms and water pricing for designated water use licence holders;
- Water recycling and reuse, especially for mining operations but also for non-potable urban use;
- Rainwater harvesting;
- Identifying and improving the treatment efficacy of poorly performing WWTWs;
- The replacement of ageing infrastructure, such as water mains, to reduce the loss of available water to the groundwater environment;
- Strict enforcement of compliance with WULs regarding authorised abstraction allocations and the quality of water discharged in each sector;
- Strengthening sectoral co-operation;
- Strengthening Limpopo Province institutional and regulatory capacity;
- Addressing service backlogs in water and sanitation provision – assessing persistent backlogs and devising strategy for service delivery;
- Changing water use behaviour – effecting change in behaviour by regulation, self-regulation, use of market-based instruments, and awareness and education; and
- Improving reticulation systems.

Scarcity of water in the country and climate change represent significant challenges, given the critical nature of water resources to human and economic well-being. The Limpopo Climate Change Adaptation Strategies Report (LEDET, 2015) identifies adaptation responses or approaches that are recognised widely as being integral to building resilience in the water sector and to combating climate change.

These include the following four recommendations:

- The creation of a cross-sectoral, inter-departmental governance framework to help integrate and mainstream climate change adaptation into all water-related operations. Limpopo should establish a governance framework or mechanism that incorporates decision-makers across all relevant sectors, with a mandate to integrate climate change adaptation into various existing water-related processes, policies, instruments and programmes to ensure sectoral alignment.

- Ensuring the integration of climate change resilience into the planning and designs of future water-related infrastructure projects, with the development of an adaptation plan that addresses how Limpopo intends to safeguard and maintain its water infrastructure in the face of climatic stressors like droughts, heavy rains and floods.

- Raising performance and efficiency of water service delivery for domestic use, with aggressive quantitative targets. Limpopo should set or strengthen targets for provision of universal and quantitative, measurable metrics for performance and efficiency (such as the reduction of conveyance losses from leaks). These should be annually evaluated and recalibrated, based on progress made.

- Strengthening of existing catchment management efforts. Specifically, efforts should be made to stem and reduce deforestation in catchment areas (as well as degradation of these areas). Attention should also be given to the removal of alien invasive species in catchments.

2.3.5 References

Alemaw, B. F. 2008. *Literature on Work Package 2: Water Availability and Access*, submitted to CPWF as Milestone 5.

Business Day (BD) Live. 2015. High chance of extended drought in South Africa. 27.09.2015.

Council for Scientific and Industrial Research (CSIR). 2010. *Climate Change Handbook for North Eastern South Africa.* http://www.rvatlas.org/k2c/download/handbook_climate_change.pdf

Department of Environmental Affairs (DEA). 2015. *Climate Support Programme (CSP) Climate Change Adaptation Strategies for Limpopo Province*.

Department of Rural Development and Land Reform (DRDLR). 2016. *Limpopo Province Spatial Development Framework (LSDF) February 2016*. Prepared by Plan Associates, Pretoria.

Department of Water Affairs (DWA). 2010. National Groundwater Strategy 2010. Water Resources Planning Systems, Pretoria.

Department of Water Affairs and Forestry (DWAF). 1996. South African Water Quality Guidelines Volume 7: Aquatic Ecosystems.

Department of Water Affairs and Forestry (DWAF). 1998. South African National Water Act (Act No. 36 of 1998).

Department of Water Affairs and Forestry (DWAF). 1999. *The Water Management Areas of South Africa*. Catchment Management Report.

Department of Water Affairs and Forestry (DWAF). 2003. *National Water Resource Strategy: Limpopo Water Management Area, Overview of Water Resources Availability and Utilisation*.

Department of Water Affairs and Forestry (DWAF). 2004. *National Water Resource Strategy*.

Department of Water and Sanitation (DWS). 2012. *Limpopo Province Water Resource Perspective: Water Management Areas and Catchments*.

Department of Water and Sanitation (DWS). 2014. *The National State of Water Resources Quarterly Report July to September 2014*. Department of Water and Sanitation, Pretoria.

Department of Water and Sanitation (DWS). 2015a. *Limpopo Province State of Dams 2015-11-02*. Internet material accessed 4.11.2015: https://www.dwaf.gov.za/hydrology/Weekly/Storage.aspx

Department of Water and Sanitation (DWS). 2015b. *National Eutrophication Monitoring Program*. Internet material accessed 13.03.2016:https://www.dwa.gov.za/iwqs/eutrophication/NEMP/report/ NEMPyears.aspx.

Department of Water and Sanitation (DWS). 2015c. South African National Standards 241 Drinking Water Guidelines.

Department of Water and Sanitation (DWS). 2016. Water Management System Database.

Food and Agricultural Organisation of the United Nations (FAOUN). 2005. *Fertilizer use by crop, South Africa*. Land and Plant Nutrition Management Service, Land and Water Development Division. FAO, Rome.

Limpopo Basin Permanent Technical Committee (LBPTC). 2010. *Joint Limpopo River Basin Study: Scoping Phase: Final Report*.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2013. *Limpopo Green Economy Plan including provincial climate change response*. Prepared by Dr A. Letsoalo, Manager Environmental Research and Planning. Evridiki Towers, Polokwane.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2015. *Climate Support Programme (CSP) – Climate Change Adaptation Strategies*. Adaptation Strategies for Limpopo Province. Evridiki Towers, Polokwane.

Regional Climate Change Programme. 2012. *Research Brief 13: Rainfall and temperature projections for southern Africa.*

SADC-HDR. 1998. *Regional strategic action plan for integration water resources development and management in the SADC countries (1999-2000)*. Water Sector Coordinating Unit. Lilongwe, Malawi.

South African National Biodiversity Institute (SANBI). 2015. Biodiversity GIS (BGIS). *Freshwater Ecosystem Priority Areas, Water Management Areas created in 2011*. Internet material accessed 13.03.2016: http://bgis.sanbi.org.

South African National Biodiversity Institute (SANBI) and Department of Environmental Affairs (DEA). 2011. National Climate Change Response White Paper.

Statistics South Africa (StatsSA). 2015. *Gross domestic product: Annual Estimates 2004-2013, Regional Estimates 2004-2013, Third Quarter 2014*.

Von Bormann, T. & Gulati, M. 2014. *The Food Energy Water Nexus: Understanding South Africa's most urgent sustainability challenge*. WWF-SA, South Africa.

Water Research Commission (WRC). 2000. *Nylsvley, Executive Summary*. Internet material accessed 16.03.2016: http://www.wrc.org.za/Lists/Knowledge%20Hub%20Items/Attachments/7733/1258-1-06_EXECUTIVE%20SUMMARY.pdf.

Water Research Commission (WRC). 2001. *The State of Rivers Report – Letaba and Luvuvhu River Systems.* Water Research Commission. Gezina, Pretoria.

Water Research Commission (WRC). 2011. *Sustainable Use of South Africa's Inland Waters*. Water Research Commission. Gezina, Pretoria.

World Health Organization (WHO)/United Nations Children's Emergency Fund (UNICEF) Joint Monitoring Programme for Water Supply and Sanitation. 2010. *Progress on Sanitation and Drinking Water*. Internet material accessed 16.03.2016: http//: www.wssinfo.org/.

2.4 Biodiversity and Ecosystem Health

2.4.1 Introduction

'Biological diversity', or 'biodiversity' for short, is a term that encapsulates the *variety of life*. According to the formal definition of biodiversity, as captured in the International Convention on Biological Diversity and the National Environmental Management: Biodiversity Act (NEMBA), Act No. 10 of 2004, this includes 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 includes diversity within species, between species and of ecosystems*".

The progressive transformation of land poses a significant threat to quality of life in South Africa, including in Limpopo. The loss of biodiversity priority areas is exacerbated by land being increasingly transformed for various land uses. The track record of land rehabilitation in South Africa is not encouraging, which suggests that once land has become degraded it is unlikely that such land will be returned to its previous ecological function. Continued urbanisation in South Africa and Limpopo and the urban sprawl associated with it, as well as a decrease in household numbers (*viz.* more houses that accommodate fewer people per household), are currently placing and will continue to place pressure on available and potentially environmentally sensitive land (DEA, 2012).

Table 1: Indicators used in the assessment of the Biodiversity and Ecosystem Health in Limpopo Province

INDICATORS	DESCRIPTIONS AND COMMENTS
Extent of natural areas remaining	'Natural areas' refer to those areas where natural habitat is still available and to the proportion of Limpopo Province that is covered by forests, woodlands and grasses.
Extent of conserved areas	The total area of land that is under formal protection in Limpopo Province.
Vegetation types, threat and protection status of vegetation types per biome	Biomes and bioregions can be further divided into vegetation types, which indicate the floral composition of smaller habitat units.
Habitat fragmentation index	'Habitat fragmentation' refers to the breaking up of a habitat into unconnected patches interspersed with other areas, which may not contain suitable living conditions for species occupying the habitat that was broken up.
Alien and invasive plant species	Alien species are species that do not occur naturally within a specific area or geographic range and frequently manage to out-compete indigenous species, thereby becoming invasive.
Status of terrestrial ecosystems	A terrestrial ecosystem is a land-based ecosystem, including communities of plants, animals and micro-organisms that are linked by energy and nutrient flows and that interact with each other and with the physical environment.
Transformation of centres of high endemism	'Endemism' refers to taxa whose distributions are restricted to a geographical region or locality, such as an island or a continent.
Status of conserved areas, including Important Birding Areas (IBAs) and biodiversity areas	IBAs are areas designated as globally important habitat for the conservation of bird populations.
Threatened and extinct species, ecosystems and habitats	'Threatened and extinct species' refer to species that occur within Limpopo with International Union for the Conservation of Nature (IUCN) Red Data status.
Endemic species	'Endemic species' can be defined as species whose habitat is restricted to a specific geographical area.
Population trends of selected species	'Selected species' refers to species that show signs of acting as good indicators of ecosystem health.
Distribution and abundance of selected alien species	An alien species is an introduced species that does not occur naturally within a specific geographic range.
Change in species distribution	'Species distribution' refers to the spatial distribution of species throughout a landscape for threatened and endemic taxa.

2.4.2 State

2.4.2.1 Spatial Biodiversity Planning

In Limpopo, the primary responsibility of managing and monitoring biodiversity vests with the Limpopo Provincial Department of Economic Development, Environment and Tourism (LEDET). The Limpopo Conservation Plan Version 2 (LCPv2)(LEDET, 2013) informs biodiversity decision-making in Limpopo in keeping with the Bioregional Planning Guidelines, published by the South African National Biodiversity Institute (SANBI) in 2009, and is regulated by the National Environmental Management: Protected Areas Act (NEMPA), Act No. 57 of 2003.

Spatial biodiversity planning helps planners identify the most important areas for conserving a representative spread of ecosystems and species, for maintaining ecological processes and for providing ecosystem services (SANBI, 2013). There are several possible approaches to biodiversity planning, which are based on three key principles:

- The need to conserve a representative sample of biodiversity, such as ecosystems, species and habitats (the principle of representation);
- The need to conserve ecological and evolutionary processes that allow biodiversity to persist over time (the principle of persistence); and
- The need to set quantitative biodiversity targets that tell us how much of each biodiversity feature should be conserved in order to maintain functioning landscapes.

The LCPv2 (LEDET, 2013) was developed with the following outcomes:

- Data is the cornerstone of a good biodiversity assessment. Data collection, management and dissemination will ultimately achieve the conservation mandate of LEDET. The three essential groups of data constitute the Protected Area Register, Land Cover Updates and Biodiversity Inventory, Mapping and Monitoring;
- LEDET is currently implementing a BioGIS system (BGIS) or Biographical Geographic Information System (GIS) that has been established to keep track of the flora and fauna at a provincial level and to assist in the planning and decision-making with regard to biodiversity conservation in Limpopo; and
- Quantitative targets are set for both biodiversity pattern and process features, which indicate how much of each feature is required to ensure representation and persistence. These targets are used as an indicator to measure progression of biodiversity conservation in Limpopo.

The primary objective of the LCPv2 was to produce a revised Conservation Plan for Limpopo Province that conformed to the Bioregional Planning Guidelines, published by SANBI in 2009. The previous Limpopo Conservation Plan was completely revised by developing and executing quantitative systematic spatial biodiversity planning methodologies that:

- Addressed the deficiencies of the previous provincial plan;
- Took into account the most up-to-date spatial data and institutional and expert knowledge;
- Aligned the methods and terminology of the plan with the national guidelines for the development of bioregional plans;
- Took into account existing spatial biodiversity planning products; and
- Involved skills transfer through working with LEDET staff on the development of the Critical Biodiversity Area (CBA) map and Gap Assessment (LEDET, 2013).

The systematic conservation planning process resulted in 40% of Limpopo being identified as CBAs and 22% as Ecological Support Areas (ESAs). Table 2 provides a breakdown of CBAs and ESAs in Limpopo.

Table 2: Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) in Limpopo Province (LEDET, 2013)

CATEGORIES	% OF THE PROVINCE	SUBCATEGORIES	% OF THE PROVINCE
CBA	40	CBA 1 – Irreplaceable areas required to meet biodiversity targets.	22
		CBA 2 – Best design selected sites required to meet biodiversity targets.	18
ESA	22	ESA 1 – Intact natural areas supporting CBAs.	16
		ESA 2 – Areas with no natural habitat that is important for supporting ecological processes.	7

The CBAs, according to the LCPv2 (refer to Figure 1), link to land-use guidelines tables, which are based on a combination of products from Mpumalanga, KwaZulu-Natal and Gauteng Province. These guidelines and recommendations are aimed at informing strategic decision-making and facilitating biodiversity conservation in priority areas outside the Protected Areas Network (PAN).

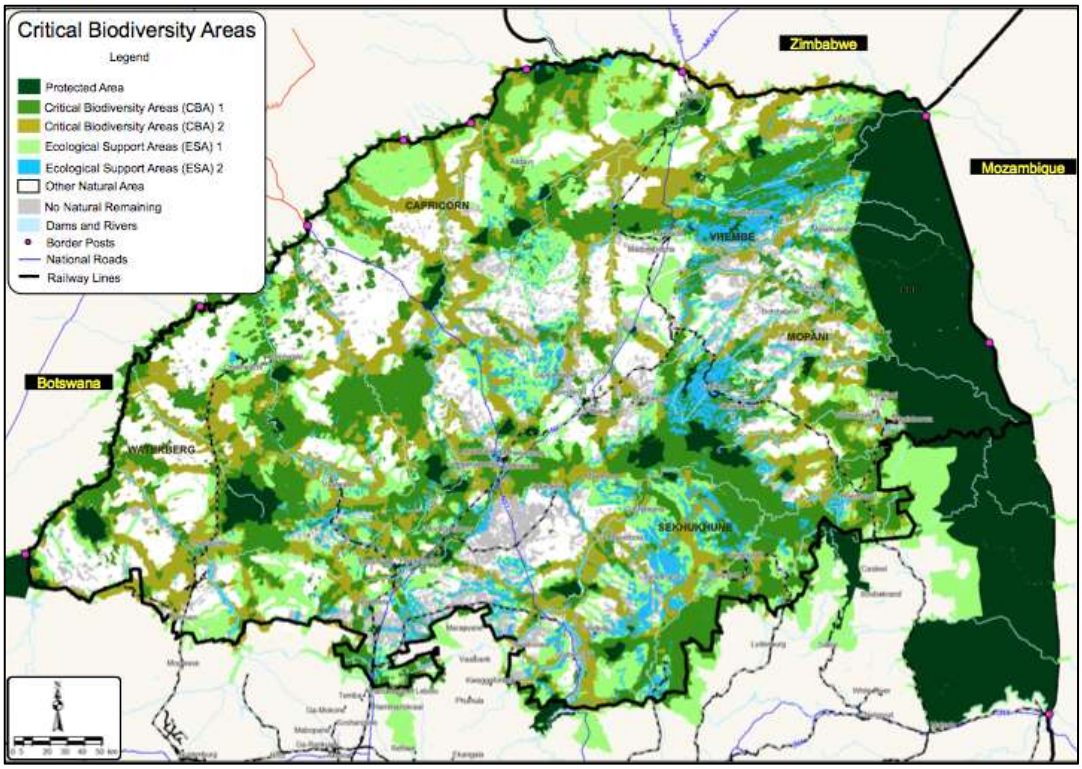


Figure 1: Limpopo Province Conservation Plan Version 2[26] (DRDLR, 2016)

[26] CBAs have been split into CBA 1 and CBA 2 on the basis of selection frequency and the underlying characteristics of the biodiversity features being protected (for example, the location of fixed features such as sites for Critically Endangered species and flexible ones such as Least Cost Corridors). The majority of the CBAs in the province are CBA 1 (22%), which can be considered irreplaceable in that there is little choice in terms of areas available to meet targets. If CBA 1 areas are not maintained in a natural state then targets cannot be achieved. CBA 2s are considered optimal as there is significant design involved in their identification. CBA 2s make up 18% of Limpopo.

2.4.2.2 Natural Areas remaining, Habitat Fragmentation and Terrestrial Ecosystems

As mentioned above, 'natural areas' refer to those areas where natural habitat is still available and this refers to the proportion of Limpopo that is covered by forests, woodlands and grasses.

Limpopo is 12 587 283 hectares (ha) in extent, of which 10 717 467 ha (85%) are in a natural or near natural state and 1 869 816 ha (15%) are not in a natural state (LEDET, 2013). Table 3 and Figure 2 below present a breakdown of the various land uses and their respective extents.

Table 3: Land cover in Limpopo Province based on 2009 SPOT 5 imagery (GTI, 2012)

NATURAL LAND SUB-CATEGORIES	HECTARES (HA)	COVER (%)
Natural	10 661 427	85
Wetlands/Water	16 991	<1
Degraded	39 049	<1

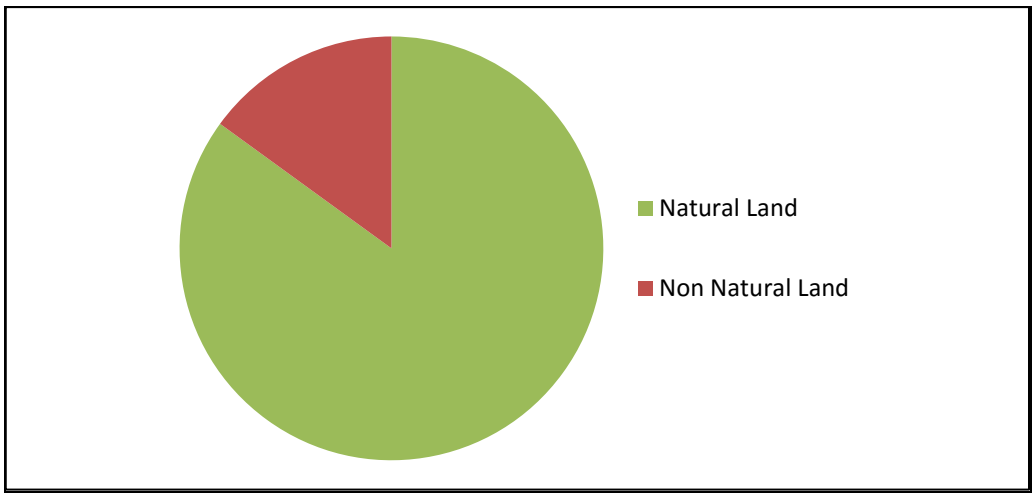


Figure 2: Land cover in Limpopo Province based on 2009 SPOT 5 imagery (GTI, 2012)

According to Mucina and Rutherford (2006), there are nine biomes in South Africa.[27] Two of these biomes are found in Limpopo: the Grassland Biome and the Savanna Biome. A biome is a group of plants and/or animals that live together with some degree of permanence. Biomes broadly correspond with climatic regions as moisture and temperature strongly influence plant establishment and survival, although other environmental controls are sometimes important. Each biome has a characteristic set of plant and animal species, and a characteristic overall physiognomy.

The Grassland Biome, which is associated with some areas of Limpopo (refer to Figure 3 overleaf), is projected to be under severe pressure, owing to climate change. The Grassland Biome is under threat of being replaced by the Savanna Biome. This is likely to be related to the high altitude of the Grassland Biome and its susceptibility to warming effects. The possible increase in tree cover, owing to a lengthened growing season and increased carbon dioxide (CO_2) fertilisation, will contribute to this. The Savanna Biome is projected to expand, with its geographic range (partly) replacing grassland (DEA, 2013a). This could significantly alter the vegetation in the Kruger National Park (KNP), for instance, with implications for wildlife in the area. There is, however, growing evidence to suggest that the Savanna Biome itself may face negative impacts from climate change, as a result of encroachment by bush and woody tree vegetation (CSP, 2015).

[27] The biomes in South Africa are Fynbos, Succulent Karoo, Desert, Nama-Karoo, Grassland, Savanna, Albany Thicket, Indian Ocean Coastal Belt and Forests (Mucina & Rutherford, 2006).

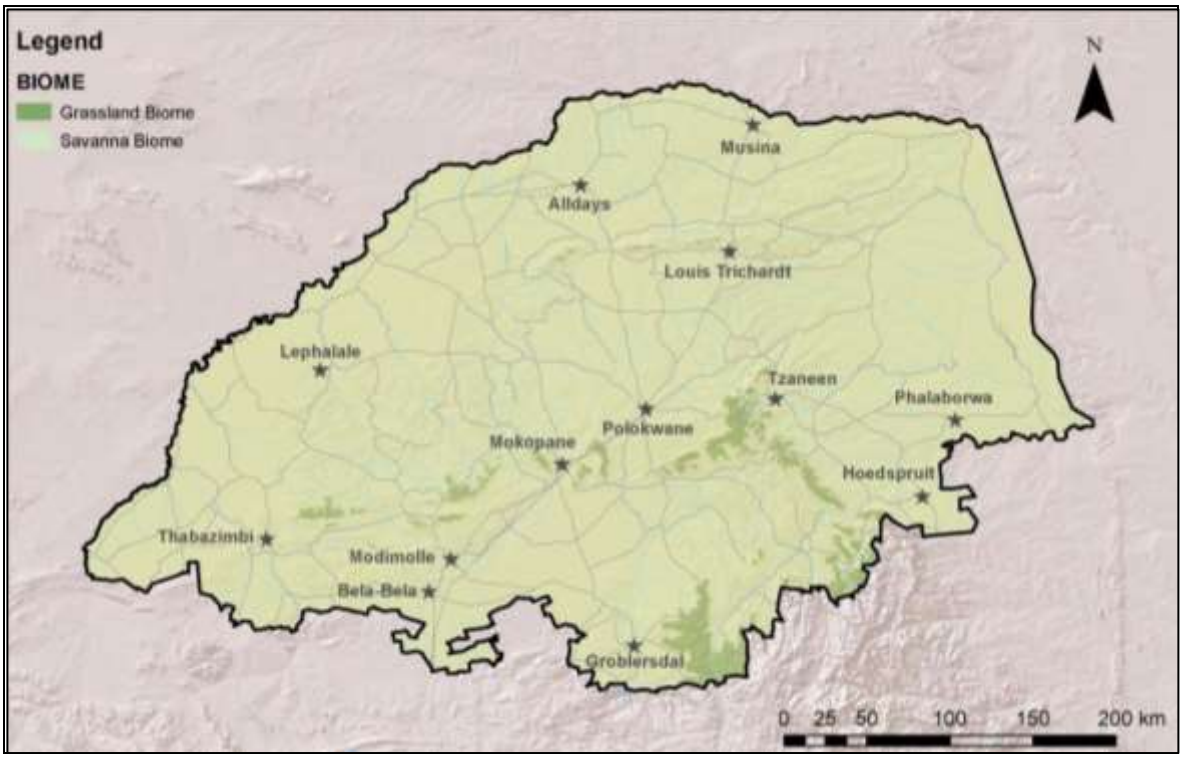


Figure 3: Grassland and Savanna Biomes in Limpopo Province

Land degradation, as a result of anthropogenic influences, is taking place throughout Limpopo, especially within the central and north-western areas of Limpopo. The higher levels of fragmentation in Limpopo are of major concern and there is a need to slow down the rate of fragmentation.

2.4.2.3 Conserved Areas

Protected Areas

Protected Areas in South Africa

A *protected area* means any of the protected areas referred to in section 9 of the NEMPA, 2003, and includes:

- Special nature reserves, national parks, nature reserves (including wilderness areas) and protected environments;
- World heritage sites;
- Marine protected areas;
- Specially protected forest areas, forest nature reserves and forest wilderness areas; and
- Mountain catchment areas.

Formal Protected Areas (PAs) cover just over 11% of Limpopo. There are currently 62 formal PAs in Limpopo, totalling 1 367 044 ha. The major contributor to this figure is the KNP, which contributes 72% to the total provincial PAN. The current informal or private conservation area estimate is 561 185 ha. Thus, 1 928 229 ha in Limpopo are currently protected, either formally or informally. This is an increase of 1.87% from 2006 (total of 1 892 123 ha protected in 2006). The PA gap analysis, which assesses protection levels of the habitats in Limpopo, indicates that an additional area, equivalent to 85% of the current PAN (1 161 900 ha), needs to be added to the PA estate in order to achieve the biodiversity targets as outlined by the LCPv2.

How to achieve this objective is the subject of the Limpopo Protected Area Expansion Strategy (LPAES). Note that the informal reserve data is used for information purposes and to help guide spatial prioritisation, but it is only the formal PAN that contributes to meeting PA targets (LEDET, 2013).

Biosphere Reserves

Biosphere Reserves (BRs) aid in understanding changes and interactions between social and ecological systems and in generating management measures that mitigate any conflicts that may arise (UNESCO, 2015). There are currently three BRs in Limpopo: the Vhembe, Waterberg

and Kruger to Canyons BRs, which contribute to the conservation of biodiversity. Figure 4 below illustrates the location of the BRs in Limpopo.

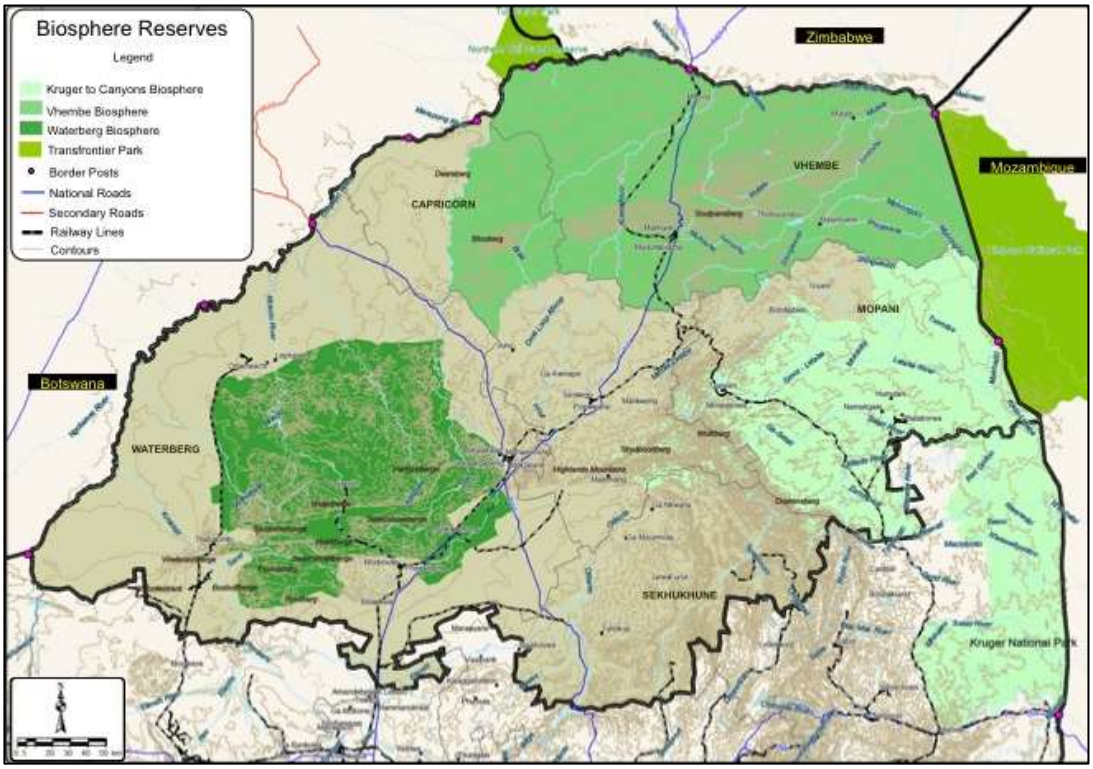


Figure 4: Biosphere reserves in Limpopo Province (DRDLR, 2016)

Important Bird Areas (IBAs)

An IBA is an area designated as globally important habitat for the conservation of bird populations. Bird Life International developed the IBA programme and the stewardship of IBAs in a given country is designated to a national conservation organisation – in the case of South Africa, to Birdlife South Africa. Limpopo houses two of the largest breeding colonies of *Gyps coprethes* (Cape Vulture) in the world at the Blouberg IBA. In addition, the Nylsvlei IBA contains 46% of the bird species found in Southern Africa and is an important bird breeding area. IBAs provide important habitat not only for birds but also for a number of other endangered and vulnerable species. Their existence is important to the conservation of biodiversity in Limpopo (LPG, 2006). Current threats to these IBAs include current mining operations and new applications, specifically with regard to the Waterberg, Nylsvlei, Blouberg and Soutpansberg IBAs. A lack of funding and staff further exacerbates these threats, often preventing the effective implementation of management plans. The IBAs largely form part of an existing PAN and expansion of the PAN should focus on including as much of the IBA as possible (Birdlife South Africa, 2015).

2.4.2.4 Threat Status

The National List of Threatened Ecosystems, which is listed under NEMBA, 2004, was amended in 2009. The list includes identified priority areas from conservation planning processes, which cover a distinct area. These priority areas, as they are threatened ecosystems, usually include more than one vegetation type. There are five threatened ecosystems in Limpopo: Malmani Karstlands, Sekhukhune Mountainlands, Sekhukhune Norite Bushveld, Blouberg Forest and Mapungubwe Forest. Together these ecosystems make up just over 1% of Limpopo. However, they have significant ecological value (LEDET, 2013). Figure 5 illustrates the protection status and location of these Nationally Threatened Ecosystems.

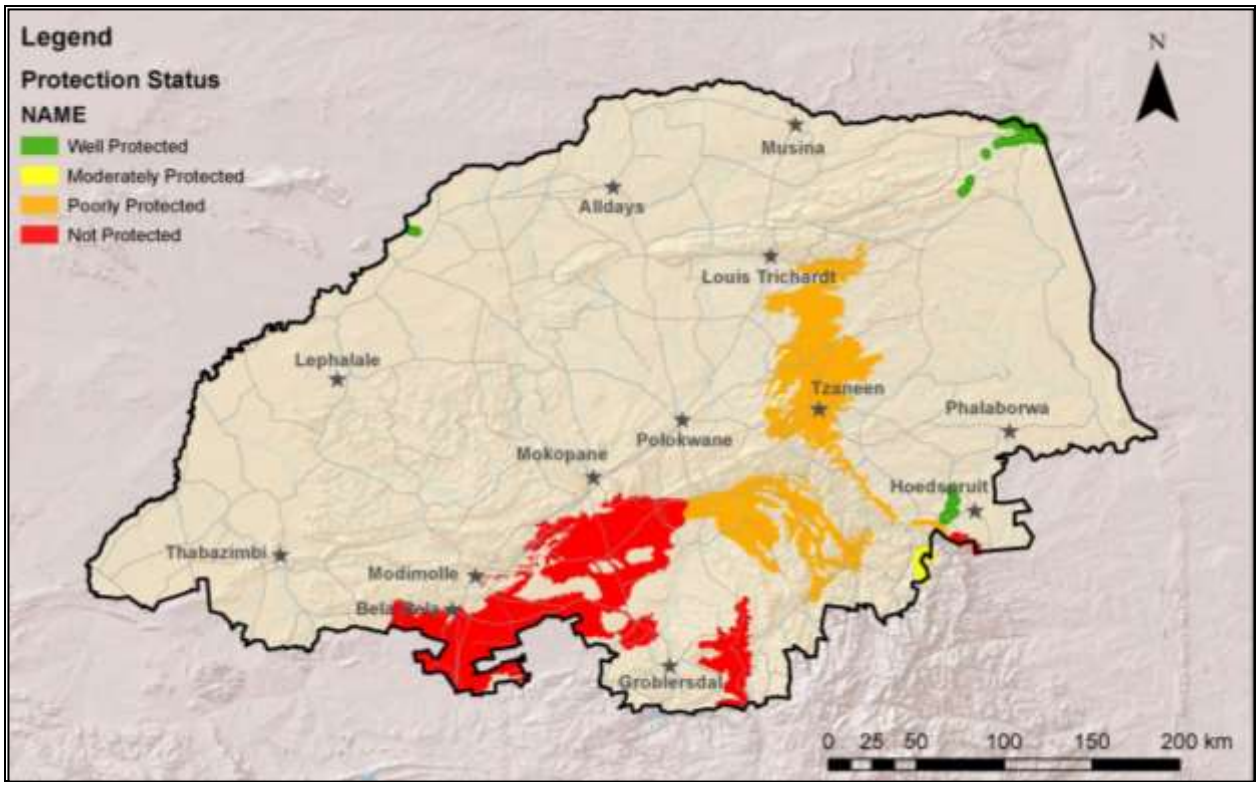


Figure 5: Protection status of Nationally Threatened Ecosystems (LEDET, 2013)

According to the LCPv2 (LEDET, 2013), eight of the 56 vegetation types found in Limpopo are threatened. One of these vegetation types is considered critically endangered, one is considered endangered and six are considered vulnerable (refer to Figure 6).

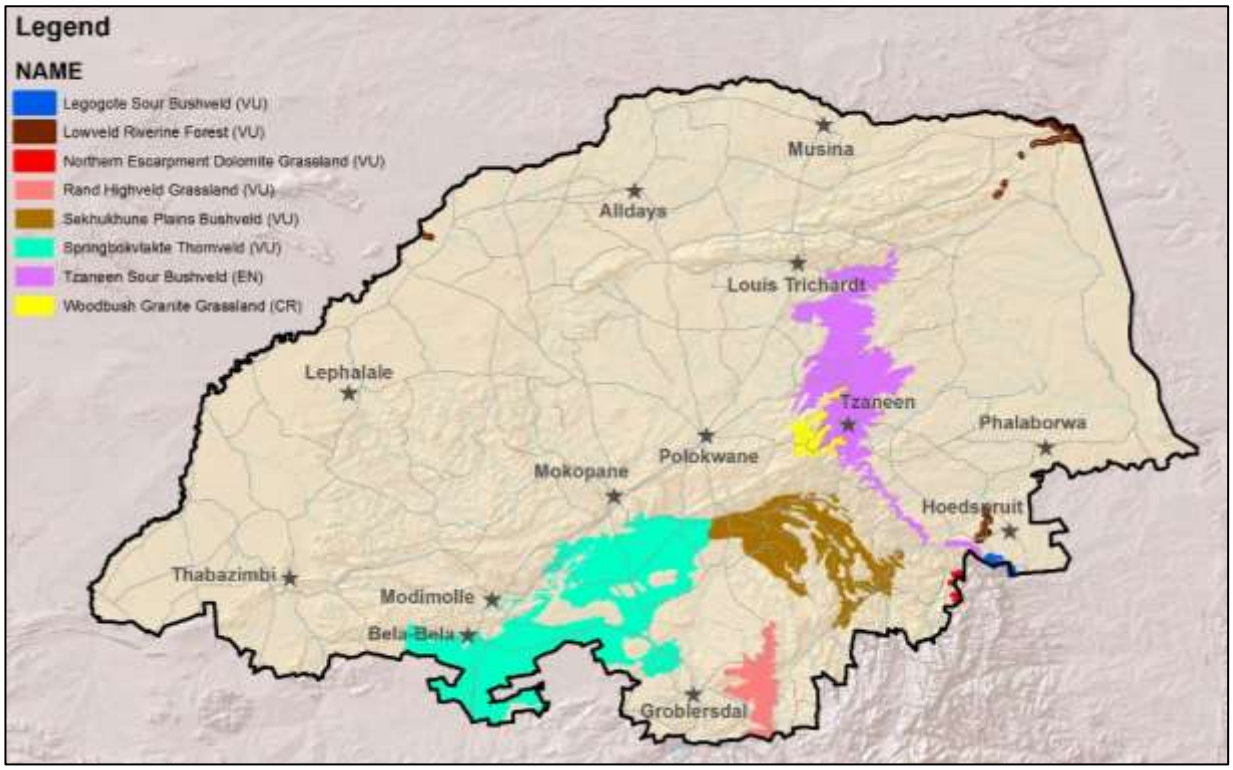


Figure 6: Threatened[28] vegetation types in Limpopo Province (LEDET, 2013)

[28] In the legend CR = Critically Endangered, EN = Endangered; VU = Vulnerable

The protection criteria used for threatened vegetation types are defined as follows:

- Well protected: 100% of biodiversity target reached;
- Moderately protected: 50% to 99% of biodiversity target reached;
- Poorly protected: 5% to 49% of biodiversity target reached; and
- Not protected: 0% to <5% of biodiversity target reached.

According to the LCPv2, the following protection status is in place for the threatened vegetation types (refer to Figures 5 and 6 above) (LEDET, 2013):

- Well Protected: Lowveld Riverine Forest;
- Moderately Protected: Northern Escarpment Dolomite Grassland;
- Poorly Protected: Sekhukhune Plains Bushveld, Tzaneen Sour Bushveld and Woodbush Granite Grassland; and
- Not Protected: Legogote Sour Bushveld, Rand Highveld Grassland and Springbokvlakte Thornveld.

The protection status of vegetation types in Limpopo is summarised in Figure 7. The status indicates the lack of protection for the Province's vegetation types, which stresses the importance of expanding the PAN in Limpopo.

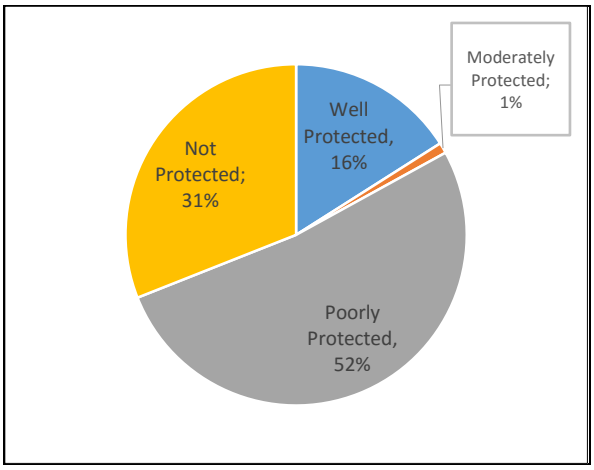


Figure 7: Percentage of vegetation types protected in Limpopo Province

Population Trends of Selected Species

Very little dataset information is available regarding the population status of species at a provincial level. Resources would need to be investigated by the Limpopo Provincial Government to keep track of selected species. Numbers of species identify the health of an ecosystem. For example, birds are bio-indicators of terrestrial ecosystem health. Low numbers of particular species or the absence of species within ecosystems can serve to identify degraded ecosystems.

Alien Invasive Species

A complete list of alien invasive plant species that should be eradicated exists for South Africa under the NEMBA, 2004. However, no specific Provincial-level list of alien invasive plant species is available. The species listed under the NEMBA, 2004, should serve as a starting point for compiling a specific list for Limpopo.

Centres of Endemism and Endemic Species

The LCPv2 states that 24 of the 56 (42%) vegetation types are endemic to Limpopo, with a further nine being near-endemic, which means that more than 80% of the vegetation type is found to occur in Limpopo (LEDET, 2013). According to the SANBI Red List for South African Plants (SANBI, 2015), Limpopo hosts 3 949 floral taxa, of which 198 are endemic to Limpopo. Of the endemic species, 75 are threatened and 106 are of conservational concern. No specific update of the percentage of Centres of Endemism conserved could be found. Furthermore, the exact

boundaries of the centres are haphazard and have not been updated recently and thus the number that is conserved is difficult to estimate. Additionally, it is highly likely that the Soutpansberg and Sekhukhuneland Centres of Endemism have come under increased threat as a result of increased mining activities and settlement encroachment in and around those centres. It is recommended that an updated analysis that utilises the latest available spatial data is commissioned. The centres of endemism have been included within the Critical Biodiversity Focus Areas in the LCPv2 (LEDET, 2013) (refer to Figure 8).

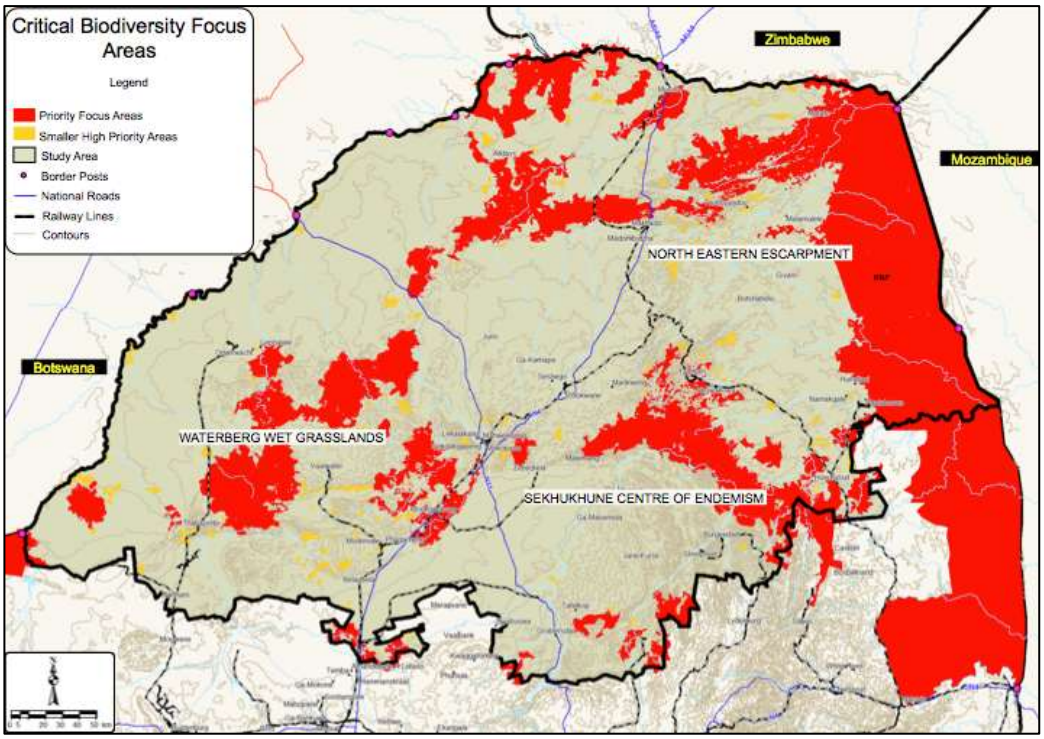


Figure 8: Critical Biodiversity Areas in Limpopo Province (DRDLR, 2016)

Change in Species Distribution

Not enough information is available to identify the state and trends of species distribution in Limpopo conclusively. Data of species present within the quarter degree square (QDS) should be recorded. Further investigation should incorporate presence-absence, or occurrence, data. Databases, such as the National Herbarium Pretoria Computerised Information System (SANBI, 2009), and the Bird (SABAP 2, 2015), and Frog Atlas (ADU, 2015), are used to determine species within a QDS. Habitat and land-cover layers can also be incorporated to determine the changes in distribution of endemic and threatened species.

2.4.3 Impacts

Biodiversity is the source of a wide range of ecosystem goods and services that are of enormous benefit to society. The loss of biodiversity will likely lead to the loss of critical ecosystem services that support the economy of Limpopo (for example, the pollination of commercial crops, eco-tourism and rangeland protection) and other services required for human survival (for example, sourcing and purification of water resources). This, in turn, will have severe cost implications for restoring such ecosystems or implementing artificial methods to perform the same services offered freely by the natural environment (NW READ, 2014).

Biodiversity loss also tends to spark a negative spiral of progressive ecosystem deterioration and further biodiversity loss, owing to the destabilisation of ecosystem integrity. Habitat loss, fragmentation, bush encroachment, invasive alien infestations and indigenous species losses are all consequences of a reduction in biological variability. Loss of ecosystem integrity determines how the natural system functions and the type and quality of ecosystem services it can provide in future (NW READ, 2014).

Habitat Fragmentation and Change

Degradation and the subsequent loss of species, habitats and ecological functions threaten not only the long-term sustainability of natural systems but also the capacity of all terrestrial systems to support human livelihoods and lifestyles (Balance, 2001). Land degradation results in a significant reduction in the production capacity of land and a degradation of ecosystem services. This, in turn, has an impact on human populations and especially rural communities. Overgrazing and small-scale farming in natural areas change habitat availability and suitability. South Africa continually updates land cover data through the use of satellite imagery, in order to track land cover change. Land cover change is being monitored more than ever before in South Africa. Despite this, the lack of appropriate spatial information from previous years regarding the irreversible loss of natural habitat and degradation is a problem in tracking change in land cover for conservation planning. This should be taken into account in allocation of resources for research and data collection aimed at supporting conservation-planning efforts in Limpopo.

Alien and Invasive Species

Alien and invasive species are generally known to erode natural capital, compromise ecosystem stability and threaten economic productivity. The consequences are not only ecological but often also economic. After direct habitat destruction, alien and invasive species infestations are having the largest impact on biodiversity (Kotze *et al*., 2010).

Urban Development

While expansion of urban areas is inevitable with an expansion in the human population, it should be kept in mind that urban sprawl does have negative impacts on the environment and ecosystem services. Urban development should be in line with the Spatial Development Frameworks (SDFs) under whose jurisdiction the urban areas fall.

Agriculture and Mining

There is a tension between the need for cultivation that provides food and livelihoods for farmers, on the one hand, and the need to conserve valuable natural habitats, ecosystems and ecosystem services, on the other. Agricultural crops inherently alter natural habitats, which impacts negatively on biodiversity. Agriculture is a generator of wealth and constitutes one of the key industries in the South African economy (NDA, 2000). Limpopo is no different and agriculture is one of the larger industries in the Province. In view of this, it is important to monitor the extent of agricultural practices in Limpopo.

The mining sector, by the very nature of its activity, has impacts on the biophysical, social and economic environment. Particular areas where the impacts of mining are on a large enough scale to drive environmental change include pollution and waste generation. For example, current mining activities and new mining applications threaten the existence of the Mapungubwe, Soutpansberg and Blouberg IBAs (Birdlife South Africa, 2015). Additional impacts include soil erosion, soil contamination and change in land characteristics. It is, therefore, important to attempt to monitor the extent of area covered by mining activities and, ideally, couple this with the type of mining that occurs.

Legal and Illegal Exploitation of Biodiversity

Owing to the multifaceted value in South Africa's biodiversity, many plants and animals are subject to exploitation. Large numbers of plant taxa are threatened by direct use and harvested at levels that are not sustainable. The greatest direct use impacts for birds are killings by humans, live bird trade and traditional medicine. For invertebrates the collector trade is a concern; for mammals hunting, persecution and traditional medicine; and for reptiles the pet trade and traditional medicine.

Medicinal Plant Species

In the South African context, medicinal plants play an important role in the traditional healthcare system, and in Limpopo this is no different. Moeng and Potgieter (2011) conducted a study on the trade of medicinal plants in Limpopo. Their study included 16 *muthi* (indigenous

medicine) shops, and it was determined that 231 medicinal plant species and 0.96 tons per year were traded from these shops. It is currently unknown how many *muthi* shops and vendors there are in Limpopo but, using the above study as a basis, it can be concluded that the medicinal plant species trade is substantial, and the impact on protected plant species conservation is therefore significant (Moeng & Potgieter, 2011).

According to SANBI (2006), medicinal plants, although viewed as problematic from a conservation perspective, can also be seen as a positive conservation opportunity, as these plants have increased value in terms of healthcare, income or cultural identity. These factors can be used as a motivator for conservation of these species and their habitats. Plant part substitution can be an important strategy for the conservation of medicinal plants and traders should be encouraged to consider this strategy. Thorough research should, however, be conducted to establish whether the substituted plant part (for example, leaves) would have the same efficacy and low toxicity levels as the original plant part (for example, the root) (Moeng & Potgieter, 2011).

The results of the assessment illustrate important biodiversity trends, as detailed in Table 4, which summarises these trends, as reflected by the various indicators used.

Table 4: Summary of Biodiversity and Ecosystem Health trends

INDICATORS	TRENDS
Extent of conserved areas	Increasing
Extent of natural areas remaining	Decreasing
Vegetation types, threat and protection status of vegetation types per biome	Decreasing
Habitat fragmentation index	Increasing
Alien and invasive species	Increasing
Status of terrestrial ecosystems	Decreasing
Transformation of centres of high endemism	Decreasing
Status of conserved areas, including IBAs and biodiversity areas	Increasing
Threatened and extinct species, ecosystems and habitats	Increasing
Endemic species	Decreasing
Population trends of selected species	Decreasing
Distribution and abundance of selected alien species	Increasing
Change in species distribution	Increasing

It is clear from the trends discovered that attention must be directed towards the protection and effective management of Biodiversity and Ecosystem Health.

2.4.4 Responses

Limpopo has developed and implemented the Limpopo Conservation Plan, a key document that serves to inform Biodiversity Conservation and Planning in the Province. To be compliant, the Bioregional Plan, as well as the extent of Limpopo that is covered by the Bioregional Plan, needs to be updated every five years.

The LCPv2 is used as a guideline to inform strategies for future biodiversity planning in Limpopo. Specific reference is made to the land management objectives and recommendations, and compatible and incompatible land uses. The LCPv2 is the reference document used when Environmental Impact Assessments (EIAs) are conducted in the Province.

Inevitably, mining activities in Limpopo will, and have already, come into conflict with land management objectives and compatible land uses, as stipulated in the LCPv2 (LEDET, 2013), especially in the Sekhukhune and Soutpansberg centres of endemism. Of particular concern is the fact that mining applications have been approved in sensitive CBAs and in close proximity to formal PAs, where mining is explicitly indicated as an incompatible land use.

Other land uses that may affect CBAs include urban development, agricultural activities and forestry. Future planning of such activities must also consider the compatibility of the land use in the CBA category in which it is situated.

The LCPv2 is the latest, most comprehensive and easily accessible biodiversity spatial planning tool and is integrated with national spatial biodiversity planning. The LCPv2 is also used as a reference for project-based Biodiversity Assessments in the EIA process. The LCPv2 is now being used as a basis for incorporating biodiversity conservation into regional plans and regional Environmental Management Frameworks (EMFs) to ensure sustainable use of resources. This is being done through new EIA applications and environmental monitoring.

2.4.4.1 Conservation Priorities

Immediate biodiversity conservation focus is on threatened vegetation types that are currently not well protected in order to increase the level of protection for these threatened vegetation types. The primary goal is to ensure that critically endangered and endangered vegetation types, as well as vulnerable vegetation types, endemic to Limpopo, are well protected, if sufficient natural areas remain to reach the biodiversity target. The primary focus includes the Sekhukhune Plains Bushveld, Tzaneen Sour Bushveld and Woodbush Granite Grassland vegetation types.

Local Government should investigate policies and actions to educate traders in terms of protected and threatened species, and should implement strategies together with local traditional healers, harvesters and vendors to obtain a means of sustainable harvesting.

2.4.4.2 Management of Land Degradation

Habitat degradation as a result of, for example, overgrazing; unsustainable harvesting of natural resources for firewood, building material and medicinal use; and alien invasive species invasion is not specifically mapped. However, the change in land use, which indicates habitat degradation, is being monitored by National Government. The South Africa National Land Use Dataset (GTI, 2015), compiled for the DEA, is a significant improvement on previous land use datasets. General understanding of land cover and the change in land cover is enhanced by the advancement in remote sensing applications and satellite imagery availability. Enhanced land cover data can be used to inform provincial and district fine-scale land use plans, such as SDFs and EMFs. These plans can then be used during the development of localised conservation plans and to identify priority areas for rehabilitation and alien invasive plant species control.

The South African Department of Water and Sanitation (DWS) and the South African Working for Water (WfW) Programme are mainly responsible for monitoring and managing alien and invasive species throughout South Africa. This programme works in partnership with the local communities in their respective regions and has become a valuable source of employment. Although a complete list of alien and invasive species that should be eradicated exists for South Africa under NEMBA, 2004, a list of species specifically related to Limpopo should be developed. As stated in the LCPv2 (LEDET, 2013), an Ecological Management Plan (EMP) should be compiled for Limpopo, which should include an alien plant control and vegetation eradication programme.

In 2010, the National Invasive Alien Plant Survey project was initiated by the WfW Programme and implemented by the Agricultural Research Council. The project objective was to establish and implement a cost-effective, objective and statistically sound alien invasive plant species monitoring system for South Africa, Lesotho and Swaziland at a quaternary catchment level (Kotze *et al*., 2010). This alien invasive plant species survey can be used as a basis for implementing an alien vegetation eradication programme in Limpopo by identifying areas where specific species should be targeted.

The Southern African Plant Invaders Atlas (SAPIA) is another important resource for planning the effective control of invasive alien plants in South Africa. SAPIA aims to collect and computerise information on the distribution, abundance and habitat types of naturalised and invasive alien plants in the Southern African region.

The abovementioned alien invasive plant species datasets should be integrated into the LCPv2, and into local fine-scale plans, and should be updated regularly in order to monitor the efficiency of eradication programmes and also the spread of alien invasive plant species into new areas.

From the outcome of the response formulation, the following key recommendations are highlighted:

- Development of a monitoring and management plan for the biodiversity key indicators;
- Establishment of appropriate environmental advisory bodies;
- Investment in GIS and database management and advisory bodies;
- Management and monitoring of datasets for PAs, sites of ecological importance and private conservation areas; and
- Funding and sufficient allocation for the allowance of proper management of conservation areas.

2.4.5 References

Animal Demographic Unit (ADU). 2015. *Virtual Museum*. Internet material accessed 11.2015: http://vmus.adu.org.za/.

Balance, A. 2001. *Country Profile for South Africa for the Second State of Environment Report for Southern Africa*. Unpublished.

Birdlife South Africa. 2015. *Important Bird and Biodiversity Areas Directory*. Internet material accessed 11.2015: http://www.birdlife.org.za/conservation/important-bird-areas/iba-directory.

Climate Support Programme (CSP). 2015. *Climate Change Adaptation Strategies: Adaptation Strategies for Limpopo Province*. Developed by GIZ and Department of Environmental Affairs (DEA).

Department of Environmental Affairs (DEA). 2012. *South Africa Environmental Outlook – Part 3: Environmental Outlook*, version 006.

Department of Environmental Affairs (DEA). 2013a. *Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa. Climate Change Implications for the Biodiversity Sector in South Africa.* Pretoria, South Africa.

Department of Environmental Affairs (DEA). 2013b. *Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa*. Pretoria, South Africa.

Department of Environmental Affairs (DEA), Department of Mineral Resources, Chamber of Mines, South African Mining and Biodiversity Forum and South African National Biodiversity Institute (SANBI). 2013. *Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector*. Pretoria.

Department of Environmental Affairs and Tourism (DEAT). 2006. *South Africa Environment Outlook.* Department of Environmental Affairs and Tourism, Pretoria.

Department of Rural Development and Land Reform (DRDLR). 2016. *Limpopo Province Spatial Development Framework (LSDF*) February 2016. Prepared by Plan Associates, Pretoria.

GeoTerraImage (GTI) Pty Ltd. 2012 *Limpopo Province land-cover dataset: Mapped from 2009 SPOT5 Satellite Imagery for ESKOM. Summary Report and Metadata*. (GTI) Pty Ltd, Pretoria, South Africa.

GeoTerraImage (GTI) Pty Ltd. 2015. *2013-2014 South African National Land-Cover Dataset*. Data User Report and Metadata. Department of Environmental Affairs (DEA) Open Access.

International Union for the Conservation of Nature (IUCN). 2015. *Community-led solutions: a key force in tackling wildlife crime*. Internet material accessed 13.03.2016: http://www.iucn.org/news_homepage/ all_news_by_theme/species_news/?18968/Community-led-solutions-key-force-in-tackling-wildlife-crime

Kotze, I., Beukes, H., van den Berg, E. & Newby, T. 2010. *National Invasive Alien Plant Survey*. Report No: GW/A/2010/21. ARC. Pretoria, South Africa.

Limpopo Department of Economic Development, Environment and Tourism (LEDET) 2013. *Limpopo Conservation Plan, Version 2 (LCPv2)*. Technical Report prepared by ECOSOL GIS.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2015. *Indicator Report for the Limpopo Environmental Outlook Report.* Compiled by EcoAfrica Environmental Consultants, October 2015.

Limpopo Province Thabazimbi Local Municipality (TLM). 2010. *Investment and Marketing Strategy*. Developed by MMS Mabu Management Solutions. Internet material accessed 11.2014: http://www.thabazimbi.gov.za/docs/strategy/TLM%20INVESTMENT%20AND%20MARKETING%20STRATEGY.pdf.

Moeng, E.T. & Potgieter, M.J. 2011. The trade of medicinal plants by muthi shops and street vendors in the Limpopo Province, South Africa. *Journal of Medicinal Plants Research*, 5 (4), 558-564.

Mongwe, H.G. 2004. *The Status of Soil Organic Carbon under Indigenous forests, Grasslands, Wetlands and Pine Plantations in Woodbush, Limpopo Province, South Africa.* Faculty of Agriculture and Forestry, Department of Soil Science, University of Stellenbosch.

Mucina, L. & Rutherford. M.C. (Eds). 2006. *The Vegetation Map of South Africa, Lesotho and Swaziland.* SANBI, Pretoria.

National Department of Agriculture (NDA). 2000. *General Information on Agriculture in South Africa.* Internet material accessed 11.2015: http://www.nda.agric.za.

National Environmental Management: Biodiversity Act (Act No. 10 of 2004) (NEMBA): Alien and Invasive Species Regulations, General Notice R598 of 2014.

National Environmental Management: Protected Areas Act (Act No. 57 of 2003). Norms and standards for the management of protected areas in South Africa, General Notice 528 of 2003.

Nellemann, C., Henriksen, R., Raxter, P., Ash, N. & Mrema, E. (Eds). 2014. *The environmental Crime Crisis – Threats to Sustainable Development from Illegal Exploitation and Trade in wildlife and Forest Resources*. A UNEP Rapid Response Assessment. United Nations Environment Programme and GRID-Arendal, Nairobi and Arendal.

North West Department of Rural, Environment and Agricultural Development (NW READ). 2014. *North West Environment Outlook Report 2013*. North West Provincial Government. Mafikeng.

South African National Biodiversity Institute (SANBI). 2006. *A South African response to the Global Strategy for Plant Conservation*. SANBI Biodiversity Series 1. South African National Biodiversity Institute, Pretoria.

South African National Biodiversity Institute (SANBI). 2009. *Plants of Southern Africa (POSA) Data Base*. Internet material accessed 11.2015: http://posa.sanbi.org/searchspp.php.

South African National Biodiversity Institute (SANBI). 2013. *Life: the state of South Africa's biodiversity 2012*. South African National Biodiversity Institute, Pretoria.

South African National Biodiversity Institute (SANBI). 2015. *Biographical Geographic Information System* (BGIS). Internet material accessed 11. 2015: http://bgis.sanbi.org.

Southern African Bird Atlas Project (SABAP) 2. 2015. Internet material accessed 11.2015: http://sabap2.adu.org.za/.

Southern African Plant Invaders Atlas (SAPIA). Internet material accessed 11.2015: http://www.arc.agric.za.

United Nations Educational, Scientific and Cultural Organisation (UNESCO). 2015. *Ecological Sciences for Sustainable Development: Biosphere Reserves – Learning Sites for Sustainable Development*. Internet material accessed 11.2015: http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/biosphere-reserves/.

2.5 Waste Management

2.5.1 Introduction

Throughout most of history, humans have generated waste. At first the levels were very low, and included pot shards and ash as we can see at many archaeological sites throughout Limpopo. But in modern times, and especially over the last few decades, the magnitude of waste has grown into an enormous problem that is directly linked to quality of life, health issues, safety, and environmental and economic hazards.

Interestingly, as far back as 1751, the build-up of waste in London and rapid deterioration of sanitation and the general quality of urban life led to the establishment of a municipal authority with waste-removal powers. Several hundred years later, in Limpopo Province, it is fully recognised that waste management is essential for reducing, or eliminating, the adverse impacts of waste on the environment. This may occur through reducing waste generation and through reusing, recovering and recycling waste, which is the main element of the waste hierarchy. This hierarchy is the foundation for the National Environmental Management: Waste Act (NEMWA), Act No. 59 of 2008, where waste disposed to landfill is seen as a last resort.

Not surprisingly, considering the obvious amount of waste in the Province, stakeholders have identified waste management as a key issue in Limpopo. The collection and disposal of solid waste in the rural areas constitute a particular concern that has been raised.

Waste is divided into two classes, based on the risk it poses: general waste and hazardous waste. General waste is waste that does not pose an immediate hazard or threat to health or to the environment and includes domestic waste, building and demolition waste, business waste and inert waste. Hazardous waste is any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment and includes hazardous substances, materials or objects within the business waste, residue deposits and residue stockpiles.

The waste management indicators used to assess the status of waste management are listed in Table 1 below.

Table 1: Indicators used in the assessment of Waste Management in Limpopo Province

INDICATORS CONSIDERED	DESCRIPTION AND COMMENT
Number of hazardous waste sites and facilities	There are no hazardous waste sites in Limpopo (LEDET, 2012) and the risk that such waste is being disposed of illegally, or to general waste sites, exists.
Number of general waste sites	The number of general waste sites across Limpopo has increased.
Percentage of licensed municipal landfill sites	The percentage of authorised municipal general waste sites has increased.
Amount of waste to landfill per annum	Currently estimated at 2 443 858 tons per annum (tpa). No baseline is available for 2006.
Amount of waste recycled per annum	No definitive information available, yet 140 recycling facilities noted across Limpopo.

2.5.2 State

2.5.2.1 Waste Management Planning

The Limpopo Integrated Waste Management Plan (IWMP) (LEDET, 2012) has been adopted, with two of the five District Municipalities (DMs) and 23 of the 25 Local Municipalities (LMs) in various stages of compiling IWMPs[29], as detailed in Table 2. The Limpopo Provincial Department of Economic Development, Environment and Tourism (LEDET) has assisted in the development of IWMPs through funding and technical assistance.

[29] Note that the NEMWA stipulates that an IWMP should have an annual performance review and a new IWMP must be developed every five years if necessary. If the status of IWMPs in Table 2 states Draft Stage, this may include second- or third generation draft IWMP documents.

For most of the municipalities in Limpopo, the following 10 goals were identified:

- Goal 1: Expansion of waste services and cost recovery;
- Goal 2: Management of waste disposal facilities;
- Goal 3: Promoting recycling initiatives;
- Goal 4: Hazardous waste management;
- Goal 5: Strengthening institutional capacity for waste management;
- Goal 6: By-law development and strengthening enforcement capacity;
- Goal 7: Education and awareness on waste issues;
- Goal 8: Regionalisation of disposal facilities;
- Goal 9: Risk assessment, monitoring and evaluation; and
- Goal 10: Research and development into emerging issues.

Table 2: Status of Integrated Waste Management Plans in District and Local Municipalities (LEDET, 2012)

DISTRICT MUNICIPALITY	LOCAL MUNICIPALITY	STATUS
Vhembe		Not available
	Mutale	Draft stage
	Musina	In process of development
	Makhado	Draft stage
	Thulamela	Draft stage
Waterberg		Completed and to be submitted to LEDET
	Mogalakwena	Completed and to be submitted to LEDET
	Mookgophong	Draft stage
	Modimolle	Draft stage
	Belabela	Draft stage
	Lephalale	Draft stage
	Thabazimbi	Draft stage
Mopani		Not available
	Ba-Phalaborwa	Submitted to LEDET for comment
	Greater Giyani	Draft stage
	Greater Letaba	Completed and to be submitted to LEDET
	Greater Tzaneen	Not available
	Maruleng	Submitted to LEDET for comment
DISTRICT MUNICIPALITY	LOCAL MUNICIPALITY	STATUS
Capricorn		Not available
	Aganang	Not available
	Blouberg	Draft stage
	Molemole	Draft stage
	Lepelle-Nkumpi	Draft stage
	Polokwane	Completed and to be submitted to LEDET
Sekhukhune		Final stage of completion
	Fetakgomo	Draft stage
	Greater Tubatse	Final draft
	Elias Motsoaledi	Draft stage
	Ephraim Mogale	Draft stage

2.5.2.2 Waste Facilities

With additional pressure from a growing population and enabling legislation, there are now, across Limpopo, more authorised waste disposal sites in place than in 2006. Since 2006, the number of authorised general waste landfill sites in Limpopo has almost doubled, from 43 to 84 waste sites and waste storage facilities in 2015, with 76% currently licensed, compared to 23% previously. Figure 1 illustrates the location of waste facilities[30] in Limpopo.

[30] 'Waste disposal facility' means any site or premises used for the accumulation of waste with the purpose of disposing of that waste at that site or on that premises (DEA, 2008). Waste facilities include landfills, recycling centres, waste

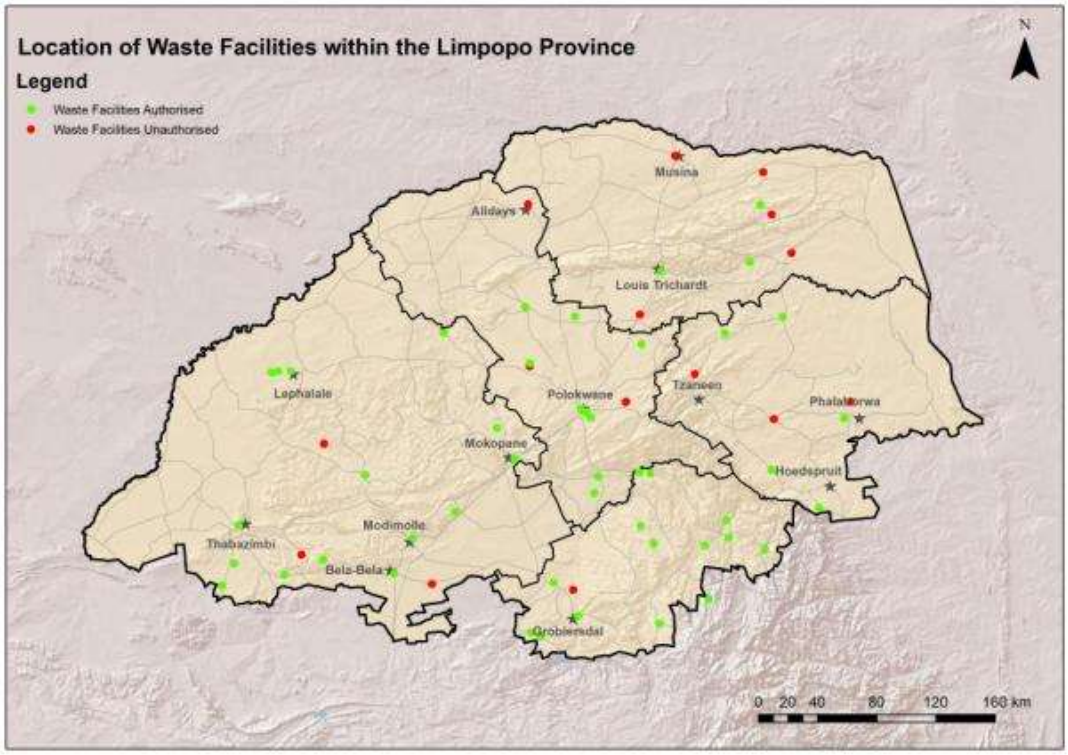


Figure 1: Authorised and unauthorised waste facilities in Limpopo Province

The effective management of waste is of critical importance to avoid environmental health issues and to protect especially rivers and wetlands in Limpopo. The waste management function should be strengthened in view of the problems experienced in the collection of waste and in monitoring of the performance of licensed waste disposal sites. Variability exists in the amount of effort applied by LMs in managing and monitoring solid waste. Waste management campaigns, such as participation in the Green Municipalities Competition, are also ongoing.

Figure 2: Waste management in Limpopo Province

There are certainly difficulties in waste management in Limpopo, yet the finalisation and implementation of IWMPs, proper functioning and monitoring of solid waste disposal sites, and improved waste collection and recycling efforts can provide significant improvement. There are no hazardous waste disposal sites in Limpopo and LEDET is currently not monitoring hazardous waste generation, or disposal. It is legislated that hazardous waste must be disposed of in a licensed, hazardous landfill. The closest site to the Province is located in Johannesburg at the Holfontein Hazardous Landfill Site. Transporting hazardous waste out of the Province is expensive and some hazardous waste is co-disposed of at existing general landfill sites.

transfer stations, and buy-back centres. Unauthorised waste facilities include illegal dumping sites and unlicensed waste facilities.

Thirteen percent (13%) of landfill sites still remain unauthorised, with an additional 5% of the sites across Limpopo under application. Waste collection in rural areas is an issue that requires priority attention. According to the National Domestic Waste Collection Standards (DEA, 2008), Category C municipalities in rural areas are allowed to have communal and individual dumping sites that are operated within the guideline parameters.

The lack of adequate financial resources and technical capacity limits the effective operation and monitoring of the performance of waste sites. This is an issue, even though monitoring of municipal waste sites for compliance is conducted by the provincial authority and the local authority waste departments at the local level. There are currently 84 waste facilities in Limpopo, as presented in Table 3.

Table 3: Number of waste sites and waste storage facilities in Limpopo Province

DETAILS	2004	2015
Waste Sites	43	77
Waste Storage Facilities (includes waste transfer stations)	-	7
Authorised Municipal Landfill Sites	10	44
Authorised Private Landfill Sites	-	13
Unauthorised Municipal Dumping Sites	24	12
Unauthorised Private Dumping Sites	-	1
Municipal Landfill Sites under Application	-	4
Private Waste Storage Facilities	-	1

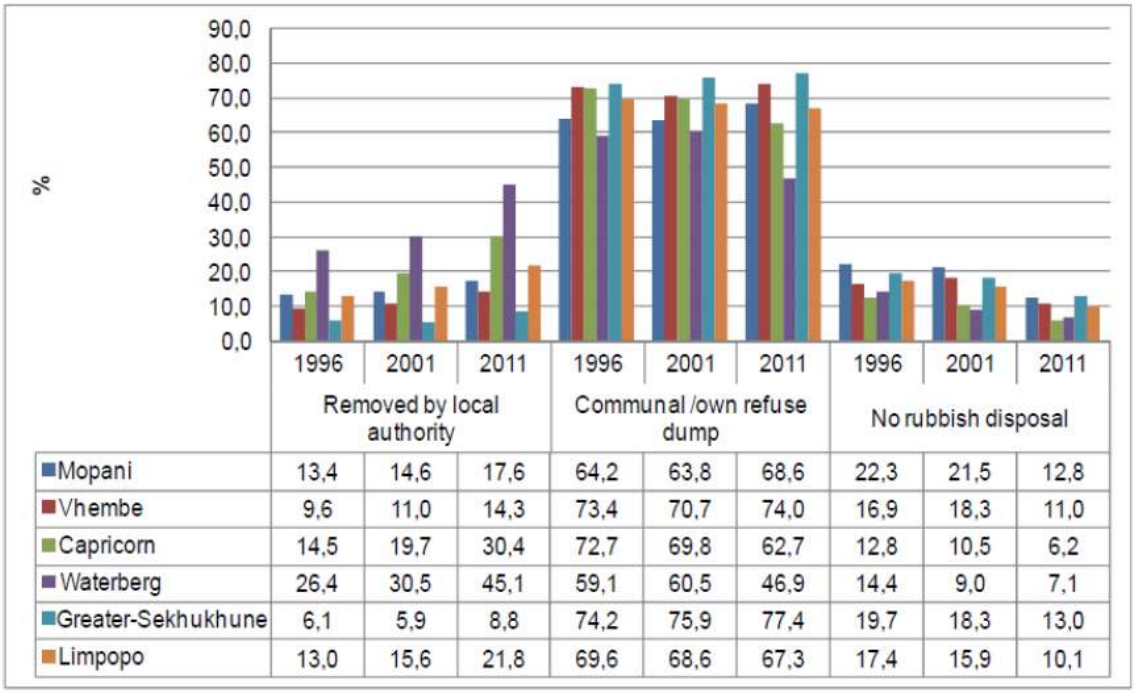
More general waste sites have been authorised. The waste received is being measured at some sites, yet these measurements are not always accurate.[31] There is certainly a growth in the volume of waste being handled in Limpopo, which is estimated at 2 443 858 tons (LEDET, 2012). There are 140 recycling facilities active across Limpopo (LEDET, 2012), yet the amount of waste being recycled is not accurately recorded.

Table 3 details the types of waste sites and waste storage facilities currently on record in Limpopo, as compared to the 2004 records, presented in the Limpopo State of the Environment Report (SOER) (LEDET, 2004).

2.5.2.3 Waste Generation

The majority of the households in Limpopo (67.3%) used communal, or own, refuse dumps in 2011 (refer to Figure 3 overleaf). The proportion of households whose refuse is removed by the respective local authority remains relatively low (21.8%), although levels have increased in all districts over the 15-year period from 1996. Furthermore, the proportion of households across Limpopo with no refuse disposal facilities decreased from 17.4% to 10.1% over this period. The Capricorn and Waterberg Districts have the highest proportion of households serviced by formal refuse removal services (DRDLR, 2016).

[31] Personal communication with Mr Tshepo Maselela, Manager of General Waste Management, Directorate of Pollution and Waste Management, LEDET, 10 September 2015.



	Removed by local authority			Communal /own refuse dump			No rubbish disposal		
	1996	2001	2011	1996	2001	2011	1996	2001	2011
Mopani	13,4	14,6	17,6	64,2	63,8	68,6	22,3	21,5	12,8
Vhembe	9,6	11,0	14,3	73,4	70,7	74,0	16,9	18,3	11,0
Capricorn	14,5	19,7	30,4	72,7	69,8	62,7	12,8	10,5	6,2
Waterberg	26,4	30,5	45,1	59,1	60,5	46,9	14,4	9,0	7,1
Greater-Sekhukhune	6,1	5,9	8,8	74,2	75,9	77,4	19,7	18,3	13,0
Limpopo	13,0	15,6	21,8	69,6	68,6	67,3	17,4	15,9	10,1

Figure 3: Households by type of refuse disposal in Limpopo Province (DRDLR, 2016)

The refuse removal service provided by LMs is one of the essential basic services, such as water, sanitation, electricity and housing. This means that government is legislated to also offer free refuse removal to indigent households.[32] Figure 3 above shows that there is a general increase in local authorities removing refuse and a decrease in households that do not have rubbish disposal. Table 4 below presents information pertaining to general waste generation per DM in Limpopo.

Table 4: Waste generation per District Municipality in Limpopo Province (LEDET, 2012)

DISTRICT MUNICIPALITY	WASTE GENERATED (tons per annum)
Capricorn	1 614 493
Waterberg	165 100
Vhembe	224 889
Mopani	226 155
Sekhukhune	212 218
Total	2 443 858

Landfill sites in Limpopo are described as being *environmentally unacceptable and unsafe*. There is, however, stringent legislation in place to monitor, manage and license landfills to make them more environmentally safe. Landfill management includes the weighing or estimation of the amount of waste entering the landfill and the characterisation of the types of waste being dumped. This is done for record keeping, and to monitor the landfill's capacity to receive additional waste. It is also done to avoid the dumping of problematic waste streams, such as hazardous waste, which also includes medical waste. There is no legal incineration of municipal waste at landfill sites and fires burning at licensed landfills are in transgression of the sites' landfill licence. The feasibility of developing waste-to-energy projects at landfill sites has been identified and needs to be further investigated. However, specific environmental conditions must be met and a certain amount of waste is needed for these projects to be viable (LEDET, 2013).

Most mines have permitted general landfill sites on their premises. Solid waste from mining activities is disposed of on tailings dams and mine dumps. Limpopo does not have a hazardous waste landfill site; therefore, hazardous waste is either co-disposed in general waste landfills or transported to other provinces (LEDET, 2012). Minimising wasteful resource extraction and

[32] Department of Environmental Affairs (DEA) National Policy for the Provision of Basic Refuse Removal Services to Indigent Households.

effectively managing pollutants within the mineral extraction life cycle can provide improved air and water quality and help in the reduction of greenhouse gas emissions. Recovery, reuse and reprocessing of mining wastes are important for minimising waste in the sector and possible waste-to-energy projects could developed.

It is believed that large quantities of hazardous waste are disposed of illegally at general waste landfills. Illegally dumped general and industrial waste is frequently observed on undeveloped land, particularly near informal settlements, in settlement areas not receiving a municipal waste service, or in industrial areas (LEDET, 2012). There are large medical waste operating facilities or incinerators at hospitals. These medical waste facilities also require licensing.

NEMWA makes it a legal requirement to quantify waste information and report it to the Waste Information System (WIS). Annual reporting of waste generation is increasingly being reported in the WIS and in individual IWMPs. Waste collected from households, institutions, commercial and industrial facilities is not measured at the source where waste is being generated and is measured when the waste arrives at the landfill weigh-in point, if such is available.

An emerging concern is electrical waste (otherwise known as *e-waste*) or Waste Electrical and Electronic Equipment (WEEE) waste generation. This includes all electrical and electronic waste, such as mobile phones, computers, fridges and the like. This waste type is currently co-disposed in communal dumpsites or in landfill sites (LEDET, 2012). E-waste contains hazardous waste materials; however, the different elements found in e-waste can also have a valuable market value if harvested.

The NEMWA legislates the development of Industry Waste Management Plans to be prepared by private industries to manage problematic waste streams; some examples are for e-waste, tyres and medical waste.

2.5.2.4 Recycling

Less than 20% of the waste generated in Limpopo is recycled. Most recycling initiatives occur in cities and towns like Polokwane, Tzaneen and Makhado, where the volume of recyclable materials is enough to make the recycling effort financially viable. The exact number of recycling facilities, material recovery facilities and buy-back centres per DM and LM is unknown and there are also many informal recycling initiatives (LEDET, 2012).

What to do with agricultural waste?

The general waste generated by the agricultural sector, which consists of tons of spoilt fruit and vegetables per year, eventually goes to general landfill sites. The African Stockpile Project generated data that indicated that the obsolete stocks in Limpopo require for future planning, in particular, targeting of prevention measures and raising awareness about the accumulation of the waste stream. Composting or organic waste is seen as an opportunity to create saleable products, like compost, which is preferable to chemical fertiliser, as it has no negative environmental impacts (LEDET, 2012).

2.5.2.5 Financial Resources Provision

Alternatives to the current waste management practices require larger budget allocation by LMs. For example, expansion of waste collection to areas that are not serviced is expected to increase the current cost of refuse collection service by 18% per annum in most municipalities. Therefore, proper planning and budgeting should be done in good time to achieve this expansion (LEDET, 2012). It is noted that, although refuse collection services are a basic service to residences, most municipalities charge for kerbside collection to subsidise the cost of providing the service. However, the revenue collection from ratepayers is not always the full amount for the services received and the charge to residences does not always cover the full cost of providing the service. Additionally, government has the Free Basic Refuse Removal Service Guidelines to offer waste collection to the indigent population. Competing budgetary items, such as government's provision of free electricity, water, sanitation and housing and other services, such as roads, have been preferred over the budgeting for waste management.

2.5.2.6 Stakeholder Engagement

During stakeholder engagement held across Limpopo, waste management was identified as a major issue, as illustrated in Figure 4. Waste management should be regarded as a priority in Limpopo.

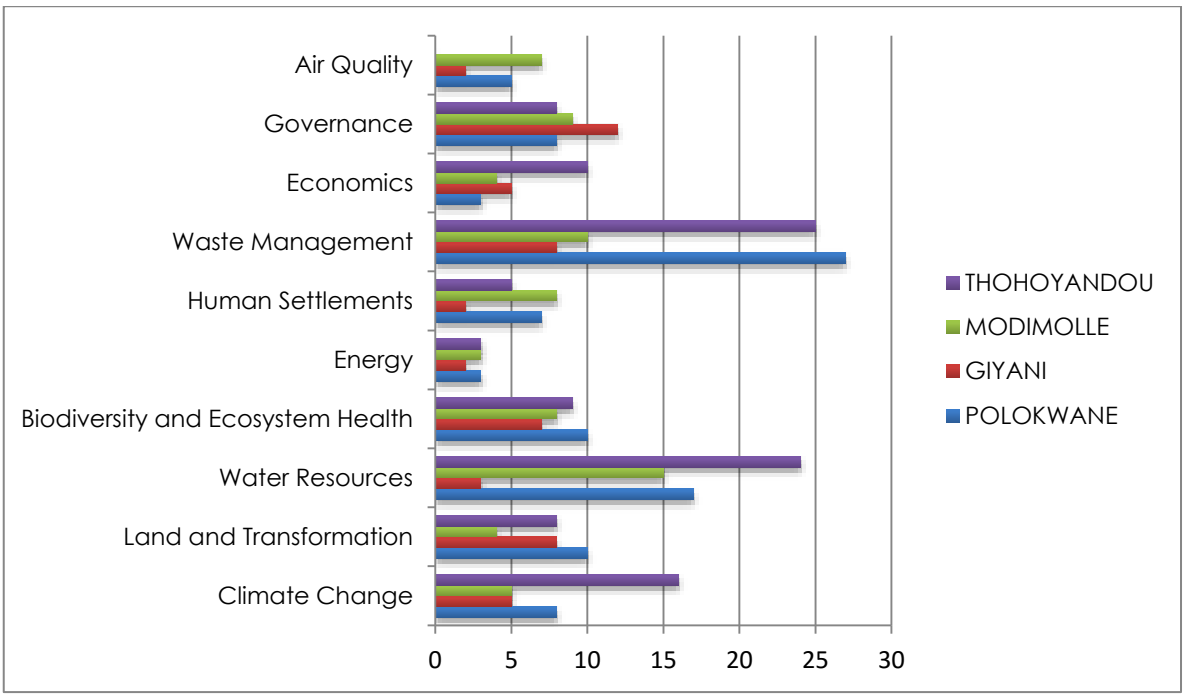


Figure 4: Environmental issues identified during public meetings and workshops held in Limpopo Province

2.5.3 Impacts

It is clear that waste management remains a key issue in Limpopo, in spite of significant progress made in terms of the number of authorised waste facilities across Limpopo. Progress is also being made in the compilation of IWMPs across Limpopo. Both these indicators show positive trends. Waste collection, especially in rural areas, remains a challenge and poses significant environmental health and pollution risks. Technical capacity for the planning, operation and monitoring of landfill sites, however, remains weak, as emerged from discussions in the stakeholder and public meetings.

The issue of burning and burying of waste in backyards and uncontrolled areas has direct negative impacts on the environment in the form of air pollution and groundwater pollution. The National Domestic Waste Collection Guidelines are to be followed to limit the negative impact on the environment.

The results of the assessment show the trends pertaining to waste management in Limpopo, as summarised in Table 5 below.

Table 5: Summary of Waste Management trends in Limpopo Province

INDICATORS CONSIDERED	TRENDS
Number of hazardous waste sites and facilities	Unknown
Number of general waste sites	Increase
Percentage of licensed municipal landfill sites	Increase
Amount of waste to landfill per annum	Unknown
Amount of waste recycled per annum	Increase[33]

[33] Limited data available.

2.5.4 Responses

The Limpopo IWMP, 2012, is in place and it is legislated in the NEMWA that this document be reviewed in order to manage waste in Limpopo. The IWMPs at district and local level also need to be finalised to ensure that waste management can be integrated into district and local municipal planning and budgeting. Waste management remains a key concern across Limpopo and requires more active responses from government, the private sector and civil society at large.

The Limpopo Green Economy Plan (LGEP) of 2013 (LEDET, 2013) outlines the priorities of Limpopo that pertain to waste management, waste facilitation and waste beneficiation, described in more detail below.

The two waste management priorities in the LGEP, 2013, are as follows:

1. Facilitate efficient waste management in Limpopo by:
   - Licensing of waste disposal sites;
   - Monitoring of conditions of licences; and
   - Creating awareness around waste issues.

2. Beneficiate waste (labour intensive waste collection practices) by:
   - Recycling of tyres, paper, glass, metal and electronic waste;
   - Establishment of material recovery centres (facilities); and
   - Recovery of methane from waste disposal sites and sewer treatment plants for electricity generation.

LMs are mandated to operate the waste sites and thus they need to be supported and resourced through appropriate budget allocation in their IWMP and subsequently in their Integrated Development Pan (IDP). It is also recommended that:

- IWMPs of LMs be finalised and implemented as a matter of urgency;
- Hazardous waste generation and disposal be effectively monitored and planned for across the Limpopo;
- The performance of general waste sites be effectively monitored at the local level; and
- Continued and improved support is provided by LEDET to waste site operators.

2.5.5 References

Department of Environmental Affairs (DEA). 2008. *National Environmental Management: Waste Act (Act No. 59 of 2008)*, Gazette No. 32000 Notice 278, Pretoria.

Department of Environmental Affairs (DEA). 2010. *National Policy for the Provision of Basic Refuse Removal Services to Indigent Households*. Notice 413 of 2011, Pretoria.

Department of Environmental Affairs (DEA). 2011. *National Domestic Waste Collection Standards.* Gazette No. 33935 Notice 21, Pretoria.

Department of Environmental Affairs and Tourism (DEAT). 2006. *South Africa Environmental Outlook 2006*. A report on the state of the environment. Department of Environmental Affairs and Tourism, Pretoria.

Department of Rural Development and Land Reform (DRDLR). 2016. *Limpopo Province Spatial Development Framework (LSDF)*. Prepared by Plan Associates, Pretoria.

Department of Water Affairs and Forestry (DWAF). 1998. *Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste*. Waste Management Series. Pretoria.

Department of Water Affairs and Forestry (DWAF). 2001. *Disposal Sites for Hazardous and General Waste in South Africa* (Baseline study in preparation for the National Waste Management Strategy for South Africa). Water Quality Management Series. Pretoria.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2004. *State of the Environment Report*.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2012. *Integrated Waste Management Plan for the Limpopo Province*. Prepared by Redlex Projects, Midrand.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2013. *Limpopo Green Economy Plan including Provincial Climate Change Response*. Prepared by Dr Antoaneta Letsoalo, Polokwane.

Limpopo Department of Finance and Economic Development. 2004. *Limpopo State of the Environment Report*. Prepared by Africon and Environomics Joint Venture. Limpopo Department of Finance and Economic Development, Polokwane.

South African National Standards (SANS 10248-8). 2008. *Management of Healthcare Waste, Part 1: Management of Healthcare Risk Waste from a Healthcare Facility*. South African Bureau of Standards (SABS). Pretoria.

2.6 Energy

2.6.1 Introduction

Energy is essential for sustaining life in all living organisms. The modern lifestyle, well-being and prosperity are associated with an increased demand for energy, and a strong link has been established between economic growth and energy demand.

In South Africa, fossil fuels dominate the energy sector, with coal (67%) and crude oil (21%) providing most of the primary energy.[34] Coal accounts for more than 90% of the electricity generation in South Africa (DoE, 2013). The Limpopo energy carriers[35] do not differ from the national situation. Coal and oil satisfy most of its energy requirements. However, the use of fossil fuel for energy generation places an overwhelming burden on the environment in the form of air pollutants, greenhouse gas (GHG) emissions, water contamination and ecosystem degradation.

The leading economic sectors in Limpopo Province are mining, tourism and agriculture. Mining and industries associated with mining are intense energy users *per se*. In fact, they are the largest consumers of energy in Limpopo. However, the long-term effect of the constant supply of energy for these activities also threatens the sustainability of the agricultural and tourism sectors. On the other hand, poverty and inequality are still present in Limpopo and about 10% of the households (StatsSA, 2012) do not have, or cannot afford, access to electricity. The indicators used to assess the energy sector in Limpopo are described in Table 1 below.

Table 1: Indicators used in the assessment of the Energy Resources in Limpopo Province

INDICATORS	DESCRIPTIONS AND COMMENTS
Household energy source	Household access to electricity, and electricity is the preferred source of energy for lighting, heating and cooking.
Trends in energy consumption per sector	Identifies the main energy users in Limpopo.
Renewable Energy (RE) production as percentage of total electricity consumption	Compares the output from renewable projects with the electricity requirements of Limpopo.

2.6.2 State

2.6.2.1 Sources of Energy

Coal is still the main source of energy at both a national and provincial level, followed by crude oil and gas in smaller proportions, as illustrated in Figure 1. This is also the case in Limpopo. As an example, the secondary[36] sources of energy for the Polokwane Local Municipality (LM), for the year 2011, are also illustrated. Current information regarding the complete sources and users of energy in Limpopo is limited; however, the State of Energy Report for the Polokwane LM (SALGA, 2013) offers a general overview of the situation in the municipalities that broadly illustrates energy use in Limpopo.

[34] Primary energy is an energy form found in nature that has not been subjected to any conversion or transformation process.
[35] An 'energy carrier' refers to any system or substance that contains energy for conversion as usable energy later or somewhere else (ISO 13600).
[36] Secondary sources derive from the transformation of primary energy sources (i.e. petrol, which derives from the treatment of crude oil – electric energy, which is obtained from coal combustion).

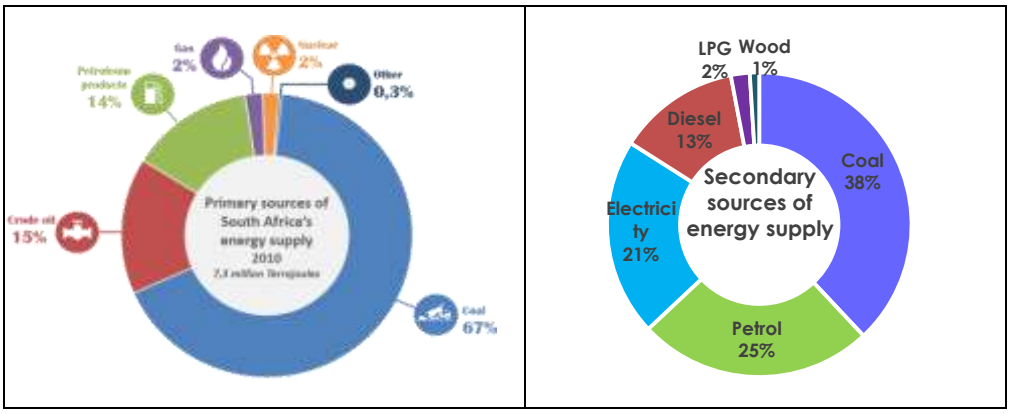


Figure 1: South Africa's primary sources of energy in 2010 (left), and Polokwane Local Municipality secondary sources of energy in 2011 (right) (StatsSA, 2015; SALGA, 2013)

2.6.2.2 Electricity Generation

Eskom produces 95% of the electricity in South Africa. This is either sold directly to the public or it is purchased and redistributed by LMs to residential, business and industrial customers. Fifteen percent (15%) of the municipal income in Limpopo is earned from re-sales of the electricity (StatsSA, 2015). Revenue collection from ratepayers is vital to the maintenance of the national energy grid and the economic performance of the various municipalities.

Limpopo houses the coal-fired Matimba Power Station in Lephalale, with an installed capacity of 3 990 Megawatt (MW). The construction of a second power station also powered by coal, Medupi Power Station in Lephalale, is currently in process. Medupi will have an installed capacity of 4 800 MW, once all six units are fully commissioned, once it is operational in 2019. Any coal power station of such magnitude has potential impacts on air quality and human health, surface and groundwater resources, soils and agriculture, flora, fauna and the ecosystem. Measures have been put in place to reduce the environmental impacts of Medupi Power Station.

Medupi was designed to use direct dry-cooling that will reduce the average water intake from 1.35 m^3 per Megawatt hour (m^3/MWh) to 0.66 m^3/MWh, including the 0.250 m^3/MWh required for the flue gas desulphurisation (FGD) operation. It is expected to operate under the Zero Liquid Effluent Discharge (ZLED) policy (Inglesi-Lotz & Blignaut, 2012).

Regarding anticipated atmospheric emissions from Medupi, the use of supercritical boilers and turbines that operate at higher temperatures and pressures is expected to be more fuel efficient, and the installation of pulse-jet fabric filters will reduce the particulate and oxides of nitrogen emissions. An FGD plant is also scheduled to minimise sulphur dioxide emissions. The ZLED and the FGD appliances will only be installed once all the six units of the plant are commissioned (Eskom, 2014).

2.6.2.3 Renewable Energy Generation

The growing awareness of the threats of climate change, rising prices of fossil fuels, increasing concerns over energy supply security and recent electricity price increases are driving to make Renewable Energy (RE) more and more competitive in South Africa. After resource assessment studies, the Limpopo Department of Economic Development, Environment and Tourism (LEDET) has identified solar and biomass as the main renewable sources for Limpopo (DOE, 2015b).

The Department of Energy (DoE) has developed a programme for attracting private investment into the energy sector. The Renewable Energy Independent Power Producer Procurement Programme (REIPPP) has been designed to contribute towards the national target of 10 000 MW of RE. Its fourth round of procurement was completed in 2015. The RE target is a small fraction of the national electricity requirements; however, it is a step towards socio-economic and environmentally sustainable growth. During the first and third round of the programme, three photovoltaic (PV) projects in Limpopo were selected: the Soutpan, Witkop and Tom Burke Solar Parks, with a combined installed capacity of 118 MW.

Off-the-grid energy installations and distributed power systems are emerging as a national trend, with rapid technology advancement and price reduction in alternative energy options. Typical small-scale rooftop solar-PV installations by May 2015 had reached 43.8 MW in South Africa. Out of these, 0.28 MW are in Limpopo (6.59%). The majority of the installations were recorded in the commercial, agriculture, industrial and mining sectors (DOE, 2015b).

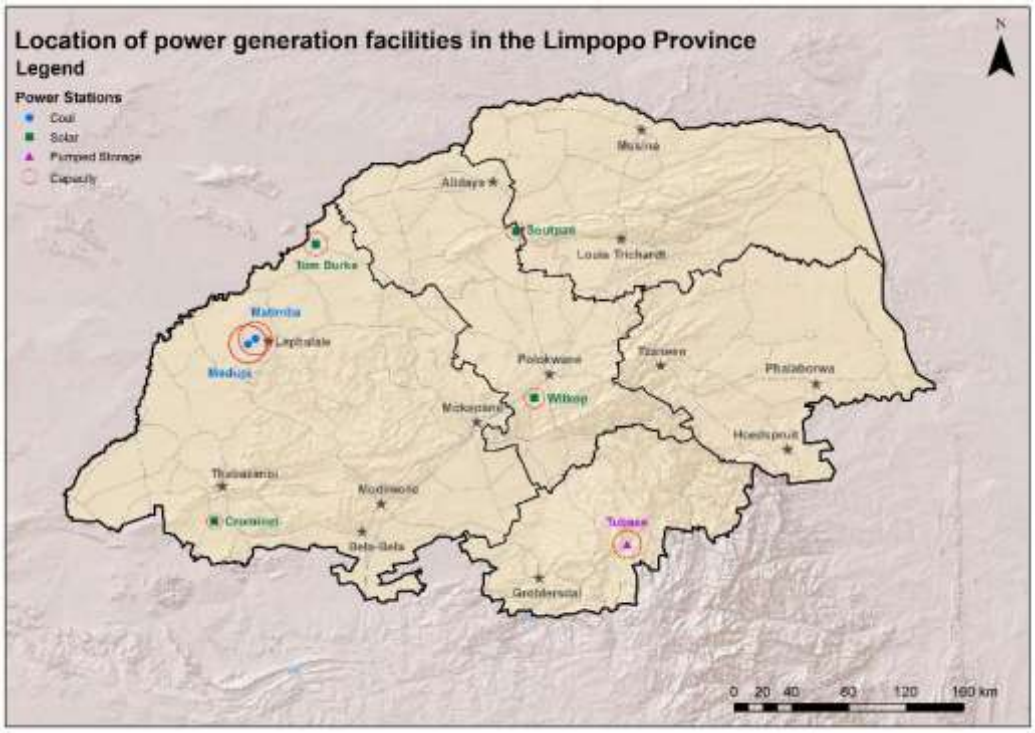


Figure 2: Location of energy-generation projects in Limpopo Province

Table 2 (below) and Table 3 (overleaf) summarise the current state of the electricity-generation projects in Limpopo. In spite of the promising solar and biomass resource, the share of RE is still very small (<1%), with most of the RE projects being developed recently and being of the solar-PV type. A representation of the installed capacity and the Eskom electricity delivered in Limpopo is given in Figure 3 (refer overleaf).

Table 2: Summary of electricity-generation projects in Limpopo Province in 2015

NAME	TYPE	INSTALLED CAPACITY (MW)	ONLINE CAPACITY (MW)	PERCENTAGE (%)
Matimba	Coal Power Station	3 900	3 900	82.00
Medupi	Coal Power Station	4 800	800	17.00
Soutpan	Solar-PV	28	28	0.60
Witkop	Solar-PV	30	30	0.60
Tom Burke	Solar-PV	60	Construction	-
PV Rooftop	Solar-PV (off-grid)	0.28	0.28	0.01
Cronimet	Solar-PV (off-grid)	1	1	-
Tubase	Pumped Storage	1 500*	*On hold	-
Total		8 818.28	4 758.28	

Table 3: Summary of electricity generation for Limpopo Province

DESCRIPTION	Gigawatt Hour (GWh)
2014 electricity delivered by Eskom to the Limpopo Province[37] (StatsSA, 2015)	11 964
2014 electricity delivered by Eskom to South Africa	231 449
2015 estimated electricity generation in Limpopo[38]	24 132
2015 estimated RE generation in Limpopo	104
RE production as percentage of provincial electricity consumption	0.87%

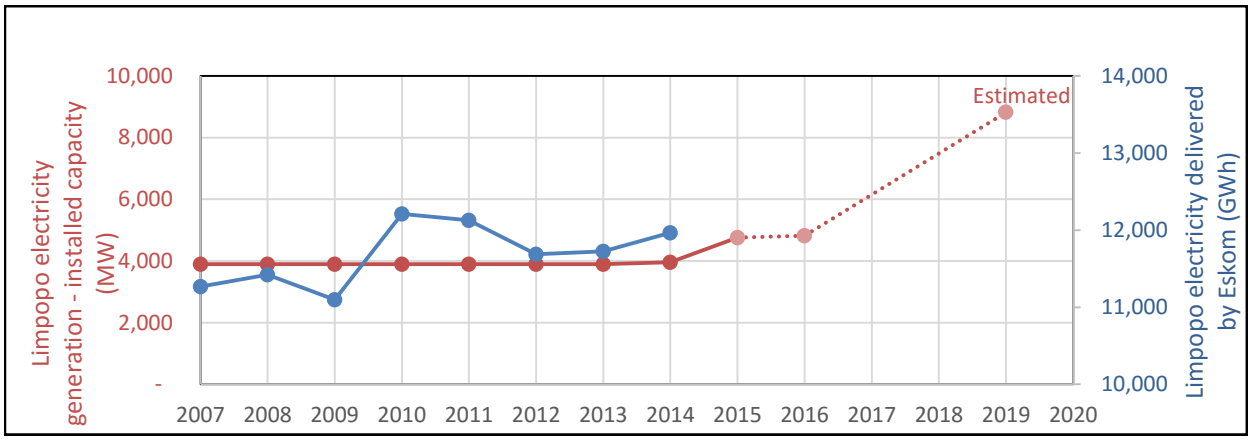


Figure 3: Installed capacity (red) and energy (blue) delivered by Eskom to Limpopo Province (StatsSA, 2015)

The Limpopo Green Economy Plan (LGEP) (LEDET, 2013) identified the potential to develop RE through concentrated solar plants with generation capacity of no less than 100 MW. Potential also exists to increase capacity from small solar power plants on dwellings outside Eskom's grid.

Limpopo has silicon reserves and the second-biggest silicone smelter in the world is located in Polokwane. The LGEP identifies potential for beneficiation of the silicon resource, production of components for solar panels, and production of solar chargers for cell phones and small-scale electrical devices as industrialisation opportunities.

2.6.2.4 Energy Consumption

Industry is the largest user of energy in South Africa and the same is true for Limpopo. Displayed results for Polokwane LM indicate that commerce and industry use almost 40% of the energy of the LM, and a similar scenario is expected for Limpopo (refer to Figure 4 overleaf). The reason for this has to do with the nature of the industries, which include metals processing and deep-level mining. These are inherently energy-intensive industries. The other reason, though, is inefficient energy utilisation by various sectors (DoE, 2013). Energy carriers for Limpopo's industry are mainly electricity and coal and, to a lesser extent, liquid petroleum gas and diesel.

[37] Assuming 0.65 capacity factor for power stations, 0.2 for PV and 0.1 for rooftop-PV. Medupi operations estimated only for the last quarter of the year.
[38] As percentage of total electricity delivered by Eskom to Limpopo Province.

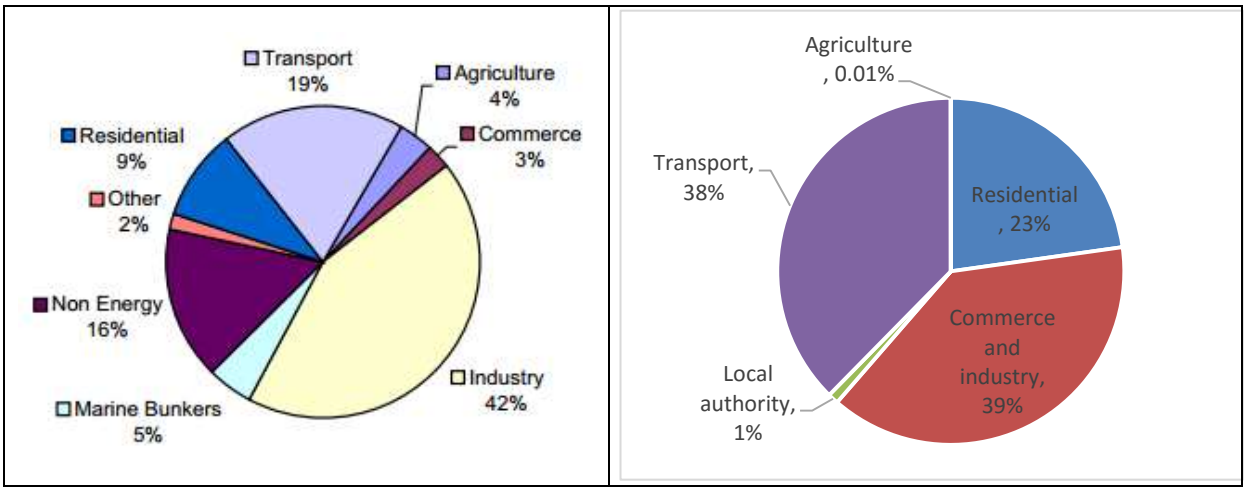


Figure 4: South African users of energy per economic sector in 2000 (left) and in 2011 (right) (StatsSA, 2015; SALGA, 2013)

2.6.2.5 Household Energy Source

The main source of energy for the household sector is electricity (87%). The percentage of households that use electricity in Limpopo per District Municipality (DM) and per type of area (that is, tribal, urban, farm) is highest in the Mopani DM (89%) and lowest in the Sekhukhune DM (86%). This is still above the national average of 84%.

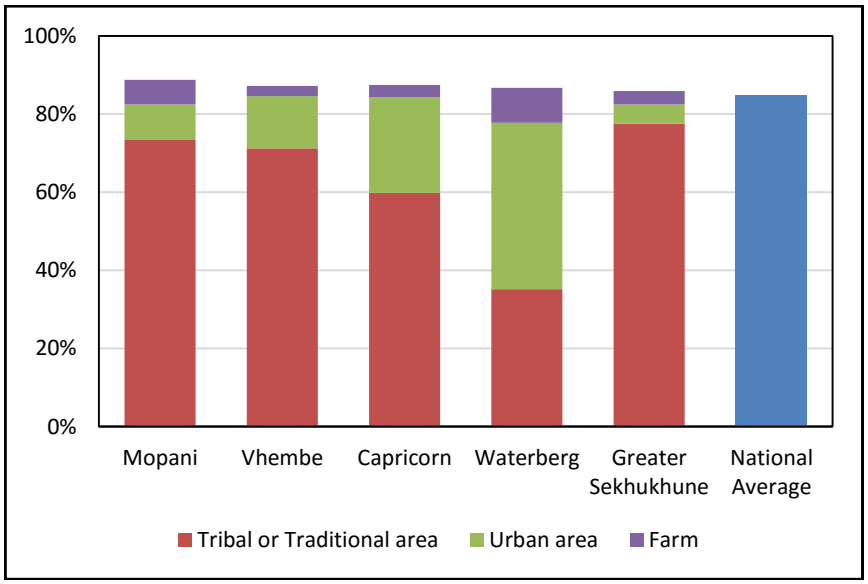


Figure 5: Percentage of households using electricity in Limpopo Province per District Municipality (StatsSA, 2012)

Extreme societal inequalities are more obviously seen in the residential sector. Inability to afford, and/or access electricity, results in households using wood, paraffin or coal, (so-called *dirty fuels*) for lighting, heating or cooking. The burning of these fuels is not only inefficient but has severe health consequences from an indoor air pollution point of view.

Figure 6 overleaf illustrates the primary source of energy (excluding electricity) per type of activity in the provincial households as recorded in the 2011 Census. Limpopo has the lowest rate of electricity use for cooking in South Africa (57%), followed by the Eastern Cape Province with 75% (StatsSA, 2015). Despite the high electrification levels, wood is the main source of energy for cooking and heating (>38%), while paraffin and candles are mainly used for lighting. Wood use is greater in the Vhembe and Mopani DMs, paraffin and gas (liquid petroleum gas) are common in the Capricorn DM, and coal is mainly used in the Sekhukhune DM.

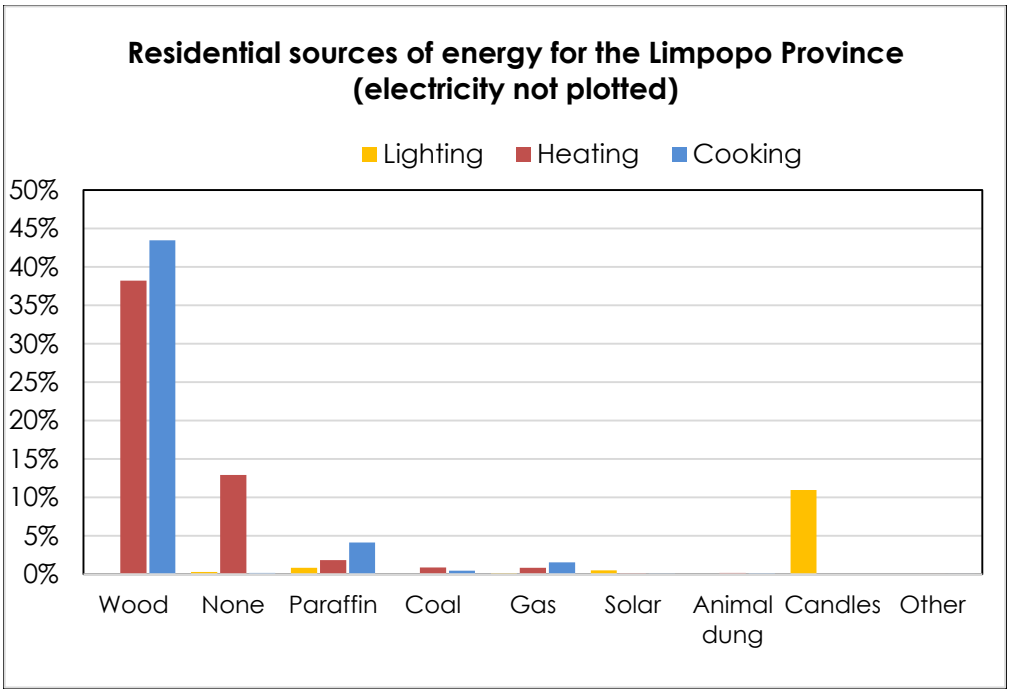


Figure 6: Primary source of energy in households in Limpopo Province (electricity not available/plotted) (StatsSA, 2012)

In terms of liquid fuels[39] (refer to Figure 7 below), the market share has been reduced across Limpopo, since 2010/11. The most significant reductions in volume between 2005 and 2013 occurred for petrol and diesel. Use of paraffin has been reduced by 82%, since 2005, and the use of liquid petroleum gas by 48%, since 2011. This explains the shift of households to electricity for heating and cooking. On the other hand, furnace oil, jet fuel and aviation gasoline have shown an increase in sales since 2005 (DOE, 2015a).

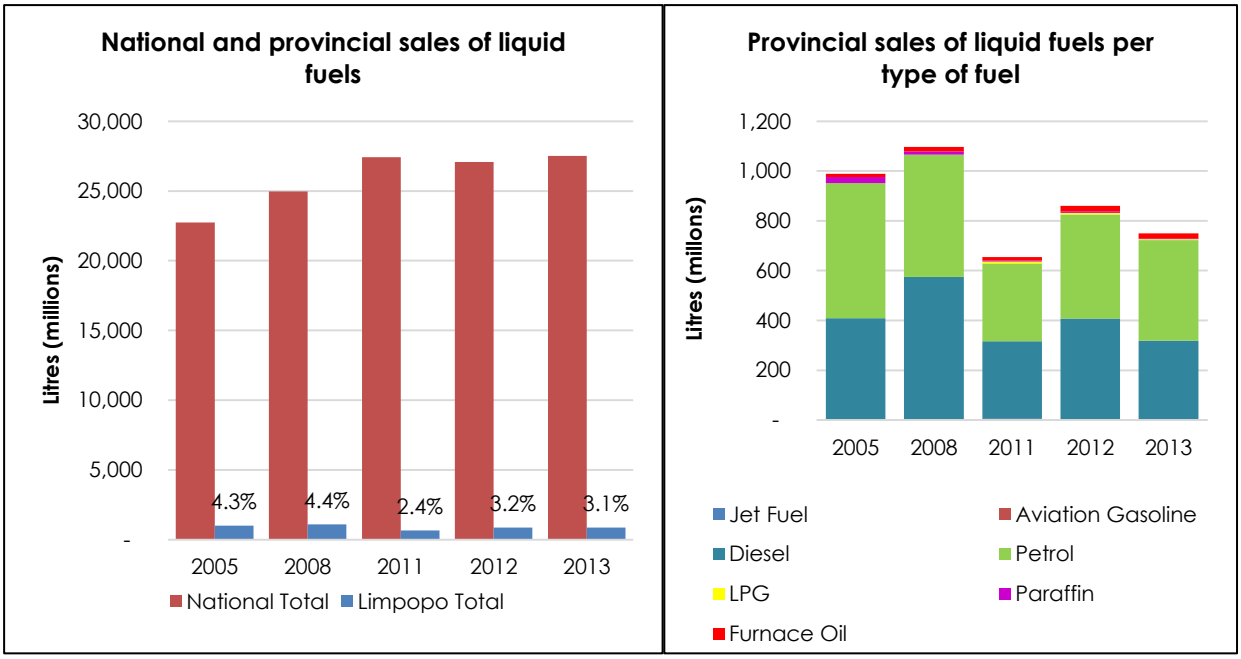


Figure 7: Comparison of liquid fuel sales (national and provincial) (left), and disaggregated per type of fuel (right) (DoE, 2015a)

There has been a significant improvement in electricity services for the household sector as a 23% increase has occurred since 2004 (StatsSA, 2012). According to Eskom, electricity distribution to Limpopo improved from 8 571 GWh in 2002 to 13 000 GWh in 2011, an increase of more than 40%.

[39] Liquid fuels include jet fuel, aviation gasoline, diesel, petrol, liquid petroleum gas, paraffin and furnace oil.

There has been a declining trend in the usage of all the *dirty fuels* since 1996 (refer to Figure 8 below). Peaks for paraffin, coal and gas in 2001 are explained by the fact that these are the intermediate fuel options while migrating from wood to electricity.

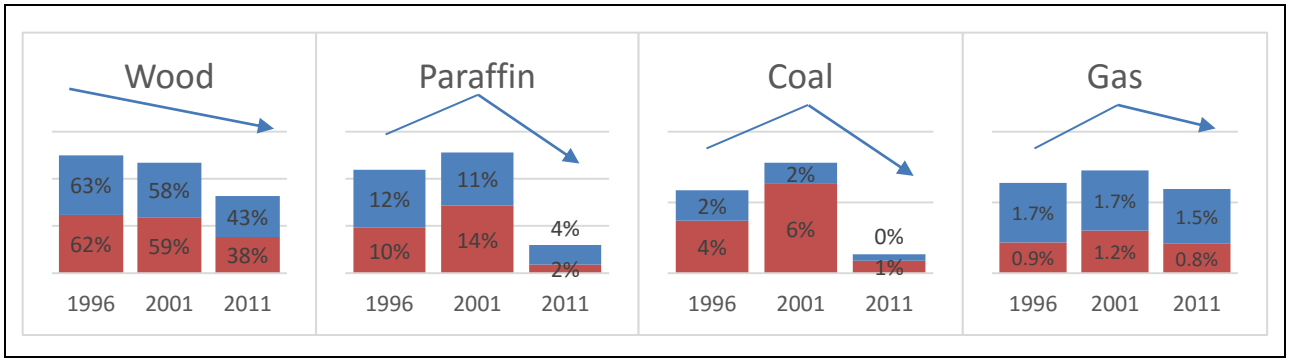


Figure 8: Trends in household fuel usage for heating (red) and cooking (blue) in Limpopo Province (StatsSA, 2012)

Like in many other developing countries, the main users of *dirty fuels* are located in the rural areas, where there is limited access to social services and infrastructure. With the abundant sunshine available in the region, solar electricity is a realistic alternative in meeting the demand for household energy. The sale of solar electric systems can also create jobs for installers in rural areas, and provide opportunities for urban and cottage industries (Masekoameng *et al*., 2005).

2.6.3 Impacts

The supply of energy in Limpopo relies mainly on coal-sourced electricity and liquid fuels. Although there are promising solar and biomass resources, the development and implementation of RE projects are slow, and pressing needs are forcing South Africa to remain reliant on traditional technologies for supply of electricity.

The mineral resources of Limpopo place it in a privileged position for extraction. However, the abundance of minerals and potential economic gains for the Province are not equalled by the need for water and the capacity for ecosystem regeneration. This is especially important for areas in the Province that already experience air quality issues, such as the Waterberg DM, where extensive coal mining occurs. Pollution of ecosystems reduces the agricultural and tourism potential in Limpopo and also affects unemployment levels.

A more sustainable impact of energy use would result from the implementation of RE projects and the development of RE-related components, which would drive more energy efficiency systems and skills development in the RE sector. Table 4 below summarises the trends for energy sources in Limpopo.

Table 4: Indicators used in the determination of trends in Energy Resources in Limpopo Province

INDICATORS CONSIDERED	QUANTIFICATIONS	TRENDS
Household energy source	77% of households using electricity for lighting in 2004 increased to 87% in 2011. Decreasing percentage of households using *dirty fuels* for cooking and heating.	Improving
Trends in electricity consumption per sector	Mostly coal-based electricity and liquid fuels. Industry and commerce are the main consumers. Petrol and diesel sales have decreased in Limpopo, while there has been a slight increase in aviation gasoline.	Uncertain
RE production as a percentage of total electricity consumption	No previous information on RE projects prior to the REIPPP. Almost 1% of electricity demand is supplied from RE.	Slowly improving

2.6.4 Responses

Since 1998, the National Government has followed a remarkable path for the integration of renewables into the electricity mix. The Integrated Resource Plan, 2010, for electricity estimates that the national electricity capacity should increase by 52 GW by 2030, of which 17.8 GW should be sourced from RE (34%). To achieve this target, a massive roll-out of transmission infrastructure, led by Eskom, has started, as has the introduction of a bidding system (REIPPP) to stimulate private investment in renewable generation. This bidding system has been ongoing for three years and has proved to be very successful, attracting more than R192 billion in investment.

At provincial level, LEDET published the LGEP in 2013. The LGEP has been formulated with the aim of generating jobs, improving environmental quality and creating conditions for a green economy. The LGEP recognises the importance of energy in the economy and the potential for strengthening the green economy in Limpopo.

The LGEP identifies renewable energy, energy efficiency and human resource development as key components for ensuring energy security and the much-needed employment opportunities in Limpopo.

It is also argued that policies that enhance integrated rural development and promote sustainable energy utilisation in rural communities need to be put in place and implemented.

Although there is a dependence on coal as the predominant fuel used in Limpopo to generate electricity, RE sources need to be considered. Solar and biomass were identified as priority and probable renewable fuel sources for Limpopo. South Africa has a high solar radiance and the Sun provides a valuable energy source. Large solar developments are being developed and some are now operational in Limpopo. These will feed into the national electricity grid. Rooftop solar panels can have household and industrial applications, which can supplement electricity supply.

The feasibility of using wind as a renewable fuel source could present additional RE projects in Limpopo. Much research is being conducted on wind potential and wind power in South Africa and globally. Wind technology advances have been made to limit the original negative environmental impacts associated with wind energy. Small windmills and solar panels are used in households in South Africa, located in sparsely populated areas to power borehole pumps, and the like, as an off-grid solution.

Hydroelectric power in Limpopo should also be considered in the future. There have been great advances in technical research and equipment for generating hydropower that may be applicable to Limpopo.

The feasibility of converting waste to energy also needs investigation. Energy can be created from landfill waste in certain scenarios. General waste landfills can be converted to waste-to-energy plants if there is enough waste to fuel the plant sustainably and climatic and land conditions are conducive to this type of operation.

Mining waste by-products from mineral extraction and processing can also be used to generate electricity. Mining has a huge electricity consumption that could be supplemented by using internal RE sources, which would elevate the already strained electricity grid.

Neglecting to supply energy, as demanded in Limpopo, has economic implications as it limits economic growth, reduces foreign investment and restricts job-generation opportunities. However, dependence on coal-generated grid electricity also implies loss of competitiveness as increasing electricity prices, additional carbon taxes, depletion of raw materials, and a non-renewable supply of coal will increase the operation and production costs. Cost of life would also be affected, which would increase the social gap in the population and result in decreased resources available for renewable sources of energy.

The following strategies were drafted in the LGEP (LEDET, 2013):

- Investigate and support the implementation of RE projects across Limpopo;
- Support the development of small-scale PV (<5 MW) in terms of off-grid solutions;
- Investigate development of industry for manufacturing solar chargers;
- Invest in the development of biogas generation for agricultural farms;
- Enhance energy efficiency, especially in government buildings;
- Create awareness at all levels about RE and energy efficiency;
- Introduce energy-efficiency modules in study curriculums in Limpopo; and
- Further support education and training in colleges for RE artisans.

2.6.5 References

Department of Energy (DoE). 2013. *Draft 2012 Integrated Energy Planning Report.* Department of Energy, Pretoria.

Department of Energy (DoE). 2015a. *Overview of petrol and diesel market in South Africa between 2002 and 2013.* Department of Energy: Directorate: Energy data collection, management and analysis, Pretoria.

Department of Energy (DoE). 2015b. *State of Renewable Energy in South Africa.* Department of Energy, Pretoria.

Eskom. 2014. *Medupi Power Station Project Fact Sheet February 2014.* Eskom.

Inglesi-Lotz, R. & Blignaut, J. 2012. Estimating the opportunity cost of water for the Kusile. *Journal of Energy in Southern Africa, 23* (4): 76-84.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2013. *Limpopo Green Economy Plan - Including Provincial Climate Change Response.* Limpopo Department of Economic Development, Environment and Tourism, Polokwane.

Masekoameng, K., Simalenga, T. & Saidi, T. 2005. Household energy needs and utilisation patterns. *Journal of Energy in Southern Africa*, 16 (3).

South Africa Local Goverment Association (SALGA). 2013. *Compilation of a state of energy report for Polokwane Municipality.* South Africa Local Goverment Association, Polokwane.

Statistics South Africa (StatsSA). 2012. *2011 South Africa Census.* Statistics South Africa, Pretoria.

Statistics South Africa (StatsSA). 2015. *2014 General Household Survey.* Statistics South Africa, Pretoria.

Statistics South Africa (StatsSA). 2015. *Electricity generated and available for distribution (Preliminary) December 2014.* Statistics South Africa, Pretoria.

Statistics South Africa (StatsSA). 2015. *Environmental Economic Accounts Compendium.* Statistics South Africa, Pretoria.

2.7 Air Quality and Atmosphere

2.7.1 Introduction

The quality of the air is a critical factor that affects not only human health but also wildlife, vegetation, water and soils. The presence of toxic chemicals in the air can trigger respiratory problems and can cause cancer or even death. These chemicals can react to form acid rain and reduce the agriculture yield production or contaminate water bodies. Typical sources of pollutants include coal power stations, mining, industry, agriculture, domestic fuel burning and vehicle tailpipe emissions, all ongoing sources and recurrent activities within Limpopo Province.

Particulate material (PM) contains microscopic solids or liquid droplets that can be inhaled and get into the blood stream or deep into the lungs, causing serious respiratory and cardiovascular problems. PM also has an influence on acid rain and climate change. Short-term exposure to sulphur dioxide (SO_2) and nitrogen oxides (NO_xs) has been related to various adverse respiratory effects. SO_2 reacts to the atmosphere, which leads to secondary formation of PM, while NO_x influences eutrophication and ozone (O_3) formation.

Main air quality concerns for Limpopo are related to the concentrations of PM, SO_2 and NO_xs from mining activities, power generation, metallurgical activities and veld fires or biomass burning. More localised concerns are related to pollution that originates from domestic fuel burning, vehicle tailpipe emissions and biomass burning. The review of the state of the air quality in Limpopo is conducted from the ambient concentration, sources of emissions, potential for impact and response point of view. The indicators used for the assessment are described in Table 1 below.

Table 1: Indicators used in the assessment of the Air Quality and Atmosphere in Limpopo Province

INDICATORS CONSIDERED		DESCRIPTION AND COMMENT
Ambient	Ambient air quality (PM_{10}[40], SO_2, NO_2)	Comparison of the recorded ambient concentration with the national standard.
	Number of operational air quality monitoring stations	As continuous monitoring stations that record pollutants of concern.
Source and impact	Sources of pollutants (PM_{10}, SO_2, NO_2)	Identification of sources of emissions for Limpopo.
	Emissions per source of pollutants (PM_{10}, SO_2, NO_2)	Total estimated emissions per type of source and per type of pollutant.
	Total emissions (PM_{10}, SO_2, NO_2)	Total estimated emissions for Limpopo per type of pollutant.
Response	Status of Air Quality Management Plans (AQMPs)	Identification of the status of the AQMPs of the district and the local AQMP.

2.7.2 State

In Limpopo, the mining sector represents 36% of the economy of the Province. It is thus expected to be a pressure on the state of air quality, especially in terms of PM and SO_2s. Pressures on air quality also result from other industrial activities, transport, domestic fuel burning, agriculture and veld fires.

2.7.2.1 Mining

In mining operations, PM is the main pollutant of concern. Fugitive dust originates from material handling, vehicle-entrainment by haul trucks and wind-blown dust from tailings, impoundments and stockpiles. The use of explosives releases carbon monoxide (CO) and methane emissions are expected from underground mining. High levels of suspended PM increase respiratory diseases, such as chronic bronchitis and asthma, in the population in the vicinity of the mines, while gaseous emissions contribute to respiratory, cardiovascular and cerebral problems. Studies conducted for the Gauteng and North West provinces have suggested a high level of chronic

[40] Particulate material with an aerodynamic diameter inferior to 10 and 2.5 µm

respiratory symptoms and diseases among elderly people in communities located within a five kilometre (km) radius of mine dumps (Vusumuzi *et al*., 2015).

2.7.2.2 Industrial Activities

The Limpopo Baseline Assessment and Emissions Inventory (LEDET, 2013a) recorded more than 300 industrial and commercial operations. These included large- and small-scale power-generation, mining (including clay and asphalt), wood-processing, incinerator, fertiliser-manufacturing, metallurgical-processing, mineral-processing, and animal matter-processing operations, among others.

Figure 1 shows the distribution of these facilities across Limpopo (where co-ordinates for location were available).

What about Soil Acidification?

One of the major contributors to soil degradation in South Africa is soil acidification. Sulphur and nitrogen emissions react with water molecules to create acids that are deposited in the soil and water bodies.

The Highveld area in Mpumalanga has been observed to be sensitive to acid deposition and, not surprisingly, this area is where the greatest of the South African coal-fired electricity plants and petrochemical and metallurgical industries are concentrated (Josipovic, 2009).

Soil fertility degradation is serious in small-scale farming areas and also in some commercial cropping areas; areas surrounding and downwind of emitters are expected to be more susceptible to this type of degradation.

Power generation, including expected emissions from Medupi Power Station, has been identified as the primary source of SO_2 and NO_x industrial emissions in Limpopo. Brick manufacturing and small boilers also seem to be an important source of PM, while the smelters and timber treatments influence largely the SO_2 industrial emissions. NO_x emissions are mainly emitted from small boilers.

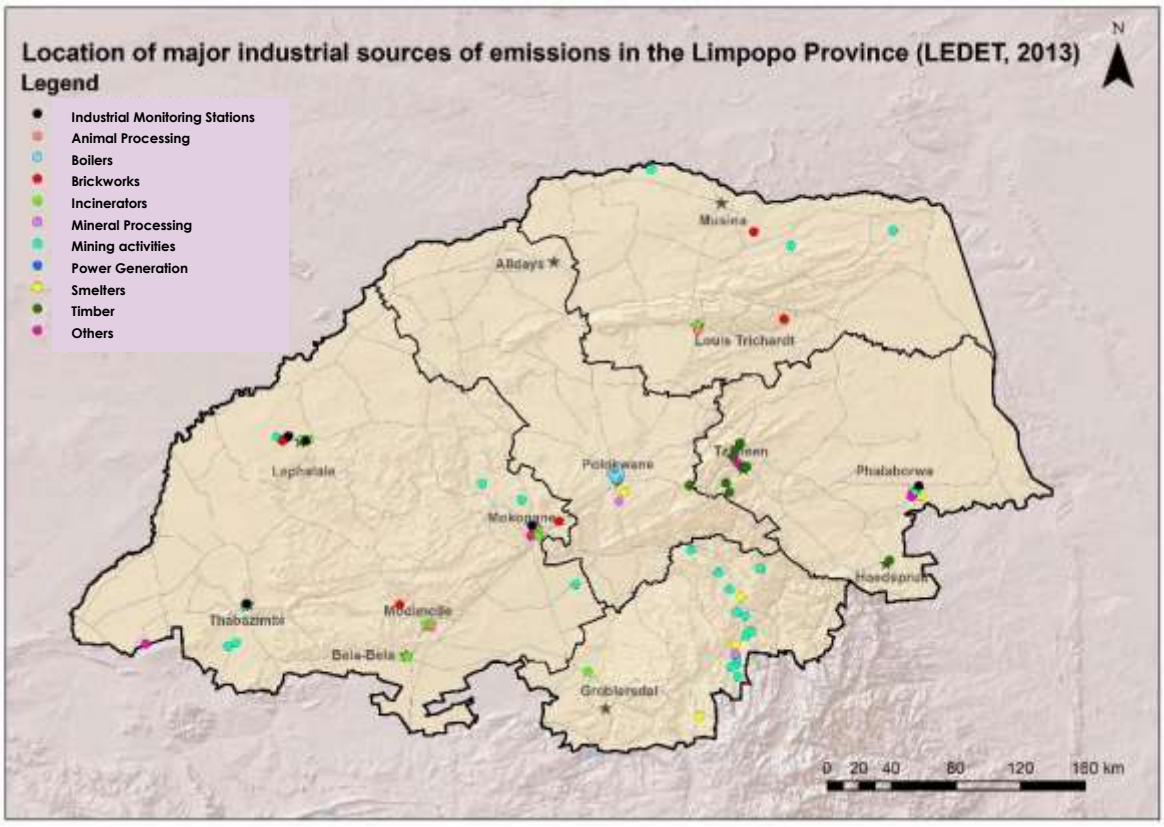


Figure 1: Location of major industrial sources of emissions in Limpopo as recorded in the Limpopo Province Air Quality Management Plan (LEDET, 2013b)

2.7.2.3 Domestic Fuel Burning

The use of wood, coal, paraffin, liquid petroleum gas, or dung for heating and cooking, and candles for lighting is still a common practice in many areas across South Africa. Limpopo, in particular, is the greatest domestic user of wood in South Africa. The usage of these types of fuels is explicated by poor adoption of electricity, low household income or cultural preferences.

Domestic fuel burning, however, is an inefficient combustion process that produces several harmful substances. Biomass and coal smoke have been described by the International Agency for Research on Cancer as a probable carcinogen and human carcinogen respectively. The type and amount of pollutant from domestic fuel burning depends on the type of fuel and the technology used for combustion, but typical pollutants include PM, SO_2, heavy metals, NO_x, CO, polycyclic aromatic hydrocarbons (PAHs) and benzo(a)pyrene.

Indoor air pollution sources are important causes of urban and rural air pollution, especially in cities, towns and settlements, where many households use biomass fuels or coal for heating and cooking. The low temperatures of combustion and short release height prevent the smoke and its contents from being dispersed in the atmosphere, increasing the ground-level concentrations of pollutants.

Wood is the most common choice of fuel in Limpopo. The highest proportion of users is found in the Vhembe and Mopani District Municipalities (DMs). Paraffin is also used (but in much smaller amounts), especially in the Capricorn and Waterberg DMs. Coal is mainly used within the Greater Sekhukhune DM, owing to its proximity to the collieries (StatsSA, 2012). Figure 2 below presents household preferred fuel for cooking in the Limpopo municipalities.

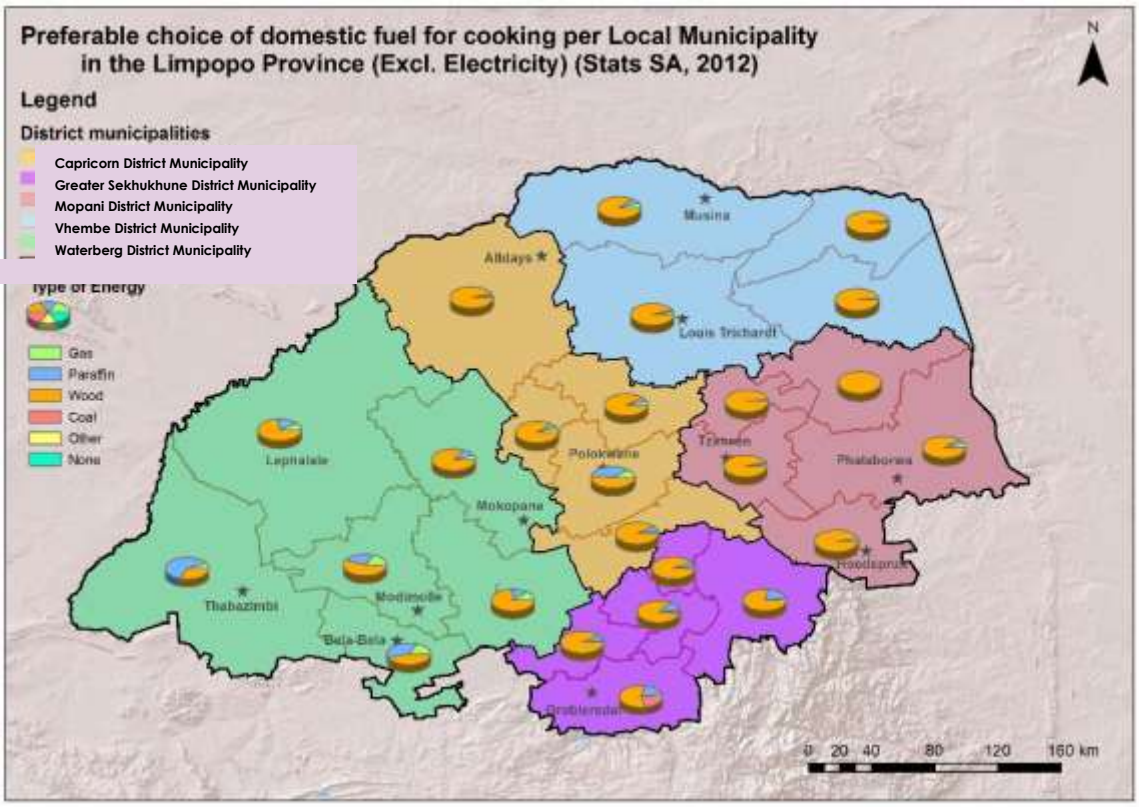


Figure 2: Preferred choice of domestic fuel for cooking per Local Municipality in Limpopo Province (excluding electricity) (StatsSA, 2012)

2.7.2.4 Agriculture

Agricultural activities in Limpopo are primarily associated with cattle farms, game farms, fruit trees and crop production. PM is the main pollutant of concern from agricultural activities as particulate emissions derive from windblown dust, tillage and harvesting, and dust from heavy vehicle movement. Chemicals associated with crop spraying and odour emissions that result from manure, fertiliser and crop residue have been identified as a main concern.

Although agricultural activities are acknowledged as a contributing source of specifically PM_{10} emissions in Limpopo, these sources were not quantified as part of the Limpopo Air Quality Management Plan (AQMP).

2.7.2.5 Veld Fires

Within Limpopo, veld fires may represent significant sources of combustion-related emissions (Maenhaut *et al*., 1996), which affect mainly the Savanna Biome. Veld fires are most extensive in Limpopo between the months of July and September, as this period coincides with the dry season.

Such biomass burning is an incomplete combustion process of organic matter, with major amounts of NO_x and CO gases being emitted. One of the main concerns related to veld fires is the high potential for sulphur and nitrate emissions to react in the environment and create minute particles (of size smaller than 2.5 µm in aerodynamic diameter), which present a potential health risk. A unique type of $PM_{2.5}$, largely generated in veld fires, is black carbon. This pollutant traps heat, which affects the temperature in the atmosphere and, therefore, influences atmospheric chemistry and climate change. Veld fires are also a substantial source of Greenhouse Gases (GHGs), especially carbon dioxide (CO_2).

Despite its significance, actions by authorities to control such occurrences and impacts are limited. Fire regime is a natural process in the savanna ecosystem, where fire has become a contributor to habitat vitality and renewal. However, for managing air quality, information regarding emissions from fires can assist in the interpretation of ambient air data (for example, background emissions in the atmosphere).

2.7.2.6 Transport

Vehicle emissions are a significant source of CO and NOx. The significance of vehicle emissions in terms of their contribution to air pollutant concentrations and health risks is increased by the low level at which the emissions occur and the proximity of such releases to high exposure areas. Vehicle emissions also tend to peak in the early morning and evenings, at which time atmospheric dispersion potentials are reduced.

In Limpopo, the main emissions from transportation are expected from the national roads N1 and N11 in the Waterberg and Vhembe DMs. These roads experience a high flow of vehicles and heavy-duty vehicles as they connect South Africa, Zimbabwe and Botswana.

2.7.3 Impacts

Impacts in air quality must be evaluated from three different perspectives to obtain a comprehensive understanding:

- Ambient air quality;
- Total emissions per sector; and
- Dispersion potential and impacts.

The measured ambient air quality indicates the real concentration of pollutants at ground-level concentration, which is what the population is actually exposed to. Estimated emissions per sector are helpful for identifying the main sources of emission and for developing mitigation strategies applicable to those sources. A dispersion model and impact assessment would determine the potential areas of risk after the pollutants have been dispersed.

2.7.3.1 Ambient Air Quality

The most common air pollutants are SO_2, NO_xs, CO, hydrogen sulphide (H_2S), O_3, PM and volatile organic carbons (VOCs). These pollutants have been identified as criteria pollutants in the National Environmental Management: Air Quality Act (NEMAQA), Act No. 39 of 2004. The Department of Environmental Affairs (DEA) sets out the maximum acceptable ambient concentration of criteria pollutants through the National Ambient Air Quality Standards (NAAQS). Metropolitan municipalities and DMs are charged with implementing the atmospheric emission licensing system and must for this purpose perform the functions of a licensing authority.

Present ambient concentrations are measured through a network of monitoring stations across South Africa. Monitoring stations in Limpopo tend to be localised in and around major industrial

and urban centres. There are in total 21 government-owned air quality monitoring stations (stations owned and operated by the DEA, the Limpopo Provincial Department of Economic Development, Environment and Tourism (LEDET), and local authorities) in use, and 25 stations owned and operated by industry. Of the government stations, only a few make use of continuous[41] samplers. The majority make use of passive[42] samplers.

Currently, only five stations report to the South African Air Quality Information System (SAAQIS): the three stations in the Waterberg DM, as part of the monitoring of the Waterberg-Bojanala Priority Area (WBPA) (since 2013); the LEDET-owned station in Phalaborwa (since 2013); and the Eskom-owned station in Marapong (since 2011).

In the last two years, power failures from load shedding have resulted in significant loss of data for air quality monitoring stations in Limpopo. Recalibration of air quality monitoring equipment, under the administration of the South African Weather Service (SAWS) and various subcontractors, does occur after power failure incidents. However, this takes time. The annual trends in ambient concentration for PM_{10}, NO_x and SO_2 are illustrated in Figure 3. The red line is the national standard as defined by the NAAQS.

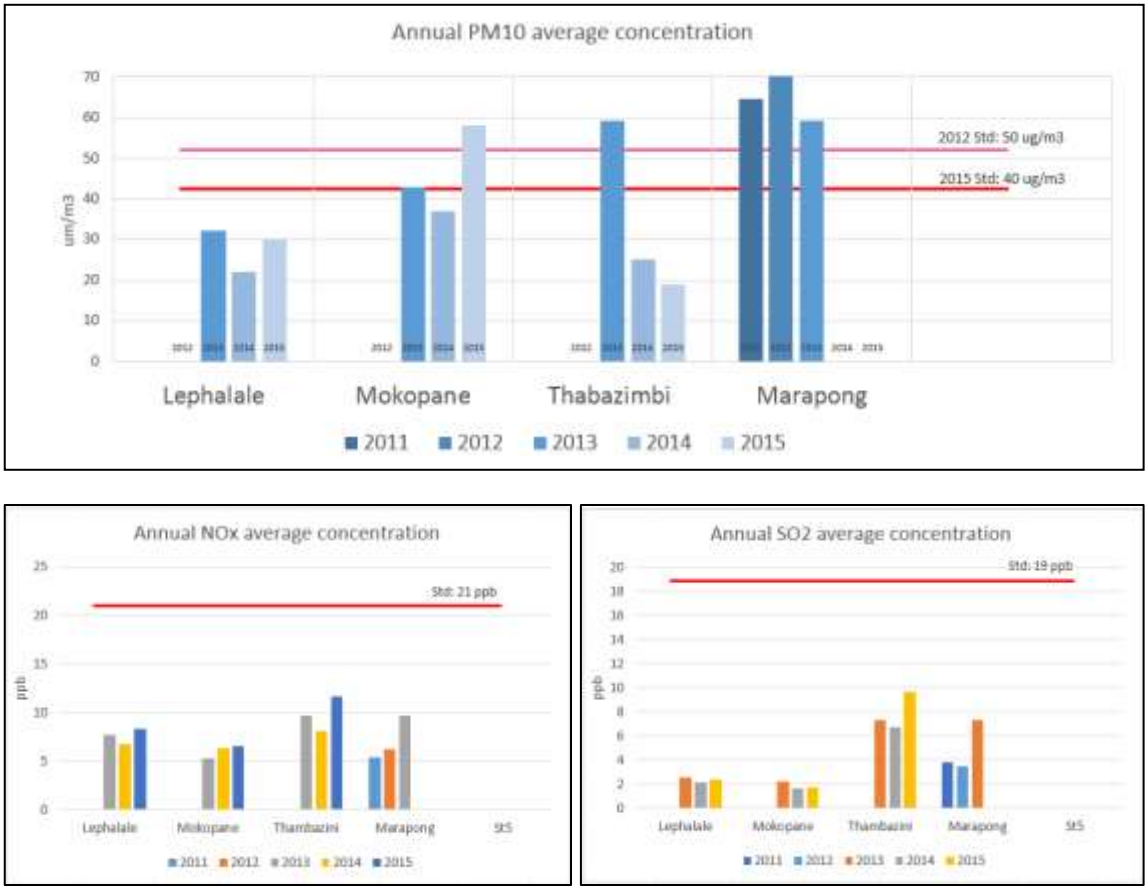


Figure 3: Annual trends in PM_{10}, NO_x, SO_2 concentrations for 2012 to 2015 at monitoring stations in Limpopo Province, including the current South African standard (in red) and 2012 national standard for PM_{10} (in pink)

Insufficient data coverage is available for some of the years[43], which makes it difficult to visualise a trend in the concentration of pollutants. Available data seems to suggest non-compliance with PM_{10} standards in the proximities of Mokopane, Thabazimbi and Marapong. However, it is difficult to reach a conclusion, given the inconsistencies in the logged data. Regarding NO_2, monthly and annual averages are low and are not expected to exceed hourly or annual

[41] With continuous sampling, air is drawn through a device at a known rate using an air-moving system and real-time data is collected continuously 24 hours per day.

[42] Passive sampling involves collecting a pollutant or pollutants with devices that have no moving parts.

[43] SAAQIS has only five reporting stations. Most stations have recently come online and therefore do not have sufficient historical data for identifying trends. In addition, existing information is incomplete owing to load shedding.

NAAQS limits. The existing AQMPs for the Waterberg, Greater Sekhukhune and Capricorn DMs and recorded data at the five SAAQIS stations did not report exceedances of SO_2 emissions.

A potential exists for SO_2 exceedances at the Marapong and Lephalale stations, once the Medupi Power Station is fully operational. Although Medupi is planned to have a Flue Gas Desulphurisation System, which may reduce SO_2 emissions by up to 90%, this system will be installed only six years after the six units of the station are commissioned (Eskom, n.d.).

2.7.3.2 Air Quality and Climate Change

Climate change and air pollution are closely related; most of the activities that cause air pollution also emit GHGs. Air pollutants, such as ground-level ozone and PM, contribute directly to global warming. Higher concentrations of ozone in the troposphere, which are dependent on methane, CO, NO_X and VOCs emissions, affect the climate. Other natural sources of ozone are lightning and transport from the stratosphere.

Particulate pollution affects climate directly and indirectly. A particle's ability to absorb or scatter light has direct effects. Particles such as black carbon absorb the sunlight, which heats the atmosphere, while sulphates and nitrates may have a cooling effect. Indirect effects on climate include changes in the reflectivity of clouds, or indirect influence in cloud lifetime and precipitation.

Similarly, climate change aggravates the effects of air pollution. For example, the pollution effects of ozone and PM are strongly influenced by shifts in the weather (such as heat waves and droughts) (EPA, 2011). Fortunately, most of the efforts to improve air quality also help to reduce GHG.

In March 2014, the DEA published a draft declaration in which GHG was declared a priority air pollutant. Once enacted, these regulations and declaration will together require emitters of GHGs to submit a pollution prevention plan for reducing GHG emissions to the DEA for consideration and approval.

2.7.3.3 Sources of Emission

Limpopo completed an Emissions Inventory (EI) for the first time in 2013 to inform the provincial AQMP (LEDET, 2013a). Total estimated emissions in tons per annum for Limpopo were estimated at 168 605 for PM_{10}, 702 941 for SO_2 and 201 866 for NO_X. A display per source is presented in Figure 4 (refer overleaf).

Existing licences granted under the Atmospheric Pollution Prevention Act (APPA), Atmospheric Emission Licence (AEL) applications, Environmental Impact Assessments (EIAs) and the first draft of the Waterberg EI, among other sources of information, were used to generate this EI. Expected emissions from future operations of the Medupi Power Station were also considered. This inventory will be updated in 2018 when the AQMP is due for review. By then, all listed emitters are expected to have been issued with an AEL, which will improve the quality of the input information.

From this first level EI, it is evident that the main sources of SO_2 and NOx are the power-generation activities in the Waterberg DM. Even with an updated EI, it is unlikely that other areas and sources will change the dominance of the power-generation contribution to total provincial SO_2 and NOx emissions.

Small boilers and mining operations (both coal and metallurgical) are the main sources of PM_{10}. The main contributor to fine particulate material ($PM_{2.5}$) and CO is biomass burning. Vehicle tailpipe emissions are the main source of hydrocarbons, specifically within the Waterberg, Capricorn and Vhembe Districts. VOCs are primarily from wood-treatment works and these are mainly restricted to the Mopani DM (LEDET, 2013a).

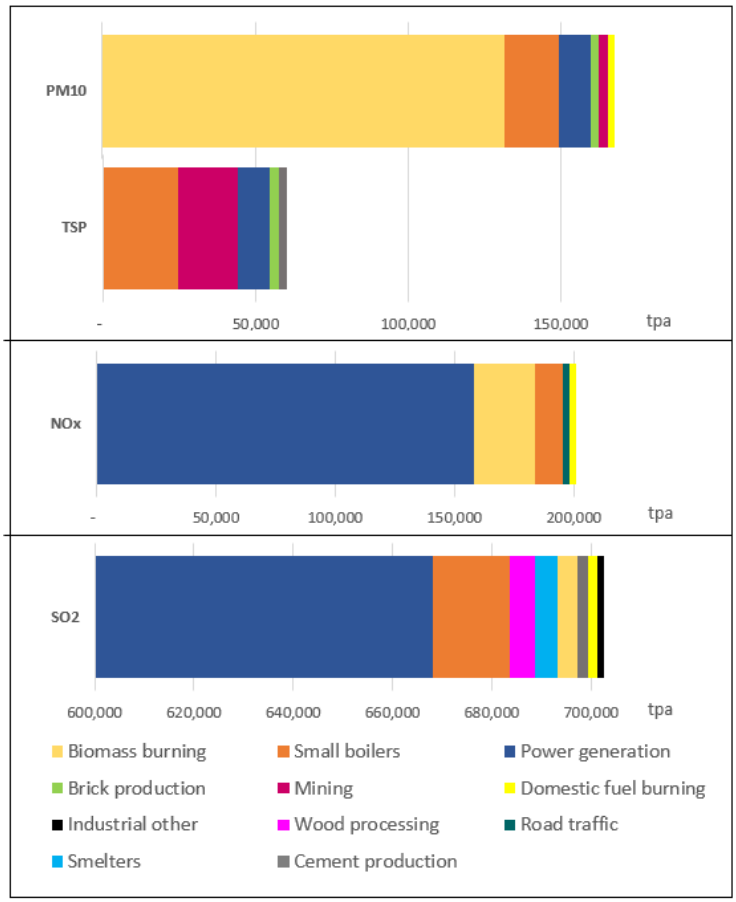


Figure 4: Estimated emission per annum for Limpopo Province per type of source for total suspended particulates (TSPs), PM10, NOx, SO2 (LEDET, 2013a)

The scale of air quality impacts depends on the type of source, the emission rates and the dispersion potentials. To investigate these impacts in Limpopo, four hot-spot areas were selected for dispersion modelling. These four regions and the main findings from the modelling are presented in Table 2 below.

Table 2: Summary of predicted impacts at the four *hot-spot* areas within Limpopo Province

IDENTIFIED AREAS	REASON FOR SELECTION	MAIN POLLUTANT	MAIN SOURCES OF CONCERN	SIGNIFICANCE
Polokwane	Presence of a high number of sources, but limited monitoring data	PM_{10}	Brickworks and asphalt plant	Medium
		SO_2	Smelters	Medium
Lephalale	House of power-generation facilities and large coal mines	PM_{10}	Mining operations	High
		SO_2	Power plants	Medium
Phalaborwa	Counts with a copper smelter, fertiliser manufacturing and two large open-cast mines	PM_{10}	Mining operations	Medium
		SO_2	Smelter and fertiliser production	High
Steelpoort area	Significant number of mines	PM_{10}	Mining operations	High

The main area of concern is around Phalaborwa, owing to very high SO_2 concentrations that impact on the town. Within the Steelpoort area, the main sources are the numerous mining operations in close proximity to villages and homesteads, which result in high PM_{10} ground-level concentrations. PM_{10} is a concern around the open-cast mines in the area of Lephalale; therefore, PM_{10} levels are predicted to exceed acceptable levels at nearby settlements. SO_2 is a concern more because of the planned operations of Medupi than because of the current situation. The predicted impacts in the Polokwane area are mainly localised and rated as being of medium significance.

2.7.3.4 Atmospheric Transport of Pollutants

The long-range transportation of pollutants occurs because of the presence of prevailing winds. From August to October, it is likely that ambient air quality in the south-western part of Limpopo will be affected by the transporting of pollutants associated with biomass burning in the sub-equator. Direct transporting of pollutants from the Highveld region is also expected. Likewise, emissions from the Waterberg DM are expected to be transported and to influence background concentrations in the North West Province. Apart from the possibility of exceedances, long-range transportation of pollutants is a concern because it is likely to build up secondary pollutants, with particulate size smaller than 2.5 µm, which are extremely harmful because of their ability to penetrate deep into the lungs. Table 3 below summarises the findings of the study in terms of the indicators.

Table 3: Summary of the outlook for Air Quality based on indicators considered for Limpopo Province

INDICATORS CONSIDERED	QUANTIFICATION	TREND
Ambient air quality (PM_{10}, SO_2, NO_2)	PM_{10} constant exceedance of standards across all stations	*Concern[44]
	SO_2: No exceedances	Stable
	NO_2: No exceedances	Stable
Number of operational air quality monitoring stations	5 SAAQIS reporting stations in 2015 from 1 in 2013 21 government owned 25 privately owned	Increasing
Sources of pollutants (PM_{10}, SO_2, NO_2)	More than 300 identified facilities in 2013 baseline	-
Emissions per source of pollutants (PM_{10}, SO_2, NO_2) (tons per annum (tpa))	Industrial PM_{10}: 31 990; SO_2: 697 043; NO_2: 170 657 Mining TSPs:19 833 Biomass Burning PM_{10}: 131 510; SO_2: 3 945; NO_2: 25 644 Domestic Fuel Burning PM_{10}: 2194; SO_2: 1 953; NO_2: 2 615 Traffic PM_{10}: 95; NO_2: 2 950	-
Total emissions (PM_{10}, SO_2, NO_2) (tpa)	PM_{10}: 168 605 SO_2: 702 942 NO_2: 201 866	-
Status of AQMPs	Provincial AQMP developed in 2013 and being implemented	Increasing
	Three out of five District AQMPs developed in the DM	Improving
	One out 25 LM AQMPs developed	Slowly improving

Inadequate ambient monitoring information limits the possibility of reaching a definite conclusion about the outlook for the air quality of Limpopo. However, available information suggests that air quality is acceptable in Limpopo in terms of NO_X levels. Although no exceedances were observed in the ambient records for SO_2, smelting and fertiliser manufacturing in Phalaborwa is a high concern for the area. There is also an expected increase of SO_2 concentration in the surroundings of Lephalale during the unabated operation of Medupi.

The main air quality issue found across Limpopo is PM, and the most common source, is activities related to mining operations. Areas of concern include Lephalale and Steelpoort. Domestic fuel burning and vehicle emissions were not flagged as major sources for Limpopo, yet these are of concern on a local scale and should be investigated. The principal problem, from domestic fuel burning and vehicle emissions, is the low release height, which means very little potential for dispersion. High concentrations of pollutants very quickly end up in the breathing space, increasing the health risk of the exposed population significantly.

Other limitations are found with regard to available resources (human, technical and financial) for the satisfactory accomplishment of the air quality management tasks of Limpopo.

[44] Insufficient information is available for a trend to be drawn for Limpopo.

2.7.4 Responses

From a policy point of view, the South African Government and Limpopo have formulated strategies for response to, management of and intervention in the air quality of Limpopo.

2.7.4.1 Air Quality Indicators

In South Africa, the NAAQS are the maximum acceptable concentration levels of criteria pollutants at ground level. They also specify the maximum allowed exceedances per type of pollutant and averaging period. These standards were given in terms of Section 9 of the NEMAQA in 2009 and 2012 for $PM_{2.5}$. More strict limits for PM_{10} and Benzene are to be enforced from 2015 and for $PM_{2.5}$ from 2016.

2.7.4.2 Atmospheric Emissions Licences, Controlled Emitters and By-laws

Since 2013, by mandate of Section 21 of the NEMAQA, industrial and materials-processing activities that are likely to result in atmospheric emissions are required to apply for AELs. Metropolitan and district municipalities approve these AELs.

These activities are classified into 10 categories, each one with a minimum emission standard per relevant pollutant. The minimum emission standards differentiate between new and existing facilities, and make provision for gradual reduction of emissions by setting more constricted limits to be complied with by 2015 and 2020.

Out of the five DMs, only the Capricorn DM has implemented a licensing system. To date, the Capricorn DM has received 10 applications and issued three licences. The other four DMs have delegated the function to LEDET, which has received 68 applications and issued 36 licences. These AELs provide the authorities with a legal mandate to control emissions from these sources.

In the case of non-listed activities with the potential for atmospheric emissions, the government can declare these activities as a controlled emitter, and set emission limits for them. So far the government has declared three controlled emitters: small boilers, temporary asphalt production and small-scale charcoal plants. The Provincial Government must identify the emitters and the applicable licensing process must be initiated.

Local governments can also impose more strict emission limits or control additional sources by means of the declaration of by-laws, which would apply to their area of jurisdiction.

2.7.4.3 Priority Areas

An area where elevated atmospheric pollutant concentrations are a concern can be declared an Airshed Priority Area, in terms of the Section 18 of the NEMAQA. Through this mechanism, the DEA can focus attention and resources on improving its air quality. The preparation of plans is undertaken by the national air quality officer, in consultation with the relevant provincial air quality officers and stakeholders, located in the area.

In 2010, the DEA declared the Waterberg DM as a Priority Area. Later in 2012, it included the Bojanala Platinum DM in the North-West Province to form in the Waterberg-Bojanala Priority Area (WBPA). Although the current state of the air quality of the area is not a problem, planned expansion of power-generation capacity for South Africa and Botswana poses a future risk to its ambient air quality.

2.7.4.4 Air Quality Management Plans

An AQMP describes the current state of air quality in an area, how it has been changing over recent years, and what could be done to ensure clean air quality in a region. The Limpopo Provincial Government department that is responsible for preparing an Environmental Implementation Plan and/or Environmental Management Plan is required to include an AQMP as part of that plan (NEMAQA Section 15). Each municipality is required to include an AQMP in its Integrated Development Plan (IDP).

Limpopo completed its AQMP in 2013, in which it stated its vision and goals regarding air quality. The Capricorn, Sekhukhune and Waterberg DMs have already developed their AQMPs. The remaining two DMs are currently working on theirs. The Waterberg DM, as part of the WBPA, also has an AQMP, with the draft published in April 2015. Out of the 25 Local Municipalities, only one Local Municipality (LM) in the Capricorn DM has developed a local AQMP. However, although most of the plans are there, implementation remains a challenge in Limpopo.

Table 4: Limpopo Province District Municipality Air Quality Management Plan development and implementation status in June 2015

DISTRICT MUNICIPALITY	AQMP STATUS
Capricorn	Due for review
Mopani	Under development
Sekhukhune	Under implementation
Vhembe	Under development
Waterberg	Under implementation

2.7.4.5 Emissions Inventory

An EI is a useful informative tool for managing air quality, and it needs to be continuously revised and updated. The current EI would be the baseline for evaluating performance of the implemented reduction strategies in Limpopo. Limpopo uses an Emissions Inventory Calculator to facilitate the tasks of quantification and tracking. In future, all EIs will report to the National Atmospheric Emissions Inventory System (NAEIS). The updated version of the EI should:

- Make use of the AEL licences to inform emissions and location of facilities, as well as to identify industries that had an APPA licence, but are no longer operational;
- Include the final EI for the Waterberg DM from the WBPA AQMP;
- Note small boilers that are still operational, their location, fuel and activity rate;
- Include data from the national vehicle emissions inventory;
- Use more recent data than the 2011 Census data for the household fuel combustion; and
- Include agricultural sources of emission.

2.7.4.6 Ambient Monitoring

Limited ambient monitored data exists in Limpopo, with poor data availability from most of the stations. Most of SAAQIS reporting stations have recorded data since 2013. However, current data presents significant gaps, owing to load shedding. No updated information could be attained for this report other than that managed by SAAQIS.

Only one out of the four hotspots identified by the Limpopo Provincial Government has a LEDET-owned monitoring station which is situated at Phalaborwa. Another station is planned for Steelpoort. Lack of financial resources is the main concern, as each station has an estimated cost of R2.8 million. It is the goal and the need of the Limpopo Provincial Government to have at least one monitoring station in each hotspot area.

As part of the licensing process, big emitters are required to monitor ambient air quality in the area in which they operate. Eskom in the Waterberg DM, Anglo American in Polokwane and Phalaborwa Mining Company in Phalaborwa are actively monitoring air quality.

2.7.5 References

Council for Geoscience. 2015. *Mineral profile of Limpopo region. Internet material accessed 30.10.2015:* http://www.geoscience.org.za/index.php/limpopo-region/247-mineral-profile-of-limpopo-region.

Environmental Protection Agency (EPA). 2011. *Climate Change and Air Quality,* s.l.: United States Environmental Protection Agency.

Eskom, n.d. *COP 17 Fact Sheet: Air Quality and Climate Change,* s.l.: Eskom.

Greater Sekhukhune District Municipality (GSDM). 2008. *Greater Sekhukhune District Municipality: Final Air Quality Management Plan.* Greater Sekhukhune District Municipality, Groblersdal.

Josipovic, M. 2009. *Acid deposition emanating from the South African Highveld – A critical levels and critical loads assessment*. Johannesburg: University of Johannesburg (PhD Thesis).

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2013a. *Provincial Air Quality Management Plan Baseline Assessment and Emissions Inventory Report.* Limpopo Department of Economic Development, Environment and Tourism: Provincial Air Quality Management, Polokwane.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2013b. *Provincial Air Quality Management Plan.* Limpopo Department of Economic Development, Environment and Tourism, Polokwane.

Maenhaut, W., Salma, I., Cafmeyer, J., Annegarn H.J. & Andreae, M.O. 1996. Regional atmospheric aerosol composition and sources in the eastern Transvaal, South Africa, and impact of biomass burning. *Journal of Geophysical Research,* 101: 23631-23650.

Statistics South Africa (StatsSA). 2012. *Census 2011,* Statistics South Africa, Pretoria.

Thompson, A.A., Kharidza, S.D. & Lirvhuwani, M. 2012. Impact of climate change on children's health in Limpopo Province, South Africa. *International Journal of Environ Research and Public Health*, 9 (3): 831–854.

Vusumuzi, N., Wichmann, J. &Voyi, K. 2015. *Chronic respiratory disease among the elderly in South Africa: any association with proximity to mine dumps?* Environmental Health.

World Health Organization (WHO). 2012. *Public health, environmental and social determinants of health (PHE*). Internet material accessed 12.11.15: http://www.who.int/hia/evidence/doh/en/.

3 The Human Dimension

3.1 Environmental Governance

3.1.1 Introduction

Governing the rich and diverse natural resources in Limpopo Province is becoming increasingly challenging. Not only are pressures increasing, but, in a globalising world of interconnected nations, economies and people, the management and protection of environmental resources require improved co-ordination of responses between a wide range of stakeholders, particularly when crossing national, provincial, district and local municipal boundaries.

Effective environmental governance at all levels is critical to finding solutions to such challenges. Sustainability is the ultimate standard for managing how people affect the environment. Sustainable development is the goal towards which people strive and it is based on balancing development and the health of the environment into perpetuity. In order to achieve this in practice, policies and institutions must shape how people interact with the environment (UNEP, 2016).

What is governance?

"…the system of values, polices and institutions by which a society manages its economic, political and social affairs through interactions within and among the state, civil society and private sector. It is the way a society organizes itself to make and implement decisions – achieving mutual understanding, agreements and action. Governance, including its social, political and economic dimensions, operates at every level of human enterprise, be it the household, village, municipality, nation, region or globe." (UNDP, 2004)

What is environmental governance?

"…the processes of decision-making, involved in the control and management of the environment and natural resources. It is also about the manner in which decisions are made - are they made behind closed doors or with input from the broader public. Principles, such as inclusivity, representivity, accountability, efficiency and effectiveness, as well as social equity and justice, form the foundation of good governance. Good environmental governance should reflect our best understanding of the structure, function, processes and variability that typify natural systems. Without this understanding, inappropriate decisions can be made with catastrophic environmental consequences, even with the best possible intentions." (Fakier *et al.*, 2005)

Good governance is critical for the achievement of environmental sustainability. Ultimately, sustainable development must be considered at the global, regional, national and local levels.

In the South African context, governance is informed by the Constitution of the Republic of South Africa (Act No. 108 of 1996) and, in particular, by Section 24 of the Bill of Rights. The Preamble to the Constitution, 1996, reads as follows: *"We, the people of South Africa recognise the injustices of the past"* (GoSA, 1996). This contextualises and informs the approach to governance in South Africa. It sets the scene and guides social change, political transformation, access to natural resources and equitable development.

Section 24 of the Bill of Rights states that everyone has a right to an environment that is not harmful to their health or well-being and that is protected now and for the future. This places a responsibility on all spheres of government to secure and protect the environment and ensure an environment that is conducive to a safe and healthy existence for all, now and in the future.

Weak environmental governance will result in poorly defined environmental policy, unachievable or irrelevant objectives, ineffective mandates, and a lack of clarity pertaining to responsibilities and regulatory practice. The inevitable result of weak governance is degradation of the natural environment and an associated compromised living environment (DEA, 2012a), which leads to decreasing well-being among people.

Assessing the performance of any governance system is complex, given the breadth and depth of the subject (Fakier *et al*., 2005). Quantitative data needs to be supported by qualitative information that provides a deeper understanding of the effectiveness of environmental governance.

The White Paper on Environmental Management Policy for South Africa (GoSA, 1998), provides us with the following guidelines as to what constitutes good environmental governance:

- Governments should be responsible and accountable;
- Regulations should be enforced;
- Integrating mechanisms and structures that facilitate participation should be established;
- Inter-ministerial and inter-departmental co-ordination should be set up;
- The institutional responsibilities for regulating environmental impacts and promoting resource exploitation should be separated;
- People should have access to information; and
- Institutional and community capacity building needs to take place.

In Limpopo, a number of government structures at different levels have a mandate for managing the allocation and use of natural resources and all three spheres of government have specific roles in this. As with other provinces in South Africa, policy and planning related to nationally strategic resources, such as minerals and energy, are directed by National Government. Provincial Government provides strategic direction to sectors such as spatial planning, human settlements, agriculture, tourism and environmental management, while Local Government has the mandate to conduct, manage and implement local-level developmental and spatial planning processes and projects.

What is good environmental governance?

Good environmental governance takes into account the role of all actors that impact the environment. From governments to NGOs, the private sector and civil society, co-operation is critical to achieving effective governance that can help us move towards a more sustainable future (UNEP, 2016).

Limpopo has a wealth of biodiversity and unique natural ecosystems and species, on which many of its citizens depend for their livelihood, health and well-being. Adverse environmental changes, driven by a variety of pressures and threats, need to be managed through effective environmental governance to realise sustainable socio-economic development for Limpopo. A key to effective environmental governance lies in understanding the value of goods and services provided by the ecosystem, as well as how ecosystems may be affected by different drivers and pressures over time.

Informed decision-making that considers the long-term benefits of a healthy environment for economic and social well-being is at times difficult to promote in the current climate and need for economic growth and transformation in South Africa. It is, however, essential, particularly in Limpopo, where a large portion of the rural population depends directly on ecosystem goods and services for many aspects of their lives, that a balance be found. To determine the state of and trends in environmental governance in Limpopo, a set of indicators was used (refer to Table 1 below).

Table 1: Indicators used in the assessment of Environmental Governance in Limpopo Province

ENVIRONMENTAL GOVERNANCE INDICATORS
Percentage of vacant posts in environment-related departments.
Number of complaints reported of non-compliance with environmental legislation.
Number and average amount of fines imposed and paid in cases of non-compliance with environmental legislation.
Number and percentage of successful prosecutions.
Number of animals/plants and products confiscated in cases of non-compliance with environmental legislation.
Area of land cleared of alien vegetation.
Budgetary allocation for environmental management.
Number and percentage of heritage sites in each protection status class.
Number and percentage of protected areas in each protection status class.
Number of provincial protected areas with approved management plans.

3.1.2 State

3.1.2.1 Policy, Legal and Institutional Framework

Provincial Policy, Plans and Strategies

The Limpopo Department of Economic Development, Environment and Tourism (LEDET) has a strategic development vision and legal mandate for environmental governance. The stated vision of LEDET is: "*A competitive economy within a sustainable environment*."

LEDET has the legal mandate to develop the provincial economy and to promote and manage environmental governance and tourism activities.

To implement its mandate, LEDET is guided by the following three strategic goals:

- Improve the service delivery to communities and stakeholders through a skilled, accountable, empowered and integrated Public Service;
- Contribute to the growth of the economy and job creation through targeted interventions; and
- Protect and enhance environmental assets and natural resources.

Limpopo has a growing policy and legislative framework to cover different aspects of environmental governance. The National Development Plan 2030 (NDP) provides critical national-level guidance to the provinces in South Africa regarding environmental governance (NPC, 2011). Chapter 5 of the NDP 2030, on Environmental Sustainability and Resilience, highlights the importance of protecting and enhancing South Africa's environmental assets and natural resources. Some of the recent provincial plans, such as the Limpopo Development Plan (LDP) 2015-2019 and the Limpopo Green Economy Plan 2013, are guided by the NDP and seek to implement priority policy goals at the provincial level (LPG, 2015; LEDET, 2013). The development and approval of these plans suggest an increasingly enabling policy environment of strengthened environmental governance. The full and effective implementation of these far-reaching policy directives is needed to effect significant change. This highlights the Province's achievements in implementing national environmental management legislation.

Guided by the strategic national goal of industrialisation, which is outlined in the NDP, and the Industrial Policy Action Plan (IPAP) 2014/15 – 2016/17, the economic development and transformation driving forces emphasised by the LDP prioritise mining, agriculture, tourism, manufacturing, and support to small businesses and co-operatives (DTI, 2014). To this end, the implementation of the Growth Points, which focus on investment in Lephalale, Musina and Makhado, Polokwane, Greater Tubatse and Phalaborwa, is promoted in the LDP.

LEDET has identified the manufacturing sector as an anchor for driving the industrialisation process and has initiated several strategic programmes, which are aimed at industrialising Limpopo (GoSA, 2015a). In addition, LEDET has put forward two Special Economic Zones (SEZs) in Tubatse and Musina, which have been sanctioned by the Department of Trade and Industry (DTI). The DTI has completed feasibility studies for the two SEZs and has signed a Memorandum of Understanding (MoU) with Hong Kong Mining Exchange Company Limited, Hoi Mor, to the value of R38 billion, to establish a South African Energy Metallurgical Industrial Zone (SAEMIZ), as part of that SEZ (GoSA, 2015a).

Biodiversity is recognised as a cornerstone of economic growth and sustainable development in all developmental initiatives. Greater emphasis is placed on the utilisation of biodiversity for economic benefit, rather than biodiversity monitoring and management. A recent budget speech by the Member of the Executive Council (MEC) of LEDET highlights the aim to transform the wildlife industry in Limpopo by facilitating the participation of previously disadvantaged communities. The allocation of hunting packages and donation of wildlife are identified as a feasible way to ensure sustainable trade in biodiversity. To transform the industry further, LEDET allocated 20 leopard tags to previously disadvantaged and individual professional hunters, who formed partnerships with established hunting outfitters (GoSA, 2015a).

The development of Bioregional Plans (BPs) forms part of the new legislated tools, identified by the National Environmental Management: Biodiversity Act (NEMBA), Act No. 10 of 2004, to aid in the conservation and management of South Africa's biodiversity. The aim of a BP, among others, is to provide a map of biodiversity priorities with accompanying land-use planning and decision-making guidelines to inform land-use planning, environmental assessment and authorisations. As such, a BP represents the biodiversity sector's input into multi-sectoral planning.

Institutional Status

In December 2011, the South African Cabinet (Cabinet) placed five Limpopo Provincial Departments under national executive administration in accordance with Section 100 (1) (b) of the Constitution (1996), including the Limpopo Provincial Treasury, Education, Transport and Roads, Health, and Public Works Departments. Improvements in governance within these departments led to an approval by Cabinet of the transition of the intervention from Section 100 (1) (b) to Section 100 (1) (a) of the Constitution (1996), on 9 July 2014. The transition allowed for the MECs of the affected Provincial Departments to resume full executive powers and the Head of Departments of the respective Provincial Departments to resume the role of accounting officer. The Provincial Executive is still required to fulfil a number of conditions, set by Cabinet, as a prerequisite for determining complete withdrawal of the intervention (GoSA, 2015a).

While LEDET is not directly involved in the intervention, the Department, along with all others in the Limpopo Provincial Government, is affected by virtue of the national executive administration of the Provincial Treasury. The long-term effects of the intervention on the increased efficiency and accountability of the Limpopo Provincial Government will need to be assessed.

Since Limpopo is largely a rural province, the role of municipalities and traditional leadership in environmental governance, sustainable economic growth and service delivery at the local level is of critical importance. This is recognised by the Limpopo Provincial Government, which has undertaken to increase support to the Local Municipalities through the Local Economic Development (LED) programmes in collaboration with the Department of Co-operative Governance, Human Settlements and Traditional Affairs (CoGHSTA) (GoSA, 2015a).

3.1.2.2 Budgeting

In the current financial year 2015/16, the total budget for Limpopo is R52 728 billion, a 4.2% increase from the 2014/15 original budget of R50 954 billion. LEDET received an allocation of R1 161 billion for the 2015/16 financial year, of which R304.3 million is for administration; R440.7 million for economic development, trade and investment promotion; R241.8 million is for environmental affairs to ensure the development, promotion and management of environmental activities; and R174 million is allocated to tourism development (GoSA, 2015b). Figure 1 below illustrates the breakdown of these allocations by percentage.

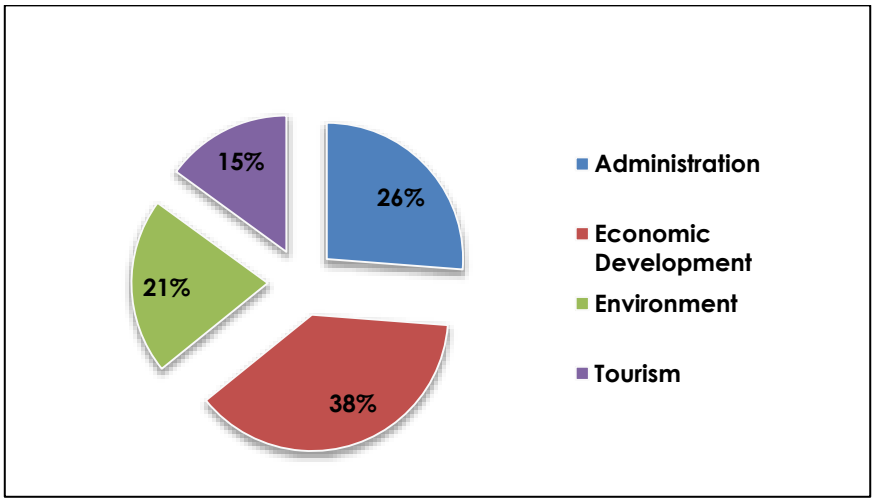


Figure 1: Budget allocation in LEDET for the 2015/2016 financial year (GoSA, 2015b)

The increasing expenditure on biodiversity management represents a positive trend for environmental governance in Limpopo and suggests a growing awareness of the need for greater care of the natural wealth of Limpopo. The relatively small budget allocation to the environment section within LEDET does, however, suggest that greater awareness of the importance of improved environmental governance among decision-makers is still needed. Figure 2 below presents the provincial expenditure on biodiversity management and shows a trend of rising expenditure.

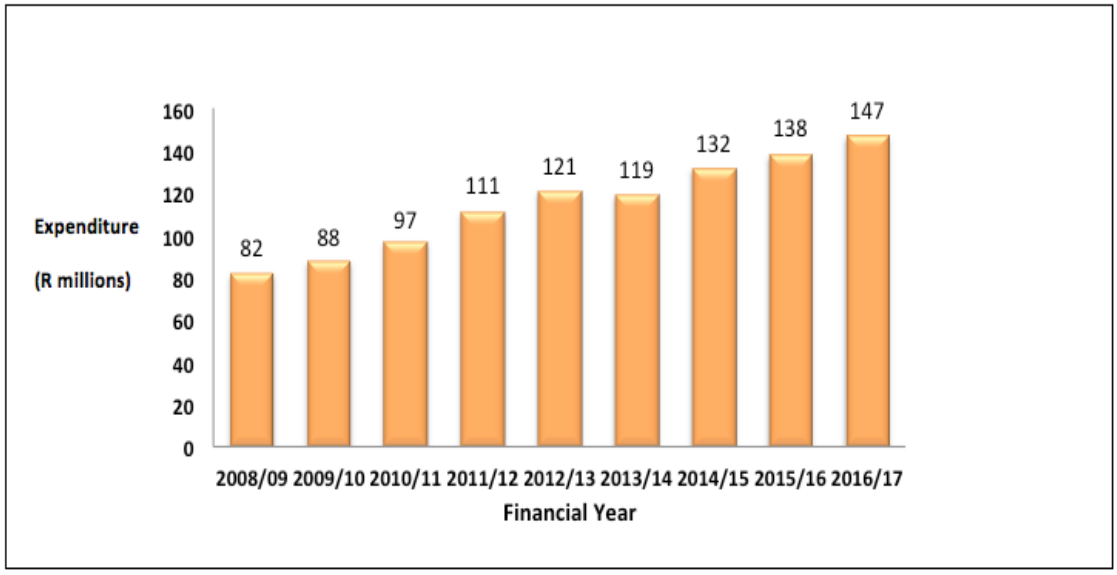


Figure 2: Limpopo Province expenditure on biodiversity management 2008/2009 – 2016/2017[45] (DEA, 2012b; Department of Treasury, 2015)

3.1.2.3 Staffing, Vacancies, Skills and Capacity

One of the key challenges to effective environmental governance in Limpopo relates to inadequate staffing in critical sections of LEDET. Figure 3 below illustrates the dire situation within LEDET, with three of the key sections in the Department having over 60% vacancy rates.

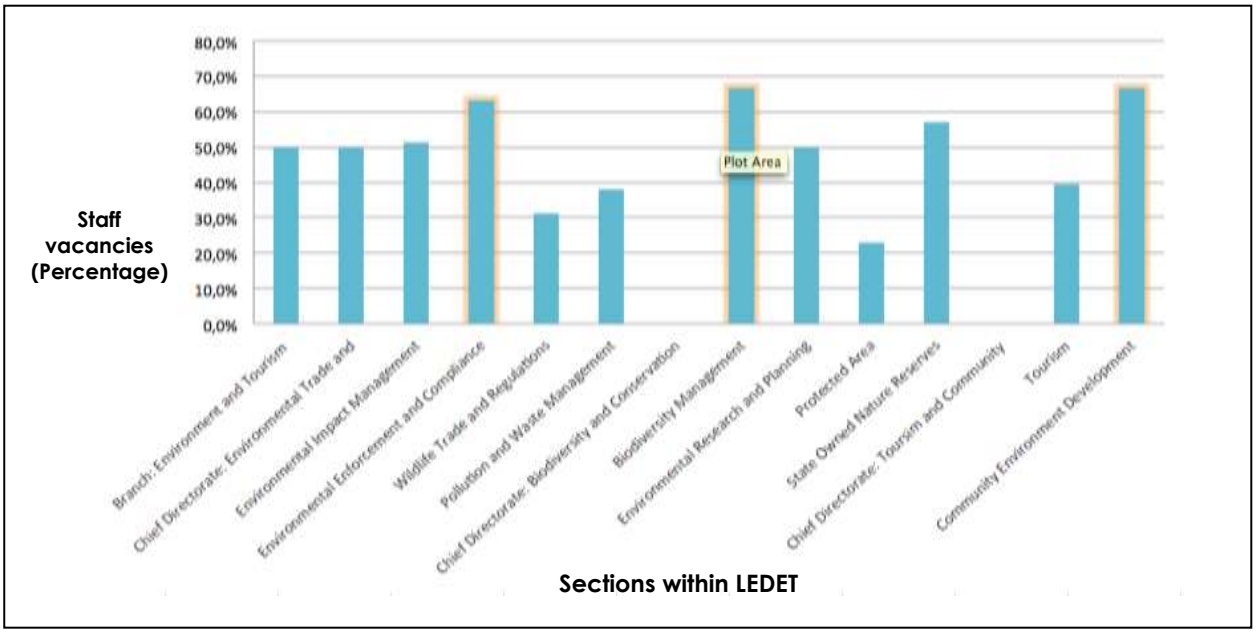


Figure 3: LEDET staffing vacancies 2015/2016 (LEDET, 2013c)

[45] Note: The total expenditure amounts are not exact. Totals have been rounded to the nearest decimal point. Expenditures for 2015/2016 and 2016/2017 are medium-term estimates.

The vacancy rates are nowhere more starkly evident than within the Provincial Nature Reserves. Figure 4 illustrates the high levels of vacancies within the reserves, with almost a complete lack of staff within two of the Reserves (Bewaarskloof and Happy Rest Reserves). The impacts of these staff vacancies are discussed further. In addition to the scarcity of staffing within LEDET, which contributes to ineffective environmental governance, the skills and capacity of existing staff that are tasked with environmental management require development and support. This is also particularly the case at the Local Government levels. During the consultation for this project, the lack of adequate skills and capacity for environmental management and compliance monitoring and enforcement at the Local Government level was identified as a key issue.

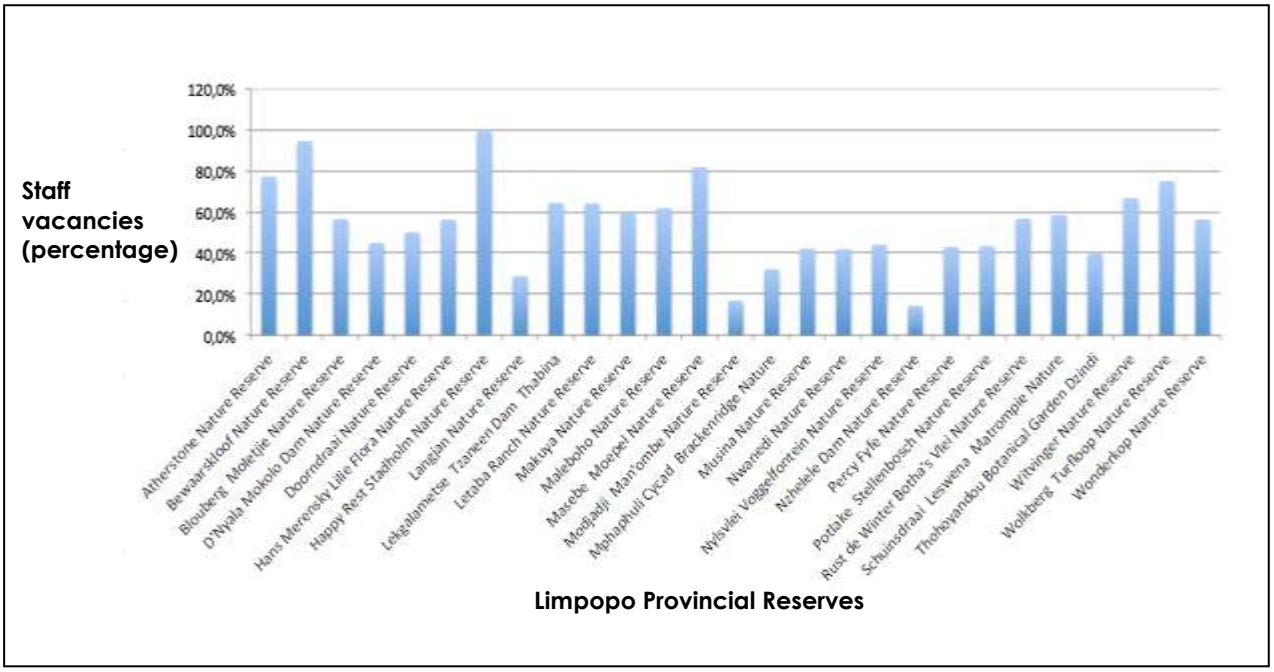


Figure 4: Staffing vacancies within the Limpopo Provincial Reserves 2015/2016 (LEDET, 2013a)

3.1.2.4 Integration with other Relevant Sectors and Stakeholders

The capacity of civil society to be involved in the nexus of environment-human settlement in Limpopo is low compared to some of the other provinces. The few environmental non-governmental organisations (NGOs) active in Limpopo focus more on wildlife than on issues that relate to sustainable human settlements. It is imperative to involve civil society as a key stakeholder and to provide incentives to develop its capacity to fill this gap. No information on trends related to NGO involvement in the environment and the impacts of human settlements on the environment is readily available.

Traditional leadership and CoGHSTA are key stakeholders that interface with the management of natural resources in communal lands. Indigenous knowledge, particularly in the rural areas, needs to be enhanced and complemented by the latest environmental management and co-operative governance legislation and knowledge so that a safe and healthy environment can be managed in a more sustainable manner.

3.1.2.5 Environmental Protection

Protected Areas (PAs) are assets that contribute to ecosystem integrity, economic development and social well-being. Limpopo has an existing Protected Areas Network (PAN) that comprises public PAs that are declared on the PAN registry and private PAs. The PAN of Limpopo is made up of 61 PAs that cover a total of 1 357 156 hectares (ha), or the equivalent of 11% of the land area of Limpopo Province (Desmet & Cloete, 2014). The Kruger National Park (KNP) is a major contributor to this and contributes 72% to the provincial PAN. Limpopo Province houses two United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Sites (WHSs), three National Parks and 43 Provincial Nature Reserves. The conservation area in Limpopo is estimated to be approximately 573 239 ha in extent. In addition to the above, there are three well-established biosphere reserves (Waterberg, Kruger to Canyons and Vhembe), two Transfrontier Conservation Areas (TFCAs) (Mapungubwe and Greater Limpopo), and six Land Reform PA Initiatives. This well-established PAN in Limpopo contributes significantly towards meeting South Africa's biodiversity conservation obligations, but will need to more than double in area in order to achieve provincial targets fully. To meet these goals, Limpopo has embarked on the Limpopo Protected Area Expansion Strategy (LPAES) process to expand the PAN (Desmet & Cloete, 2014).

Wildlife Crime

Awareness is growing that wildlife and environmental crime is seriously undermining regional and national development goals. This type of crime threatens not only biodiversity but also national security and good governance. The monetary value of all transnational, organised, environmental crime is US$ 70 – 213 billion annually, with the illegal wildlife trade (IWT) in a wide range of valuable endangered species being worth up to US$23 billion annually (Nellemann *et al.*, 2014).

Not all wildlife trade is illegal; plants and animals from many species are caught or harvested from the wild and then sold legitimately as food, pets, ornamental plants, leather, tourist ornaments or medicine. Wildlife trade escalates into a crisis when an increasing proportion is illegal and unsustainable, directly threatening the survival of many species in a variety of biomes.

There is a real cause for concern regarding IWT in Limpopo. In 2015, a set of recommendations on engaging communities in combating the IWT at its source was developed (IUCN, 2015). The report recognised the central role of the communities that live close to wildlife in addressing and combating IWT, and highlighted to the paramount importance of responding to community rights and recognising the distinction between IWT and legitimate, sustainable use and trade of wild resources.

In addition to strengthening law enforcement and reducing consumer demand for illegally sourced wildlife commodities, the engagement of indigenous and local communities is crucial for success in ensuring a lasting and sustainable future for the Limpopo's extraordinary celebration of plants and animals.

A key challenge in Limpopo relates to the management and maintenance of the Provincial Nature Reserves. LEDET is the designated authority for managing the 43 Provincial Nature Reserves in Limpopo and is responsible for the development and implementation of a Protected Area Management Plan (PAMP) for each reserve, in accordance with the National Environmental Management: Protected Areas Act (NEMPA), Act No. 57 of 2003. Each PAMP is required to provide an overarching management framework and zonation plan for the PA and informs the subsequent management activities on the reserve. Each PAMP also comprises a five-year Strategic Plan and five consecutive Annual Operational Plans (AOPs).

LEDET is further required to engage with stakeholders in the compilation of the PAMPs. A total of 28 PAMPs were completed by March 2013. Implementation of the completed PAMPs has yet to begin and the remaining 15 PAMPs are yet to be completed.

A serious lack of resource allocation for management and maintenance of the Provincial Nature Reserves highlights staffing vacancies for the reserves. These challenges have resulted in the reported decay of existing infrastructure and the increasing illicit harvesting of natural resources, animal mortality and environmental degradation of areas within the reserves. The recent negative media coverage (Carte Blanche, 2015) highlights the dire state brought about by the lack of management of the Provincial Nature Reserves, as well as severe inefficiencies within LEDET and the need for urgent intervention to stem further loss of biodiversity.

Economic transformation through commercialisation of state-owned nature reserves is of paramount importance. In this regard, LEDET has been directed to develop and finalise a model

that will empower communities that live adjacent to state-owned nature reserves. The model will be finalised during the third quarter of the 2015/2016 financial year (GoSA, 2015b).

3.1.2.6 Alien Vegetation Removal

The Department of Environmental Affairs (DEA) currently records the removal of alien vegetation in Limpopo. Alien vegetation clearing is undertaken under the Working for Water (WfW) Programme, as well as under rehabilitation and special project schemes. A total of 31 projects are currently underway. Figure 5 below outlines the areas that have been cleared since the 2009/2010 financial year. The degree of involvement of the provincial and local environmental management authorities in the alien vegetation-removal initiatives has yet to be clarified. Removal of alien vegetation involves three phases (DWA, 2016). The one-off clearing of alien vegetation is only the start. The three phases are:

- Initial control: drastic reduction of existing population;
- Follow-up control: control of seedlings, root suckers and coppice growth; and
- Maintenance control: maintenance of low alien plant numbers with annual control.

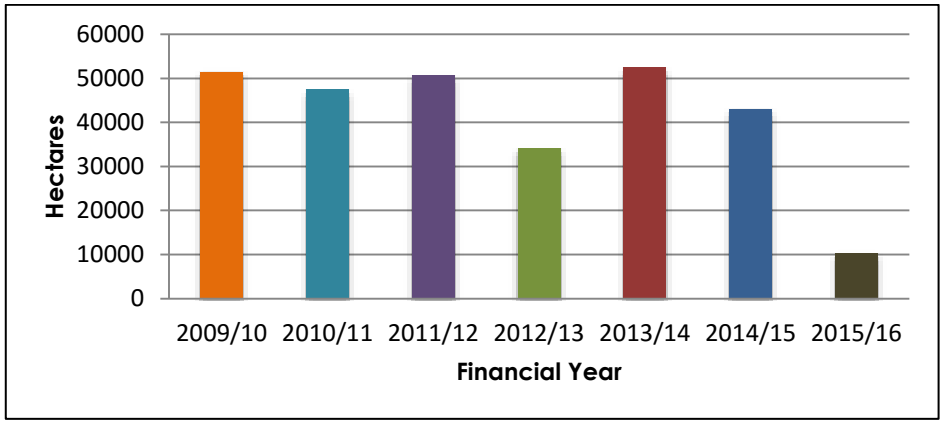


Figure 5: Alien vegetation removal in Limpopo Province (2009/2010 – 2015/2016) (DEA, 2015)

3.1.2.7 Environmental Impact Management

Limpopo has strong environmental management legislation in place, and a growing network of Environmental Management Inspectors (EMIs) and Environmental Impact Assessment (EIA) assessors. The effectiveness of the EMIs is discussed under 3.1.2.8 Compliance, Enforcement, Prosecution and Fines.

Figure 6 overleaf illustrates the number of EMIs in LEDET and in Local Government. The increase in EMIs in LEDET shows a positive upward trend from 104 in 2012/2013 to 255 in 2014/15 (refer to Figure 6). Nationally, the number of EMIs stationed at Local Government level throughout all provinces increased from 42 in 2013/2014 to 180 at the end of the 2014/2015 financial year. As illustrated in Figure 6, the number of EMIs stationed in Local Government in Limpopo has slightly decreased. This is a worrying trend, since the responsibility for much of the implementation of environmental management directives rests at the Local Government level. During the 2014/2015 financial year, the Department received a total of 171 EIA applications for infrastructure projects, including those for basic services.

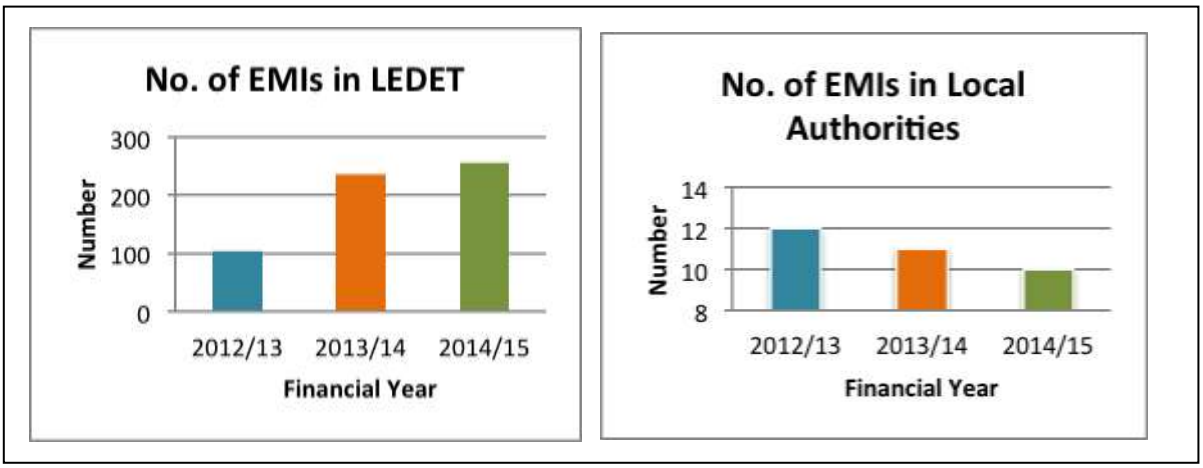


Figure 6: Number of Environmental Management Inspectors (EMIs) within LEDET compared to those in Local Authorities in Limpopo Province 2012/2013 – 2014/2015 (DEA, 2015)

EMIs are graded from 1 to 5, with 5 being the highest grade. Figure 7 illustrates the number of EMIs designated per grade in the Province. Grades 1, 2, 3 and 4 EMIs are located within all EMI institutions and undertake compliance monitoring, administrative and criminal law enforcement activities in the brown, green and blue sub-sectors. Grade 5 EMIs are appointed as field rangers in order to execute compliance and enforcement duties within various national and provincial PAs. These officials play a critical role in monitoring activities within the PAs by conducting routine patrols and other compliance and enforcement activities. The financial year 2012/13 saw an increase in EMIs for compliance and enforcement activities, which local authorities are mandated to regulate in terms of Schedules 4 and 5 of the Constitution (DEA, 2015).

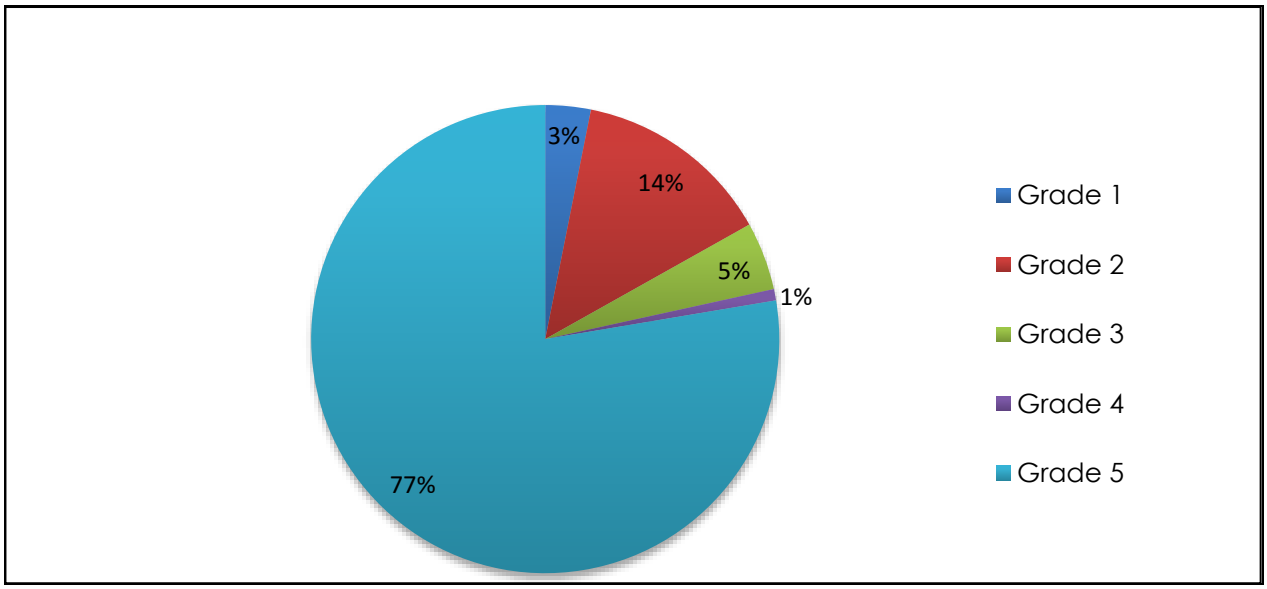


Figure 7: Number of EMIs per grade in Limpopo Province 2015/2016 (DEA, 2015)

3.1.2.8 Compliance, Enforcement, Prosecution and Fines

The number of criminal dockets registered in 2014/2015 in Limpopo was 512, the second highest in the country after the South African National Parks Board (SANParks). LEDET also recorded the highest number of arrests out of all the provinces, with 432 arrests. Successful prosecution of environmental crimes resulted in LEDET's issuing of the highest number of admission of guilt fines, referred to as 'J534s' (refer to Table 2 overleaf).

Table 2: J534 fines issued by LEDET in Limpopo Province 2014/2015 (DEA, 2015)

CATEGORY	NUMBER OF J534[46] FINES	INSTITUTION	LEGISLATION
Highest number of admission of guilt fines issued compared to other provinces	601 J534 fines were issued for the sum of R161 080.	LEDET	Limpopo Environment Management Act(Act No. 7 of 2003)

LEDET also issued 138 warning letters, the highest number from the EMI institutions. LEDET recorded the second-highest number of facilities inspected, at 798, of which 670 were in respect of brown issues, 126 green issues and two blue issues. LEDET recorded 212 non-compliances detected during the execution of compliance inspections (DEA, 2015). A total of 81 complaints were received by LEDET for non-compliance with environmental legislation in 2014/2015 and the most prevalent crimes reported (666 incidents) related to picking indigenous plants without a permit (DEA, 2015). Table 3 below provides a detailed overview of the compliance and enforcement results from LEDET for the 2012-2015 period.

Table 3: Compliance and enforcement activities by LEDET in Limpopo Province 2012 – 2014 (DEA, 2015)

COMPLIANCE AND ENFORCEMENT ACTIVITIES	2012-13FY	2013-14FY	2014-15FY
Criminal Enforcement			
Arrests by EMIs	643	514	432
Criminal dockets registered	45	435	512
Cases handed to NPA	87	161	49
NPA declined to prosecute *(nolle prosequi)*	8	0	0
Section 105A agreements (plea bargains)	1	0	1
Acquittals	3	0	4
Convictions	15	20	28
J534s issued	791	564	601
J534s paid (number)	653	503	377
J534s paid (value)	R326 580	R128 230	R129 780
Administrative Enforcement and Civil Actions			
Warning letters written	0	80	138
Pre-directives issued	0	7	0
Pre-compliance notices issued	8	2	26
Directives issued	1	0	1
Final compliance notices issued	4	0	17
Civil court applications launched	2	0	0
S24G administrative fines paid (total value/number)	R27 700	R0	R4 947 403.72
	2	0	32

Recent results on the Section 24G[47] (S24G) fines paid in 2014/15 indicate that the revenues generated from transgressions of environmental legislation vary considerably (see Figure 8 overleaf) but provide substantial revenue for the government.

[46] J534-type fines are Admission of Guilt Fines, which means the fines paid for less serious environmental offences in terms of Section 56 of the Criminal Procedure Act, 1977.

[47] Section 24G fines are fines issued for illegal activities related to activities commenced with in the absence of the required Environmental Authorisation, Waste Management Licence or Air Emissions Licence.

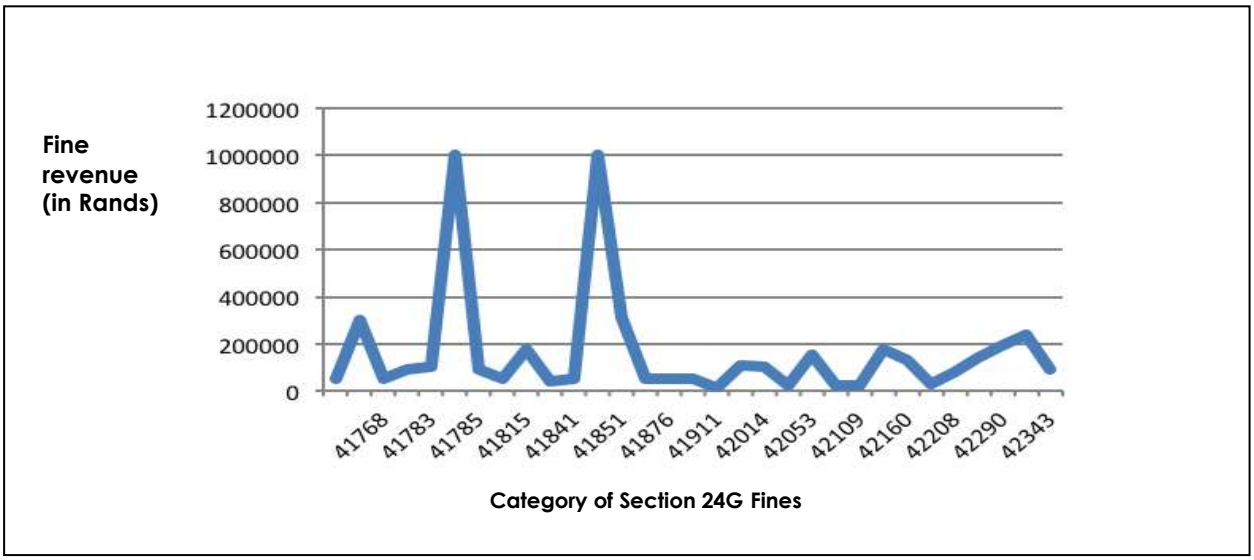


Figure 8: Selected Section 24G fines paid in Limpopo Province in 2014/2015 (LEDET, 2016a)

Over the 2014/2015 period, a number of plants and animals and plant/animal products were confiscated in cases of non-compliance with environmental legislation in Limpopo, as described in Table 4 below. Table 5 below describes such confiscations between 2007 and 2015.

Table 4: Number of plant and animal products confiscated in Limpopo in cases of non-compliance with environmental legislation in 2014/2015 (LEDET, 2016b)

ITEM DESCRIPTION	QUANTITY
Hippo trophy – skull	1
Blue wildebeest trophy –skin	1
Leopard trophy – skin	1
Elephant trophy – skull two tusks	1
Serval trophies – skin and full mount	2
Buffalo trophy – European mount skull[48]	1
Bird trophies – full mount	2
Sable trophy – European mount skull	1
Caracal trophy – skin	1
Baboon trophy – skull	2
Cycads	18

Table 5: No. of plants & animals and plant/animal products seized in Limpopo 2007-2015 (LEDET, 2016b)

ITEM DESCRIPTION	QUANTITY
Lion skins	2
Leopard skins	5
Leopard skull	1
Brown Hyena skin	1
Baboon skins	3
Baboon skulls	6
Baboon full-mount trophy	1
Caracal skins	7
Caracal skulls	4
Crocodile skin	1
Serval skins	2
African Wild Cat skin	1
African Civet skin	2

[48] A 'European mount skull' refers to an animal skull that is mounted on a plaque.

ITEM DESCRIPTION	QUANTITY
Vervet Monkey skin	1
Vervet Monkey skull	1
Cheetah skins	3
Pangolin skin	1
Honey Badger skin	1
Jackal	1
Python skins	4
Rhino horn	1
Elephant ivory	100 kg
Lions (live animal)	10
Elephant (live animal)	1
Pangolin (live animal)	3
Snakes (live animal)	4
Leopard (live animal)	1
Crocodile (live animal)	6
Tortoises (live animal)	20
Birds (live animal)	5

Despite intensive government initiatives to combat rhino poaching, the onslaught on this animal persists. In 2014 alone, 148 poachers were arrested and the annual growth rate of arrests since 1994 is reported at 97%. The number of rhinos poached in Limpopo increased from 114 in 2013/2014 to 134 in 2014/2015 (GoSA, 2015b). Incidents of mass poisonings of endangered birds of prey (specifically vultures) are also on the increase in Limpopo.

These criminal issues require urgent and targeted attention to avoid further losses of valuable species. The MEC for the Limpopo Provincial Department of Treasury has undertaken to support strengthened law enforcement efforts through specialised training, acquisition of adequate equipment and strategic deployment. Support to anti-poaching groups includes: the establishment of partnerships with the DEA and private landowners and the continued replacement of ageing field rangers that exit the system with young, competent and adequately trained rangers. Environmental Compliance Officers to combat poaching are some additional undertakings promised (GoSA, 2015b).

3.1.2.8 Environmental Programmes, Awareness and Education

LEDET continues to implement environmental programmes that benefit communities through the Expanded Public Works Programme. A total of 625 green jobs have been created for beneficiaries that live adjacent to Nature Reserves. These interventions involved skills development in road and fence maintenance (GoSA, 2015b). In addition, the Department has disseminated information and knowledge about environmental legislation and the green economy through various environmental campaigns in schools and communities, including traditional leaders. A total of 1 200 trees were planted in schools and churches in 2014 to promote conservation of trees and to mitigate the impact of climate change. The planting of a further 1 500 trees was planned for 2015. LEDET also facilitated the implementation of the Green Municipalities Competition in Limpopo, with the aim of empowering municipalities to improve environmental planning and to implement

Winners Environmentalist & Projects is an NGO that was established as a small organisation in 2014, with the aim of empowering communities as previously disadvantage groups of people. It is a 100% black-owned organisation, composed of previously disadvantaged individuals from various professional backgrounds. It has a committee that manages the organisation and volunteers who carry out the day-to-day activities. It is officially registered as a non-profit organisation, with the following objectives:

- Establishment and training of new environmental and related projects
- Tree name tags
- Promotion and protection of wetlands
- Monitoring of and support for newly established projects
- Planting and protection of indigenous trees
- Promotion of the use of natural resources in a sustainable manner
- Peace garden to old age families
- Encouraging of communities to attend environmental activities
- Clean up campaigns

(Winners Environmentalist & Projects, 2016)

responsible natural resource management. Mogalakwena Local Municipality was designated as the national winner of the competition in the 2012/2013 financial year (GoSA, 2015b).

While the above activities indicate a positive trend in improving environmental governance, more effort is needed to align planning, budgeting and performance in Limpopo. For instance, in the case of environmental awareness activities conducted in 2013/2014, Limpopo Province reportedly did not plan for any activities but did allocate funds to this programme and managed to carry out 2 232 activities (National Treasury, 2015).

A number of NGO-sponsored environmental education and awareness programmes are run in Limpopo. One example is the Wildlife and Environment Society of South Africa (WESSA), which runs the Eco-Schools programme in Limpopo. The Eco-Schools programme supports the national education curriculum and incorporates environmental awareness and management. The schools in the programme are evaluated according to their efforts to improve environmental awareness in the school and the community (WESSA, 2016).

3.1.3 Impacts

The impacts of ineffective environmental governance are cross-cutting and extensive and negatively impact multiple sectors. The short-term environmental degradation and biodiversity loss from lack of compliance and enforcement will result in widespread habitat loss and transformation, and possible extinction of threatened and endemic species. The knock-on effects of this range from a decrease in benefits from existing valuable sectors in Limpopo, such as eco-tourism and agriculture, to wholesale ecosystem failure and a permanent loss of critical ecological infrastructure and ecosystem goods and services. The impacts to the citizens of Limpopo, particularly the most vulnerable, being the poorest of the poor, who depend directly on natural resources, cannot be overestimated. The additional costs that will be required to substitute for ecological failure (such as the provision of potable water and adequate food resources) will be prohibitively expensive and will further stress the provincial economy.

Continued poor decision-making that prioritises short-term economic benefit and activities that have severe negative environmental impacts over long-term, strategic and integrated planning that supports sustainability will fail to balance social well-being with sustainable economic development and environmental health. Similarly, the lack of implementation of the existing environmental policies, legislation and plans will result in further environmental degradation. The environmental change, disaster and loss of future economic opportunities that result from placing short-term gain above long-term sustainability will soon prove a challenge to combat without considerable resources and expertise.

3.1.4 Responses

From a provincial perspective, there is a need for LEDET to align planning and budgeting and to better manage performance to achieve the Departmental goals. Urgent interventions are required regarding specific issues related to staffing and capacity, the management of Provincial Nature Reserves, illicit trade in threatened plant and animal species, and informed decision-making. All of this requires strong political will.

Economic growth and social well-being are closely tied to South Africa's ability to protect the natural environment. Mining, electricity generation and agriculture are among the economic activities that have a direct negative impact on the environment and need to be carried out in a more sustainable and responsible manner. Intergovernmental relations in environmental matters need to be made more efficient and effective. Owing to the cross-cutting nature of environmental management issues, it is becoming increasingly important that relations are improved across the different spheres of government.

The need for stronger environmental governance is gaining recognition nationally and provincially. There is also a growing awareness that a sustainable and effectively protected environment yields numerous benefits for economic development, social health and well-being over the long term.

Some key policies, laws and structures are in place in Limpopo, and more are under development. The presence of such frameworks and tools, however, does not always translate into effective implementation. Shortfalls in resources, skills and capacity allow for significant room for improvement in implementation in Limpopo.

Key priorities that require urgent attention in terms of environmental governance include:

- Review, align and implement key policies, plans and laws that pertain to environmental management at the different levels of government in Limpopo Province;
- Strengthen institutional structures and capacities and, as a matter of priority, allocate more staff and financial resources for essential environmental management functions, focusing on compliance monitoring and enforcement as a top priority;
- Foster collaboration among government sectors, different levels of government and other parties to promote and support co-operative environmental governance;
- Support and integrate environmental education and awareness programmes into the school curriculum; and
- Continue to support environmental observation, research and monitoring to inform decision-making and improve risk identification and mitigation, especially in terms of adaption to climate change.

3.1.5 References

Carte Blanche. 2015. *Limpopo Park Exposé*. Internet material accessed 09.12.2015: http://carteblanche.dstv.com/player/969644.

City of Polokwane. 2015. *Draft Integrated Development Plan 2015/2016.*

Department of Environmental Affairs (DEA). 2012a. *South Africa Environment Outlook 2012.*

Department of Environmental Affairs (DEA). 2012b. *National Compliance and Enforcement Report 2011/12*.

Department of Environmental Affairs (DEA). 2015. *National Compliance and Enforcement Report 2014/15.*

Department of Rural Development and Land Reform (DRDLR). 2013. *Climate Change Risk and Vulnerability Assessment for Rural Human Settlements*. Department of Rural Development and Land Reform: Spatial Planning and Facilitation Directorate.

Department of Rural Development and Land Reform (DRDLR). 2016. *Limpopo Province Spatial Development Framework (LSDF)*.Prepared by Plan Associates, Pretoria.

Department of Trade and Industry (DTI). 2014. *Industrial Policy Action Plan (IPAP)* 2014/15 – 2016/17.

Department of Treasury. 2015. *Provincial Budgets and Expenditure Review*: *2010/11 – 2016/17*.

Department of Water Affairs (DWA). 2016. *Management of Invasive Alien Plants*. Internet material accessed 12.03.2016: https://www.dwa.gov.za/wfw/Control/.

Desmet, P.G. & Cloete, J. 2014. *Making the Case for Protected Areas in Limpopo.* Contract Number EDET/QUT/2371/13. Report for Limpopo Department of Economic Development, Environment and Tourism (LEDET) by ECOSOL GIS, Port Elizabeth.

Fakier, S., Stephens, A., Tholin, J. & Kapelus, P. 2005. *Background Research Paper: Environmental Governance, South Africa Environment Outlook*. Specialist Study, commissioned by SRK Consulting on behalf of the Department of Environmental Affairs and Tourism (DEAT) as part of the National State of the Environment Reporting Programme, Pretoria.

Government of South Africa (GoSA). 1996. Constitution of the Republic of South Africa, 1996 (Act 108 of 1996). Internet material accessed 12.03.2016: http://www.info.gov.za/documents/constitution/1996.htm

Government of South Africa (GoSA). 1998. White Paper on Environmental Management Policy for South Africa (GN 749 in GG 18894 of 15 May 1998).

Government of South Africa (GoSA). 2015a. *The 2015/16 Budget Speech by Mr SC Sekoati, Limpopo MEC for Economic Development, Environment and Tourism, Limpopo Provincial Legislature.* Internet material accessed 09.12.2015: http://www.gov.za/speeches/mec-seapora-sekoati-limpopo-economic-development-environment-and-tourism-prov-budget-vote.

Government of South Africa (GoSA). 2015b. *The 2015/16 Budget Speech MEC Kgolane Phala: Limpopo Provincial Budget 2015/16.* Internet material accessed 09.12.2015: http://www.gov.za/speeches/mec-kgolane-phala-limpopo-budget-201516-12-mar-2015-0000.

International Union for the Conservation of Nature (IUCN). 2015. Community-led solutions: a key force in tackling wildlife crime. Internet material accessed 13.03.2016: http://www.iucn.org/news_homepage/ all_news_by_theme/species_news/?18968/Community-led-solutions-key-force-in-tackling-wildlife-crime

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2013a. *Limpopo Conservation Plan Version 2.*

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2013b. *Limpopo Green Economy Plan. Including Provincial Climate Response*.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2016a. Personal communication with Vusi Maluleke: 24.02.2016.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2016b. Personal communication with Riaan De Jager: 25.02.2016.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2016c. Personal communication with TP Mokgoka: 25.02.2016.

Limpopo Environmental Management Act 2003. (Act No. 7 of 2003).

Limpopo Provincial Government (LPG). 2015. *Limpopo Development Plan (LDP) 2015-2019*. Summary Document.

National Planning Commission (NPC). 2011. *The National Development Plan 2030.* Report for the South African National Government.

National Treasury. 2015. *Provincial Budgets and Expenditure Review which covers a seven-year period from 2010/11 to 2016/17*. 13th edition. Internet material accessed 0.12.2015: http://www.treasury.gov.za/publications/igfr/2015/prov/default.aspx.

Nellemann, C., Henriksen, R., Raxter, P., Ash, N. & Mrema, E. (Eds). 2014. *The Environmental Crime Crisis – Threats to Sustainable Development from Illegal Exploitation and Trade in Wildlife and Forest Resources*. A UNEP Rapid Response Assessment. United Nations Environment Programme and GRID-Arendal, Nairobi and Arendal.

North West Department of Rural, Environment and Agricultural Development. 2014. *North West Environment Outlook Report 2013.* North West Provincial Government, Mafikeng.

Statistics South Africa (StatsSA). 2011a. *Census 2011Community Profiles.*

Statistics South Africa (StatsSA). 2011b. *Statistics by Place: Local Municipality*. Internet material accessed 12.11.2015: http://www.statssa.gov.za/?page_id=993&id=polokwane-municipality.

United Nations (UN). 2015. Internet material accessed 25.11.2015: http://www.un.org/sustainabledevelopment/sustainable-development-goals/.

United Nations Environment Programme (UNEP). 2016. *Environmental Governance*. Internet material accessed 07.03.2016: http://www.unep.org/pdf/brochures/Environmental Governance.pdf.

United Nations Millennium Development Goals (MDG). 2015. Internet material accessed 07.03.2016: http://mdgs.un.org/unsd/mdg/Resources/Static/Products/Progress2015/English2015.pdf.

Wildlife and Environment Society of South Africa (WESSA). 2016. *WESSA Eco-Schools*. Internet material accessed 07.03.2016: http://www.wessa.org.za/what-we-do/.

Ziervogel, G., New, M., Archer van Garderen, E., Midgley, G., Taylor, A., Hamann, R., Stuart-Hill, S., Myers, J. & Warburton, M. 2014. *Climate change impacts and adaptation in South Africa.* WIREs Climate Change 2014.doi: 10.1002/wcc.295.

3.2 Economics

3.2.1 Introduction

Economic growth involves the combination of different factors of production (land, labour, management) with types of capital to produce goods and services. The types of capital that are required include:

- Produced capital, such as machinery, buildings and roads;
- Human capital, such as skills and knowledge;
- Natural capital; for example, raw materials extracted from the earth and carbon sequestration services provided by forests and soils; and
- Social capital, including institutions and ties within communities.

Natural capital can be defined as stocks of natural assets, which include geology, soil, air, water and all living things. It is from this natural capital that humans derive a wide range of ecosystem services that make human life possible. However, natural capital has critical thresholds or sustainable yields beyond which sudden and dramatic ecosystem decline may occur, since the use of natural assets has finite limits. The use of natural capital beyond the limits of sustainable yield is potentially irreversible and the impacts can extend across many generations.

Therefore, while natural capital is important for generating economic growth, it needs to be used sustainably and efficiently in order to secure economic growth over the long term. Historically, society and business, in particular, have taken ecosystem services for granted, externalising them from purely financial decision-making. However, as modern levels of consumption rise, so natural capital declines and so does productivity. Now there is growing international understanding that the use of natural capital comes at a cost and the value of such use is more and more being expressed as economic value through the rise in the field of environmental economics and the valuation of ecosystem services.

South Africa has released a New Growth Path (NGP) that is aimed at enhancing growth, employment creation and equity. The principal target of the framework is to create 5 million jobs over the next 10 years. Central to the NGP is a massive investment in infrastructure as a critical driver of job creation across the national economy. The NGP identifies investments in the following five key areas: energy, transport, communication, water and housing. Sustaining high levels of public investment in these areas will create jobs in the construction sector and in the operation and maintenance of infrastructure (South African Government, 2016).

In 2009, the Limpopo Provincial Growth and Development Strategy (PGDS), 2005, was superseded by the Limpopo Employment, Growth and Development Plan (LEGDP) 2009 – 2014, which serves as an implementable plan meant to form a solid base towards the development of the Provincial Growth and Development Strategy 2030 and the Limpopo Spatial Development Vision 2030. The obligation of the LEGDP is to confront the problem areas of economic growth, decent jobs and poverty reduction (DRDLR, 2016).

The main objective of the LEGDP is to improve the quality of life of the people in Limpopo Province. It is envisaged that this will be achieved through an economy that will:

- Create decent jobs, which is a foundation to sustainable livelihoods;
- Create reliable health care infrastructure;
- Afford the building of houses of acceptable standard;
- Provide for social development; and
- Result in comprehensive rural development, food security and land reform.

Furthermore, Limpopo is committed to the implementation of the Limpopo Green Economy Plan (LGEP) of 2013. The LGEP, 2013, centres on local production and consumption, efficient use of energy and water, and care of natural and created resources, giving everyone the opportunity

to participate in economic activities (DRDLR, 2016). The LGEP provides socially and environmentally just solutions to economic exclusion and resource degradation (LEDET, 2013).

Against the above-mentioned background, the following indicators were used to assess the economy of Limpopo (refer to Table 1 below).

Table 1: Indicators used to assess the Economy in Limpopo Province

INDICATORS	DESCRIPTIONS
Economic growth	Gross Domestic Product (GDP) and Gross Geographic Product (GGP) (total and by sector). To measure economic growth and composition of the economy.
Employment per sector	Contribution to employment in the Province by various sectors.
Contribution to economy from *working for/on* initiatives	Effectiveness of the programme should be monitored.
Periodic calculation of economic value of local subsistence economies	Increasingly important due to current economic outlook and food security.
Contribution of natural resources to the provincial economy	Estimation of use values (direct, indirect and option values) and estimation of non-use values.
Food production index	Food production index covers food crops that are considered edible and that contain nutrients. Coffee and tea are excluded because, although edible, they have no nutritive value (World Bank, 2016a). Contributes to food security monitoring.
Food price index	A measure of the monthly change in international prices of a basket of food commodities. It consists of the average of five commodity group price indices, weighted with the average export shares of each of the groups (FAO, 2016). This contributes to food security monitoring.
Agricultural production index	Crop production index shows agricultural production for each year relative to a base period. It includes all crops except fodder crops (FAO, 2016b). The performance of the sector has a large knock-on effect on the economy as a whole.
Mainstreaming of the Green Economy in provincial plans and processes	Degree and prominence of *Greening the* Economy consideration in planning processes.

3.2.2 State

3.2.2.1 Economic Structure

Modern economies can be divided into three sectors that reflect the economic development of that society. Generally, as economies develop they move from one built on the extraction of raw materials for consumption and sale (the primary sector of the economy) to one that is more dependent on revenue from services (the tertiary sector). In between these two sectors is the secondary sector, which involves the transformation of raw materials into goods and the development in this sector can be attributed to demand for more goods and food, which leads to industrialisation.

The primary economic sectors of Limpopo's economy (predominantly mining and agriculture) (refer to Figure 1) play a key role in the provincial economy. There has been an increase in the primary economy in Limpopo, from 28% in 2002 to over 30% in 2011 (StatsSA, 2011).

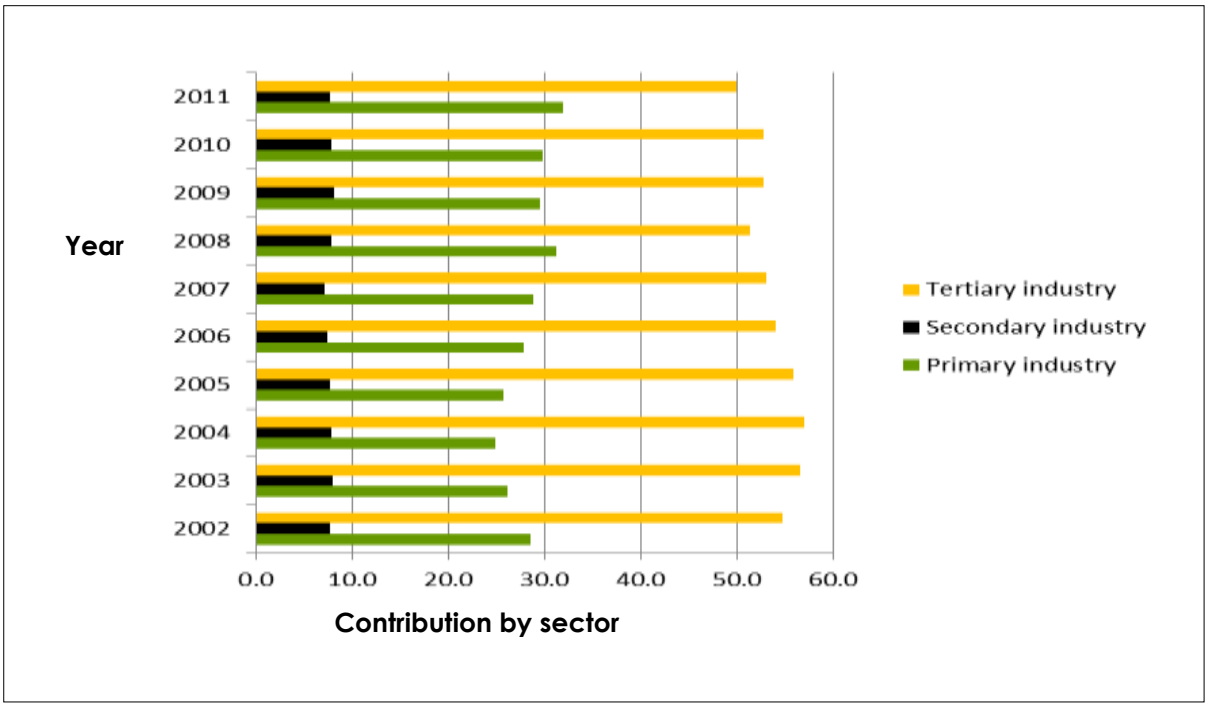


Figure 1: Proportionate contributions to Limpopo Province's economy by sector (%) (StatsSA, 2011)

The secondary sector (which manufactures finished goods where they are suitable for use by other businesses, for export, or for sale to domestic consumers) has maintained a contribution of 7% to 8% share of the economy each year. The tertiary sector (the service sector that consists of the *soft* parts of the economy; that is, activities where people offer their knowledge and time to improve productivity, performance, potential and sustainability) has consistently contributed over 50% of the economy, but has decreased its share in recent years. Table 2 presents the exact figures of Limpopo's Gross Domestic Product (GDP) sector contribution between 2003 and 2012.

Table 2: Gross Domestic Product sector contribution 2003 to 2012 in Limpopo Province (StatsSA, 2013)

INDUSTRY	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
	Percent (%)									
Primary Industries	26.1	24.9	25.8	27.9	28.9	31.3	29.6	30.4	33.4	31.4
Agriculture, forestry and fishing	3.7	3.2	2.6	2.8	2.9	3.0	2.9	2.7	2.5	2.7
Mining and quarrying	22.4	21.7	23.2	25.0	26.0	28.3	26.6	27.6	30.9	28.7
Secondary Industries	8.0	7.8	7.7	7.4	7.1	7.8	8.1	7.9	7.7	7.7
Manufacturing	3.6	3.6	3.4	3.1	2.7	3.3	2.8	2.9	2.5	2.1
Electricity, gas and water	2.9	2.6	2.7	2.5	2.5	2.4	2.9	2.8	2.8	3.1
Construction	1.4	1.5	1.6	1.7	1.9	2.0	2.4	2.2	2.4	2.5
Tertiary Industries	56.6	57.0	55.8	54.0	53.0	51.3	52.7	52.2	48.7	50.6
Wholesale, retail and motor trade	11.4	11.7	11.1	10.6	10.2	10.5	10.0	10.6	10.6	11.0
Transport, storage and communication	7.8	8.5	8.4	7.5	6.9	6.7	6.6	6.2	5.3	5.4
Finance, real estate and business services	15.1	14.4	14.9	15.2	15.2	14.5	14.8	13.8	13.3	13.9
Personal services	4.7	4.7	4.7	4.4	4.4	4.1	4.4	4.2	3.8	3.9
General government services	17.5	17.7	16.6	16.3	16.3	15.6	16.9	17.3	15.6	16.5
All industries at basic prices	90.7	89.8	89.2	89.2	89.0	90.3	90.4	90.5	89.8	89.7
Taxes less subsidies on products	9.3	10.2	10.8	10.8	11.0	9.7	9.6	9.5	10.2	10.3
Gross Domestic Product Regionally at market prices	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Analysis shows that changes in the growth performance of the Limpopo economy correlate closely with the fortunes of the primary industry. Drought conditions have a serious effect on the agricultural component of the primary sector, but also have a knock-on effect on the secondary sector. Volatile performances in this sector also stem from external causes, such as economic crises and major oil price changes. For example, the Asian economic crisis of the late 1990s led to a 28% depreciation of the Rand, which made exports of primary goods more attractive. Thus, the Limpopo economic growth pattern tends to be equally volatile.

Within the secondary sector, manufacturing in Limpopo contributed 4.8% to the provincial economy in 1996, but this fell to 2.1% in 2012. Nationally, this sector is seen as an important contributor to future job creation. The NGP aims to create 350 000 jobs from labour-intensive manufacturing activities in South Africa by 2020. By 2013, this sector employed 1 114 7000 people nationally, but only 79 000, or 6.8%, of the national manufacturing jobs were found in Limpopo. The contribution of the wholesale, retail, catering and accommodation industry has been declining since 1996; however, it remains an important sector of the provincial economy. The transport, storage and communication sector is expected to increase in the future, owing to government plans to rollout Information Communication Technology (ICT) programmes and other logistics initiatives, linked to the Special Economic Zone (SEZ) programme and Special Infrastructure Programme (SIP) (LEDET, 2013).

The tertiary sector contributed 50.6% to the Provincial GDP in 2012. Government itself falls within this sector and contributed 16.5% to the Limpopo economy in 2012.

3.2.2.2 Economic Growth

The growth rate target set in the National Development Plan (NPC, 2010) for South Africa was 5.6%, while the growth rate target for Limpopo, outlined in the Limpopo Development Plan (LPG, 2015), is 3% per annum by 2019 and 5% per annum by 2030. Table 3 presents, and Figure 2 illustrates, that the Limpopo average growth rate between 2002 and 2012 was 2.9% (compared to a national average growth rate of 3.9%). A high economic growth scenario of 5% economic growth is possible with improved efficiency of capital and labour, increased foreign investment and the creation of an advantageous environment for the private sector.

Special Economic Zones (SEZs)

SEZs are geographically designated areas set aside for targeted economic activities supported through special arrangements, such as incentives.

The Department of Trade and Industry (DTI) SEZ programme can be briefly described as an economic development tool to promote economic growth and export, by using support measures to attract targeted domestic and foreign direct investment and technology. The objectives, broadly, are increased trade and investment (foreign and local), sustainable job creation and effective administration (DRDLR, 2016).

Table 3: South African provincial average growth rate in economy from 2002 to 2012 (StatsSA, 2013)

	PROVINCE								
	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu-Natal	North West	Gauteng	Mpumalanga	Limpopo
GDP Regionally (GDPR) 2002 – 2012	4.5	3.7	2.4	3	4.1	2.9	4.4	3.2	2.9
South Africa GDPR 2002 – 2012	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9

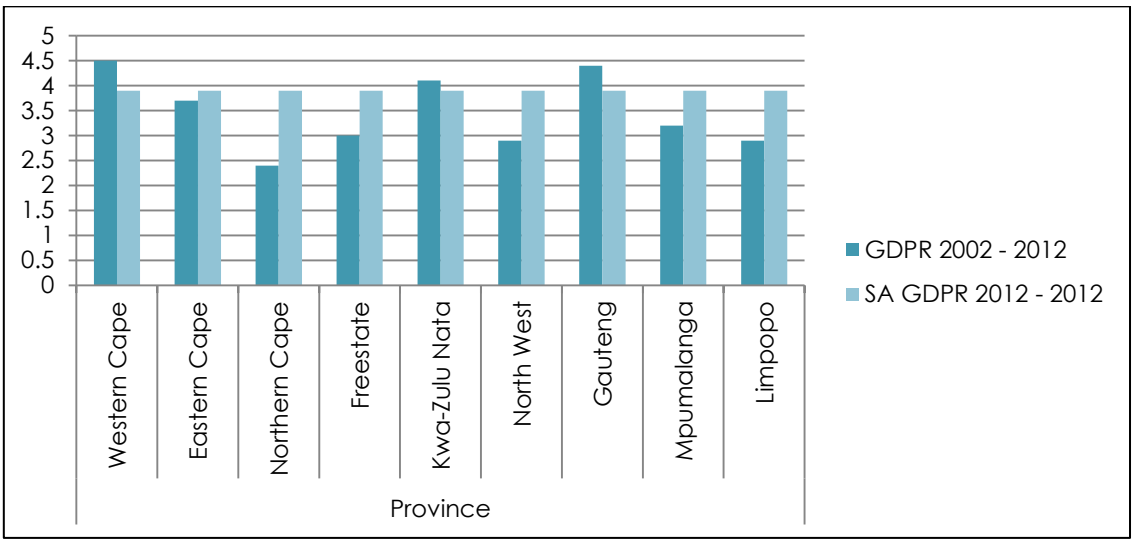


Figure 2: South African provincial average growth rate in economy from 2002 to 2012 (StatsSA, 2013)

3.2.2.3 Employment

Official unemployment statistics show an improvement in Limpopo since 2008 (refer to Figure 3 below). However, this hides other aspects of unemployment that affect Limpopo. Despite this improvement in the unemployment rate, there are still employment issues that need to be addressed. There needs to be an increase in the labour force participation rates in the Limpopo economy. In March 2014, the labour force participation rate was 40% (StatsSA, 2014), with more than 2 million people classified as not economically active, while 377 000 job seekers were classified as being discouraged and not actively looking for work. The unemployment rates across Limpopo are illustrated in Figure 4.

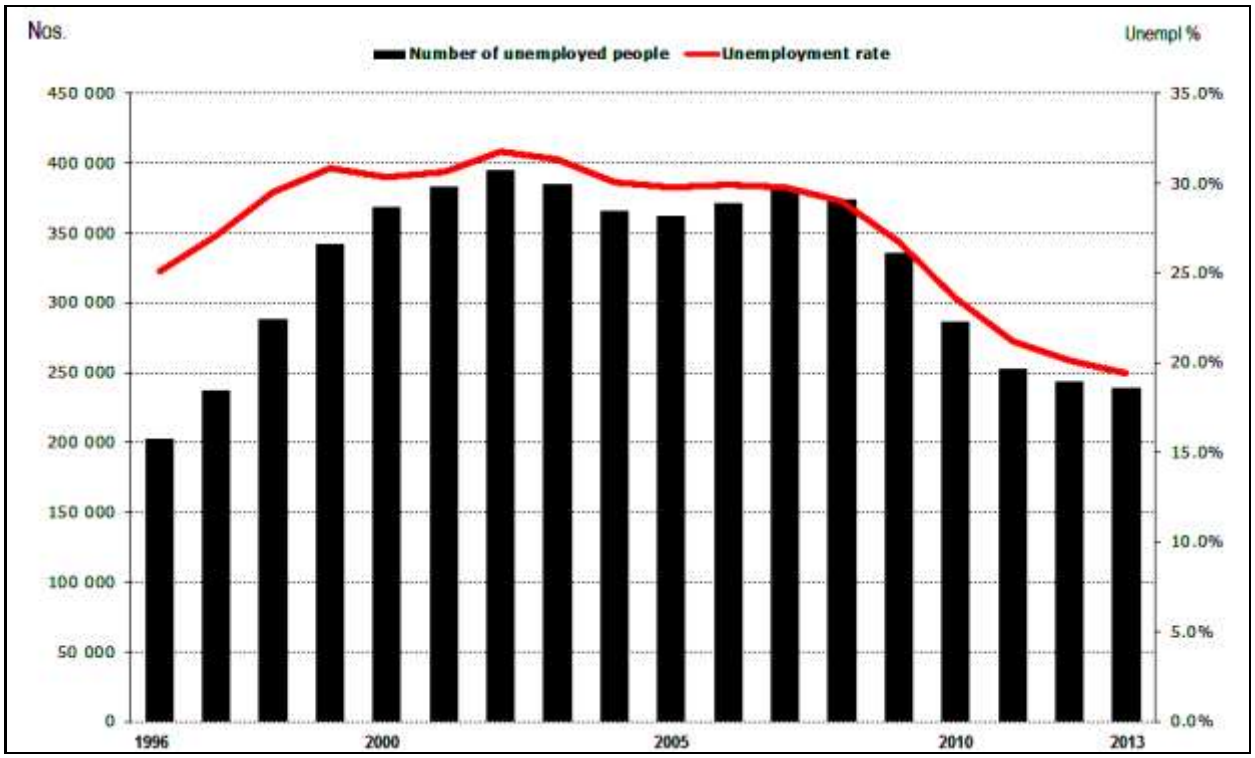


Figure 3: Unemployment trend in Limpopo Province (IHS Global Insight, 2014)

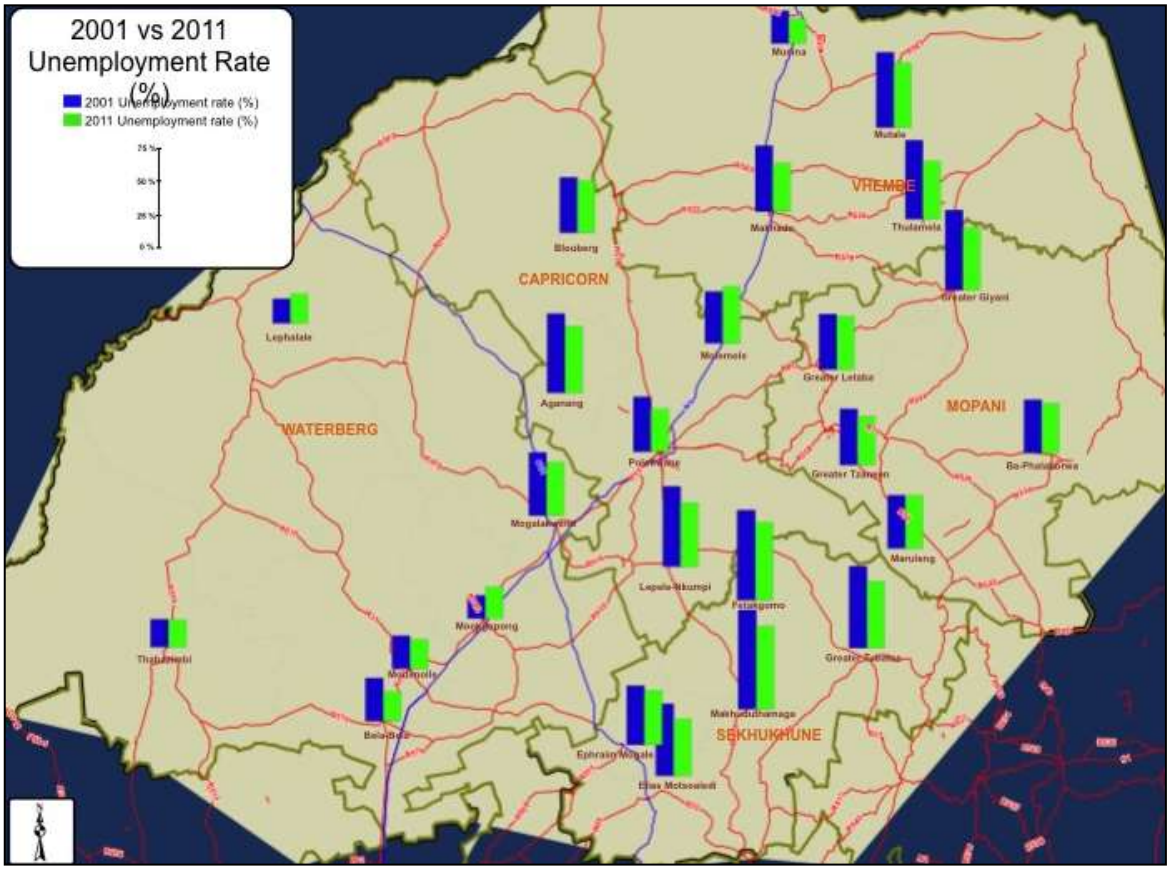


Figure 4: Unemployment rate in Limpopo Province (DRDLR, 2016)

The labour force absorption rate in Limpopo must be increased from the current rate of 30%. The absorption of labour into the market is expected to affect the economy negatively in the near future, owing to the bulging youth population entering the labour market in the next few years. Currently, there is a net annual increase of population to working age of some 45 000 people (equivalent to 1.3% of current working age population). Limpopo has the highest provincial proportion population of youth at working age (StatsSA, 2013) and against a background of South Africa having the third-highest unemployment rate in the world for people between the ages of 15 and 24 (WEF, 2015). The detailed unemployment statistics for Limpopo are presented in Table 4.

Table 4: Labour force characteristics of Limpopo Province ('000 head) (StatsSA, 2013)

INDICATOR	YEAR					
	2008	2009	2010	2011	2012	2013
Population of Working Age (15 to 64 years)	3 082	3 140	3 313	3 378	3 442	3 466
Employed Persons	870	910	962	985	1 092	1 168
Unemployed Persons	353	335	196	249	266	238
Not Economically Active	1 859	1 895	2 155	2 144	2 084	2 060
Discouraged Work Seekers	192	219	393	441	330	324
Unemployment Rate (%)	28.9	26.9	16.9	20.2	19.6	16.9
Labour Force Participation Rate (%)	39.7	39.6	35.0	36.5	39.5	40.6

3.2.2.4 Poverty and Inequality

Although the population of Limpopo has increased by 12.9% since 1996, Limpopo GDP output (at constant prices) has increased at a faster rate and theoretically, therefore, individuals are better off. Figure 5 presents the GDP per capita at 2010 prices and illustrates the above-mentioned trend.

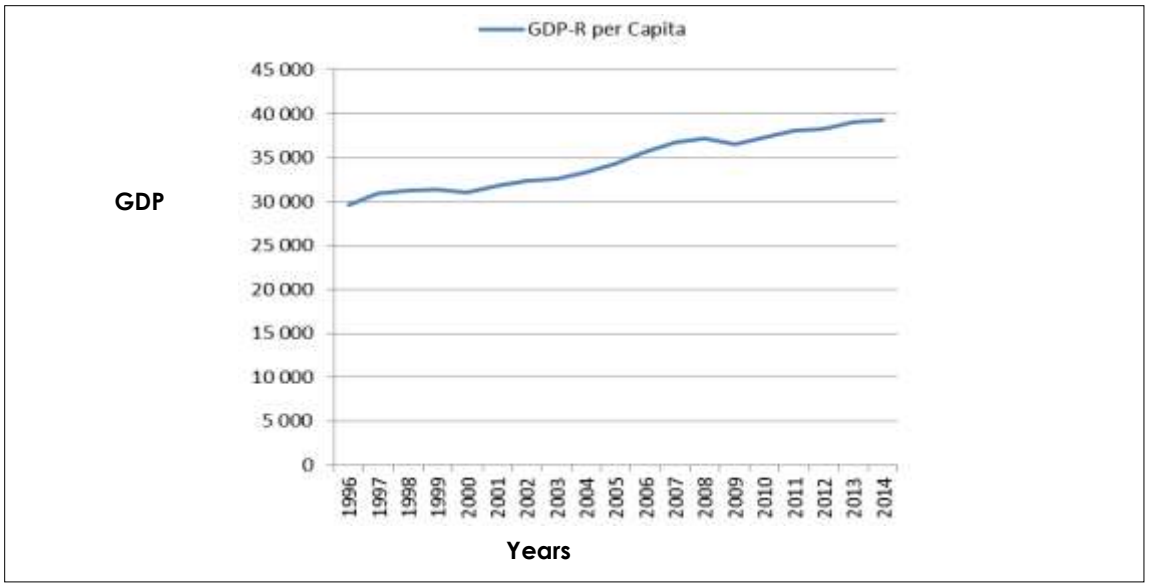


Figure 5: Gross Domestic Product Regionally per capita in Limpopo Province (IHS Global Insight, 2014)

Poverty and inequality among the population, however, remain key challenges in the local economy. To indicate this, inequality in income distribution is measured by the Gini coefficient.[49] Figure 6 below illustrates the trends in Gini coefficient.

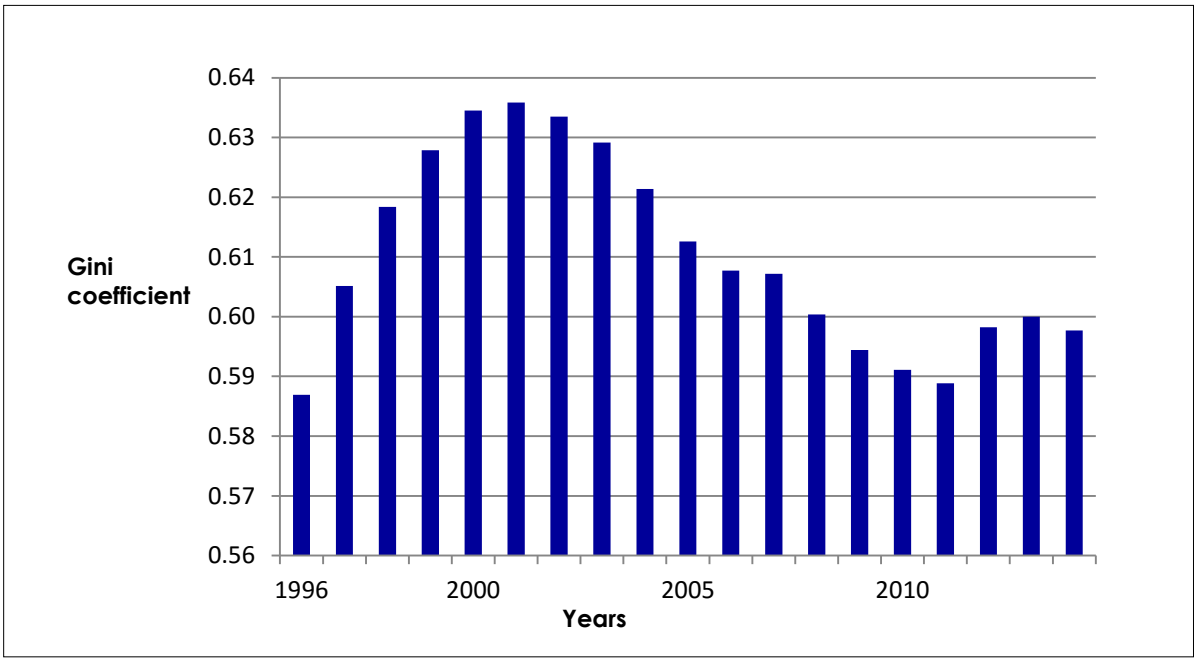


Figure 6: Gini coefficient trends in Limpopo Province 1996-2013 (IHS Global Insight, 2014)

Although the downward trend in Gini coefficient in Limpopo since 2003 is encouraging, the index shows that there is still skewed distribution of income in Limpopo. By comparison, South Africa as a whole has the international reputation of having the highest Gini coefficient in the world (0.63) while Ukraine has the lowest at 0.25. Limpopo still has high levels of poverty, despite improvements since 1996, from which time access to basic services has improved. Figure 7 illustrates the trends in percentage of population in poverty in Limpopo between 1996 and 2014.

[49] If the Gini coefficient is zero, the income distribution is perfect. If the value is equal to one, then one person would theoretically receive all income.

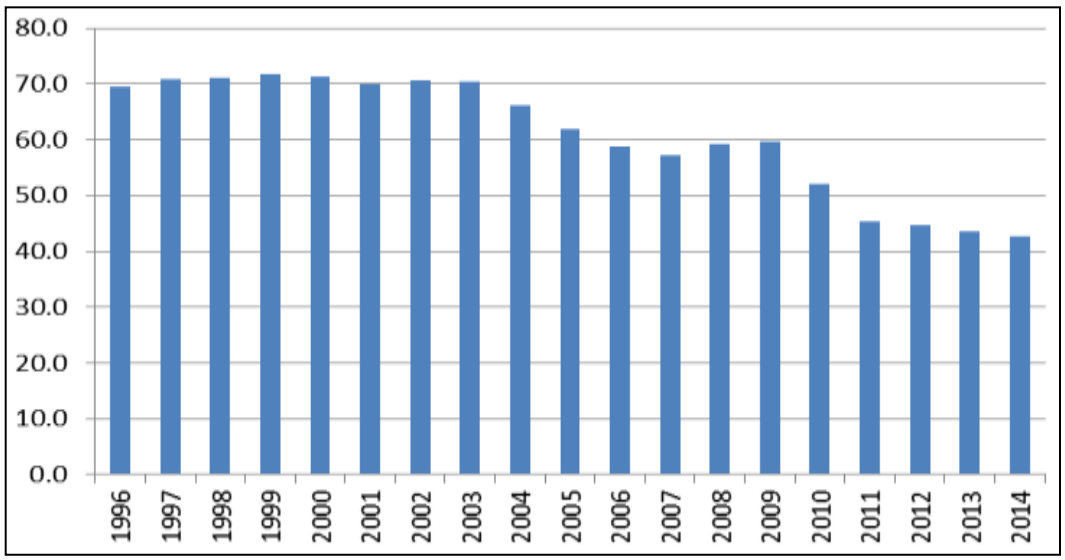


Figure 7: Percentage of population in poverty in Limpopo Province (IHS Global Insight, 2014)

3.2.2.5 Food Prices and Agricultural Production

There is not enough provincially specific information to ascertain state and trends regarding food production, food price index and agricultural production indices for Limpopo. These indicators have been suggested in order to monitor and manage food production, food prices and agricultural production in Limpopo in the future.

3.2.3 Impacts

The Limpopo Provincial Government faces a challenge, not uncommon to all governments, which is to meet these two imperatives simultaneously:

- Developing its economies to meet the needs of its people; and
- Ensuring that the productivity and viability of the underlying ecosystems and ecosystem services are maintained at healthy levels over time.

From an economic perspective, sustainable development requires that social welfare (well-being) be at least maintained over time. One way of interpreting this would be in terms of maintaining the stock of productive capital on which social welfare depends. This would include human capital (skills and knowledge), natural capital (ecosystems and natural resource deposits) and manufactured capital (produced assets). A summary of the trends identified regarding Limpopo's economy is presented in Table 5.

Table 5: Economic trends in Limpopo Province

ECONOMIC ASPECT	TREND	DISCUSSION
Economic growth rate: short term	Slight decrease	Drought; mineral commodity outlook
Economic growth rate: medium term	Slight increase	Unlikely to achieve the State of the Province Address aim of 5% growth by 2019
Primary economic sector contribution to GDP	Increasing	Mainly due to mining, there will be pressure on the agricultural sector and environmental resources
Labour force	Increasing	Net increase of at least 45 000 per year, illustrating the triangular age profile of the population as the large youth reservoir currently enters the labour market
Employment	Increasing	Unlikely to grow substantially in the private sector; however, government has job-creation programmes in place. Could result in heavy pressure on the subsistence sector (food security) and environmental resources
Wealth disparity (Gini coefficient)	Slight increase	Poverty is increasing yet wealth gap is currently narrowing. These rates are uncertain

Limpopo is under pressure to be able to protect its natural capital owing to its economic structure. It has a strong primary economic sector and an obligation to reduce poverty, unemployment and economic inequality. There is, thus, a temptation, if not a need, to rely on all forms of capital to meet its growth objectives and targets. In the short- to medium term, a number of economic challenges exist, which include the drought effect, climate change, down-turn in world trade of mineral commodities, local real unemployment, reduction in grazing capacity and the falling value of South African Rand, among others.

The socio-economic challenges that Limpopo faces mean a compromise needs to be found in order to ensure sustainable economic growth for Limpopo. Substitution between different forms of capital may be the answer in order that the core stock of critical natural capital is maintained.

3.2.4 Responses

3.2.4.1 The Limpopo Green Economy

With South Africa beginning to experience the impacts of climate change, and an increasing awareness of its future likely impacts, this has led to provincial responses. An important first step was the preparation of the LGEP of 2013 (LEDET, 2013). Focus points that are outlined in the LGEP are presented in Table 6 below.

Table 6: Focus points outlined in the Limpopo Green Economy Plan, 2013 (LEDET, 2013)

FOCUS POINTS	
Short-term goals	Job creation
	Improvement of environmental quality
Medium-term goals	Create enabling conditions for green growth
	Change behavioural and production patterns
Long-term goals	Build a new economic/environmental paradigm for Limpopo

The above-mentioned focus points of the LGEP will be implemented through specified initiatives in the following key focus areas:

- Sustainable production and consumption;
- Water management;
- Sustainable waste management practices;
- Clean energy and energy efficiency;
- Resource conservation and management;
- Agriculture, food production and forestry;
- Green buildings and the built environment;
- Sustainable transport and infrastructure;
- Green municipalities; and
- Cross-cutting areas.

Thereafter, major sectors and their comparative vulnerability were identified in Limpopo, which led to general planning of strategies as a coping mechanism. Relevant stakeholders have validated this project approach. Five major sectors were identified as being particularly prone to climate change effects.

Sector strategies were developed for each of the following sectors:

- Agriculture;
- Livelihoods and settlements (rural and urban);
- Ecosystems (terrestrial and aquatic);
- Water supply; and
- Human health.

The responses to the implementation plans should now come from each sector, with both Provincial and National Government strengthening mechanisms to make Limpopo more resilient to climate change.

A transition to a green economy is increasingly receiving support as a means to drive and implement economic and social sustainability. Nevertheless, the concept is still relatively new and there are probably some significant capacity and knowledge gaps, both in South Africa as a whole and in Limpopo in particular.

Limpopo and its economic structure are heavily dependent on natural resources for economic development. Historically, this has worked to allow for some progress in the social and economic priorities of Limpopo. However, faced now with evident changes to the natural environment, many aspects of Limpopo will come under strain as its *natural capital* dwindles further. Therefore, a bold new economic direction, or orientation, is required – one in which a number of explicit and aligned green economic strategies, policies and programmes are developed. The new economic direction, or orientation, should recognise the imperatives of developing the economy to improve the livelihoods of the people of Limpopo and of ensuring that the productivity and viability of the underlying ecosystem and ecosystem services are maintained at healthy levels over the long term.

Such an economic direction or orientation requires a complex set of tasks to be performed, including:

- A system of awareness creation at all levels;
- A definitive and authoritative planning process, based on ecosystem services valuation;
- Development of indicators for monitoring and reporting on green economy performance; and
- Integrated multi-sectoral commitment by the Limpopo Provincial Government.

3.2.5 References

Department of Rural Development and Land Reform (DRDLR). 2016. *Limpopo Province Spatial Development Framework (LSDF*). Prepared by Plan Associates, Pretoria.

Everett, T., Ishwaran, M., Ansaloni, G.P. & Rubin, A. 2010. *Economic Growth and the Environment*. Paper 2, DEFRA Series.

Food and Agricultural Organisation of the United Nations (FAO). 2016. *World Food Situation*. Internet material accessed 14.04.2016: http://www.fao.org/worldfoodsituation/foodpricesindex/en/.

IHS Global Insight, 2014. *Regional eXplorer*. *Various statistics.*

Johannson, T.O. 2001. *The interactions between Economic Growth and Environmental Quality*. *Paper 2, TVA Rural Studies.*

Limpopo Department of Finance and Economic Development. 2004. *Limpopo State of the Environment Report*. Prepared by: Africon and Environomics Joint Venture. Limpopo Department of Finance and Economic Development, Polokwane.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2013. *Limpopo Green Economy and Climate Change Response*. Prepared by Dr A. Letsoalo.

Limpopo Provincial Government (LPG). 2015. *Annual Performance Plan 2015 – 2016*. Internet material accessed 16.03.2016: http://www.lda.gov.za/Annual%20Reports/APP%202015-16.pdf. Published by Limpopo Economic Development Agency.

Limpopo Provincial Treasury. 2012. *Socio-Economic Review*. Internet material accessed 16.03.2016: http://policyresearch.limpopo.gov.za/handle/123456789/448.

National Planning Commission (NPC). 2010. *The National Development Plan 2030*. Prepared for the Presidency of South Africa.

South African Government. 2016. *The New Growth Path*. Internet material accessed 13.03.2016: http://www.gov.za/about-government/government-programmes/new-growth-path.

Statistics South Africa (StatsSA). 2011. *Quarterly Labour Force Surveys*. Internet material accessed 16.03.2016: http://www.statssa.gov.za/publications/.

Statistics South Africa (StatsSA). 2014. *National and provincial labour market*. Internet material accessed 16.03.2016: http://www.statssa.gov.za/publications/P02114.2/P02114.22015.pdf

Statistics South Africa (StatsSA). *Quarterly Labour Force Surveys*. Internet material accessed 16.03.2016: http://www.statssa.gov.za/publications/.

Statistics South Africa (StatsSA). *Various press releases and surveys*.

World Economic Forum (WEF). 2015. Internet material accessed: 14.03.2016www.enca.com/money/sa-youth-unemployment-rate-among-global-worst.

World Bank. 2016a. *Food Production index (2004 – 2006).* Internet material accessed: 14.03.2016: http://data.worldbank.org/indicator/AG.PRD.FOOD.XD.

World Bank. 2016b. *Crop Production index (2004 – 2006).* Internet material accessed: 14.03.2016: http://data.worldbank.org/indicator/AG.PRD.FOOD.XD.

3.3 Human Settlements

3.3.1 Introduction

Human settlements to a large extent define people's existence. *"Human settlements mean the totality of the human community – whether city, town, or village – with all the social, material, organizational, spiritual, and cultural elements that sustain it"* (Vancouver Declaration on Human Settlement, 1976). Human settlements are places – large and small, urban and rural, formal and informal – where people live, learn, work and create (refer to Figures 1 and 2). They also comprise an important component of the entire environment, namely the built environment (DEAT, 2006).

The world has witnessed a dramatic increase in the movement of people to urban areas, especially in developing countries. This has resulted in more urban settlements with larger populations and the dramatic expansion of existing urban centres. The urban population in the developing world is growing at 2.4% per year, which is double the global growth rate. Rural-urban migration is most evident in Sub-Saharan Africa, which has an urbanisation rate of 3.5% per year. About 300 million Africans currently live in urban areas. It is estimated that this figure will rise to 1 405 million by 2030 (DEAT, 2006).

South Africa is experiencing a similar trend. Close to 58% of the population is urbanised, up from 53% in 1996. This is much higher than the average for Sub-Saharan Africa, which stands at 34%. As with the rest of the developing world, this rapid urban growth has placed significant pressure on the natural and human systems that underpin and maintain settlements. Although the larger urban settlements in South Africa occupy less than 2% of the land area of South Africa, they exert a considerable influence on the natural environments outside their own boundaries (DEAT, 2006).

Human settlements lie at the centre of global efforts to address the multiple challenges that face sustainability, sustainable development and sustainable settlements. Against this background, and with the socio-political overlay of settlement engineering, the pattern of human settlement in contemporary Limpopo is complex and multi-faceted. State of the Environment or Environment Outlook reporting is one way to assess both the natural resource capacities and the quality of life in human settlements in Limpopo.

Figure 1: Aerial view of a city (Polokwane) (Source: Google Earth: Digital Globe, 2016)

Figure 2: Aerial view of a rural village (Morebeng) (Source: Google Earth: Digital Globe, 2016)

Indicators provide an important tool for mapping the sustainable development process and for monitoring the sustainability of the human settlements in Limpopo. The set of Human Settlement indicators that have been developed for Limpopo is presented in Table 1 below.

Table 1: Indicators used in the assessment of Human Settlements in Limpopo Province

DETERMINANTS	INDICATORS
Demographic Change (Population Extent, Composition, Distribution, Growth, Density and Migration)	Number of persons/households.
	Number/percentage change in population (persons/households).
	Number/percentage change in population (persons/household) density.
	Number/percentage change in migration patterns to/from Limpopo.
Health Change (Fertility, Life Expectancy, Mortality and Deaths)	Number/percentage change in infant/child mortality rates.
	Number/percentage change in person deaths due to Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS).
	Number/percentage change in person deaths from Respiratory Disease (RD) and Tuberculosis (TB).
Educational Change (Education and Literacy)	Number/percentage change in levels of education.
Economic Change (Employment, Jobs, Poverty and Indigents)	Number/percentage change in persons/households living below the poverty line.
Settlement Change (Urban-Rural Settlement Shifts and Formal/Informal Dwelling Unit Splits)	Number/percentage change of households residing in urban/rural settlements.
	Number/percentage of households residing in formal/informal dwelling units.
Transport Change (Infrastructure, Facilities and Services and Mode)	Number/percentage change in persons having access to transport infrastructure, facilities and services.
	Number/percentage change in transport mode use.
Engineering Services Change (Water Access, Sanitation Services Access, Energy Resource Use, Refuse Removal Services and Waste Disposal Sites)	Number/percentage change in households having access to water in urban/rural areas.
	Number/percentage change in households having access to acceptable levels of sanitation services in urban/rural areas.
Equality	Number/percentage change in equality/inequality.

The above-mentioned indicators are discussed in this section of the Limpopo Environment Outlook (LEO) Report.

3.3.2 State

The information and data for compiling the state of Human Settlements in Limpopo was extracted from the 2011 Census Survey, conducted by Statistics South Africa (StatsSA, 2011), and the Limpopo Spatial Development Framework, dated February 2016, compiled by Plan Associates, Pretoria, for the National Department of Rural Development and Land Reform (DRDLR, 2016).

3.3.2.1 Demographic Change

Population Extent and Composition

The population of Limpopo increased from 4 995 462 people in 2001 to 5 404 868 people in 2011 and represents 10.4% of the population of South Africa.

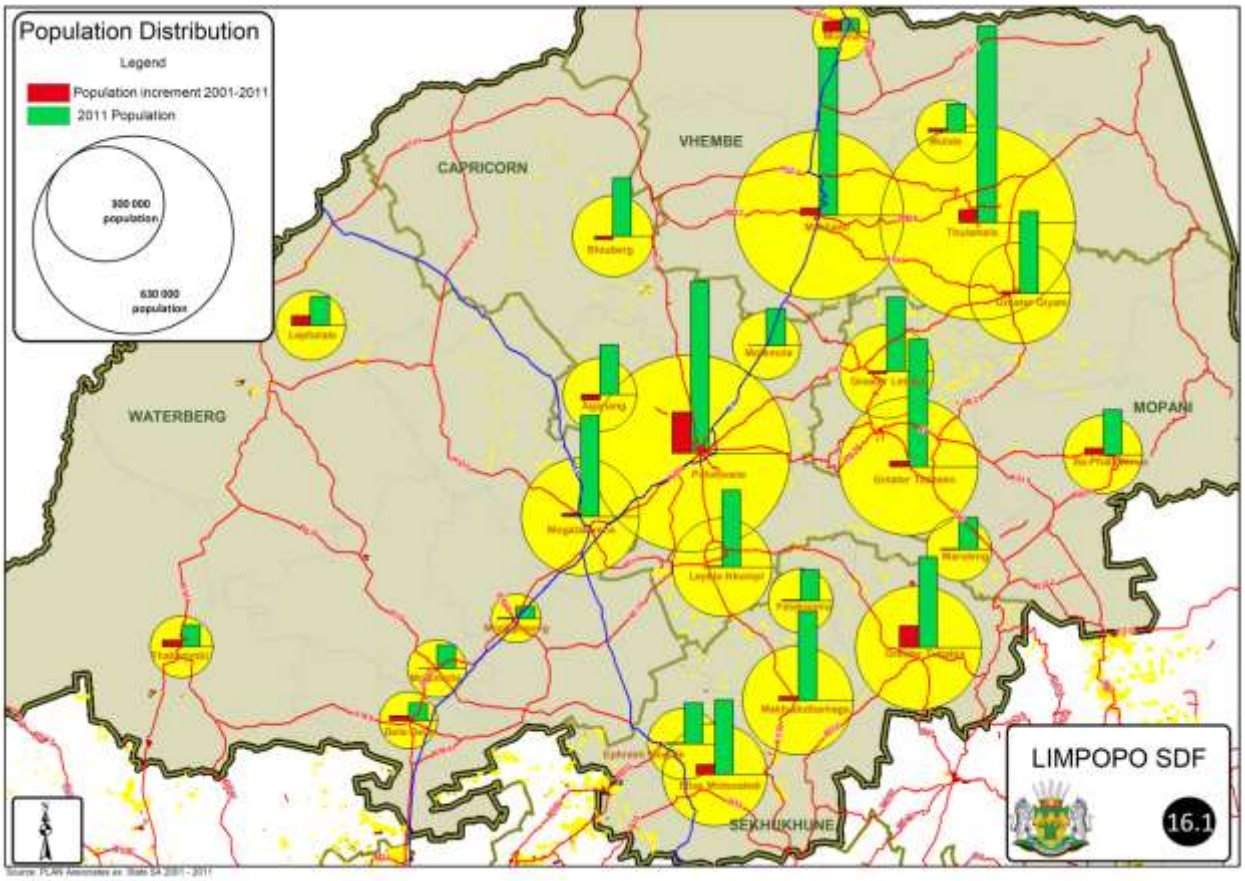


Figure 3: Population size (DRDLR, 2016)

There has been an increase of approximately 500 000 people (± 50 000 people/annum) over the 10-year period. The annual population growth rate is calculated at 0.89%.

Population Distribution and Growth

The population of Limpopo is more or less equally distributed between the districts, apart from Waterberg District Municipality (DM), which has a relatively small population, despite its large physical extent. The population growth rate in Limpopo is declining, particularly in the northern parts of Limpopo (StatsSA, 2011).

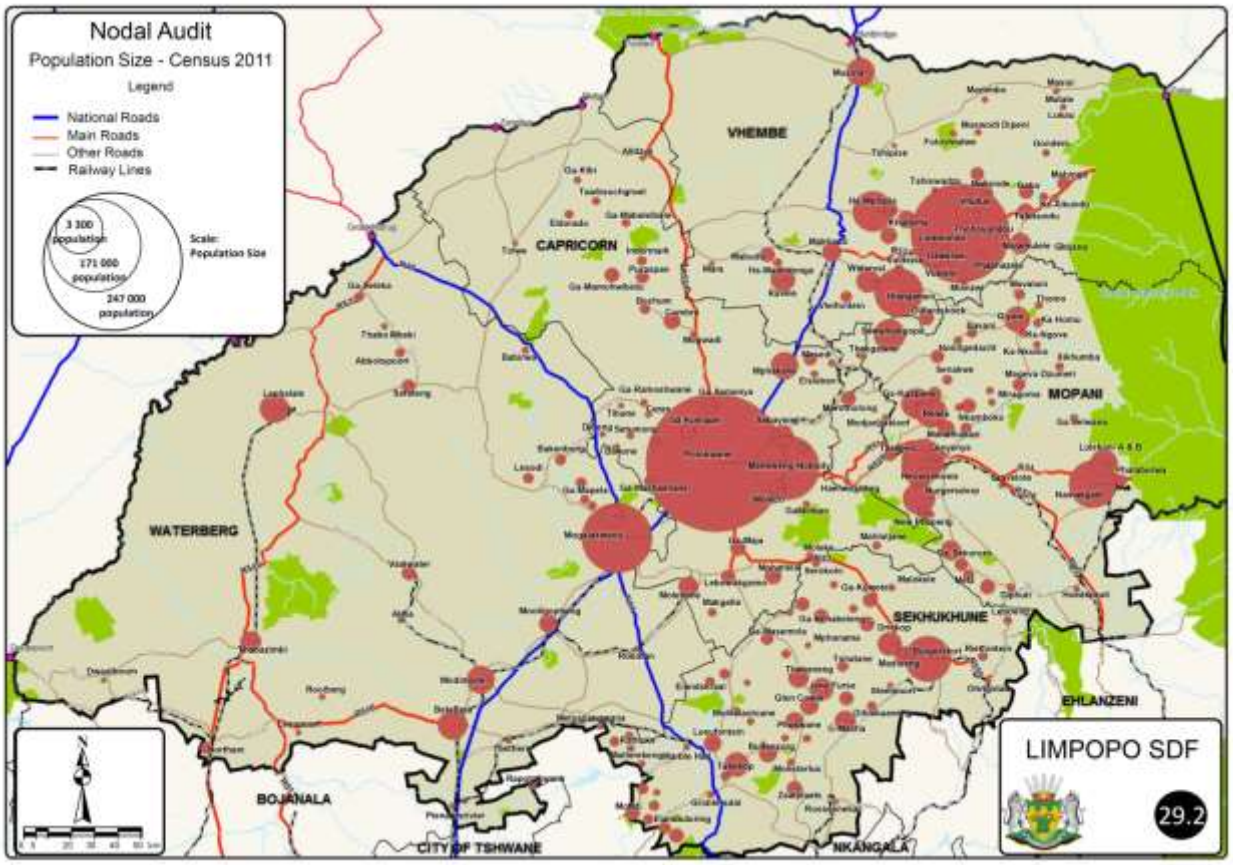


Figure 4: Population distribution and growth (DRDLR, 2016)

Population growth[50] impacts on the need for housing and service delivery within municipalities. The following are important to note with regard to population distribution and growth in Limpopo when planning for its future:

- The bulk of the provincial population resides in the central and north-eastern parts of Limpopo, which have the most densely populated rural areas, typically those under traditional authority, with the western extents (Waterberg District) very sparsely populated and with a relatively small population;

- Nearly all the municipalities experienced positive population growth in the period 2001 to 2011 and only three municipalities – Greater Letaba Local Municipality (LM), Blouberg LM and Aganang LM – experienced negative population growth, likely representing trends of urbanisation from these rural areas; and

- The western municipalities (Waterberg District) have relatively small local populations but three of them – Lephalale, Thabazimbi and Bela-Bela – experienced substantial population growth.

Population Density

A number of changes occurred in terms of provincial and municipal boundaries during the period between the 2001 and 2011 Censuses. The geographical land changes in Limpopo, since 2001, had been small. The land area of Limpopo increased from 122 816 km^2 in 2001 to 125 754 km^2 in 2011, an increase of approximately 1.02%. Limpopo lost a portion of the Bela-Bela LM to North West's Moretele LM. In turn, North West lost a portion of the Moretele LM to Limpopo's Bela-Bela LM, based on the current provincial boundaries.

[50] The population growth figures from the 2011 Census capture both natural population growth and in-migration.

Some of the most populous areas in Limpopo are in the Polokwane area, Groblersdal, Phalaborwa-Namakgale, Modjadjiskloof, Makhado and Thohoyandou provincial centres, and the service towns of Giyani and Musina. The rural settlements in the southern parts of the Vhembe District are also particularly densely populated. Low densities are found in the far north of Limpopo and in pockets in all other districts.

Population Migration

In line with national migration trends, Limpopo shows strong net out-migration. The 2011 Census estimated a net outward migration from Limpopo of 156 896 people, the third-highest out-migration numbers among the nine provinces in South Africa. These high out-migration numbers signal fairly low levels of economic activity in Limpopo as a whole.

The largest migration out of Limpopo is to the Gauteng City Region, where economic activity and job opportunities are the highest in South Africa. This trend was particularly strong from the Vhembe and Mopani districts. With regard to *internal* migration (between settlements in Limpopo), key settlements/towns show net positive migration, which confirms a trend of people moving from rural, more isolated regions to towns where services and facilities can be better accessed.

According to Census 2011 results, 6% of the population in urban areas in Limpopo moved there from another province in South Africa from 2001. A total of 4% moved to urban areas from outside of South Africa and a massive18% relocated from within Limpopo. In contrast, in traditional areas in Limpopo, only 1% of the population relocated from a different province from 2001, 1% moved from outside of South Africa and only 4% relocated to rural areas from within Limpopo. It is interesting to note the emerging important role of small towns as key development nodes. Women, in particular, are relocating, taking families out of the rural villages and permanently moving to small, nearby towns.

Physical expansion (as proof of growth) is most evident in the biggest cities in Limpopo, especially in Polokwane, the administrative capital of Limpopo. Large clusters of poor people are found in the big towns and cities, extending the population pressure in terms of service delivery, job creation and social welfare.

3.3.2.2 Health Change

Disability

The 2011 figures for Limpopo that present the distribution of the population aged 5 and older in Limpopo Province by sex and disability status indicated that 6.8% of the population was disabled. The figures also showed that about 6.3% and 7.3% of males and females respectively were disabled. Greater Sekhukhune recorded the highest proportion of people living with disability (8.2%), followed by the Waterberg (7.6%) and Capricorn (7.1%) districts. However, the Vhembe and Mopani districts recorded the lowest proportion (5.8% and 6.1% respectively). Finally, sex variations across all districts within Limpopo confirmed that, as far as disability was concerned, females were more affected than males.

Mortality

A total of 53 815 deaths was estimated for Limpopo in the year 2000. Of these, 26 404 (49.1%) were females and, slightly more, 27 410 (50.9%) were males. This is the reverse pattern to the numbers in the population. In terms of causes, half of the deaths were the result of Group 1 causes (communicable, maternal, peri-natal and nutritional diseases, including HIV/AIDS). The proportions of deaths from other communicable diseases, maternal and peri-natal conditions, nutritional deficiencies and non-communicable diseases were similar for males and females (27% and 25% respectively).

The cause-of-death profile shows that:

- HIV/AIDS was the leading cause of death in both men and women (24%); followed by cardiovascular disease (18%); infectious and parasitic diseases, excluding HIV/AIDS (14%); malignant neo-plasmas and respiratory infections (6%); and intentional injuries (5%); and

- Differences were observed between men and women, with HIV/AIDS, cardiovascular disease and diabetes accounting for a higher proportion of female than male deaths.

3.3.2.3 Educational Change

Education is a key indicator of potential for economic growth. The education levels of Limpopo for those aged 20 and older indicate that there has been a decrease in the number of people with no schooling and an increase in the number of residents having completed primary school, attained Grade 12/Matric Certificates and completed a form of higher education. The number of people aged 20 and older with no schooling is, however, still at 17% and comprises a greater percentage of females than males. This indicates that efforts to improve access to all levels of education should continue and should be focused on girls/women especially. Only 9.2% of the population older than 20 has a higher education, with a slightly higher representation (9.5%) of males than females (8.9%).

3.3.2.4 Economic Change

Economic Sectors

Limpopo is the fourth-largest contributor to the national economy, at 7.2% in 2011. The average economic growth rate of Limpopo from 2000 to 2010 was relatively low, at 3.5%. The urban areas show consistently strong growth. Of the more rural economies, Musina LM, in the Vhembe District, has shown particularly strong growth, while Mopani DM has shown very little gross value added (GVA) growth. Limpopo is a typical developing area in the sense that it is largely resource based (predominantly exporting primary products and importing manufactured goods and services). The sectoral contribution to the economy of Limpopo is as follows:

- The dominant economic sectors in Limpopo are Mining (constituting 22.7% of the provincial economy in 2010), General Government Services (19.2%), Business Services (18.7%), and Retail, Catering and Accommodation (12.2%). These sectors jointly contributed about 72.8% of the provincial Gross Domestic Product (GDP) in 2010;

- The relative contribution of some sectors, for example, General Government, Retail, and Mining and Quarrying, decreased in the period 2000 to 2010, while others, notably Transport and Agriculture, Forestry and Fishing, showed relative increases for the same period; and

- The Limpopo Information Society and Knowledge Economy Plan put forward suggestions on how Limpopo can transform itself from a resource-based economy to a knowledge economy of the twenty-first century.

Employment

With regard to the level of employment/unemployment, there has been a steady increase in the number of employed people in Limpopo over the course of 15 years between 1996 and 2011 – from 23.9% to 29.0% of the labour force. This growth in employment was accompanied by a slight decrease in unemployment, from 19.6% of the labour force in 1996 to 18.6% in 2011. The number of *not economically active* people decreased as a relative percentage of the total labour force, but in absolute numbers stayed more or less constant from 2001 to 2011. The latter represented 52% of the labour force in 2011, which indicated that more than half of the people who are considered fit for work have given up trying to secure employment in the formal sector. In the face of generally low income levels (refer to the next section), this high level of dependency creates a massive challenge for households and indicates a need for intervention of some sort.

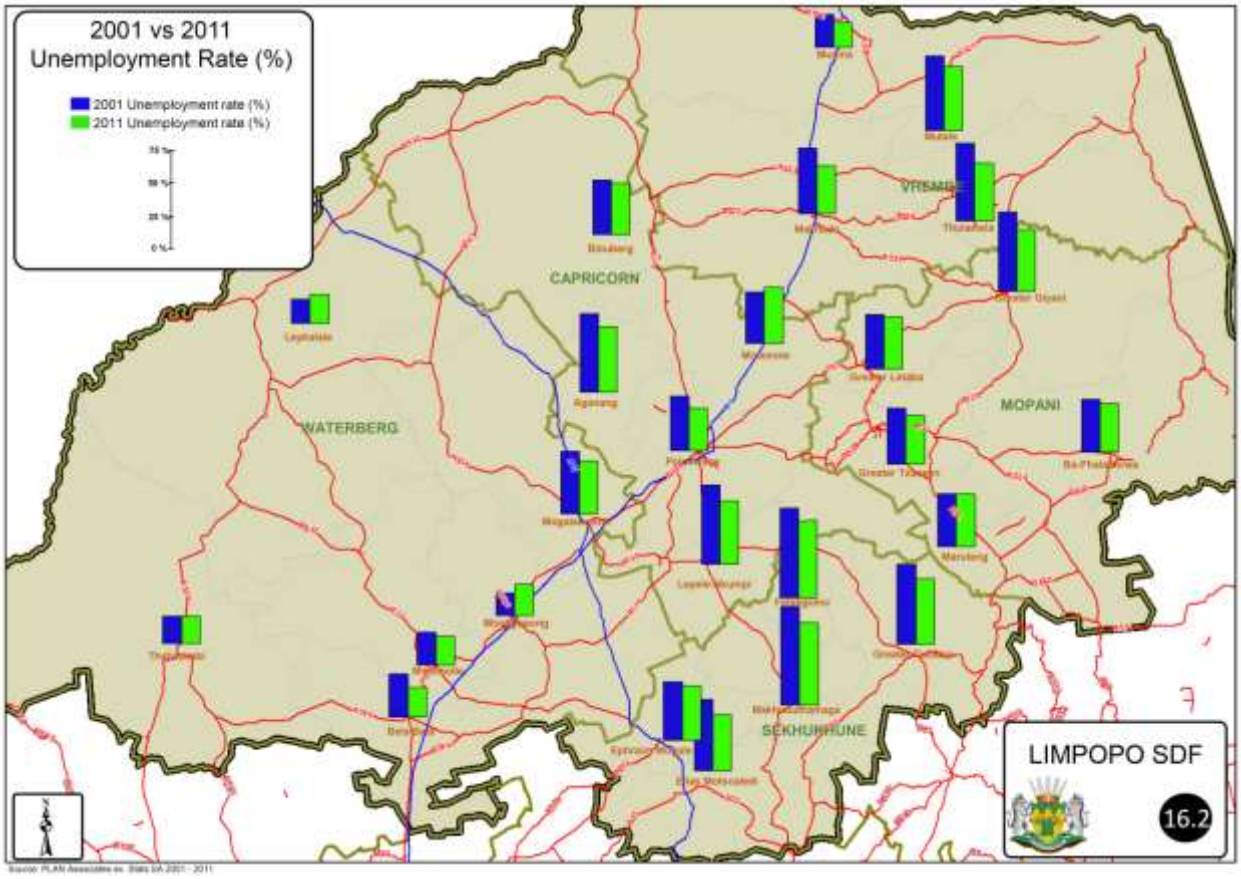


Figure 5: Unemployment (DRDLR, 2016)

With regard to the distribution of employment/unemployment, the official unemployment rate in Limpopo decreased from 45.1% in 1996 to 38.9% in 2011, which is positive, but it is still much higher than the national average of approximately 25%. The highest unemployment rates were recorded in the more rural parts of Limpopo, namely in the far north-east (former homeland areas) and in the Sekhukhune District in the south-east. The lowest unemployment rates were recorded in the west, and in Polokwane and Musina.

With regard to employment by economic sector, the economic sectors that, in relative numbers, are the greatest employers in Limpopo are notably Retail, Catering and Accommodation, followed by Community, Social and Personal Service, General Government, and Mining and Quarrying. There is, thus, a good distribution between the primary, secondary and tertiary sectors of the economy. Note that the Business Services and Manufacturing sectors in Limpopo are relatively weak employers, compared to the respective national averages. Trade is the highest employing sector in four of the five districts. In the Waterberg DM, Mining and Quarrying employs the greatest number of people.

Level of Income

There was more than a 100% increase in the average household income in all districts in Limpopo from 2001 to 2011. Yet, despite this, Census 2011 indicated that Limpopo remains the province with the lowest average annual household income in South Africa. The highest levels of income were recorded in the Waterberg and Capricorn districts, while the lowest income levels were in the Sekhukhune District. The characteristically large number of youth and elderly, and the high unemployment rate, results in a very high dependency rate, in this way increasing the burden on the relatively small economically active population. Furthermore, the Income Expenditure Survey (IES) Report indicated that there is an increase in the number of households that depend on social grants. There is, therefore, a need for interventions that address, among other challenges, education and training.

Poverty

The Human Sciences Research Council (HSRC) and National Development Agency (NDA) conducted an investigation into poverty in South Africa that resulted in the document, State of Poverty and its Manifestation in the Nine Provinces of South Africa, 2014. Findings from this report have great significance for planning in Limpopo Province. As expected, Limpopo's Gini coefficient of 0.67 is lower than the national Gini coefficient. Notably, Limpopo was found to be one of the three poorest provinces in South Africa – together with KwaZulu-Natal and Eastern Cape – as measured by both poverty and inequality standards. The report findings, with reference to Limpopo, are summarised below and should be considered when compiling the Limpopo Province Spatial Development Framework (SDF) interventions:

- The poverty rate among graduates in Limpopo (5%) is alarmingly high. This may seem to suggest acute labour demand side issues that may be addressed by job creation interventions in Limpopo. Education and skills development should, therefore, be accompanied by programmes that create employment that can absorb the skills.

- The dependency of Limpopo residents on grants, allowances and remittances as main source of income is highest of all provinces (22%).

- Limpopo is categorised as a *low growth-low inequality* zone, which indicates a lack of economic activities in Limpopo. Therefore, anti-poverty activities in Limpopo should emphasise expansion of economic activities together with investment in the skills of the poor.

- According to the findings of the HSRC and NDA, the limited economic growth that does take place in Limpopo (and other poor provinces) is clearly *pro-rich*.

- Limpopo is at high risk of increasing inequality if growth is pursued without addressing the skewed distribution of growth.

- Linked to the above, the key sectors of employment in Limpopo (and the other poor provinces) are Household, Community Services and, to some extent, Trade and Agriculture. The implication is that policies that enhance the creation of manufacturing firms should be considered while attention is paid to labour supply disparities to prevent inequalities (that is, upgrading and improving manufacturing investment).

- Also, there is a need for upgrading the skills of the poor to enable them to move from low-paid employment (that is, Community Service and Households) to high-paid employment (that is, Financial Services and Manufacturing).

- From the poor's own perspective through the interviews conducted, the key determinant of poverty is education, which links to employment status. All other concerns were considered secondary. This may be interpreted as a demand that exists for access to quality education.

Available information in the document: State of Poverty and its Manifestation in the Nine Provinces of South Africa, 2014, which analysed patterns of public sector investment in South Africa, revealed the following important findings:

- In terms of pro-poor programming, the *poor provinces* in South Africa (notably Limpopo, KwaZulu-Natal and the Eastern Cape) generally fell short of spending targets in key areas that have a strong link to poverty reduction. The result is that the outcomes of these service categories are also dismal.

- Given the important role of water and sanitation in the building of health human capital, the low share of this component for Limpopo is an issue of concern.

- Poor provinces paid less attention to the delivery of key services related to housing, electricity and sanitation than the other provinces.

- Given the key role of electricity in income generation, especially in small- and medium-sized enterprises, as well as in the facilitation of effective functioning of health systems and respiratory disease prevention in households, it is important for poor provinces to pay attention to this category of spending.

3.3.2.5 Settlement Change

Spatial Structure

Limpopo is essentially a rural area as it comprises approximately 12% urban and 88% non-urban land uses. Polokwane, the provincial capital, is the only major city in Limpopo and is situated virtually in the centre of Limpopo. The western parts of Limpopo mostly comprise a range of smaller towns, which include Lephalale, Thabazimbi, Modimolle, Bela-Bela, Mokopane, Mookgopong and Vaalwater. The N1 Freeway is a strong structuring element in Limpopo, as many of the larger cities and towns in Limpopo (including Polokwane) are situated along or near this north-south corridor.

In stark contrast, large parts of the north-eastern, eastern and southern extents of Limpopo comprise extensive and predominantly small, scattered rural villages. Three main concentrations of traditional/rural villages are found in Limpopo. There is a distinct difference between the former homeland areas and the remainder of Limpopo:

- The loosely concentrated group of small villages to the north-west of the capital, Polokwane;

- The cluster in the south-eastern extents of Limpopo, including the majority of the Sekhukhune DM and the southern parts of the Capricorn DM up to Mankweng near Polokwane, which comprises slightly larger individual villages; and

- The concentration of small villages in the regions of Thohoyandou and Tzaneen, and Giyani in the Mopani and Vhembe districts.

Many of these villages accommodate less than 1 000 people. Owing to their small size and scattered settlement pattern, municipal services and infrastructure are difficult and costly to supply in these areas. Medium-sized towns in and around these rural areas that function as provincial service centres include Makhado, Musina and Thohoyandou in the north, Giyani, Tzaneen, Phalaborwa and Hoedspruit to the east, and Burgersfort, Marblehall and Groblersdal in the south.

From a spatial perspective, there is a relatively good/fair distribution of higher-order towns and cities throughout Limpopo, even in the highly populated rural areas. However, the scattered development pattern of rural areas results in relatively longer travelling distances to the higher-order towns, compared with the more compact urban areas. With regard to the remainder of Limpopo, the land cover, as quantified and reported in the National Transport Master Plan (NATMAP) 2050, revealed the following:

- The bulk of the provincial area (68.7%) comprises non-cultivated land for grazing purposes and approximately 13.7% is under cultivation for a variety of crops;

- The same amount (13.7%) is officially under conservation and only 0.7% of the land comprises forest plantations;

- Approximately 2.9% of the land is used for a mix of urban activities, including industrial and commercial, as well as rural villages and mining activity; and

- Rural villages in Limpopo comprise a greater geographical area (1.9%) than urban areas do (0.95%).

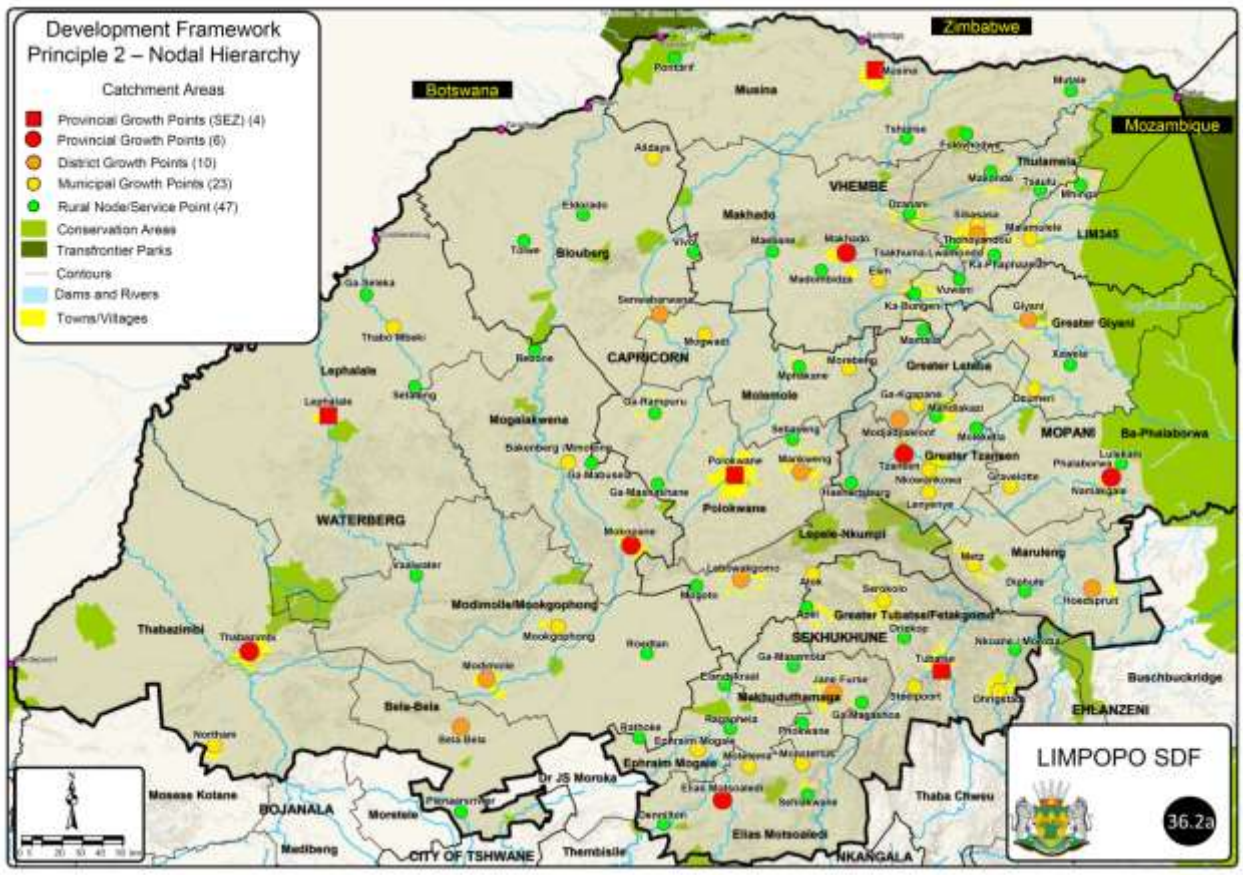


Figure 6: Spatial Structure (DRDLR, 2016)

Settlement Patterns

Rural villages have a very distinct development pattern. Rural villages start at road intersections and then – instead of expanding in all directions around the intersection – households establish in a linear pattern along the road. This is referred to as 'linear creep'. The dependence of these communities on access to the local and provincial network is, thus, very high. The result of this development pattern is that villages are scattered and relatively small. Larger rural villages, rather than being the result of planned concentration, are mostly the result of a number of small villages in close proximity to one another eventually merging, owing to market forces pulling them toward one another. As a result, larger settlement clusters in Limpopo just *happen*, with very limited supporting economic activities or social and engineering infrastructure.

Residential Demand and Supply

According to Census data, the number of households in Limpopo increased from approximately 1.1 million in 2001 to about 1.4 million in 2011, while the total population increased from approximately4.9 million to 5.4 million people in the same period. It is significant to note that the number of households grew at a faster rate than the individual population, notably at an average of 2.4% for households, compared to 0.8% for individuals for Limpopo over the 10-year period. These figures not only signify smaller household sizes – notably from 4.5 in 2001 to 3.8 in 2011 – but also underscore urbanisation trends evident in Limpopo (urban households are typically smaller than rural households). Importantly, about 74.4% (three quarters) of local dwellings in 2011 were situated in traditional areas, compared to a national average of 27.1%. This makes communal land an important aspect of development in Limpopo. There is a challenge with small villages locating on undevelopable and environmentally sensitive land, such as on ridges (for example, the Soutpansberg Mountain) and along deep floodplains. This presents risks, such as flooding to inhabitants, but is also damaging these high biodiversity areas.

Residential Profile

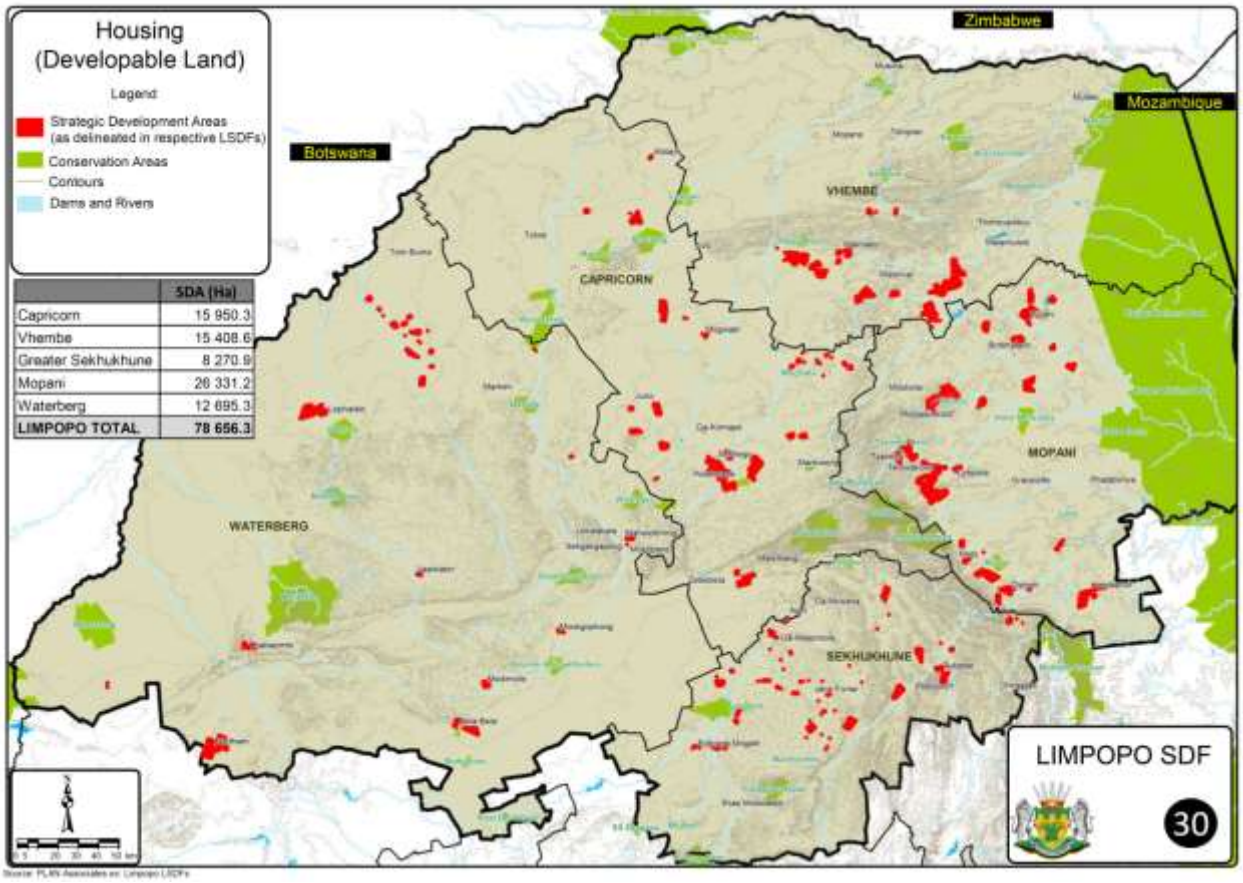
The proportion of households living in formal housing increased from 73% of all households in 2001 to 90% in 2011 while the proportion living in traditional dwellings declined dramatically from 20% to 5%. The proportion of households living in shacks not in backyards declined from 7% to 5% over the same period. In quantitative terms, the total number of households living in formal housing (including houses, flats and townhouses) increased significantly from 810 686 dwellings in 2001 to 1 272 971 in 2011. This represents an increase of just over 462 000 formal dwellings over the 10-year period (57% growth).

In the same time period, the number of informal dwellings (shacks not in backyards) slightly declined from 78 966 to 73 712, which represents a decrease of just over 5 000 dwellings. It is significant that the total growth in informal settlements in Limpopo was negative (7%). However, the most significant decline has been in the number of traditional dwellings, with the total number of households living in such dwellings declining from 225 307 to 63 976, representing a massive decrease of 161 331 (72% decline). The Provincial Department delivered 63 123 dwelling units in Limpopo over the previous five years.

As might be expected, levels of ownership in Limpopo are highest for formal dwellings and traditional dwellings and lowest for *shacks not in backyard* (predominantly informal settlements), where higher rental accommodation trends are evident. Although the levels of ownership remain fairly high, there has been a relative decrease of the latter across the respective categories (except for *shacks not in backyard*). This trend is coupled with relative increases in rental stock across all categories, especially in the two informal categories (*shacks in backyard* and *shacks not in backyard*), and decreases in levels of *rent-free* occupation across all categories. According to the Limpopo Multi-Year Housing Plan, the current backlog for title deeds is 26 604. The Limpopo Provincial Government has committed itself to transferring 22 605 housing properties (85% of the backlog) to beneficiaries in the next five years, which will lead to even higher rates of ownership.

With regard to housing backlog, there are approximately 56 945 households living in 151 informal settlements in Limpopo (StatsSA, 2011). In addition to the various housing delivery commitments by the Limpopo Provincial Government, as part of the Limpopo Multi-Year Housing Development Plan, it is also committed to the upgrading of 51 informal settlements through township establishment and the provision of basic services in the period 2015 to 2019. The number of households in informal settlements to be connected to new basic water and sanitation services in the next five years totals 4 370.

'Strategic Development Areas' (SDAs) refer to areas where the respective LMs will support expansion of the urban footprint, subject to environmental approval and the availability of bulk engineering service capacity. As part of the respective local Spatial Development Framework (SDF) processes, SDAs were delineated to reflect the Municipality's envisaged direction of growth.



	SDA (Ha)
Capricorn	15 950.3
Vhembe	15 408.6
Greater Sekhukhune	8 270.9
Mopani	26 331.2
Waterberg	12 695.3
LIMPOPO TOTAL	78 656.3

Figure 7: Housing (DRDLR, 2016)

3.3.2.6 Transport Facilities and Services Change

Transport Networks

The national road network, together with parts of the provincial network in Limpopo, plays a strategic regional role as it links the country to adjoining Southern African Development Community (SADC) countries. The National Corridor that traverses Limpopo from south to north is the N1 freeway. There are nine provincial roads that are also key provincial linkages, complementing the national road network. The scattered and dispersed land use pattern in Limpopo does not support the development and maintenance of a cost-effective and efficient transportation network. Limpopo holds some 1 923 kilometres of national and 21 908 km of provincial roads (totalling 23 831 km), of which roughly one-third (38%) is paved and the remainder (62%) are gravel. Road conditions are generally poor, especially in the rural areas. About 55% of the provincial road network is deemed to be in a good to very good condition (including the N1 national road), 34% fair and 11% in a poor to very poor condition. Poor road conditions have an adverse effect on the operating life of vehicles, the level of public transport service and even on the economy – especially tourism and logistics sectors, although the last mentioned is one of the major causes of road damage.

Motor vehicle ownership in Limpopo is low owing to relatively low income levels, which implies that commuters are largely dependent on public transport, mainly bus and taxi operations. The Household Travel Survey of 2013 indicated that 22.6% of households use bus transport and a much larger 45.8% use taxis. Both minibus taxis and buses provide inter-provincial/long-distance services. There is a general lack of good public transport infrastructure in Limpopo, particularly at long-distance rail stations. The Provincial Land Transport Framework (PLTF) noted that a multi-modal transport system is essential and that rail especially should be expanded as a mode of transport. Furthermore, rail transfer facilities were found to be poorly integrated with the urban fabric of cities and towns by not being positioned at major destinations, such as shopping centres and employment hubs.

Railways

The rail network in Limpopo is fairly well developed and connects to the major mining, industrial, forestry and agricultural nodes in Limpopo. The rail network in Limpopo is primarily used for freight purposes.

Airports

Limpopo has one international airport (Polokwane International Airport), two national airports (Kruger Park Gateway at Phalaborwa and Eastgate at Hoedspruit) and 21 other licensed airfields. The majority of airports/airfields in Limpopo do not offer cargo services.

3.3.2.7 Community Facilities and Services Change

The dispersed settlement structure in Limpopo is a great challenge to the equitable and effective provision of social facilities and calls for strategic intervention. Hospitals, fire stations, correctional facilities and libraries are generally only located at major cities and towns, while clinics, postal services, government/municipal offices and police stations appear to be more localised. In other words, it also serves more rural parts of Limpopo. Despite the low education levels across Limpopo, the provision of primary and secondary schools in Limpopo seems sufficient in terms of quantity and distribution. There may, however, be a need to augment the limited number of tertiary education institutions.

3.3.2.8 Engineering Facilities and Services Change

Engineering Services Access

In general, electricity provision/distribution in Limpopo is relatively high, including to the rural areas, whereas the levels of water and sanitation provision vary significantly from one LM to another. Interestingly, there seems to be no correlation between the level of service provision and the formality of respective settlements. However, in Sekhukhune, where the dependency ratio is highest, the service levels are also the lowest of all districts in Limpopo. It may thus be deduced that the level of service provision is strongly linked to the ability of households to pay for basic services.

In spite of patterns of out-migration and slow growth in Limpopo, the natural population and settlement growth is still significant, which results in continued demand for access to basic services and rising pressures on municipalities to address backlogs and to provide (and maintain) services in a sustainable way. In deciding on the rate and type of service delivery to a particular settlement/village, note should be taken of its respective population growth rate to ensure that infrastructure investment is proactive in serving areas of high growth.

Water Sources, Facilities and Services

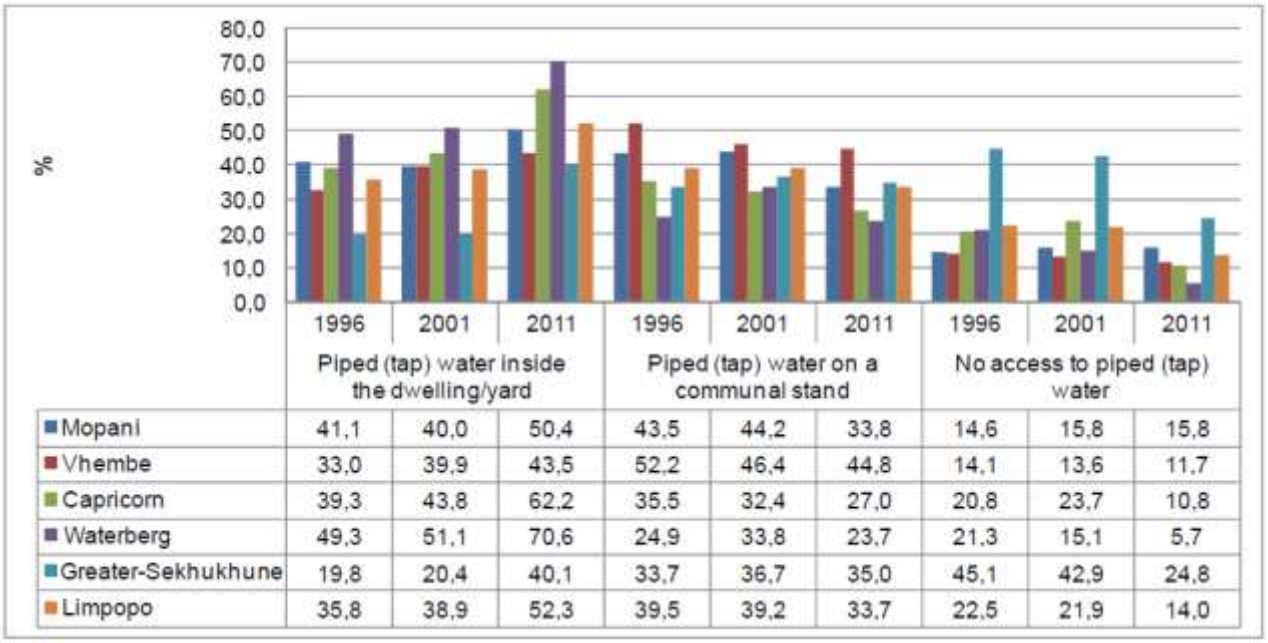
Each LM in Limpopo is divided into a number of water schemes. Water is sourced from a combination of surface water and groundwater. Generally, towns and larger settlements have established water treatment works (which operate at varying levels of capacity), whereas more rural areas are typically reliant on groundwater, accessed via boreholes. The most prevalent challenges regarding water provision in Limpopo are:

- Some infrastructure has exceeded its design life span and is deteriorating;
- Maintenance costs are high owing to ageing water and wastewater reticulation network;
- Inter-basin water transfers are expensive;
- Certain activities, such as mining and industry, have a negative impact on water quality and the environment;
- Groundwater is sometimes of poor quality;
- Boreholes are drying up (certain parts of Sekhukhune DM);
- Illegal connections are made;
- Vandalism and theft of water services infrastructure take place;
- Demand for water often exceeds supply; many water treatment plants are operating above design capacity;
- Unplanned residential sprawl continues to increase demand;

- A need for local operation and maintenance master plans exists to stop the trend of reactive maintenance; and
- There is limited cost recovery for water provided.

The total proportion of households in Limpopo with access to piped water inside the dwelling or yard increased from 35.8% to 52.3% from 1996 to 2011, while the proportion of households with access to a communal tap and with no access to piped water respectively decreased slightly. Significant progress has been made in water provision in Limpopo. While the highest increase of households with piped water was seen in the Sekhukhune DM, the highest proportion of households with access to piped water was found in Waterberg. The greatest proportion of households in the Waterberg District (70.6%) had access to piped water inside the dwelling/yard, while a massive 24.8% of households in Sekhukhune still had no access to piped water.

Some of the larger centres such as Polokwane, Mokopane and Makhado receive their water partly from local well-fields, while many of the rural areas are solely reliant on groundwater accessed via bore holes. It has been reported that many of the boreholes (especially in the Sekhukhune DM) have dried up, leaving the onus on municipalities to provide water and sanitation to these villages. If not well managed, the pressure on groundwater is bound to increase, which will further exacerbate the service delivery challenge in Limpopo. A project is underway to benefit more than 2 million people in the Sekhukhune, Capricorn and Waterberg areas. This involves connecting the water treatment works at Steelpoort with the De Hoop Dam, together with a pipeline to Sekuruwe in the Waterberg area and Pruissen in the Capricorn area.

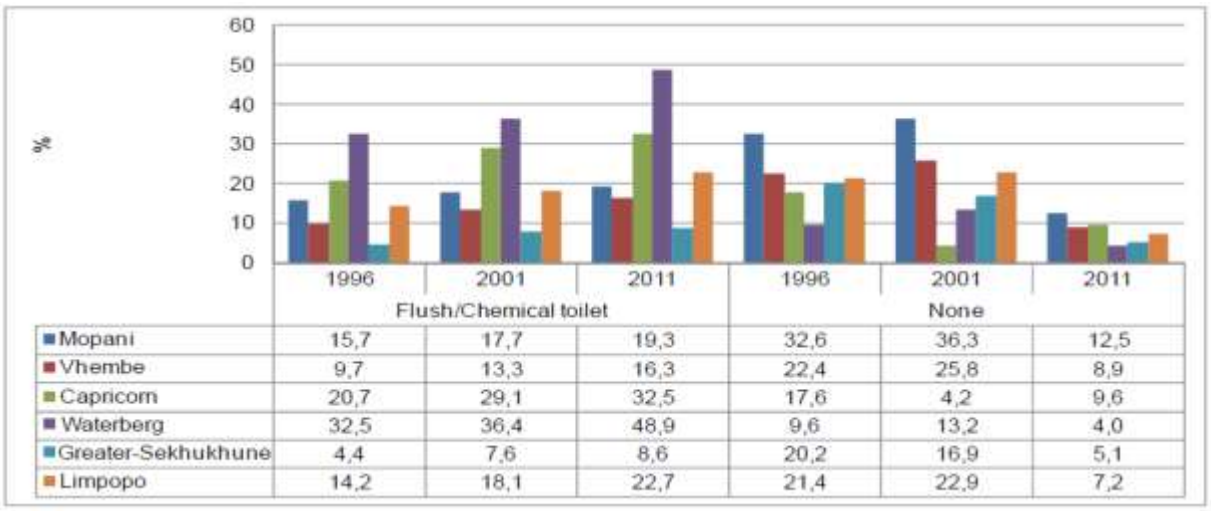


	Piped (tap) water inside the dwelling/yard			Piped (tap) water on a communal stand			No access to piped (tap) water		
	1996	2001	2011	1996	2001	2011	1996	2001	2011
Mopani	41,1	40,0	50,4	43,5	44,2	33,8	14,6	15,8	15,8
Vhembe	33,0	39,9	43,5	52,2	46,4	44,8	14,1	13,6	11,7
Capricorn	39,3	43,8	62,2	35,5	32,4	27,0	20,8	23,7	10,8
Waterberg	49,3	51,1	70,6	24,9	33,8	23,7	21,3	15,1	5,7
Greater-Sekhukhune	19,8	20,4	40,1	33,7	36,7	35,0	45,1	42,9	24,8
Limpopo	35,8	38,9	52,3	39,5	39,2	33,7	22,5	21,9	14,0

Figure 8: Households by water source (DRDLR, 2016)

Sanitation Facilities and Services

The recorded levels of formal sanitation provision in Limpopo were still relatively low in 2011 (22.7%) despite relative increases in all five districts. The percentage of households with no access to toilet facilities decreased significantly, from 21.4% to 7.2%. Similar to water provision, the lowest levels of flush/chemical toilets (formal sanitation) in 2011 were in the Sekhukhune District (8.6%), while the Waterberg District had the highest proportion of households (48.9%) with such infrastructure. Figure 9 schematically illustrates the level of sanitation service provision across the five districts in Limpopo.

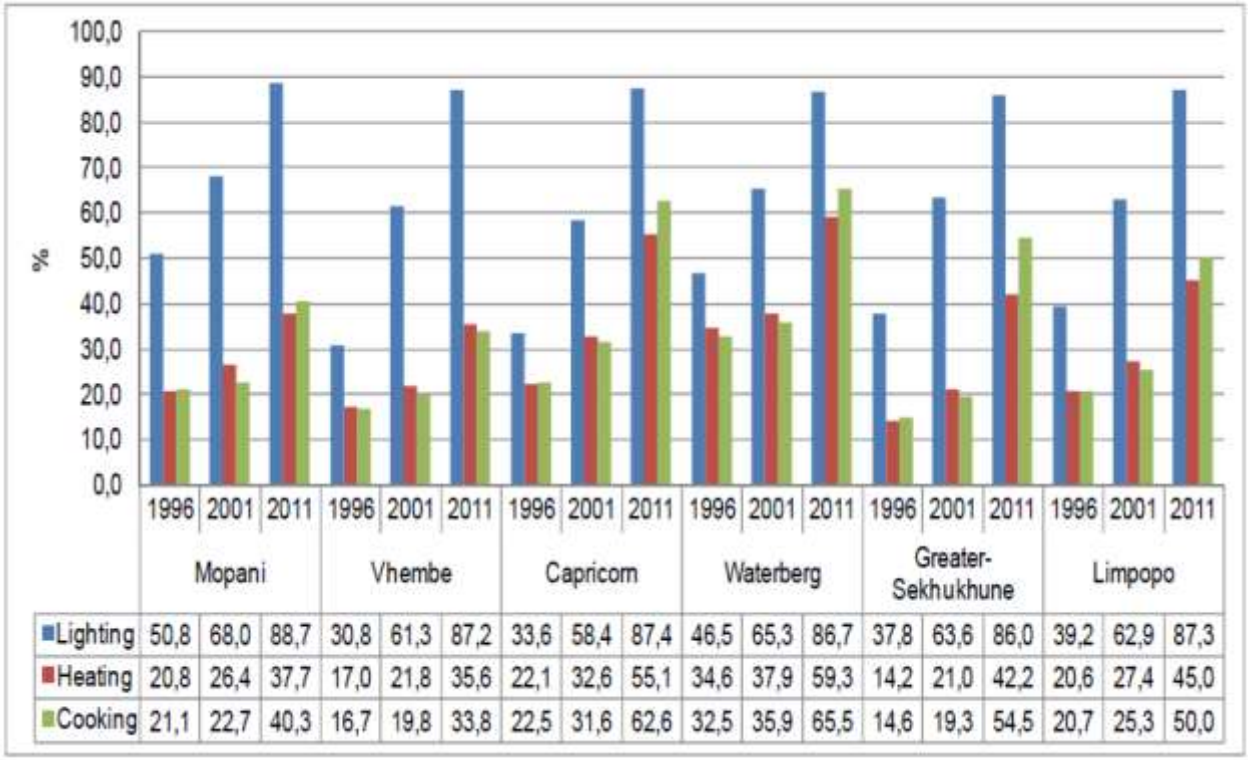


	Flush/Chemical toilet			None		
	1996	2001	2011	1996	2001	2011
Mopani	15,7	17,7	19,3	32,6	36,3	12,5
Vhembe	9,7	13,3	16,3	22,4	25,8	8,9
Capricorn	20,7	29,1	32,5	17,6	4,2	9,6
Waterberg	32,5	36,4	48,9	9,6	13,2	4,0
Greater-Sekhukhune	4,4	7,6	8,6	20,2	16,9	5,1
Limpopo	14,2	18,1	22,7	21,4	22,9	7,2

Figure 9: Households by sanitation service (DRDLR, 2016)

Energy Facilities and Services

The proportion of households that use electricity generally increased in all five districts in the 15-year period. It is interesting to note that the level of electricity use for lighting is significantly higher (nearly 90% across the board in 2011) than for heating or cooking purposes, which ranges between 33% and 65%. This could indicate a relatively high dependence on alternative sources of fuel, which bodes well for the greening initiatives in Limpopo. The need for alternative and affordable sources of energy has become imperative, although there is apparently a low adoption rate in rural areas as a result of price and criminality.



	Mopani			Vhembe			Capricorn			Waterberg			Greater-Sekhukhune			Limpopo		
	1996	2001	2011	1996	2001	2011	1996	2001	2011	1996	2001	2011	1996	2001	2011	1996	2001	2011
Lighting	50,8	68,0	88,7	30,8	61,3	87,2	33,6	58,4	87,4	46,5	65,3	86,7	37,8	63,6	86,0	39,2	62,9	87,3
Heating	20,8	26,4	37,7	17,0	21,8	35,6	22,1	32,6	55,1	34,6	37,9	59,3	14,2	21,0	42,2	20,6	27,4	45,0
Cooking	21,1	22,7	40,3	16,7	19,8	33,8	22,5	31,6	62,6	32,5	35,9	65,5	14,6	19,3	54,5	20,7	25,3	50,0

Figure 10: Households using electricity for lighting, heating and cooking (DRDLR, 2016)

Telecommunications and Information and Communication Technology Facilities and Services

Information and Communication Technology (ICT) can enable access to basic services, such as banking, healthcare and education, and to social services, economic opportunities and empowerment. According to the Limpopo Development Plan (LDP), 88% of households in Limpopo have mobile phones while only 6% have fixed telephone lines.

Furthermore, 27% of households have a computer, of which only 3% have internet access at home. The lack of ICT infrastructure to access the digital world and the lack of technical and managerial skills to operate, maintain and manage the infrastructure represent major weaknesses in the development of the sector, together with the low rate of passes in Mathematics and Science in secondary schools and the relatively low proportion of Science, Engineering and Technology (SET) graduates from universities.

This low level of access to ICT is particularly relevant in light of the Limpopo Information Society and Knowledge Economy Plan, which envisions transferring the Province from a resource-based economy to a knowledge economy of the twenty-first century. Note that a 'knowledge economy' refers to the use of knowledge to produce economic benefits. The knowledge revolution manifests in many different ways and at an ever-increasing rate. In order to move the provincial economy from a resource-based economy to a knowledge-based economy, it is crucial that the level of investment in ICT, research and development (R&D), and education, in general, is prioritised accordingly. In a knowledge economy, R&D, software and education (the intangibles) are even more important than fixed capital as they enable and drive innovation and competitiveness.

3.3.3 Impacts

3.3.3.1 Demographics

Increased human settlement and increased population density are key drivers of environmental change. At 0.82% average annual growth, Limpopo's population growth is low (LPG, 2015) and the population density has only marginally increased since 1996. Population and density growth are, therefore, rated as medium-pressure factors with a moderate growth trend.

3.3.3.2 Urbanisation

The current impact of urbanisation has been rated as medium, while the trends and location of growth points imply a potentially much higher impact in terms of the ecological footprint of urban settlements in Limpopo. This rating does not take into consideration responses in place such as the shift to integrated planning.

3.3.3.3 Urban Growth and Sensitive Environmental Areas

The 10 growth points that are to be co-ordinated for high-priority development support in Limpopo are Lephalale, Greater Tubatse, Musina, Makhado, Greater Tzaneen, Ba-Phalaborwa, Elias Motsoaledi, Mogalakwena, Thabazimbi and Polokwane. These growth points are in close proximity to a number of areas of high ecological value in Limpopo, according the Limpopo Conservation Plan version 2 (LCPv2) (LEDET, 2013a). Future negative impacts on and degradation of these areas of high ecological value could occur as a result of the growth points. The LCPv2 indicates a generally high percentage of natural land cover and relatively low correlation between human settlement and degradation. It is, however, particularly important to monitor settlements situated in Important and Necessary and in Irreplaceable areas (LEDET, 2013a).

3.3.3.4 Economic Growth and Poverty

Global evidence shows that socio-economic development is a more significant indicator for environmental degradation than poverty. The human ecological footprint increases with income up to the level of middle income. This is generally referred to as the environmental Kuznets Curve (UNEP, 2011). Prevalent poverty is, however, not a sustainable situation, forces quick-wins or less preferred policy scenarios and can exacerbate the impact of other indicators such as urbanisation and impact of poor housing, of poor solid and liquid waste management, poor governance, and the like. The environmental impact of economic growth and poverty in Limpopo is rated medium.

3.3.3.5 Basic Services and Environmental Impacts

The impact of a lack of access to water and waste management should be seen in the context of other trends such as economic growth and urbanisation. In a low-density low-income rural context, households produce mainly organic waste and the low density allows the ecosystem to absorb any contaminated liquid waste or cope with low-efficient decomposition of solid waste.

In high-density, urban or peri-urban areas, the cumulative impact will be much higher. If the current poor infrastructure situation persisted, these trends would increase the environmental impact. However, one of the major advantages of urbanisation is the opportunity for improved infrastructure provision to communities, as long as the housing is mainly formal.

The current state regarding access to water and waste management is concerning. The state of these services is regarded as poor. Furthermore, the poor state of water and waste management poses particularly high risks for existing surface and groundwater resources. The ongoing improvements and the services being implemented in formal urban settlements present the trend as stable.

3.3.3.6 Housing and Environmental Impacts

High concentrations of poor communities in peri-urban areas can contribute to degradation, in particular in the functioning of the chosen areas; for example, near water sources, leading to catchment degradation and soil erosion. Considering the low population growth and the controlled provincial planning of growth points and decrease in informal housing, the current environmental impact is ranked as medium and the trend is downward.

3.3.3.7 Transport Facilities and Services

Road infrastructure development is regarded as resulting in significant negative environmental impacts, in terms of both the direct physical impact of road development and the impact of road works (lack of restoration and waste management). Additionally, habitat fragmentation impacts result from the road and roadside developments.

An increase in road infrastructure results in an increased demand for transport, which has multiple negative impacts, primarily the increase in carbon emissions. Increased road construction also has an indirect negative effect through an increase in access to areas formerly unreachable. Improved access can also increase opportunities for illegal biodiversity use (for example, access to harvesting or poaching of protected species; new illegal dumpsites for solid or liquid waste).

Rail transport infrastructure has a significant impact on the landscape, but if it is extensively used this will reduce need for road infrastructure and the impacts of road transport. Limpopo plans to strengthen its passenger network; however, the potential for goods transport by rail is limited to long-distance bulk transport.

The environmental impact of transport infrastructure also applies to the effectiveness of hubs, such as public transport nodes, heavy vehicle resting places and facilities. Urban centres and roads with adequate facilities for accommodating buses, taxis and trucks will face a significantly reduced transport impact. Such infrastructure is a positive indicator. Non-motorised transport is by definition low-impact. An enabling environment for non-motorised transport, particularly urban and peri-urban, is therefore an indicator of positive environmental change.

With Limpopo actively advertising the Province as a transport corridor and tourism venue, and other mainly socio-economic factors increasing transport needs and opportunities, the current pressure of the transport indicators is high. It is expected that the pressure for transportation will continue to increase, which will cause an increasing trend in transportation infrastructure. It should be noted that this does not consider the responses already in place to address this.

3.3.3.8 Water Infrastructure

Water infrastructure has a particularly significant environmental impact in Limpopo. This includes the direct impacts of infrastructure, such as dams, pipes, pumps, canals and the like, and the impact of extraction and transfer of water resources, especially the negative impacts on aquatic ecosystems.

Limpopo faces challenges with regard to management of water and, therefore, water quality management and infrastructure carry an extremely high environmental risk. The current impact is ranked as high; the trend is improving. Table 2 summarises the core indicator impacts and trends.

Table 2: Summary of core indicator impacts and trends in Limpopo Province

INDICATOR	CURRENT IMPACT LEVEL	TREND
Demographics	Medium	Stable
Urbanisation	Medium	Increasing
Economic Growth and Poverty	Medium	Stable
Housing and Environmental Impacts	Medium	Decreasing
Basic Services and Environmental Impacts	High	Decreasing
Transportation Facilities and Services	High	Increasing
Water Infrastructure	High	Decreasing
Governance	Medium	Decreasing

3.3.4 Responses

Important progress has been made in Limpopo in terms of integrated development planning. All the DMs and LMs have compiled Integrated Development Plans (IDPs). The integrated approach is an opportunity for improved resource planning and assessment of cumulative impacts of planned settlement development. The LDP also incorporates strong elements of sustainability. The deliberate planning of specific growth points with attention to reducing the number of informal settlements offers opportunities for a positive transition to an inevitably more urbanised future demography, with the benefits of scale for water and waste management and other improved infrastructure, such as domestic energy, and with mitigation of the risks of rapid and uncontrolled colonisation of the landscape. The low population growth rate offers a significant advantage in this regard.

The following recommended initiatives are supported:

- In this improved provincial planning one should also include the emerging landscape approach, with attention to human settlements in the landscape, particularly the emergence of Biosphere Reserves (BRs) in Limpopo. Limpopo and the Western Cape are the leading provinces that have rolled out the development of BRs as model sites for sustainable development at landscape level. One of the differences between BRs and other landscape approaches – for instance the Transfrontier Conservation Area (TFCA) model – is precisely the explicit inclusion of human settlements.

- There are currently three BRs in Limpopo: Kruger to Canyons, Vhembe and Waterberg. The BR model is unique in its integrated view of conservation and its buffer and transition zones, with the latter including human settlements. Its approach of multi-stakeholder co-ordination platforms offers opportunities for improved landscape sustainability, including biodiversity off-sets for urban development and infrastructure. Historically, the BRs have been focused on the core (protected) and buffer areas. Experiences with planning of transition areas and urban BRs are more recent and require explicit planning and capacity building. Strengthening the fulfilment of the functions (conservation, sustainable development, and related research and education) in these BRs with attention to human settlements is more urgent than developing additional BRs.

- Limpopo has developed the LGEP (LEDET, 2013b), with sections on water, waste, building, transport and infrastructure sectors. The plan provides priorities for Limpopo that are relevant to the human settlement and infrastructure impact: reduced household water

consumption, regulation of swimming pools, efficient waste management, waste beneficiation, concentrated solar plants, energy efficiency, greened government buildings, proper town planning based on green principles, improved public transport, energy-efficient urban design, regulations to reintroduce rail transport and Green Municipalities.

- The national measures include solar water heating in new houses, awareness and skills development related to solutions of green cities. They also provide guidelines on legislation/ regulations regarding economic instruments (rebates/subsidies/ grants, low-interest loans, tax concessions, import duties, and the like), and efficient spatial development frameworks. The measures focus on the reuse of water resources, buildings with lower electricity and water demand, solar grid feeding, reducing/reusing/recycling of waste, use of buffer strips for densification or urban agriculture and the promotion of mixed-use and mixed-income communities – bring people closer to work opportunities to reduce the need for transport, water security, pricing of ecosystem goods and natural systems. They promote municipalities as custodians of the environment and use natural capital indicators and define the carbon sync value of ecosystems within cities. They include carbon financing for sustainable energy interventions in Reconstruction and Development Programme (RDP) households.

- Some of these measures are clearly in line with environmentally sustainable human settlements. Others may need to be assessed on a case-by-case basis. These include the use of buffer strips to densify population or to promote urban agriculture, which may have negative impacts.

- The Limpopo strategy includes a Green Municipalities competition where sustainability practices in five DMs and 25 LMs are assessed, based on waste management, water management, energy management, and landscape; public participation; governance and capacity building; review of all municipal by-laws, IDPs and Sector Plans; and calculation of the ecological footprint of the municipalities (LEDET, 2013b).

3.3.5 References

Department of Environmental Affairs (DEA). 2012. *2012 South Africa Environment Outlook, Part 1, Chapter 5: Human Settlements.*

Department of Environmental Affairs (DEA). 2013. *Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa. Climate Trends and Scenarios for South Africa*.

Department of Environmental Affairs and Tourism (DEAT). 2006. *South Africa Environment Outlook: A Report on the State of the Environment 2006*. National Department of Environmental Affairs and Tourism. Pretoria.

Department of Human Settlements (DHS). 2014. *A Social Contract for the Development of Sustainable Human Settlements. Building Partnerships for Accelerated Delivery*.

Department of Roads and Transport (DRT). 2007. *Development of the Limpopo Rural Transport Strategy. Desktop study report.*

Department of Rural Development and Land Reform (DRDLR). 2013. *Climate Change Risk and Vulnerability Assessment for Rural Human Settlements*. Department of Rural Development and Land Reform: Spatial Planning and Facilitation Directorate. Pretoria.

Department of Rural Development and Land Reform (DRDLR). 2016. *Limpopo Spatial Development Framework 2016*. Prepared for the National Department of Rural Development and Land Reform by Plan Associates. Pretoria.

Department of Water Affairs (DWA). 2012a. *Sanitation Services – Quality of Sanitation in South Africa.* Report on the status of sanitation services in South Africa.

Department of Water Affairs (DWA). 2012b. *Blue Drop Report.*

Department of Water Affairs (DWA). 2012c. *Green Drop Progress Report.*

Department of Water Affairs (DWA). 2015. *Limpopo Province State of Dams.* Internet material accessed 13.11.2015: https://www.dwa.gov.za/Hydrology/Weekly/ProvinceWeek.aspx?region=LP.

Du Plessis, C. & Landman, C. 2002. *Sustainability Analysis of Settlements in South Africa*. Prepared for the National Department of Housing by the Council for Scientific and Industrial Research (CSIR), Building and Construction Technology, Programme for Sustainable Human Settlement. Pretoria.

Housing Development Agency (HDA). 2013. *Informal Settlements Status.*

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2013a. *Limpopo Conservation Plan v.2.* Limpopo Provincial Department of Economic Development, Environment and Tourism. Polokwane.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2013b. *Limpopo Green Economy Plan, including Provincial Climate Response.* Limpopo Provincial Department of Economic Development, Environment and Tourism. Polokwane.

Limpopo Provincial Government (LPG). 2015. *Limpopo Development Plan (LDP) 2015-2019. Summary Document.*

Medical Research Council. 2000. *South African National Burden of Disease Study Limpopo Province Estimates of Provincial Mortality 2000*. Burden of Disease Research Unit, Medical Research Unit. South Africa.

Report No. 03-01-78 (2011) *Census 2011 Provincial Profile: Limpopo.* Report 03-01-78.

South African Cities Network (SACN). 2004. *State of the Cities Report 2004*. South African Cities Network, Johannesburg.

Statistics South Africa (StatsSA). 2011. *Census 2011 Community Profiles*.

Statistics South Africa (StatsSA). 2014. *Poverty Trends in South Africa. An examination of absolute poverty between 2006 and 2011*.

The World Bank. 2013. *Sustainable Cities Report.*

United Nations (UN). 2015. Internet material accessed 25.11.2015: http://www.un.org/sustainabledevelopment/sustainable-development-goals/

United Nations Department of Environmental and Social Affairs (UNDESA). 2015. *World Population Prospects: 2015 Revision.* Internet material accessed 12.11.2015: http://esa.un.org/unpd/wpp/DVD/

United Nations Environment Programme (UNEP). 2011. *Decoupling Natural Resource Use and Environmental Impacts from Economic Growth*. International Resource Panel.

Vancouver Declaration on Human Settlement. 1976. Vancouver.

4 Conclusion

4.1 Key Challenges

The *snapshot* of the current state or condition of the environment provided by the Limpopo Environment Outlook Report (LEO Report) affords the people of Limpopo a point in time to take stock of their environmental resources. In doing so, environmental issues and trends in resource use in the Province can be identified and assessed and priorities can be determined. The LEO Report also provides evaluations of the adequacy and completeness of environmental policies, and the plans and actions that are in place to ensure effective implementation.

The LEO Report also considers the future and allows the people of Limpopo to assess likely scenarios and appropriate responses in terms of a range of interrelated measures that may either enhance or undermine the pursuit of a sustainable future and the environmental resilience of Limpopo. This resilience is critical to further strengthen the Province on various fronts and to improve the prospects that its people and the economy have for navigating environmental changes.

The Limpopo Provincial Government and the people of Limpopo have made significant progress in the area of environmental management over the past decade. Policies, strategies, programmes, plans and projects have been devised and implemented that focus on key environmental areas, such as biodiversity, air quality, protected areas, urban and rural development, waste and disaster management. Efforts to further strengthen and enforce the policy framework have intensified.

Limpopo has much going for it, if the people play their part well. The purpose of this chapter is to provide information that will inform further public debate, policy development and decision-making in order to promote and further support the implementation of sustainable development in Limpopo.

Despite progress thus far, the detailed assessments in the LEO Report show that the ecological footprint of humans in Limpopo is increasing, the natural capital is being used up and the condition of the environment in Limpopo is deteriorating. Increasing pollution and declining air quality are harming people's health. Natural resources are being exploited in an unsustainable way, threatening the functioning of ecosystems. Water quality and the health of aquatic ecosystems are declining. Land degradation remains a serious problem. At the same time, the basic needs of the current generation are not yet being adequately met, and inequality and unemployment levels remain unacceptably high. Poverty remains deeply entrenched and is on the increase in some areas.

With the majority of the poor in Limpopo being directly dependent on natural resources to survive, the environment cannot be allowed to deteriorate. Poverty reinforces people's dependence on natural resources and makes them more vulnerable to environmental threats, such as polluted water, degraded land, indoor air pollution and climate change. Lack of access to basic resources, such as clean water and safe sanitation, strips people of their dignity. People living outside the formal sector, many of them rural dwellers, and the large number of people affected by HIV and AIDS are particularly vulnerable to a deteriorating environment.

Many challenges still obstruct the path of sustainable development, and some of them need urgent and dedicated attention. It is important to act decisively now, to safeguard society and the economy through sound environmental management. Limpopo has a tremendous array of natural resources; this is a significant asset in the Province. The environment, which is made up of basic natural resources that sustain life, such as clean air, water and food, is the basis for economic activity and it sustains human cultural and spiritual needs. Thus, a healthy environment is not only a Constitutional right in South Africa but is fundamental for a vital society and a sustained economy in Limpopo. There are increasing pressures on the environment and insufficient means to deal with these pressures.

The message is clear: action is needed now, both from individuals and the collective, the people of Limpopo, to reverse environmental deterioration. Decisive action is needed to avert

irreparable damage to the environment which is of critical importance to sustain the people, communities and life in Limpopo.

4.1.1 What are the Key Challenges?

The following Key Challenges were identified by the stakeholders and specialists as part of the process of compiling the LEO Report, in no particular order of priority:

- Climate Change;
- Water Resources;
- Land and Transformation;
- Waste Management; and
- Environmental Governance.

4.1.1.1 Climate Change

South Africa emits more greenhouse gases (GHGs) per person than many industrialised countries. Reasons for this lie in the country's dependence on coal for cheap electricity. Predictions for climate change over the next 50 years are that there will be less rainfall, especially in the western parts of South Africa, and higher temperatures, particularly in the interior. It is likely that there will be more frequent floods and droughts. South Africa is one of the most vulnerable countries to the effects of climate change, given the high levels of human vulnerability and the predictions for increased floods and droughts. All South Africans, including the people of Limpopo, have a duty to do more to address climate change.

Climate change, as a global phenomenon, is becoming increasingly apparent in Limpopo. The Province faces a predicted high increase in temperatures, strong variations in rainfall patterns and more frequency of extreme events. Limpopo is perhaps the most vulnerable province to climate change in South Africa. The vulnerability is exacerbated by this because poverty, inadequate housing, poor access to services and low levels of governance are all affected by environmental change. These debilitating issues further compound the inability to respond adequately to the effects of climate change that can be disastrous and often require timely actions. Observed data predicts increases in temperatures and variations in rainfall across the Province and it could be said that Limpopo is already experiencing the effects of climate change. The consequences of experienced extreme events between 2014 and 2015 are exposing the lack of preparation of the Province to handle climate variations. There is a definite need for greater preparation in the Province to handle climate change. There is a need for better adaption. Notable efforts have been made by the Province in the development of a framework and strategies for mitigation and adaptation. However, the lack of appropriate changes in governance limits improved resilience. It is expected that the biggest challenge that mitigation and adaptation plans face will be integration and effective implementation at local municipality (LM) level.

State and trends:

- GHG emissions in South Africa are INCREASING, with carbon dioxide concentration increasing by 0.6% per year;
- GHG emissions are INCREASING significantly, with the largest portion resulting from generating electricity by making use of coal; and
- GHG emissions per person in South Africa are DISPROPORTIONATELY HIGH, owing to reliance on coal and the high energy intensity of the economy.

4.1.1.2 Water Resources

Water resources in Limpopo show a general decreasing trend. This is largely evident in the increasing demand for water and the insufficient supply available to meet current and rising demands. There is a decrease in water resources per capita. The state of water availability, the quality of available water and the ecosystem goods and services supplied by aquatic ecosystems are in decline. This is due to limited available sources, over-utilisation (beyond the ecological reserve) of existing resources and increases in pollution of the existing sources. Furthermore, the current supply of available and renewable water in the Province is inadequate

in relation to rising demand. This will result in restricted socio-economic development and potentially stir conflicts between economic sectors. A positive trend is, however, evident in the groundwater resources as groundwater levels are increasing.

State:

- There has been significant progress in the development of Provincial policy and legal framework to deal with water resources;
- Despite positive changes in water management, less water is now available and of poorer quality;
- Deteriorating water quality is having adverse effects on health in some areas, compounded by the lack of sanitation;
- Climate change is predicted to influence the availability of water in Limpopo; and
- Groundwater levels are increasing, but groundwater use has increased dramatically, mainly owing to increased irrigation.

Trends:

- Use of available water resources: INCREASING, with almost all exploitable sources being tapped;
- Freshwater flows: DECREASING, and most evident in water courses through time;
- Water quality: VARIABLE, with overall DETERIORATION;
- Salinity levels in surface water: either VARIABLE or INCREASING for sample sites; and
- Health of river ecosystems: DECLINING, with effluent pollution continuing to grow.

4.1.1.3 Land and Transformation

Livestock grazing, cropping, mining, human settlements and forestry are increasing across the Province, which all contribute to an increase in land transformation. Land is the basis of many life-support systems, from production of biomass that provides food, fodder, fibre and fuel for human use, to being an essential natural resource in other respects. A diverse climatic variation within Limpopo allows the Province to produce a diversity of agricultural outputs, ranging from extensive cattle and game farms to intensive horticultural production. Since agriculture accounts for 90% (11.3 million ha) of Limpopo's 12.6 million ha land area, land represents a critical issue for residents in the Province. This land use reveals the biggest changes over the 24-year span reviewed. To avoid further adverse land transformation, improved management of two key agricultural areas is critical: stocking pressure, particularly in areas of land under communal tenure, and the *subsistence* or small farmer-cropping component. Results from the assessment indicate that grazing capacity is diminishing because of overgrazing and inadequate area availability for current livestock levels. As a result, grassland areas are transforming at a rapid rate. In addition, increased irrigation presents a concern for current and future water resource limitations. From a management and planning perspective, more detailed and regular spatial information is required if detailed planning, monitoring and control are to be successful.

State:

- Land is being overexploited;
- Land use is intensifying. The intensification of land use for cultivation is leading to higher overall food productivity, but the increasing population at a rate higher than production may influence future national food security;
- A large proportion of the land is transformed from natural habitat and most is being used for cultivation;
- The transformation of land, including degradation and desertification, is leading to a loss of biodiversity, productivity, associated ecosystem services and livelihoods;
- Land is degraded and desertification is worsening. Land degradation is seen to be especially severe in communal areas, where it is a serious threat to ecosystem functioning, biodiversity, household food security and rural livelihoods. Degradation of land affects former *homeland* areas the most; and

- The land reform programme is unsustainable and access to land and financial and technical support for beneficiaries of the land reform programme are lacking. The land reform programme in its current form is in general not providing substantial benefits to beneficiaries.

Trends:

- Land degradation: UNCERTAIN whether this has increased because of lack of comparable data;
- Area used for grazing: DECLINED owing to the expansion of settlements, bush encroachment and other activities;
- Food production per person: DECREASING, notably for maize, which is the major crop;
- Food productivity per unit land area: INCREASING, pointing to increased fertiliser use and improved technology; and
- Land delivered by restitution, redistribution and tenure reform: INCREASED, with the majority of land claims being settled in urban areas.

4.1.1.4 Waste Management

In any developing society waste generation increases and Limpopo is no exception. The effective management of waste is of critical importance for avoiding environmental health issues and the protection of especially rivers and wetlands in Limpopo. The waste management function should be strengthened in view of the problems experienced in the collection of waste and the monitoring of the performance of waste disposal sites. Although work is being carried out by LMs in managing solid waste and monitoring it through participation in the Green Municipalities Competition, waste sites are not being managed effectively. There are certainly difficulties in dealing with waste management in Limpopo, yet proper functioning and monitoring of solid waste disposal sites and improved waste collection and recycling efforts can provide significant improvement. The Limpopo Department of Economic Development, Environment and Tourism (LEDET) is currently not monitoring hazardous waste generation or disposal in the Province and limited data is available in this regard.

Thirteen percent (13%) of landfill sites are unauthorised, with an additional 5% of the sites across Limpopo under application. Compliance at the authorised sites is uncertain. Although monitoring of waste sites for compliance is conducted by the provincial authority, technical capacity and the lack of adequate financial resources limit the effective operation and monitoring of the performance of waste sites at the local level. Waste collection in rural areas is an issue that requires priority attention. There are currently 84 waste facilities in Limpopo and more general waste sites have been authorised. The waste received is being measured at some sites, yet these measurements are not accurate enough. There is certainly a growth in the volume of waste being handled in Limpopo, which was estimated at 244 384 tonnes, and there are 140 recycling facilities active across Limpopo (LEDET, 2015). Yet, the amount of waste being recycled is not accurately recorded. There is a general increase in the extent of waste being generated in the Province and a lack of waste management to respond to the trend. Throughout stakeholder engagement, waste management was raised as a critical and, increasingly, key concern across the Province. Increasing incidences of pollution and its negative impacts on human and environmental health and well-being require urgent and proactive responses from government, the private sector and civil society. The degradation of ecosystem health and productivity and the subsequent economic losses will continue unabated, if waste management in the Province is not addressed as a top priority.

4.1.1.5 Environmental Governance

Planning frameworks are increasingly being put in place at a national level, but a lack of implementation reduces effectiveness, as is the case in Limpopo. Staffing shows a decreasing trend as consistently high levels of vacant posts in key environmental management departments at different levels of government in Limpopo (Provincial, District and Local). Although strides are being made towards better compliance and enforcement, owing to increases in wildlife crime, staffing issues and insufficient resources to meet this rising challenge hamper efficient enforcement. Resources and capacity are insufficient at the Provincial, District and Local levels.

Environmental governance is a cross-cutting theme that touches all environmental issues in the Province. The need for stronger environmental governance is well recognised, as is the link between a sustainable and effectively protected environment and the numerous benefits for economic development and social health and well-being. Some key policies, laws and structures are in place in Limpopo Province and a few more are under development. The presence of such frameworks and tools requires urgent and effective implementation.

Shortfalls in resources, skills and capacity must be addressed to ensure alignment and implementation of key policies, plans and laws that pertain to environmental management at all levels of government within the Province. Strengthened institutional structures and capacities and increased staffing and resources are essential for the environmental management functions. Collaboration among government sectors, different levels of government and other parties to promote and support co-operative environmental governance, and support for environmental observation, research and monitoring to inform decision-making and improve risk identification and mitigation are also required.

State and trends:

- Adequate skills and capacity: DECREASING, although resource allocation is increasing, it is inadequate to meet the current and rising need;
- Access to environmental information: IMPROVING, yet many citizens are not aware of their environmental rights or struggle to access information;
- Enforcement of environmental management legislation: IMPROVING, but dedicated attention is needed to meet the current demand; and
- Delivery of services by Local Government: IMPROVING, but is hampered by a lack of skills and resources.

4.1.2 What are the Other Challenges?

The following are other challenges identified during the process of compiling the LEO Report and are also of importance:

- Air Quality and Atmosphere;
- Biodiversity and Ecosystem Health;
- Energy;
- Economics; and
- Human Settlements.

4.1.2.1 Air Quality and Atmosphere

Inadequate ambient monitoring information limits the opportunity to confidently predict the air quality in Limpopo. However, available information suggests that air quality is acceptable in Limpopo in terms of NO_X. Although no exceedances were observed in the ambient records for SO_2, smelting and fertiliser manufacturing in Phalaborwa are a high concern for the area. An increase of SO_2 concentration in the surroundings of Lephalale is expected once Medupi is fully operational.

The main air quality issue found across Limpopo is particulate material (PM) and the most common source is activities related to mining operations. Areas of concern include Lephalale and Steelpoort. Domestic fuel burning and vehicle emissions were not flagged as major sources on a Provincial scale, yet these are of concern on a Local scale and should be investigated. The principal problem from domestic fuel burning and vehicle emissions is the low release height, which means very little potential for dispersion. High concentration of pollutants ends up very quickly in the breathing space, increasing the health risk of the exposed population significantly.

State and trends:

- Air quality: DECREASING, in general;
- Health problems, owing to air pollution: INCREASING;
- Vehicle exhaust emissions: INCREASING;

- GHG emissions: INCREASING;
- Households with electricity: INCREASED;
- Use of renewable energy: INCREASING slowly, mainly through solar water heating;
- Use of ozone-depleting substances: DECREASED significantly; and
- Concentrations of Persistent Organic Pollutants: UNKNOWN and need to be quantified.

4.1.2.2 Biodiversity and Ecosystem Health

The progressive transformation of land poses a significant threat to quality of life in Limpopo and to the loss of biodiversity priority areas, exacerbated by land being increasingly transformed by various drivers. Once land has become degraded it is unlikely that such land will be returned to its previous ecological function. Continued urbanisation in Limpopo, and associated urban sprawl, and a decrease in household size (more houses accommodating fewer people per household) are currently and will continue to place pressure on available and potentially environmentally sensitive land in Limpopo.

The Grassland Biome, which is associated with some areas of Limpopo, is projected to be under severe pressure, as a result of climate change. According to the Limpopo Conservation Plan: Version 2 (LCPv2) (LEDET, 2013), eight of the 56 vegetation types found in Limpopo are threatened; one of these is considered critically endangered, one is considered endangered, and six are considered vulnerable. There are five threatened ecosystems in Limpopo: Malmani Karstlands, Sekhukhune Mountainlands, Sekhukhune Norite Bushveld, Blouberg Forest and Mapungubwe Forest. Together these ecosystems make up just over 1% of Limpopo.

Limpopo is 12 587 283 ha in extent, of which 10 717 467 ha (85%) is in a natural or near natural state, and 1 869 816 ha (15%) is not in a natural state. Formal Protected Areas (PAs) cover just over 11% of Limpopo. There are currently 62 formally PAs in Limpopo, totalling 1 367 044 ha, just over 11% of the provincial footprint. The major contributor to this is the Kruger National Park (KNP), which contributes 72% to the provincial Protected Area Network (PAN). The current informal conservation area estimate is 561 185 ha. Thus, a total of 1 928 229 ha in Limpopo is currently protected, either formally or informally. This is an increase of 1.87% from 2006 (total of 1 892 123 ha protected in 2006).There are currently three biosphere reserves (BRs) in Limpopo: the Vhembe, Waterberg and Kruger to Canyons BRs, which contribute to the conservation of biodiversity.

There is a tension between the need for cultivation, which provides food and livelihoods for farmers, on the one hand, and the need to conserve valuable natural habitats, ecosystems and ecosystem services, on the other. Inevitably, mining activities in Limpopo will, and have already, come into conflict with land management objectives and compatible land uses, as stipulated in the LCPv2, especially in the Sekhukhune and Soutpansberg centres of endemism. Of particular concern is the fact that mining applications have been approved in sensitive Critical Biodiversity Areas (CBAs) and in close proximity to formal PAs, where mining is explicitly indicated as an incompatible land use. Other land uses that may affect CBAs include urban development, agricultural activities and forestry. Future planning of such activities must consider the compatibility of the land use in the CBA category in which it is situated.

State and trends:

- Biodiversity loss: INCREASING;
- Health of ecosystems: DECLINING, with systems in very poor condition;
- Human pressure on ecosystems: INCREASING, particularly in areas of high biodiversity;
- Natural resources that support livelihoods: RAPIDLY DECLINING because of overexploitation, particularly in forests and grasslands;
- Programmes to rehabilitate ecosystems: INCREASING, including budget increase for Working for Water (WfW); and
- Rate of spread of alien invasive plants: INCREASING faster than the WfW Programme can clear.

4.1.2.3 Energy

In South Africa the fossil fuels dominate the energy sector, with coal (67%) and crude oil (21%) providing most of the primary energy (primary energy is an energy form found in nature that has not been subjected to any conversion or transformation process). Coal accounts for more than 90% of the electricity generation of the country. The Limpopo energy carriers do not differ and it is electricity, coal and oil that satisfy most of its energy requirements. However, the use of fossil fuel for energy generation brings an overwhelming burden to the environment in the form of air pollutants, GHG emissions, water contamination and ecosystem degradation.

The leading economic sectors in Limpopo Province are mining, tourism and agriculture. Mining and mining-associated industries are intense energy users *per se*, and they are the largest consumers of energy in Limpopo. However, the long-term effects of a constant supply of energy for these activities also threaten the sustainability of the agricultural and tourism sector. On the other hand, poverty and inequality are still present in Limpopo and about 10% of the households do not have, or cannot afford, access to electricity.

Limpopo houses the Matimba Power Station in Lephalale, with an installed capacity of 3 990 megawatt (MW). The construction of a second power station, Medupi, also in Lephalale, is currently in progress. Medupi will have an installed capacity of 4 800 MW, once all six units are commissioned, which is expected in 2019. Any power station of such magnitude has potential impacts on air quality and human health, surface and groundwater resources, soils and agriculture, flora, fauna and ecology.

The Limpopo Green Economy Plan (LGEP) identified the potential to develop Renewable Energy (RE) through concentrated solar plants with generation capacity of no less than 100 MW. Limpopo's geographic location will allow transmission and sale to Zimbabwe, Botswana, Mpumalanga and Gauteng. Potential also exists to increase capacity from small solar power plants on dwellings outside Eskom's grid.

Limpopo also has silicon reserves and the second biggest silicone smelter in the world is located in Polokwane. The LGEP identifies potential for beneficiation of the silicon resource, production of components for solar panels and production of solar chargers for cell phones and small-scale electrical devices as industrialisation opportunities.

The main source of energy for the household sector is electricity (87%). The percentage of households that use electricity in Limpopo per District Municipality (DM) and per type of area (that is, tribal, urban, farm) is as follows: the highest percentage is for the Mopani DM (89%) and the lowest is Sekhukhune DM (86%). This is still above the national average of 84%. Extreme societal inequalities are more obviously seen in the residential sector. Households' inability to afford and/or access electricity results in their using wood, paraffin or coal (the so-called *dirty fuels*) for lighting, heating or cooking. The burning of these fuels is not only inefficient but also has severe health consequences from indoor air pollution. Limpopo has the lowest rate of electricity use for cooking in South Africa (57%), followed by the Eastern Cape Province with 75% (StatsSA, 2015). Despite the high electrification levels, wood is the main source of energy for cooking and heating (>38%), while paraffin and candles are mainly used for lighting. Wood use is greater in the Vhembe and Mopani DMs, paraffin and gas are common in the Capricorn DM, and coal is mainly used in the Sekhukhune DM.

4.1.2.4 Economics

The primary economic sectors of Limpopo's economy (predominantly mining and agriculture) play a key role in the Provincial economy. There has been an increase in the primary economy in Limpopo, from 17% in 1996 to over 30% in 2011. The secondary sector (which manufactures finished goods suitable for use by other businesses, for export or sale to domestic consumers) has maintained a contribution of 7% to 8% share of the economy each year. The tertiary sector (the service sector that consists of the *soft* parts of the economy; that is, activities where people offer their knowledge and time to improve productivity, performance, potential and sustainability) has consistently contributed over 50% of the economy, but has decreased its share in recent years.

Official unemployment statistics show an improvement in Limpopo since 2008, but Limpopo is still the South African province with the highest level of poverty, with 78.9% of the population living below the national poverty line. In March 2014, the labour force participation rate was at 40% with more than 2 million people classified as not economically active. A total of 377 000 job seekers were classified as being discouraged and not actively looking for work. Poverty and inequality among the population remain key challenges in the local economy.

4.1.2.5 Human Settlements

The main issues related to human settlements in Limpopo are integrating rural and urban settlement economies and services, integrating urban settlements to remove the distortions of apartheid planning, and delivering basic services, including housing, water, sanitation, electricity and waste removal. The main causes of change are urbanisation (and its rate) owing to migration from within and outside the Limpopo, the capacity of government to deliver services, and the economic activities and conditions.

In Limpopo human settlements have the following characteristics. They are still socially and economically divided. There has been a rapid expansion of informal settlements around urban centres and peri-urban areas, with nearly 50% of the population in Limpopo living in urban areas. Housing backlogs have increased dramatically but there has been some success in service delivery, most notably clean water and electricity. Many poorer households still lack access to basic services, notably adequate sanitation facilities. LMs are faced with a severe shortage of capacity and resources, and increased levels of corruption. Access to adequate health care and quality schooling is varied across South Africa and, particularly, in poor rural areas. Many known waste disposal sites do not have permits. There are many illegal communal dumping sites, many waste sites do not meet the required environmental health standards, and many settlements are located near to unhealthy areas, which pose health risks to the people living there, including mining areas, waste sites, polluted water courses and industrial areas.

The consequences of all of the above-mentioned issues for human settlements in Limpopo are reduced quality of life for the people of Limpopo, especially the poor and those without access to basic services, an increased ecological footprint, degradation of ecosystems through consumption patterns and production of wastes and pollutants, and expanding settlements and urban sprawl, which lead to the destruction of natural habitat and the loss of high potential agricultural land.

The opportunities from human settlements in Limpopo are enterprise development around waste management (reuse and recycling) and increased pace of delivery of water supplies and sanitation services, waste collection and housing.

The key emerging issues regarding human settlements in Limpopo are the effects of climate change and delivery on land reform.

State and trends:

- Urbanisation: INCREASING, with almost a quarter (25%) of the population living in urban areas;
- Informal settlements: EXPANDING rapidly, around urban centres and peri-urban areas;
- Housing backlogs: INCREASING;
- Slum households: INCREASED in absolute terms;
- Households with access to piped water: INCREASED;
- Access to good basic services: INCREASED; and
- Households with access to adequate sanitation: INCREASED.

4.2 Linkages

Linkages between Drivers and Pressures, State, Impact and Responses have been presented throughout the chapters within this document. Numerous overlaps between the themes have been identified.

The outlook for the Limpopo environment cannot be understood in terms of a number of isolated issues or themes, but rather as a complex web of inter-connected issues. If one part of the environment is affected (negatively or positively) another part of the environment changes.

4.3 Scenarios

Two potential scenarios are presented in this section. Scenario 1 describes the projected future state of environment for the Province should trends continue and nothing be done to address the critical issues at hand. Scenario 2 describes the projected future desired state of environment for the Province should the required intervention occur.

It is clear from the LEO Report that the assessment of key environmental issues in Limpopo requires dedicated and focused attention and intervention, in order to stem the further degradation of environmental resources. In many regards, the issue of improving the management of water resources is perhaps the fulcrum around which many other issues revolve. The planning related to the protection of water resources seems to require elevation to the highest levels and will thus influence all aspects of environmental management and future planning in Limpopo.

4.3.1 Scenario 1: Inadequate Intervention

4.3.1.1 Climate Change

Climate change is here to stay and will worsen. Scenarios for South Africa have been modelled with local and international climate modelling expertise[51], over six hydrological zones (DEA, 2013). The Limpopo Province is included in the Limpopo-Olifants-Inkomati Hydrological (LOIH) Zone. During the modelling, less uncertainty was found in temperature predictions than in rainfall predictions. Only general conclusions of the study are presented in this document. For additional information regarding methodology and complete results the reader is referred to the *Long Term Adaptation Scenarios Report* and the *Climate trends and scenarios for South Africa Technical Report*.

Minimum temperatures experienced in Limpopo have increased by about 0.5-1.2°C in the last 20 years and by about 0.6-0.9°C for maximum recorded temperature. Modelled results for near-future temperature for the LOIH Zone suggest a scenario within the current realm, with slight increase towards 2030 reaching 2°C. The mid-future scenario suggests a temperature increase of 1-5°C; and the long-term scenario predicts an increase of 3-7°C from the baseline scenario.

Table 1: Annual average temperature increase projections for the Limpopo/Olifants/Inkomati Hydrological Zone (DEA, 2013)

SCENARIO	PERIOD	ANNUAL AVERAGE TEMPERATURE INCREASE	
Baseline	(1971-2005)	-	-
Near-future	(2015-2035)	2°C	Within realm of present-day climate
Mid-future	(2040-2060)	1-3°C (2-5°C)	Beyond present-day climatology range
Long-term	(2080-2100)	3-6°C (4-7°C)	Well beyond natural temp. variability

[51] Using statistical and dynamical downscaling methodologies based on outputs from IPCC AR4 and IPCC AR5. These represent an unmitigated future energy pathway and mitigated future energy pathway.

Rainfall projections for the LOIH Zone are presented in Table 2 (below) for four possible scenarios. The probability of occurrence of scenarios 3 and 4 is reduced significantly if mitigation strategies are put in place. However, even under strong mitigation responses, wetter or dryer scenarios are expected to bring socio-economic implications for vulnerable communities in the form of water resource availability and frequency of extreme events (droughts and floods).

Table 2: Rainfall projections for the Limpopo/Olifants/Inkomati Hydrological Zone (DEA, 2013)

SCENARIO	EXPECTED RAINFALL	SEASON	LIKELIHOOD OF OCCURRENCE IF MITIGATION PLANS
1 Warmer/wetter	Increase	Spring and summer	Same
2 Warmer/drier	Decrease	Summer, spring, autumn	Same
3 Hotter/wetter	Strong increase	Spring and summer	Reduced
4 Hotter/drier	Strong decrease	Summer, spring, autumn	Reduced

Projected changes in rainfall and temperatures carry the potential for affecting the environment, society and economy directly or indirectly.

Various repercussions will ensue should nothing be done to address climate change within Limpopo. A decrease in summer rainfall will be followed by an anticipated decrease in river flows, which will lead to water shortages. There will be increased evapotranspiration and decreased soil moisture, which will have particularly negative repercussions for agriculture. Pressure on water resources will be further exacerbated by reduced recharge of groundwater and falling water levels in boreholes. Furthermore, the incidence of flooding, contamination of available water and droughts will increase.

The agricultural sector will suffer owing to a projected decrease in productivity of food crops. Crop irrigation requirements will increase because of increased temperature and increased soil moisture levels, as a result in changed runoff patterns. Crops grown on marginal land will have to contend with land degradation and reduced soil productivity. Furthermore, crop and livestock production could be adversely affected by changes in the distributions of diseases, pests and insects. Certain agricultural crops will be highly vulnerable because of decreased water availability and increased temperature. Food security will become an increasing concern and health impacts will arise or worsen from both climate stresses and climate shocks.

4.3.1.2 Water Resources

Should nothing change and the current trends in water abstraction and use continue in proportion to economic growth and population increase more water will be required. Water scarcity will continue to be an issue and water will become more scarce. Additional storage will be required and more efficient storage of water will be needed. Alternative sources of water for the Province (aside from inter-basin and intra-basin transfer), especially groundwater, will need to be explored. Water quality is expected to deteriorate as a result of various activities, but predominantly those of mining and agriculture. Furthermore, the issue of poor sanitation will contribute to poor water quality in the Province.

4.3.1.3 Land and Transformation

Land degradation will continue should nothing change regarding the land and transformation trends currently occurring in Limpopo. Poor planning and control of land use and transformation of land will result in further increases in land transformed for grazing, cropping, mining, human settlement and forestry. The monitoring of these actions will continue to be reactive and ad hoc. Valuable grasslands will continue to decrease. Land availability and productivity will also decrease. Communal land and livestock will continue to deteriorate, as a result of poor land use practices. An increase in subsistence farming is expected, which would directly address food security issues, which are predicted to increase.

4.3.1.4 Waste Management

Waste management will become a growing problem should current trends continue unaddressed by the Province. As a result there will be a need for more waste sites to accommodate increased volumes of waste. Recycling will need to be mainstreamed in order to address the increased volumes of waste. The co-disposal of hazardous waste at general waste sites will become a growing concern in Limpopo.

4.3.1.5 Environmental Governance

Governance within Limpopo will not improve and potentially decrease should nothing change. The decreasing trends of enforcement, compliance, resource and capacity will continue. A lack of implementation of planning and frameworks will continue to be an issue, hampered by the inabilities of government. This will ultimately mean that a sustainable and effectively protected environment that yields economic benefits for Limpopo will not be achieved over the long term.

4.3.2 Scenario 2: With Adequate Intervention

4.3.2.1 Climate Change

Climate change will not go away, but there is much that can be undertaken to prepare for it, and adjustments that can be made to weather the most severe impacts. If Limpopo moves toward building an adequate climate adaptation strategy for the Province, the first step will be to continue to implement the vulnerability tool currently being developed. This will allow for the identification of key areas within the Province that are vulnerable to climate change so that they can receive the required attention. Focal areas such as ecosystems, livelihoods, economic activity, infrastructure and utilities as well as public health and safety will mainstream climate change responses into their functioning. This will allow for effective implementation of climate change responses on the ground and, therefore, strengthening of climate change resilience within the Province.

4.3.2.2 Water Resources

Should the Province implement effective responses and further address the issues regarding water resources, then improvement in this sector can be achieved. Water demand must be analysed to assess how demand can be brought more in line with availability. The exploration and extraction of groundwater reserves can contribute to greater water availability and reduce water scarcity. Additionally, improved water storage will allow for increased water resources available to the Province. Improved infrastructure, including reparation and upgrade, will allow for more efficient use of water resources. The strengthening of water-monitoring programmes will allow for better record keeping and, therefore, aid the Province in making decisions and planning for the future. Solutions that decrease water pollution from the major sectors of mining and agriculture, and from human settlements, will improve water quality.

4.3.2.3 Land and Transformation

Positive change is expected to occur regarding land and transformation within Limpopo should the necessary actions be undertaken. Full planning and control will allow for efficient use and preservation of land resources. Sustainable land use will maintain capability of agricultural lands. The monitoring and management of the land will be regular and effective. As a result, land cover statistics will not change dramatically (livestock and cropping will remain relatively similar). Solutions regarding the management of communal lands and livestock will result in decreased degradation.

4.3.2.4 Waste Management

Should things change, increases in waste will be effectively dealt with through efficient waste management in Limpopo. There will be an increase in licensed waste disposal facilities, which will be well managed, efficient and compliant. There will be an increase in recycling, mainstreamed into schools and public facilities in order that increased volumes of waste are separated at source for recycling. Correct methods for dealing with hazardous waste will be adopted and licensed hazardous waste facilities will be developed.

4.3.2.5 Environmental Governance

Most of the environmental trends reported on here relate strongly to human impacts. How human beings respond to these issues is key to finding solutions. At the heart of an effective human response lies good governance. With improved governance things can change for the better; without it, this will not happen. Key aspects of governance include better planning frameworks that will guide effective and efficient responses to environmental issues and implementation on the ground. Implementation will be undertaken by a capable and effective staff within all levels of government. Staff will enforce and manage the various sectors within the environmental field, ensuring effective monitoring, compliance and enforcement. Resources will be fairly allocated and used to enforce compliance and to build skills and capacity. Improved governance that supports sustainable development and effectively protects the environment will yield multiple economic benefits for Limpopo.

4.4 References

DEA. 2013. *Long Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa. Climate Trends and Scenarios for South Africa.* Pretoria: Department of Environmental Affairs.

Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2013. *Limpopo Conservation Plan version 2.*

Limpopo Provincial Government (LPG). 2015. *Annual Performance Plan 2015 – 2016*. Internet material accessed 16.03.2016: http://www.lda.gov.za/Annual%20Reports/APP%202015-16.pdf. Published by Limpopo Economic Development Agency.

Statistics South Africa (StatsSA). 2015. *Environmental Economic Accounts Compendium.* Statistics South Africa, Pretoria.

5 Recommendations

5.1 Recommendations for the Key Challenges

The Limpopo Environment Outlook Report (LEO Report) paints a clear picture of the realities that affect the environment in Limpopo, and the impact on its people. It also points to various actions that need to be taken to place the Province firmly on a sustainable path.

Key challenges in the different chapters brought forth a range of recommendations for action to be taken by the Limpopo Provincial Government, Local Government, the private sector, communities and down to the level of individuals. If the implementation of these recommendations is well co-ordinated and effective, the Province will find itself firmly on the road to the desired state described in the previous chapter.

The following Key Challenges were identified by the stakeholders and specialists as part of the process of compiling the LEO Report, in no particular order of priority:

- Climate Change;
- Water Resources;
- Land and Transformation;
- Waste Management; and
- Environmental Governance.

The recommendations regarding the Key Challenges are presented below in a check-list format, so they can be easily found and referred to.

5.1.1 Climate Change

The following recommendations for action by Province are made:

1 Implement early warning systems and disaster relief programmes for the predicted increase in droughts and floods, as a short- to medium-term measure to manage the effects of climate change.

2 Promote with greater urgency the use of cleaner technology across Limpopo and increase the implementation of renewable energy programmes.

3 Ensure adequate funding and capacity for research on climate change and its impacts on society and the environment in order to guarantee the development of appropriate strategies and policies focused on local-level adaption, including funding increases for renewable energy and energy efficiency interventions.

4 Integrate, on an ongoing basis, the findings of climate change studies and proposals for adaptation strategies into planning and development across sectors.

5 Steadily reduce the dependence on fossil fuels through a focused drive to develop cost-effective alternative sources of energy, including solar, wind, water, hydrogen, nuclear and biomass. Particular attention should be paid to developing and implementing market incentives and disincentives to promote energy efficiency, renewable energy and cleaner technology.

6 Draft a strategy in response to climate challenges for Limpopo, focusing on adapting to climate change, developing a sustainable energy programme, adopting an integrated response by the relevant government departments, compiling inventories of greenhouse gases (GHGs), accessing and managing financial resources, and promoting research, education and training.

5.1.2 Water Resources

The following recommendations for action by Province are made:

1 Urgently expand existing water conservation and water demand management initiatives across sectors, and develop strategies to promote the reuse of treated sewage or mine water by industry.

2 Integrate land and water policy and management. At the local level, provide additional resources and build capacity to ensure that this takes place in integrated development plans and catchment management strategies.

3 Protect water resources, in particular more pristine water sources, in order that their quality does not further deteriorate as a result of a change in land use or management practice.

4 Ensure sustainable water resource use in Limpopo.

5 Mainstream the management of water resources and place it at the forefront of all planning.

6 Strengthen institutional and regulatory capacity urgently, particularly with respect to monitoring, management and increasing the availability and capacity of decision-making tools. In addition, change water use behaviour among all sectors and users, and implement water conservation and water demand management measures more effectively.

7 Local communities should act on the following recommendations to contribute to water quantity:

- Do not leave taps dripping; get them repaired.
- Do not waste water when watering their gardens.
- Capture rainwater for use in the garden.
- Water gardens during cool periods in the day, when there is less evaporation.
- Adhere to water-saving regulations.
- Use water from the kitchen/bathroom to water gardens.
- Plant indigenous species, which do not have large water requirements, in their gardens.
- Only flush the toilet if necessary (place a brick in the cistern and save water).
- Install two-system flush toilets.
- Rather have a quick shower than a deep bath; it uses less water.
- Attend environmental awareness programmes.

8 Local communities should act on the following recommendations to contribute to water quality:

- Do not flush foreign materials down the toilet.
- Do not throw waste (that is, oil, household waste, and the like) into the sewer or storm water system.
- Report any leaking water or sewerage pipe to the Municipality or local councillor.
- Report unlawful discharge of effluent by industry, business and/or the mining sector to the local health department.
- Harvest storm water on their property and use it for irrigation purposes. Ensure that there are soft permeable surfaces on their property.

5.1.3 Land and Transformation

The following recommendations for action by Province are made:

1 Stop and reverse degradation in grazed landscapes as an opportunity to protect biodiversity.
2 Strengthen agricultural extension and support services.
3 Devise integrated and holistic programmes to deal with sustainable land management.
4 Optimise the utilisation of land for supporting livelihoods, while at the same time improving environmental conditions.
5 Avoid land degradation, particularly in grazed landscapes.
6 Ensure the availability of reliable information and data on land resources.
7 Compile reliable temporal and spatial data for land cover and use, and for degradation and desertification.

The following recommendations for action by Local Communities and Individuals are made:

1 Encourage your community to grow food crops for subsistence and small community markets.
2 Create your own compost heap to feed your vegetable garden.
3 Collect rainwater to water your urban crops.
4 Introduce practical and workable solutions to food security programmes.
5 Initiate and take part in community forestry programmes in your area.

5.1.4 Waste Management

The following recommendations for action by Province are made:

1 Finalise and implement the Integrated Waste Management Plans for the Local Municipalities in Limpopo.

2 In addition, implement more effective monitoring and planning for hazardous waste disposal across the Province.

3 Give priority attention to the performance of general formal and informal waste sites in terms of effective implementation and monitoring at the local level.

4 Designed and launch further waste recovery initiatives in the Province, including:
- Recycling and garden waste drop-off centres, where waste is delivered by members of the public to drop-off centres already separated into glass, paper, cans, scrap metal, plastics, garden waste and other waste.
- Collection banks to be used on a small scale for glass and paper.
- Recyclable waste buy-back centres in some lower income group communities.
- Waste-minimisation activities, including composting garden waste, kerb side collection of recyclables and waste material recovery.

The following recommendations for action by Local Communities and Individuals are made:

1 Participate in a meaningful manner in landfill site monitoring in your area.
2 Get involved in the initiative to secure landfill sites for the future.
3 Recycle your waste at home.
4 Practise composting of all organic waste.
5 Support initiatives to reduce the packaging of products.
6 Reuse *waste items*, wherever possible.
7 Support clean and green campaigns.
8 Teach waste separation at nursery school level.
9 Undertake waste separation at home.

5.1.5 Environmental Governance

Four fundamental cross-cutting issues have been identified as key leverage points for change. To confront and deal effectively with the Key Challenges facing Limpopo, the following recommendations pertaining to Governance are made:

1 Improve implementation and enforcement significantly:

- Facilitate implementation and enforcement in key environmental priority areas by consolidating and co-ordinating crucial sectoral provisions in the National Strategy for Sustainable Development.
- Ensure public reporting and oversight.
- Improve the capacity within regulatory authorities to manage, implement and review the various Integrated Environmental Management procedures and tools effectively, notably the new EIA Regulations.
- Mobilise sufficient resources and ensure appropriate, adequate and continuous training for Environmental Management Inspectors throughout the country.
- Train the judiciary in the principles of environmental management and sustainable development and build legal capacity within the relevant national and provincial departments.

2 Increase and consistently monitor information and make it accessible:

- Build on the process initiated by the Department of Provincial and Local Government in 2001 to develop a comprehensive national monitoring framework. Ensure a good fit between key sustainability indicators and those reported on in the integrated development planning process at local level.
- Integrate the collection, management and sharing of information and reports on environmental and other related matters across all government departments and research institutions, particularly for cross-cutting data sets.
- Set in place mechanisms to fill data gaps for environmental priority areas and to monitor progress. Gaps to be filled include areas of air quality, carbon emissions, some aspects of water quality, groundwater use and recharge, spatial aspects of land and habitat degradation, cultural heritage, human vulnerability and certain aspects of biodiversity. These mechanisms must be supported by the ongoing development of appropriate environmental indicators and indices.
- Ensure the appropriate translation of environmental science and research into practical policy and into public information that is useable and understandable.

3 Build the capacity of Provincial and Local Government:

- Address the challenges of Limpopo's current land-use planning and administration to deal effectively with the priority environmental issues identified in this report. Use a range of mechanisms, including improving capacity for strategic environmental assessments, to underpin the spatial development framework of local integrated development plans.
- Focus capacity-building efforts for environmental management at the local level on the priority environmental issues identified in this report, including air quality, biodiversity, and climate change. Capacity-building initiatives must take place at appropriately

senior levels in order to embed environmental considerations in municipal strategies and plans.

- Establish partnerships to improve access to information and build the skills that non-governmental and community-based organisations need for participating in technical debates regarding environmental management and sustainable development. Special attention should be given the organisations that represent women, youth and vulnerable groups.

4 Shoulder the joint responsibility to ensure sustainable development:

- Target and develop community environmental education and awareness campaigns that make a clear link with societal priorities such as poverty and employment. Ensure that the campaigns incorporate simple strategies for action and are identified with champions who have the power to mobilise support.

- Develop mechanisms to encourage companies and investors to become more committed to sustainability, in recognition that this may enhance reputation and reduce business risk, and that a strong interrelationship exists between sustainability and long-term shareholder value.

5.2 Recommendations for the Other Challenges

The following are other challenges identified during the process of compiling the Limpopo Environment Outlook Report and are also of importance:

- Air Quality and Atmosphere;
- Biodiversity and Ecosystem Health;
- Energy;
- Economics; and
- Human Settlements.

The recommendations pertaining to other challenges for action by the Limpopo Provincial Government, Local Government, communities and individuals to attain the desired state are presented below.

5.2.1 Air Quality and Atmosphere

The following recommendations for action by Province are made:

1 The number of the air quality parameters that are monitored should be extended. To quantify the potential impacts described in the State of Air Report 2005, additional pollutants should be monitored and more extensive monitoring is recommended for pollutants that are monitored at present at a very limited number of locations. In particular, these should include cancer risk pollutants, such as volatile organic compounds, and specifically benzene, as well as O_3 (potential damage to vegetation).

2 Considering the importance of climate change impacts, the need for quantification of mitigation and adaptation options, and the general lack of GHG ambient data for Southern Africa, GHG monitoring should also be extended.

3 Programmes and initiatives aimed at addressing air pollution, energy and climate change should be devised.

The following recommendations for action by Local Communities and Individuals are made:

1 Ensure that your family vehicle is using unleaded petrol.
2 Report any air pollution incidents to the Municipality or your councillor.
3 Make use of lift clubs, walk or use bicycles, wherever possible.

4 Initiate and propose the development of cycling lanes for your neighbourhood, linking with open spaces and other neighbourhoods.
5 Propose the improvement of road infrastructure in your neighbourhood to reduce dust pollution.
6 Take part in public monitoring of air quality standards (for example, SABS) to ensure that emissions from industries are within the set standards.
7 Minimise the burning of fossil fuels in your home where possible, by using alternative cleaner energy sources such as solar energy (for example, sunstones).
8 Schools should participate in the monitoring of air pollution stations.

5.2.2 Biodiversity and Ecosystem Health

The following recommendations for action by Province are made:

1 Prevent and control the impact of invasive alien species. This requires co-ordination and alignment of resource allocation and implementation strategies between the multiple institutions involved in preventing invasive alien species (plants, animals and micro-organisms) from entering Limpopo and controlling those already present in Limpopo.

2 Take urgent steps to conserve aquatic biodiversity, including enforcing control over effluent pollution and extending the River Health Programme assessments to cover all catchments. The results from these and other national assessments (such as the National Spatial Biodiversity Assessment) should be incorporated into water resources planning.

3 Mainstream biodiversity further by extending bioregional planning and provide ongoing support and incentives for incorporating such activities into land use planning and decision-making.

4 Expand the Protected Area network to incorporate a representative sample of Limpopo's biodiversity as well as key ecological processes.

5 Develop and implement in a co-operative manner wise-practice guidelines for production sectors that are major land users such as agriculture, infrastructure, property development, forestry and mining. This process should be complemented by regularly updating and standardising land-cover data so that it can be used for comparison purposes.

6 Increase the use of co-management agreements with communities and business to improve sustainable management of ecosystems.

7 Develop a monitoring and management plan for the biodiversity key indicators.

8 Establish appropriate environmental advisory bodies.

9 Invest in Geographic Information System (GIS) and database management and advisory bodies.

10 Manage and monitor datasets for protected areas, sites of ecological importance, protected areas and private nature reserves.

11 Fund and provide sufficient allocation for the allowance of proper management of conservation areas.

12 Province should assist Local Government with the following:
- Education programmes to sensitise the youth to the importance of wetland and river conservation
- Training of personnel in bio-monitoring methods
- Implementation of limited bio-monitoring surveys, within the framework of the National River Health Programme

The following recommendations for action by Local Communities and Individuals regarding biodiversity are made:

1 Support local reserves and conservation areas.
2 Plant indigenous trees in your garden.
3 Local schools should assist in managing reserves.
4 Take part in environmental education programmes.
5 Be aware of alien invasive species and assist your local authority in removing these species.
6 Familiarise yourself with the Red Data species in your area and take part in the protection of these species and their habitats.
7 Owners of land on ridges can protect their properties through formal legislation.
8 Communities can form conservancies to protect and manage ridges in their neighbourhoods.
9 The public should play a watchdog role by objecting to development proposals on ridges, bringing insensitive development proposals to the attention of local media and requesting that their local councils implement the policy fully.

The following recommendations for action by Local Communities and Individuals regarding ecosystem health are made:

1 Participate in community projects to remediate streams and remove alien plants within the different catchments.
2 Attend education programmes regarding river and wetland conservation.
3 Conserve the natural water systems in your community.
4 Take part in the establishment of secondary industries, which are linked to the eradication of alien vegetation (for example, furniture-making woodlots).

5.2.3 Energy

The following recommendations for action by the Province are made:

1 Make use of sources of renewable energy (for example, wind and solar energy).
2 Use less electricity and invest in energy-efficient appliances.
3 Start using bio-energy specifically in the rural areas; for example, wood chips for heating.

5.2.4 Economics

The following recommendations for action by Province are made:

1 A transition to a green economy is required to drive and implement economic and social sustainability.

2 A bold new economic direction, or orientation, is required – one of developing a number of explicit and aligned green economic strategies, policies, and programmes.

3 A complex set of tasks needs to be performed, which includes:
- A system of awareness creation at all levels;
- A definitive and authoritative re-planning process;
- Development of new indicators for monitoring and reporting; and
- Integrated multi-sectoral commitment by Limpopo Provincial Government.

The following recommendations for action by Local Communities and Individuals are made:

1 Take a course or learn new skills.
2 Invest in your entrepreneurial skills.

5.2.5 Human Settlements

The following recommendations for action by Province are made.

5.2.5.1 Settlements

1 Provide adequate shelter for all (performance of the Housing Programme):

- Effectively implement Local Government integrated development plans that identify well-located land for low-income housing.
- Local Government needs to be capacitated to plan, implement, develop and manage human settlements.
- Local Government needs to be capacitated to manage existing slums and prevent the establishment of new ones.
- Enable beneficiaries to *house themselves* through access to information, increased participation and building skills training, all within a user-friendly process.

2 Improve human settlement management (improving human settlement through Local Government):

- A key action required for local governments to succeed and become self-supporting is for National and Provincial Government to regularise the manner in which powers and functions are assigned to Local Government. To this end, the Framework for the Assignment of Powers and Functions to Local Government, as well as the Inter-governmental Relations Bill, will go a long way to ensure that Local Government does not have mandates that are not funded.
- There is a need to improve on the initial integrated development plans and ensure greater co-ordination by sector departments with integrated development plans.
- An action to promote financial independence of Local Government has been the promoting of local economic development within municipalities, in order to attract investments. However it is critical that future local economic development initiatives seek projects that harness comparative economic advantages of specific local governments.

3 Improve the financial viability of Local Government. This will also require:

- The co-ordination of funds from all relevant departments to Local Government;
- Affordable remuneration packages for Local Government staff;
- Improved revenue-raising skills; and
- Improved borrowing frameworks.

4 Improve Local Government capacity as follows:

- Establish new instruments, such as provincial response teams, Local Government administration support projects, skills programmes and learning networks.
- Ensure that skills are imparted to Local Government officials so as to reduce dependency on consultants.
- Ensure that capacity-building support in the provincial departments, particularly the sector departments, is not the sole responsibility of Local Government affairs departments in provinces but that other provincial departments also develop their own capacity-development strategies.
- Provide clarity on how integrated development plans relate to land use management tools. Key to this issue is finalisation of the Land Use Management Bill.

5 Promote sustainable land use planning and management (performance of land use management):

- The Land Use Management Bill, discussed, once legislated, will provide a far more detailed approach to land management than a focus on meeting the need for land redistribution. It will focus on the practical issues of developing land use frameworks and detailed land use planning procedures for Local Government.

- With regard to improving security in traditional authority areas, the Communal Land Rights Bill will address this issue.

6 Promote the integrated provision of environmental infrastructure: water, sanitation, drainage and solid waste management.

7 Promote sustainable energy and transport systems in human settlements.

8 Promote human settlement planning and management in disaster-prone areas.

9 Promote sustainable construction activities.

10 Promote human resource development and capacity-building for human settlement development.

The following recommendations for action by Local Communities are made:

1 Support new housing projects in your area, which consider passive solar energy principles.
2 Support housing projects by making use of local community skills and local building materials.
3 Participate in Environmental Impact Assessments (EIAs) in your area. Instil a sense of pride in your area.
4 Utilise the parks and recreational facilities in your area.
5 Visit the local tourist attractions.
6 Volunteer to help maintain the nature reserves, open spaces and conservation areas.
7 Support clean and green campaigns and participate in cleaning up urban open space areas in your community.
8 Volunteer to assist with the rehabilitation of disturbed and neglected areas in your community.
9 Avoid littering and illegal dumping in public open space.
10 Participate in recycling initiatives in your community.
11 Participate in alien vegetation removal programmes.
12 Participate in urban greening and community parks programmes in your community.
13 Report erosion and pollution caused by stormwater.
14 Share travelling lifts to work and school.
15 Walk or ride a bicycle, where possible.
16 Make use of public transport as much as possible.
17 Reuse waste products and recycling of effluent where possible.
18 Convert your French drain or septic tank to a vacuum/conservancy tank.

5.2.5.2 Human Vulnerability

The following additional recommendations for action by Local Communities are made:

1 Carry out local level vulnerability assessments, which should incorporate the possible effects of climate change, and integrate these into development and land-use planning.

2 Implement a programme to rectify the effects of past poor land-use planning processes. This would require incorporating environmental and human vulnerability considerations, including the possible effects of climate change, into development and land-use planning.

3 Assist vulnerable communities to build their coping capacity through initiatives to enhance social capital and to increase prevention and preparedness.

4 Fund research to understand better the interplay between the social, environmental, economic and political factors that determine vulnerability, and integrate the findings into policy and practice.

The Limpopo Environment Outlook Report was compiled by the Department of Economic Development, Environment and Tourism (LEDET) with support from EcoAfrica Environmental Consultants, Pty Ltd.

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