LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

LIMPOPO SPATIAL DEVELOPMENT FRAMEWORK

Phase 2: Spatial Analysis Report

Part B: Bio-Physical Analysis

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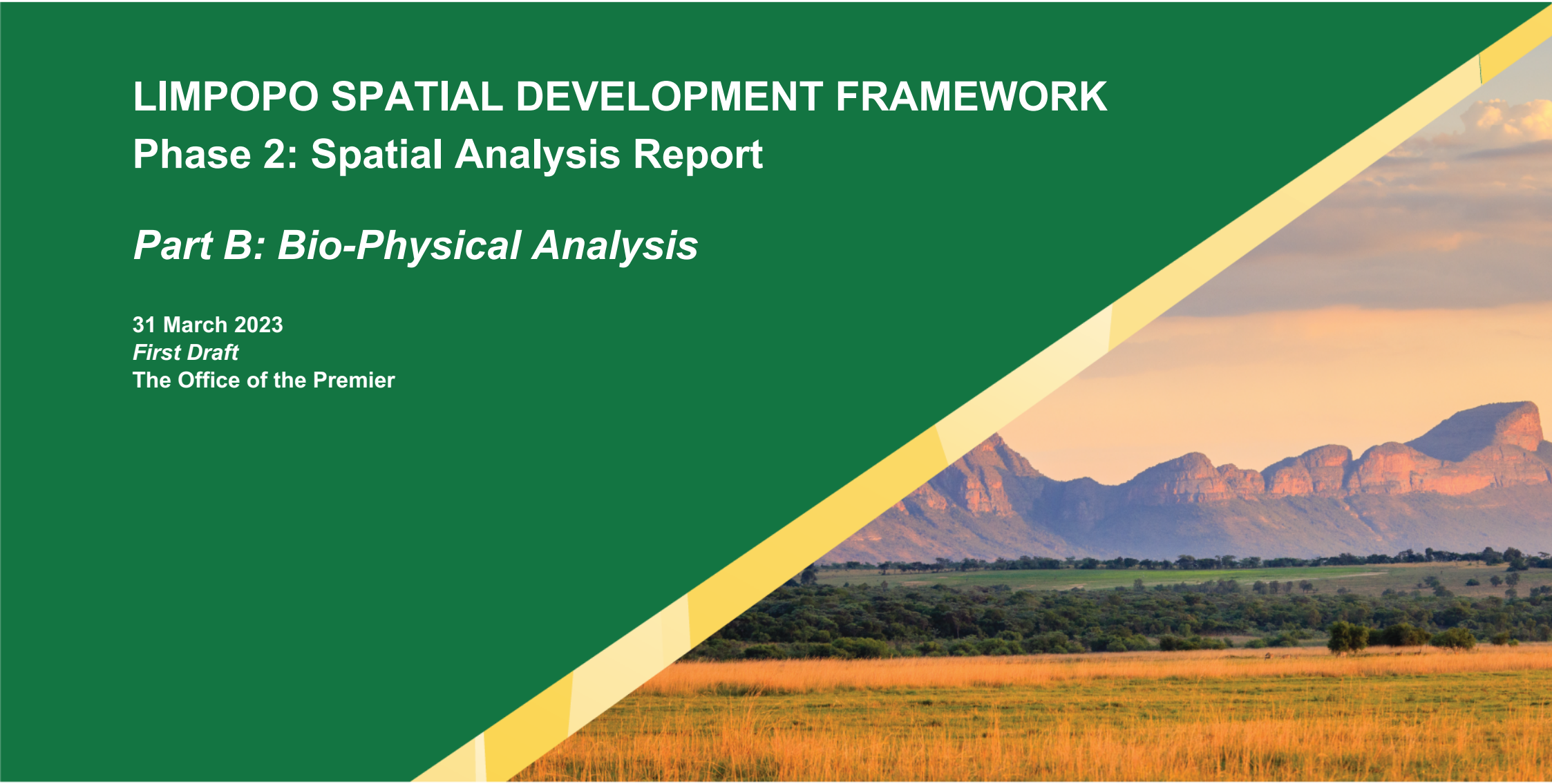
The Office of the Premier



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ABBREVIATIONS

Acronym		Term
AAGR	:	Average Annual Growth Rate
AAMP	:	Agro-Processing Masterplan
ADZ	:	Agricultural Development Zones
AfCFTA	:	African Continental Free Trade Area
AH	:	An Agricultural Holding established in terms of the Agricultural Holdings Act, 1919 (Act 22 of 1919)
AIDA	:	Accelerated Industrial Development for Africa
AMV	:	African Mining Vision
AU	:	African Union
BEPP	:	Built Environment Performance Plan
BIAT	:	Boosting Intra-African Trade
BBLU	:	Building Based Land Use
BDRR	:	Blue Drop Risk Rating
CAADP	:	Comprehensive Africa Agricultural Development Programme
CBO		Community-based Organisations
CDP	:	Cluster Development Programme
CIB	:	Central Innovation Belt
CIR	:	Capital Investment Framework
CLN	:	Customer Load Network
CRDP	:	Consolidated Rural Development Programme
CSIR	:	Council for Scientific and Industrial Research
CRU	:	Community Residential Units
COGHSTA	:	Department of Cooperative Governance, Human Settlement and Traditional Affairs
CWP	:	Community Work Programme
DALRRD	:	Department of Agriculture, Land Reform and Rural Development
DCoG	:	Department of Cooperative Governance
DDM	:	District Development Model
DEA	:	Department of Environmental Affairs (historical name)
DEFF	:	Department of Environment, Forestry and Fisheries
DGP	:	District Growth Point
DLRRD	:	Department of Land Reform and Rural Development (historical name)
DM	:	District Municipality
DMRE	:	Department of Mineral Resources and Energy
DoT	:	Department of Transport
DPME	:	Department of Planning, Monitoring and Evaluation
DSAC	:	Department of Sport, Arts and Culture
DSI	:	Department of Science and Innovation
DWA	:	Department of Water Affairs (historical name)
DWS	:	Department of Water and Sanitation
EbA	:	Ecosystems based Adaptation
EBSST	:	Electricity Basic Services Support Tariff
EDF11	:	Economic Development Fund Programme 11
EPHP	:	Enhanced People's Housing Process
ESA	:	Ecological Support Area
EU	:	European Union
FEPAs	:	Freshwater Ecosystem Priority Areas
FLISP	:	Finance-Linked Individual Subsidy Programme
FLNG	:	Floating Liquefied Natural Gas
FOA	:	Food and Agriculture Organisation of the United Nations
FPL	:	Food Poverty Line
FPSU	:	Farmer Production Support Unit
FTSEZ	:	Fetakgomo-Tubatse Special Economic Zone
GAAL	:	Gateway Airport Authority Limited
GDP	:	Gross Domestic Product
GLeWAP	:	Groot Letaba Water Augmentation Project
GLTP	:	Greater Limpopo Transfrontier Park
GSDF	:	Gauteng Provincial Spatial Development Framework
GTI	:	GeoTerraImage
GVA	:	Gross Value Added
HLEA	:	Highest Level of Education Attainment

HSDG	:	Human Settlements Development Grant
HSMP	:	Human Settlements Master Plan
ICP	:	International Cooperating Partners
ICT	:	Information and Communication technology
IDP	:	Municipal Integrated Development Plan
IDPF	:	Industrial Development Policy Framework
IDZ	:	Industrial Development Zone
IGF	:	Intergovernmental Forum
IGFRA	:	Intergovernmental Relations Framework Act
IPILRA	:	Interim Protection of Informal Land Rights Act, 1996
IPRP	:	Industrial Parks Revitalisation Programme
IRDP	:	Integrated Residential Development Programme
IRP	:	Integrated Resource Plan
ISPH	:	Infrastructure Strategic Planning Hub
IT	:	Information Technology
ITMP	:	Integrated Transport Master Plan
IUDF	:	Integrated Urban Development Framework
JMPT	:	Joint Municipal Planning Tribunal
KNP	:	Kruger National Park
KPA	:	Key Performance Area
LBPL	:	Lower-Bound Poverty Line
LDP	:	Limpopo Development Plan
LED	:	Local Economic Development
LEDA	:	Local Economic Development Agency
LEDET	:	Limpopo Department of Economic Development, Environment and Tourism
LIIMP	:	Limpopo Integrated Infrastructure Master Plan
LIMCOM	:	Limpopo Watercourse Commission
LM	:	Local Municipality
LIMP	:	Limpopo Industrialisation Master Plan
LNP	:	Limpopo National Park
LQ	:	Location Quotient
LRB	:	Limpopo River Basin
LSDF	:	Limpopo Spatial Development Framework
LSP	:	Local Service Point
LTGS	:	Limpopo Tourism Growth Strategy
LTPF	:	Long Term Planning Framework
LUMS	:	Land Use Management System
MEC	:	Member of Executive Council
MIIF	:	Municipal Infrastructure Investment Framework
MGP	:	Municipal Growth Point
MMSEZ	:	Musina-Makhado Special Economic Zone
MPSDF	:	Mpumalanga Provincial Spatial Development Framework
MPT	:	Municipal Planning Tribunal
MSA	:	Municipal Systems Act
MTSF	:	Medium Term Strategic Framework
MuSSA	:	Municipal Strategic Self-Assessment
MYHSDP	:	Multi-Year Human Settlements Development Plan
MYPE	:	Mid-Year Population Estimates
NAMP	:	National Airspace Master Plan
NBA	:	National Biodiversity Assessment
NBF	:	National Biodiversity Framework
NBSAP	:	National Biodiversity Strategy and Action Plan
NDC	:	Nationally Determined Contribution
NDP	:	National Development Plan
NDPWI	:	National Department of Public Works and Infrastructure
NEDLAC	:	National Economic Development and Labour Council
NEPAD	:	New Partnership for Africa's Development
NERSA	:	National Electricity Regulator of South Africa
NGP	:	New Growth Path
NPAES	:	National Protected Area Expansion Strategy
NRRA	:	National Resource Risk Area
NSAA	:	National Spatial Action Areas
NSC	:	North–South Corridor
NSDF	:	National Spatial Development Framework
NSTETR	:	National Spatial Transformation and Economic Transition Region
NWRS	:	National Water Resource Strategy
OTP	:	Office of the Premier

PDPF	:	Provincial Development Planning Forum
PGM	:	Platinum Group of Metals
PGDS	:	Provincial Growth and Development Strategy
PGP	:	Provincial Growth Point
PHP	:	People's Housing Programme
PHSHDAs	:	Priority Human Settlements and Housing Development Areas
PLTF	:	Provincial Land Transport Framework
RAAVC	:	Revitalisation of Agriculture and Agro-processing Value Chain
RAL	:	Roads Agency of Limpopo
REDZ	:	Renewable Energy Development Zone
RSA	:	Republic of South Africa
RSDF	:	Regional Spatial Development Framework
RISDP	:	Regional Indicative Strategic Development Plan
SADC	:	Southern African Development Community
SANBI	:	South African National Biodiversity Institute
SANRAL	:	South African National Roads Agency SOC Ltd
SAPP	:	Southern Africa Power Pool
SEZ	:	Special Economic Zones
SIC	:	Standard Industrial Classification
SIP	:	Strategic Integrated Projects
SWSA		Strategic Water Source Area
SACAD	:	South African Conservation Areas Database
SADT	:	South African Development Trust
SAMAC	:	Macadamias South Africa
SAPAD	:	South African Protected Areas Database
SDF	:	Spatial Development Framework
SDG	:	Sustainable Development Goals
SDI	:	Spatial Development Initiative
SEA	:	Strategic Environmental Assessment
SEZ	:	Special Economic Zone
SIPs	:	Strategic Infrastructure Projects
SLP	:	Social and Labour Plans
SOPA	:	State of the Province Address
SPLUMA	:	Spatial Planning and Land Use Management Act
StatsSA	:	Statistics South Africa
STISA	:	Science, Technology and Innovation Strategy for Africa
STOSAR	:	Support Towards Operationalization of the SADC Regional Agricultural Policy
STR	:	Small Town Regeneration
SWSA	:	Strategic Water Source Area
TBVC	:	Transkei-Bophuthatswana-Venda and Ciskei states
TFCA	:	Transfrontier Conservation Area
TRP	:	Title Restoration Programme
UBPL	:	Upper-Bound Poverty Line
UISP	:	Upgrading of Informal Settlements Programme
UK	:	United Kingdom
UN	:	United Nations
WHO	:	World Health Organisation
WHS	:	World Heritage Site
WMA	:	Water Management Area
WSA	:	Water Services Authorities
WSDP	:	Water Service Development Plan
WSP	:	Water Service Provider
WWTW	:	Wastewater Treatment Works
ZETDC	:	Zimbabwean Electricity Transmission and Distribution Company

2 Spatial analysis of the bio-physical environment

A detailed spatial analysis of the provincial bio-physical environment is presented in this document.

Limpopo's bio-physical environment is highly diverse, which offers both opportunities and constraints to development. These include:

- A rich natural resource base, in particular with regards to mineral resources, agricultural opportunities and eco-tourism.
- Significant environmental assets such as the Kruger National Park and other nature reserves, two World Heritage Sites, two Ramsar Wetlands, three Biosphere Reserves, two Transfrontier Conservation Areas, numerous Important Bird Areas and three Centres of Floristic Endemism.
- The key development constraint is a shortage of water. Further development of water resources is not a sustainable solution as most water resources are already over-allocated and under severe ecological pressure. The emphasis must be on water management and re-use and on promoting developments that are not water intensive.
- Ecosystems most under threat in the province are rivers, wetlands and mountain grasslands. Land uses that minimise pressure on these ecosystems should be preferred over intensive development.
- The main pressures on aquatic ecosystems are changes in hydrological regime and pollution, while the main pressure on terrestrial ecosystems is habitat loss due to clearing for agriculture, mining and afforestation.
- The province is vulnerable to the impacts of climate change, especially in areas where there is low resilience, such as where there is high reliance on subsistence farming.

This document consists of the following sections:

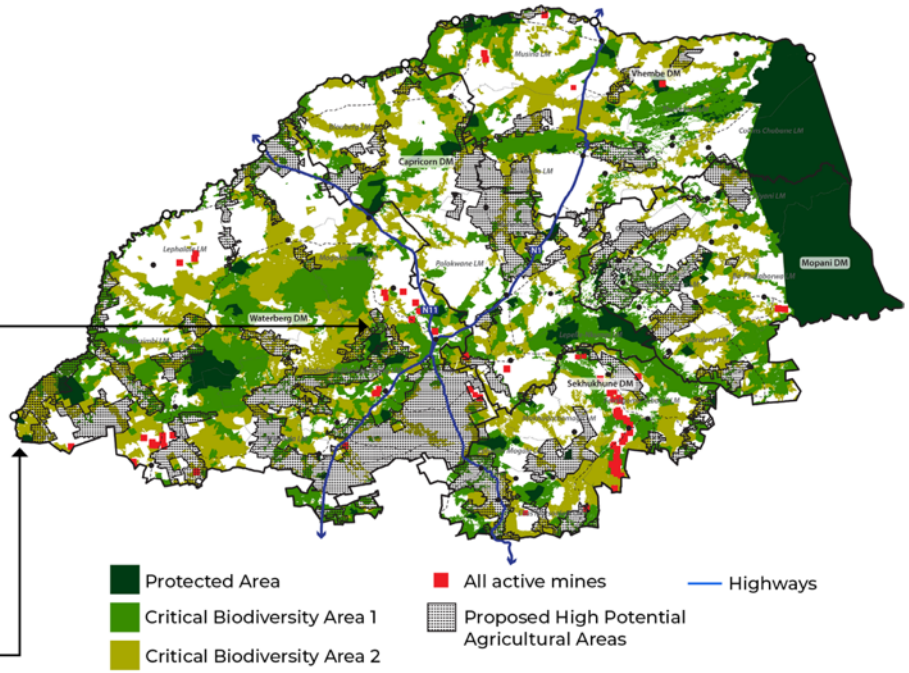
- Graphic summary: key bio-physical spatial issues
- Biodiversity protection
- Ecosystem services
- Climate change
- Natural resource economic base
- National resource risk areas
- Synthesis: bio-physical environment

BIODIVERSITY

CRITICAL BIODIVERSITY AREAS AND HABITAT LOSS

Habitat Loss is one of the main threats to biodiversity

- The **high level of terrestrial biodiversity** is a natural asset that can be capitalised on for tourism and nature-based developments
- A **key threat facing terrestrial ecosystems** in the province is continued habitat loss - an estimated 286 455 hectare of natural habitat was lost between 2014 to 2020 to **mining, cultivation, afforestation and urban settlement development**
- Extensive parts of the province are covered by **Critical Biodiversity Areas,** in some areas **conflicting with current and proposed developments** such as mining, residential and agricultural development (see map to the right)

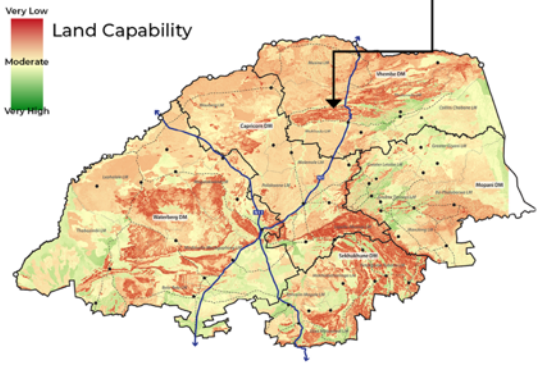


LAND CAPABILITY AND AGRICULTURAL ACTIVITIES

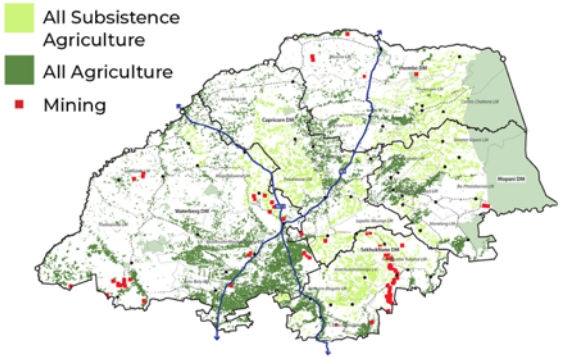
Extending Agricultural Development should be done with caution

- Overall the province has **low to very low Land Capability levels**, with only a few moderate to high capability clusters found in the southern and eastern parts
- **Subsistence agricultural** activities are spread throughout the **central parts** of the province, with **commercial agriculture largely clustered in the southern and eastern parts**
- Some of the **Proposed High Potential Agricultural Areas** in the province are in **conflict with the CBAs** and/or located in areas with low Land Capability levels

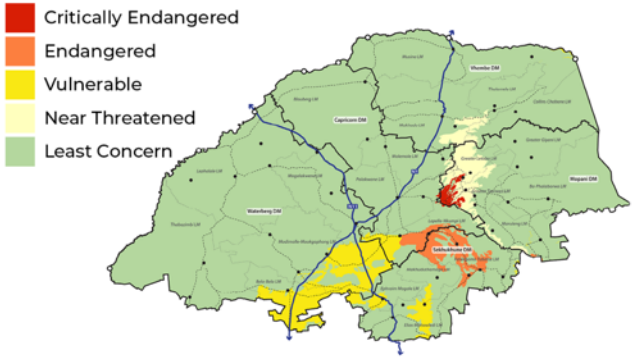
LAND CAPABILITY



AGRICULTURE AND MINING ACTIVITIES



TERRESTRIAL ECOSYSTEM THREAT STATUS



WATER RESOURCES

SEVERE PRESSURE ON AQUATIC SYSTEMS

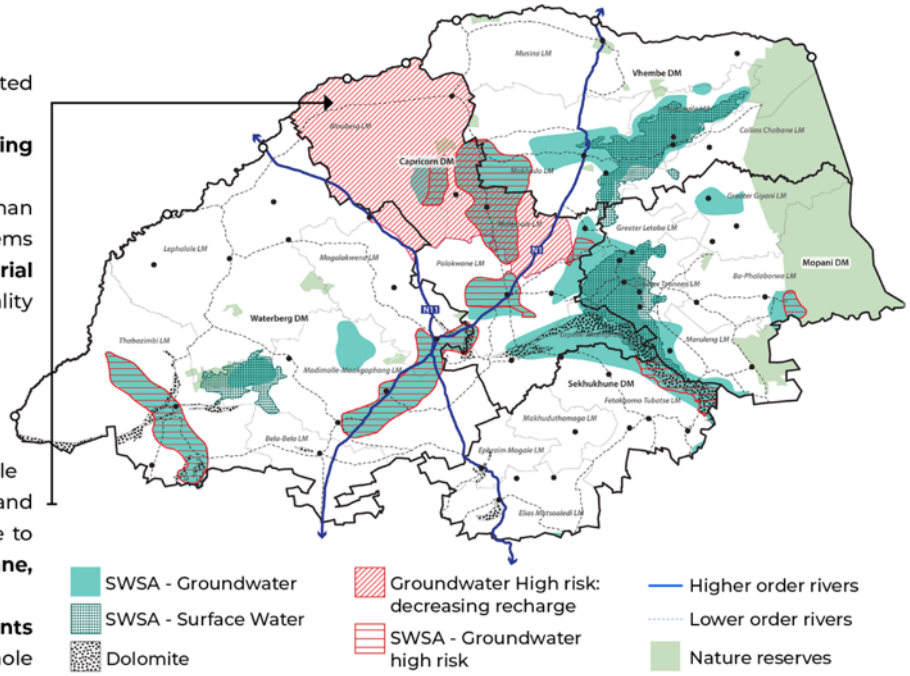
Only 35% of rivers in natural/near-natural condition

- The majority of the rivers in Limpopo are under severe pressure, with the rivers located in the central and southern parts of the province especially endangered
- The **greatest pressure** on aquatic systems are **abstractions, dams and deteriorating water quality**, with agriculture and mining as the biggest water users
- The **over-abstraction of water and building of dams** (primarily for crops, human settlements and mining) results in **direct negative impacts** on species and ecosystems
- The **pollution of inland aquatic ecosystems** by a combination of **mining, industrial and urban wastewater and agricultural** return flows negatively impacts water quality

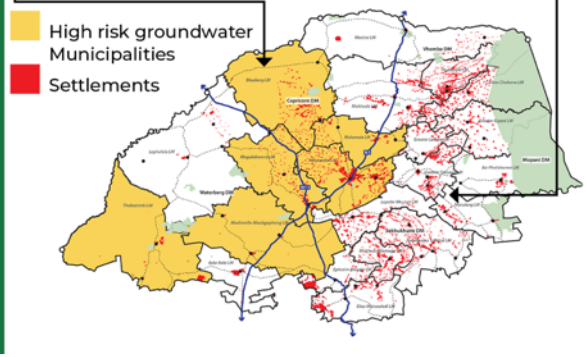
WATER AND DEVELOPMENT

Water is the key constraining factor for development

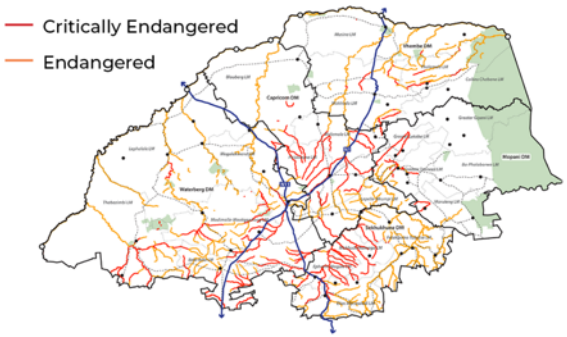
- Overall **water demand exceeds supply**
- Further dam development and abstraction schemes are not ecologically sustainable
- Further **groundwater extraction should be limited** in locations where demand already exceeds supply, and where groundwater recharge is likely to decline due to climate change, especially in SWSAs: **Blouberg, Molemole, Mogalakwena, Polokwane, Modimolle-Mookgophong and Thabazimbi**
- **Development should be carefully managed in SWSAs with extensive settlements** (eastern half of Limpopo Province), especially areas where Dolomite is present (sinkhole danger)



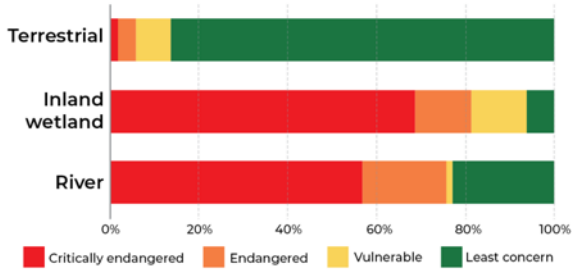
MUNICIPALITIES WITH HIGH RISK GROUNDWATER SOURCES



AQUATIC ECOSYSTEM THREAT STATUS



PERCENTAGE OF THREATENED ECOSYSTEMS IN EACH THREAT CATEGORY

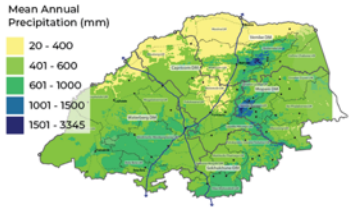


CLIMATE CHANGE

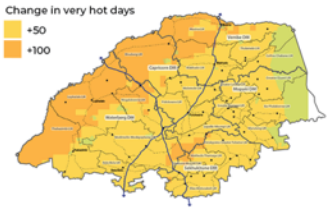
CLIMATE CHANGE PREDICTIONS 2050

- The whole of Limpopo Province will experience an **increase in maximum temperature**, with the **eastern half increasing by +3°C**, in addition there will be up to more than a **100 day increase in very hot days** on the **north-western border**.
- Although there is a slight increase in mean annual precipitation in some areas, **half of Limpopo** will have a **very high drought tendency by 2044**, specifically in the centre of Limpopo.

ANNUAL RAINFALL



CHANGE IN VERY HOT DAYS 2050



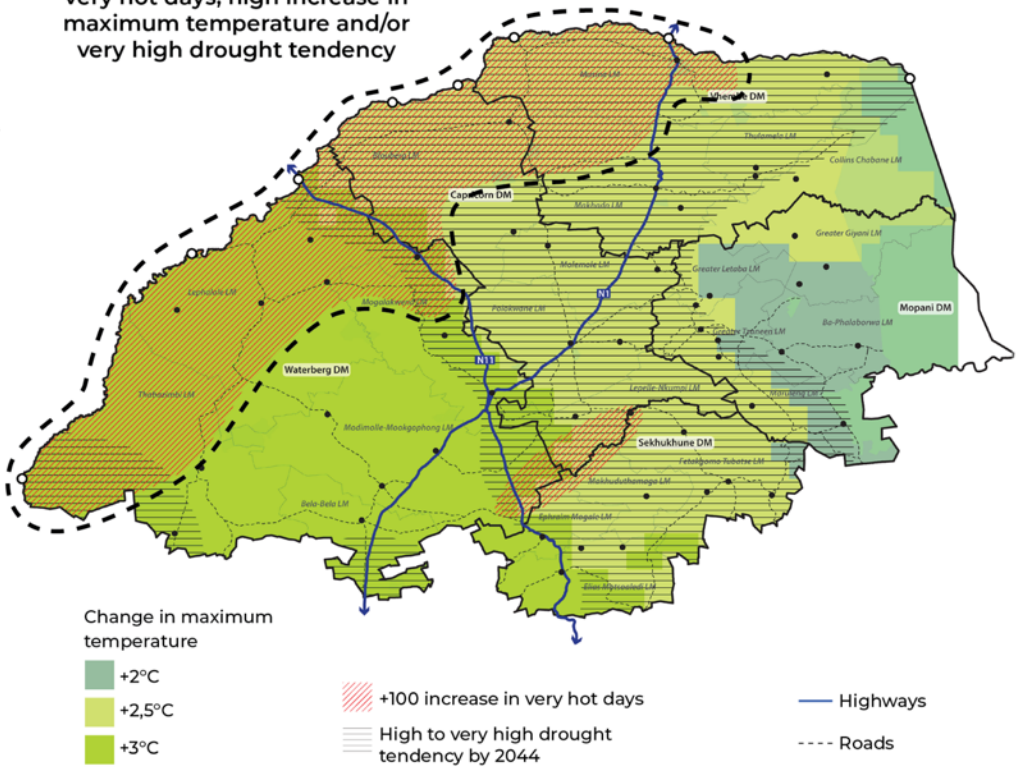
CHANGE IN ANNUAL RAINFALL 2050

CHANGE IN MAX TEMPERATURE 2050

CHANGE IN EXTREME RAINFALL EVENTS 2050

DROUGHT TENDENCY 2015 - 2044

Overlap of predicted increase in very hot days, high increase in maximum temperature and/or very high drought tendency



- Although the majority of Limpopo will be extensively impacted by climate change, it is the **municipalities bordering the north-western border of the province which will be most severely affected.** These areas already have relatively low rainfall levels, and it is predicted that these areas will experience an **increase in very hot days, as well as an increase in maximum temperature and/or very high drought tendency.**

2.1 Biodiversity protection

2.1.1 Topography and geology

2.1.1.1 Topography

The province is characterised by a diverse topography, as shown in Figure 1. The overall landscape can generally be divided into the lower-lying Lowveld, the mountainous escarpment, and the relatively flat and gently undulating landscape of the Limpopo plain and Bushveld areas. Prominent features include the rugged mountain ranges of the Waterberg, Drakensberg, Soutpansberg, Wolkberg and Blouberg and the river valleys of the Limpopo and Olifants rivers and their tributaries. Elevations range from around 200 m in the Lowveld to over 2,000 m in the mountainous regions.

This topographical diversity is reflected in the range of ecosystem types in the province, the varied climatic conditions experienced, and in the distribution of human settlement patterns and land use.

Settlement is largely constrained to the less rugged areas of the province and to where there is access to water and other natural resources.

The impact of topography on local climate, for instance, can be seen in the uneven rainfall distribution patterns and temperature variations across the province. Areas to the east of the Drakensberg escarpment receive higher rainfall due to orographic lift effect caused by the mountains, while areas to the west experience a rain shadow. North-facing slopes are typically hotter and drier than south-facing ones, which often creates micro-climates. Such variations in climate affect, amongst other things, are the agricultural potential of an area and the types of crops or agricultural activities that are most suitable in that area.

The higher rainfall and warmer temperatures to the east of the Drakensberg escarpment, for example, provide ideal conditions for the growing of subtropical crops, while the semi-arid Bushveld region is better suited to livestock and game farming.

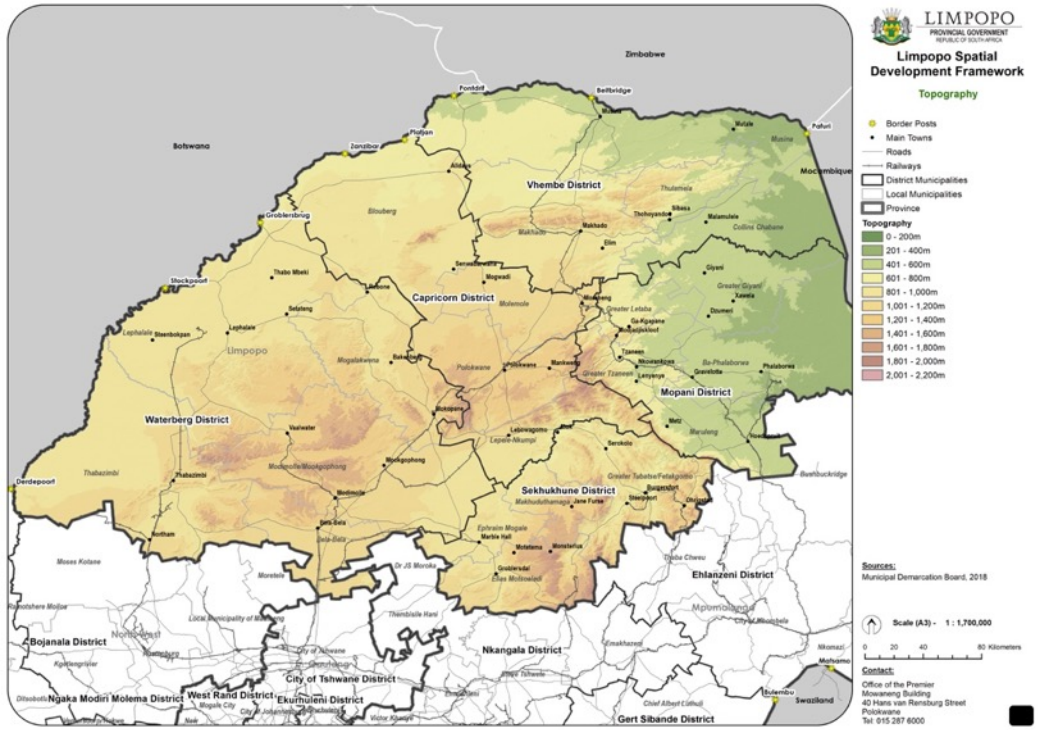


Figure 1: Topography of the province

The link between topography and the vulnerability of an area to natural disasters is also important to consider. Settlements in valley bottoms, for example, may be more susceptible to flooding, while mountainous grassland areas are more vulnerable to fire, as fire moves more quickly up slopes than along flat areas, and grass burns easily. These hazards are discussed in more detail in Sections 2.3.4 and 2.3.5 on climate change.

2.1.1.2 Geology

The province is underlain by the granite-greenstone-dominated Kaapvaal and Zimbabwe Cratons, the metamorphic Limpopo Belt, and the Bushveld Igneous Complex. It has a complex geology with over 14 different geological strata, as shown in Figure 2.

Due to this geological complexity, there are many different mineral resources in the province, and considerable variation in geologically related factors such as soil type and groundwater availability.

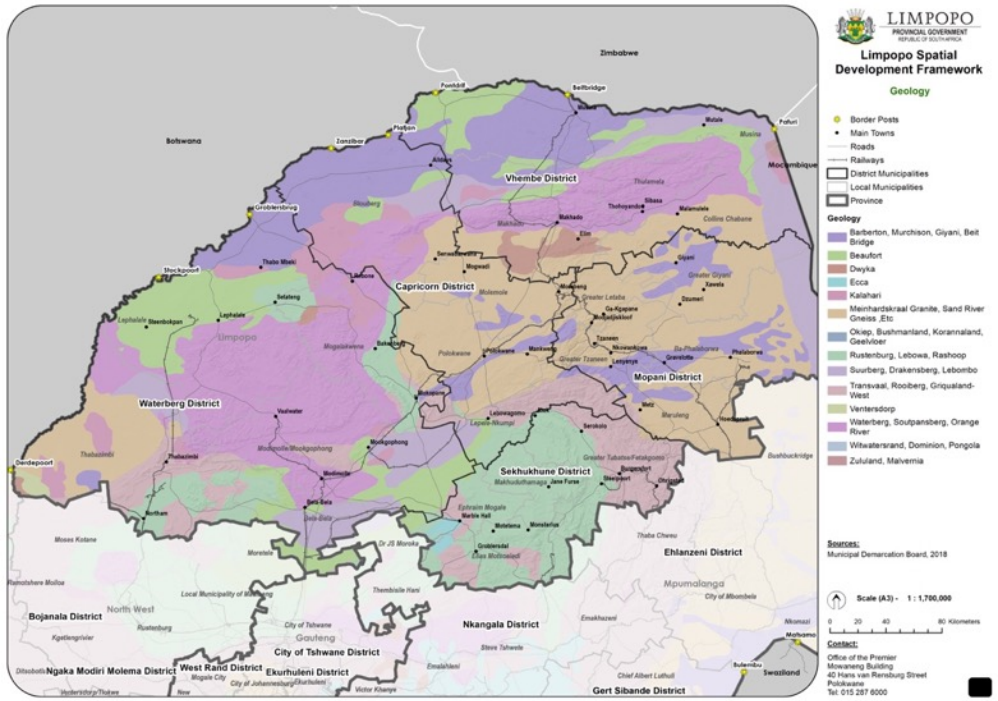


Figure 2: Geology

Key geological opportunities and constraints include:

Mineral resources

Important mineral resources in the province include the gold, antimony, copper-zinc, iron, asbestos, talc, mercury, magnesite and gemstone deposits of the Barberton Supergroup greenstones and the platinum group metals (PGMs) of the Bushveld Igneous Complex. The Bushveld Igneous Complex also contains significant quantities of iron, tin, chromium, titanium and vanadium. The orebodies within the complex include the chromite-containing UG2 Reef and the platinum-bearing Merensky and Plat Reef horizons. Other important resources include red-granites and significant coal reserves.

This wealth of mineral resources plays a leading role in the province's economy and is discussed further in Section 2.4.3

Ground stability – Dolomite and limestone areas

In Limpopo, dolomite formations are found primarily in the Malmani Subgroup of the Chuniespoort Group of the Transvaal Supergroup, while limestone is particularly evident north of Mokopane, as shown in Figure 3.

As these calcareous rock types are prone to sinkhole formation; ground stability becomes a potential development constraint in these areas. Dolomite stability investigations are therefore required where dolomite bedrock is present up to 60 m below the ground surface in a non-dewatering scenario, and up to 100 m below the ground surface in a dewatering scenario.

As sinkholes develop primarily because water erodes the dolomite or limestone formations, poor water management (e.g. leaks from water infrastructure, poorly managed surface drainage, and over-abstraction of groundwater or dewatering) can increase the likelihood of sinkhole formation (Council for Geoscience, 2011).

Fossils

The presence or absence of fossils in an area is dictated by rock type and can either constrain development in paleontologically sensitive areas or present the opportunity to protect and market an area as an important heritage resource.

Significant fossils in Limpopo are associated with Cenozoic cave breccias underlain by dolomite of the Transvaal Supergroup, the Permian Ecca Group and the Triassic aged red sediments of the upper Karoo Supergroup which are rich in dinosaur remains (Groenewald, 2014).

Geohydroloy and groundwater resources

Geology has a strong influence on groundwater availability and quality. Minerals leached from surrounding rocks may result in water that is unfit to drink or that requires expensive treatment. Groundwater resources are discussed further in Section 2.1.2.2 on hydrology.

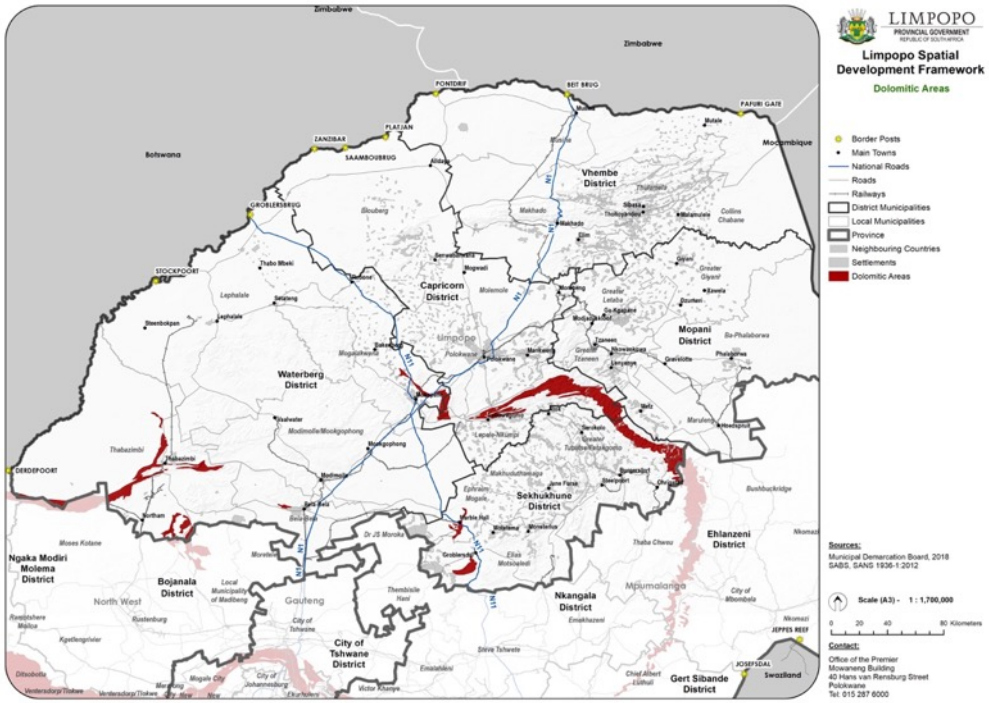


Figure 3: Dolomitic areas in the province

Soil type

Soil type is influenced by the underlying geology of an area and is relevant to spatial planning in terms of factors such as determining agricultural potential, sensitivity to erosion and suitability for building on. The area's complex geology results in a mosaic of different soil types.

The basalts and dolerites associated with the Drakensberg and Lebombo Groups were formed by lava flows, and typically weather to produce dolerite soils that are mineral-rich and clayey. They typically have good moisture-retaining capacity. Intrusions of dolerite in the form of dykes and sills can also be found and are often linked with good groundwater resources.

The shales, mudstones, tillites and sandstones associated with the Beaufort, Dwyka and Ecca Groups are sedimentary deposits with little inherent fertility. They tend to form soils that are fine, shallow and often high in sodium and magnesium; all characteristics promoting accelerated erosion if disturbed by cultivation or overgrazing.

The granites and greenstones may give rise to a variety of soil types, from the relatively poor granitic soils to the toxic (due to high mineral content) serpentine soils derived from the greenstones.

The influence of soil type is reflected in the identification of high potential agricultural areas. High potential agricultural areas in the province are discussed in Section 2.4.2.

2.1.2 Hydrology

The province falls within two Water Management Areas (WMAs), namely the Olifants and the Limpopo WMAs (

Figure 4). This is a reduction from the four WMA that previously covered the province due to a national redefinition of the WMA in September 2016.

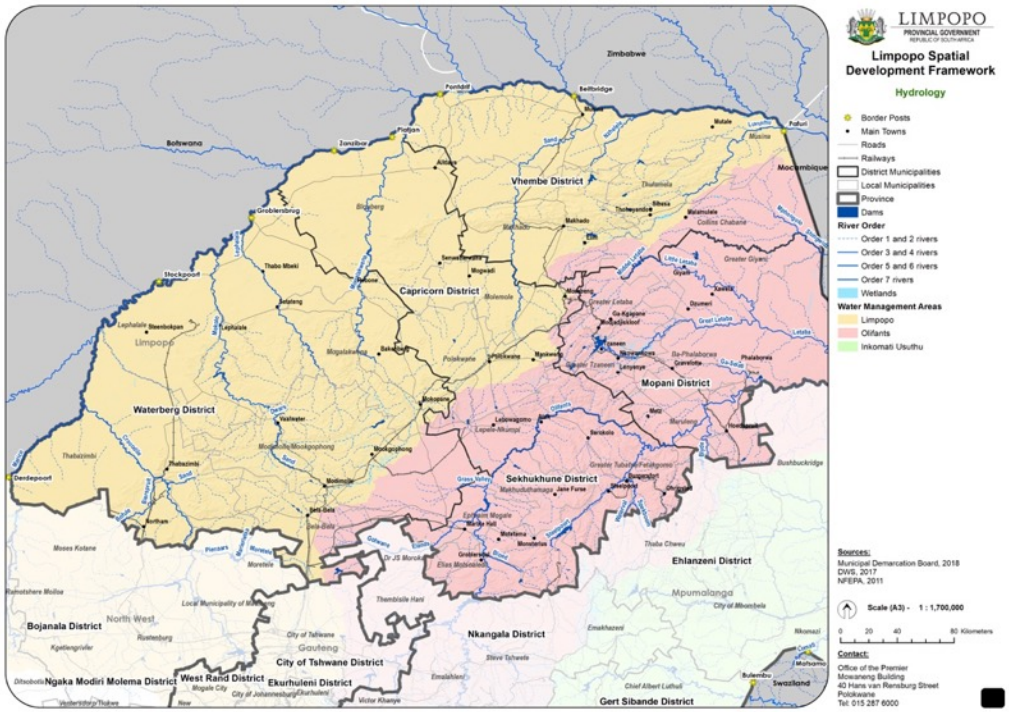


Figure 4: Hydrology, including rivers and Water Management Areas

2.1.2.1 Surface water

Surface water resources in the province include rivers, dams and inter- and intra-basin transfer schemes. Wetlands also form an important ecological resource.

Most of the province receives low rainfall, which limits the natural run-off generated. As run-off is also seasonal and variable, many of the smaller watercourses have only intermittent flow. Major, perennial watercourses include the Limpopo, Matlabas, Mokolo, Lephalala, Mogalakwena, Sand, Nzhelele, Mutale and Luvuvhu systems in the Limpopo WMA and the Elands, Wilge, Steelpoort, Olifants and Letaba river systems in the Olifants WMA.

The ecological state of the rivers in the province is mostly very poor, with only 35% of the river length in the province remaining in a natural or near-natural condition, as shown in Figure 5 (SANBI, 2019). Rivers still in a good condition are largely restricted to protected areas such as in the Kruger National Park and Waterberg. To ensure that they remain so, rivers in a near natural condition should continue to be protected and managed.

There are three flagship free-flowing rivers in the province, namely the Luvuvhu, Mohlapitse and Mutale, all of which are classified as Critically Threatened and poorly protected. As there are only 19 free-flowing rivers left in the whole of South Africa (SANBI, 2019), preserving their free-flowing status is important; and they should not be impounded or subjected to intensive development or abstraction.

The main pressures on aquatic systems in the province are changes in hydrological regime (e.g. the building of dams) and poor water quality. Over-abstraction is another critical problem, with the greatest water users still being agriculture, mining and human settlements. Pollution is largely the result of a combination of mining, industrial and urban wastewater and agricultural return flows (SANBI, 2019).

In the province, there are 28 main water supply dams, which provide a total full storage capacity of 1,480 million cubic metres, as indicated in Table 1. There are also numerous smaller local and farm dams. An extract from the weekly State of Dams on the Department of Water and Sanitation's website (https://www.dws.gov.za/Hydrology/Weekly/Province.aspx) shows that most of the dams were either close to full or overflowing in the first week of February 2023. This situation is typical for February, as the province is within the summer rainfall region and in winter the dam levels would be expected to be lower. Compared to the same period last year, most of the dam levels remain roughly the same, except for the Luphephe, Middel-Letaba, Modjadji, Tzaneen and Nsami dams, which show a significant decrease. The Doorndraai Dam shows a significant increase, as indicated in Table 1.

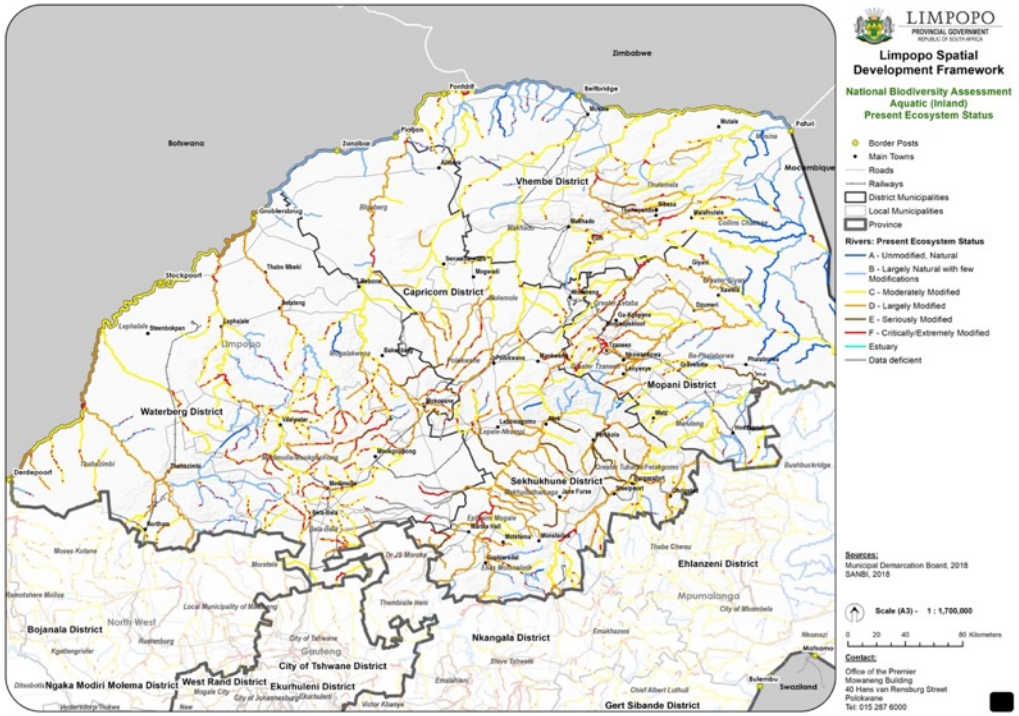


Figure 5: Present Ecological Status of rivers in the region

Table 1: List of dams and their storage capacity

Dam	River	Full Storage Capacity (Mm^3)	Feb 2022 (Week 1) (% full)	Feb 2023 (Week 1) (% full)
Albasini Dam	Luvuvhu River	28.2	99.7	98.1
Dap Naude Dam	Broederstroom River	2.0	105.6	99.9
De Hoop Dam	Steelpoort River	348.7	100.8	101.3
Doorndraai Dam	Sterk River	43.8	65.3	99.1
Ebenezer Dam	Groot-Letaba River	69.2	100.9	98.1
Flag Boshielo Dam	Olifants River	185.2	105.4	107.0
Glen Alpine Dam	Mogalakwena River	18.9	98.8	102.7
Hans Merensky Dam	Ramadiepa River	1.3	103.2	102.7
Houtrivier Dam	Hout River	6.7	96.5	95.4
Klaserie Dam	Klaserie River	5.7	101.0	101.3
Luphephe Dam	Luphephe River	14.0	101.8	82.9
Magoebaskloof Dam	Politsi River	4.9	101.1	100.6
Middel-Letaba Dam	Middel-Letaba River	172.0	4.6	0.7
Modjadji Dam	Molototsi River	7.2	62.8	38.0
Mokolo Dam	Mokolo River	145.8	104.2	101.2
Mutshedzi Dam	Mutshedzi River	2.4	96.2	101.6
Nandoni Dam	Levuvhu River	166.2	102.4	101.7
Nsami Dam	Nsama River	21.9	63.4	39.8
Nwanedzi Dam	Nwanedzi River	5.2	100.7	80.5
Nzhelele Dam	Nzhelele River	51.3	101.2	98.7
Rust De Winter Dam	Elands River	28.2	107.9	102.8
Tonteldoos Dam	Tonteldoos River	0.2	100.7	100.5
Tours Dam	Ngwabitsi River	6.1	100.6	100.5
Tzaneen Dam	Groot-Letaba River	114.3	101.4	82.4
Vergelegen Dam	Tributary of Politsi River	0.3	101.1	101.3
Vlugkraal Dam	Vlugkraal River	0.5	97.8	100.3
Vondo Dam	Mutshindudi River	30.5	101.5	101.5
Warmbad Dam	Buffelspruit River	0.6	101.6	101.6
Total		**1480.1**	**89.1**	**87.1**

Source: https://www.dws.gov.za/Hydrology/Weekly/ProvinceWeek.aspx?region=LP

2.1.2.2 Groundwater

In Limpopo, groundwater plays a strategic role in supporting economic development and sustaining water security in several rural and urban settlements that are either entirely or partially dependent on groundwater supply. Groundwater is, however, a natural resource whose availability and distribution is highly influenced by climate variability and change (CSIR, 2019). A large part of the province (ten municipalities) is very dependent on groundwater, with more than 60% of water used being groundwater. The municipalities with the greatest groundwater dependence (> 80% of water supplied from groundwater) include Lephalale, Blouberg, Mogalakwena, Molemole and Fetakgomo Tubatse. Five municipalities exceed 60% dependence, including Polokwane, Makhado, Greater Letaba, Modimolle-Mookgopong, and Makhuduthamaga. Some of these municipalities also have a large number of rural settlements, the majority of which might not have easy access to alternative water sources.

The main water uses of groundwater in South Africa are for irrigated agriculture (66%), mining (15%), domestic water supply (13%), livestock, industry use (including power generation) and aquaculture (6%). (CSIR, 2019)

Threats to groundwater include pollution and surface hardening, which does not allow for water to infiltrate the ground. Over-abstraction is also a problem, particularly in dolomitic areas where dewatering can increase the chances of sinkhole formation (Council for Geoscience, 2011).

2.1.2.3 Wetlands

There are several different wetland ecosystem types in the province, as shown in Figure 6, and a number of important wetland systems. Wetlands of especial note are the two Ramsar sites of Nylsvley and Makuleke, and the rare peatland wetlands in the Soutpansberg, the Matlabas mire in the Marakele National Park and the thermal springs at Malahlapanga in the Kruger National Park.

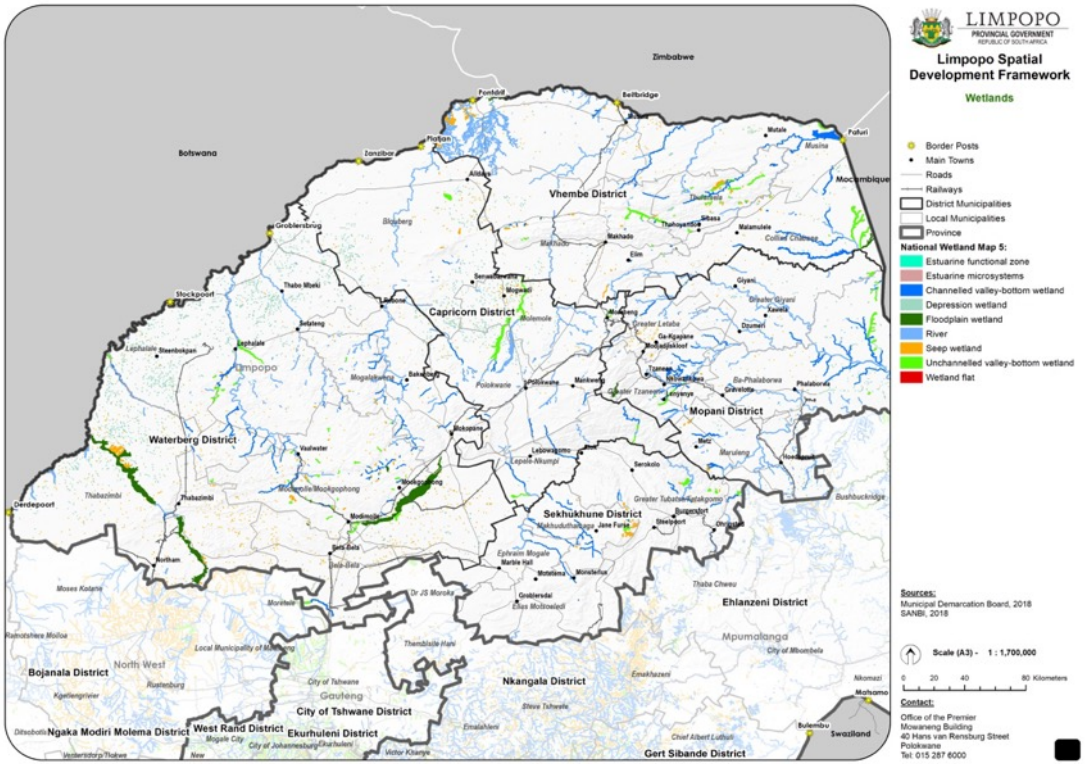


Figure 6: Wetlands

Wetlands in the province play an important role in regulating the quality and quantity of both ground and surface water and in providing habitat for endangered species. They have, however, been very heavily impacted on and the National Biodiversity Assessment (SANBI, 2019) estimates that less than 5% of ecosystem extent remains in a natural or near-natural condition. This is concerning, given the vitally important ecosystem services that wetlands provide such as being able to promote groundwater recharge, regulate water flow and help with flood attenuation. Wetlands will become increasingly important in the future to help mitigate the drop in groundwater recharge and the predicted increase in flooding in parts of the province due to climate change, which is discussed in Section 2.3.

Threats to wetlands in the province include mining, overgrazing and trampling by livestock, afforestation, changes in hydrological regime and water abstraction (DEA, 2019).

The following wetlands should receive priority for conservation and should not be subjected to intensive development in or close to them:

- Peat wetlands, which are an extremely scarce type of wetland, with only 1% of all wetlands in South Africa being peat (Grundling, Grundling, Pretorius, Mulders, & Mitchell, 2017). Important peat wetlands in the province include Marakele Park (the Matlabas mire) and the Malahlapanga thermal springs and wetlands in the Soutpansberg.
- The wetlands in the Strategic Water Source Areas, which are shown in Figure 7, as they help to maintain water quality (e.g. by trapping sediments and pollutants) and quantity (e.g. by regulating streamflow and promoting the infiltration of run-off).
- Wetlands in areas that are predicted to have a very high flood hazard index in the future due to climate change (refer to Figure 29 in Section 1.1.1 for a map of the high flood hazard index areas).
- The Ramsar wetlands.
- Wetlands identified as priority areas for rehabilitation by the Working for Wetlands programme managed by the Department of Environmental Affairs. Top-priority wetlands identified for the 2019-2024 term are centred in the Woodbush, Wolkberg and Soutpansberg areas (DEA, 2019).

Given their critical role, wetlands should be protected and rehabilitated as far as possible. Land uses that could compromise wetland functioning should not be allowed in wetland areas or in their immediate catchments, especially not in areas that are predicted to pose high flood risks in the future. Unsuitable land uses include ones that result in wetland fragmentation, catchment surface hardening (e.g. extensive urban development) or pollution (e.g. unlined landfill sites or intensively cultivated areas that release sediment and contaminated run-off). A minimum “no development” buffer of 500m from the delineated boundary of a wetland is often recommended as a guideline by the Department of Water and Sanitation when considering applications for Water Use Licences.

2.1.2.4 Strategic Water Source Areas

Strategic Water Source Areas (SWSA) are areas that are considered to be of national importance in terms of providing the country with water. Surface water SWSAs are defined as areas that supply a disproportionately large quantity of mean annual surface run-off in relation to their size, often to users a significant distance downstream. Groundwater SWSAs are areas that have a high groundwater recharge rate and where the groundwater resource is of national importance. Maintaining the quality and quantity of water in these areas is therefore paramount, as deteriorating water quality and quantity will have disproportionately large downstream effects (WWF, 2013).

Important SWSAs in the province include the Wolkberg, Soutpansberg and Waterberg areas for surface water and the Upper Sand (Polokwane) aquifer, the Vivo Dendron, Blouberg, Phalaborwa, Crocodile River Valley and Giyani areas, amongst others, for groundwater. The SWSAs are shown in Figure 7. Because of the national importance of SWSAs, proper water resource management in these areas is a high priority. The

Waterberg SWSA is already relatively well protected through the Waterberg biosphere reserve and the designated Critical Biodiversity Areas, which are discussed in Section 2.1.3.2. The Wolkberg and Soutpansberg areas are less protected. Groundwater SWSAs, especially in the central parts of the province, are poorly protected (not designated as Critical Biodiversity Areas) and are thus more vulnerable to development-related impacts such as over-abstraction and pollution.

Other threats to SWSAs include invasion by alien invasive plants, afforestation and other water-intensive land uses, as well as pollution (e.g. by sewage or wastewater) and ecosystem degradation. Spatial plans should be aimed at ensuring that ecological infrastructure (e.g. wetlands) in SWSAs is protected as far as possible. The focus should also be on limiting land uses that are water-intensive (e.g. afforestation, mining and crop irrigation) or that have a high potential for surface water pollution (e.g. heavy industry, mining or crops which require high levels of fertiliser or pesticides), and on preventing surface hardening as far as possible.

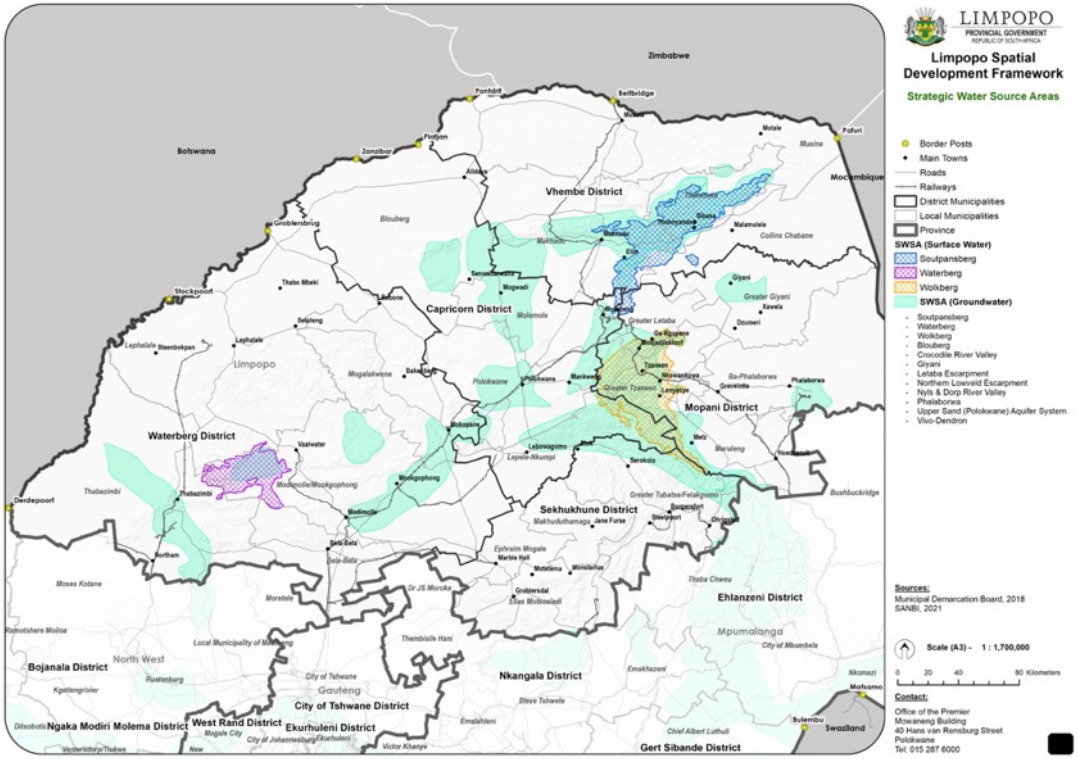


Figure 7: Strategic Water Source Areas – ground and surface water

2.1.2.5 Water resource management

Supply and demand

Limpopo is a water-scarce province and there are increasing demands on limited resources. The indication is that the overall demand will exceed the supply by 2045, and that there will still be a negative water balance in the near future, even if water re-use and saving methods are implemented. The situation is likely to be exacerbated by

climate change (as discussed further in Section 2.3), making water conservation and demand management of prime importance.

The ecological reserve requirements are factored into the water supply cycle. The ecological reserve is the amount of water that needs to remain in a river to keep it functioning from an ecological perspective. If this essential reserve is sacrificed to meet human demand, river ecosystems will collapse.

The dominant water user in the province is the agricultural sector, which accounts for more than half of all water use in the province. Mining is also a significant water user. The Limpopo Environmental Outlook Report (LEDET, 2016) and the Provincial Water Master Plan (DWS, 2017) indicate that water demands from these two sectors are likely to keep increasing to the point where supply will not be able to meet demand and alternative water sources will need to be looked at.

While the increased utilisation of groundwater has been suggested as an alternative, it may be unsustainable in the long term for certain areas, especially where there is high groundwater use and dependency. Water Conservation and Demand Management, water reallocation between sectors and the re-use of wastewater rather than the development of additional large-scale abstraction or transfer schemes must be considered.

Water Classes and Resource Quality Objectives

Another important water resource mangement measure that the Department of Water and Sanitation has implemented is the setting of water management classes and associated Resource Quality Objectives (RQOs) for both surface and groundwater supplies. Water management classes essentially describe the desired condition of the water resource and the degree to which it can be utilised. This is linked to RQOs, which set the water quality and quantity goals to be met to ensure sustainability. The classes and goals have considerable economic, social and ecological implications as they significantly impact on water allocation and availablility and become binding on all authorities or institutions when exercising any power or performing any duty under the National Water, 1998 (Act no.36 of 1998)

Water resource classes and quality objectives have been gazetted for the following systems:

- Olifants catchment (Government Gazette Notice 466 of April 2016)
- Letaba catchment (Government Gazette Notice 1617 of December 2016)
- Mokolo, Matlabas, Crocodile (West) and Marico catchments (Government Gazette Notice 562 of 2019)

2.1.3 Biodiversity assessment

A number of important biodiversity assessments have been undertaken since the 2016 LSDF, including the following:

- Bioregional plans for all the district municipalities, which have subsequently informed the 2018 revision of the Limpopo Conservation Plan Critical Biodiversity Area (CBA) map
- Limpopo Environment Outlook Report, 2016
- National Biodiversity Assessment, 2018
- Updates to the protected and conservation area databases (SACAD and SAPAD)
- South African National Land-Cover Assessment dataset, 2022

These help to identify current threat and protection levels and inform various spatial development plans such as Critical Biodiversity Areas, Protected Area Expansion Strategies and provincial and municipal planning documents.

2.1.3.1 National Biodiversity Assessment

South Africa's National Biodiversity Assessment (NBA) is the primary tool for monitoring and reporting on the state of biodiversity in South Africa. The outcomes of the assessment can be used to inform strategic biodiversity objectives and to feed into various policies, strategies and land-use planning decision-making (SANBI, 2019). The last NBA was undertaken in 2018.

The NBA includes an assessment of the extent to which ecosystems are threatened using the classification system developed by the International Union for the Conservation of Nature (IUCN) Red List categories, which are indicated in Table 2.

Table 2: Biodiversity threat classifications

CR	Critically Endangered – facing an extremely high risk of extinction in the wild
EN	Endangered – facing a very high risk of extinction in the wild
VU	Vulnerable – facing a high risk of extinction in the wild
NT	Near Threatened – close to qualifying for one of the above categories in the near future
LC	Least Concern – stable enough that risk of facing extinction in the wild in the near future is unlikely
DD	Data Deficient – not enough information to estimate risk of extinction
NA	Not Assessed – has not yet been evaluated

Terrestrial ecosystems

The threat and protection levels for terrestrial ecosystems in the province are shown in Figure 8 and Figure 9 and also summarised in Table 4. The table also indicates the historical, current (at the time the National Biodiversity Assessment was carried out in 2018) and predicted percentage of natural area remaining for each ecosystem type.

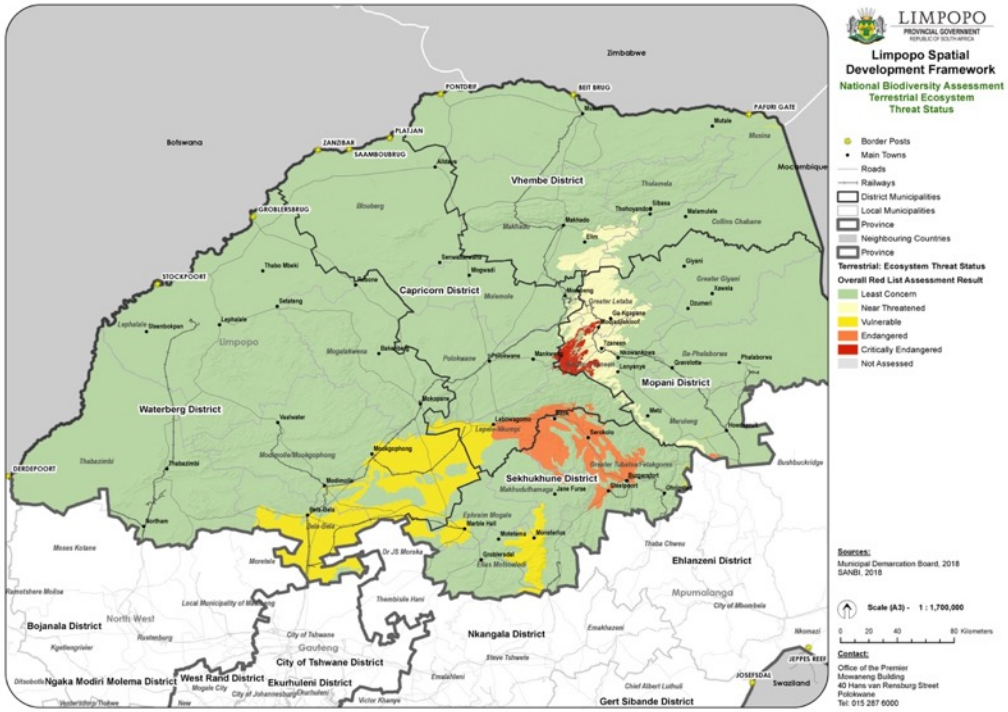


Figure 8: Terrestrial ecosystem threat status

Of the 51 ecosystem types in the province, 8 are considered threatened, the most critically endangered being the Woodbush Granite Grassland, which occurs along the western edge of the Greater Tzaneen local municipality near Moria and the Endangered Sekhukhune Plains Bushveld centred in the Wolkberg and stretching eastwards towards Steelpoort and Burgersfort.

According to the National Biodiversity Assessment (SANBI, 2019), the main pressure on the terrestrial ecosystem in the province is habitat loss, which is generally higher in the southern and central parts of the province.

A key threat is the continued habitat loss due to the clearing of land for croplands, settlements, plantations and mining, as indicated in Table 3. This table shows the change in land cover over the period 2014 to 2020, which totals an estimated 286,455 hectares of natural habitat loss to these uses.

Commercial cultivation and urban areas where the two uses that expanded the most in hectares over the said period.

Table 3: Land cover changes 2014 to 2020

Land cover class	New areas of expansion from 2014 to 2020	
	Hectares	%
Mining	9,548	34
Planted forest	23,276	30
Commercial pivot, irrigated cultivation	36,813	22
Commercial cultivation	153,698	18
Urban areas	63,120	15
Total	**286,455**	

Source: South African National Land-Cover 2014/2020 Change Assessment Report (DFFE, 2022)

Other pressures on terrestrial ecosystems include overgrazing and overstocking, changes to fire regimes, alien species invasions, mining, and climate change. Bush encroachment is also becoming widespread and impacting on species distribution due to habitat change.

Medicinal plant harvesting, poaching, and the hunting and trapping of birds, reptiles and mammals also remain ongoing pressures, especially in areas where human settlement has expanded into the borders of protected areas, resulting in increased hunting intensity for bushmeat and/or traditional cultural regalia (SANBI, 2019).

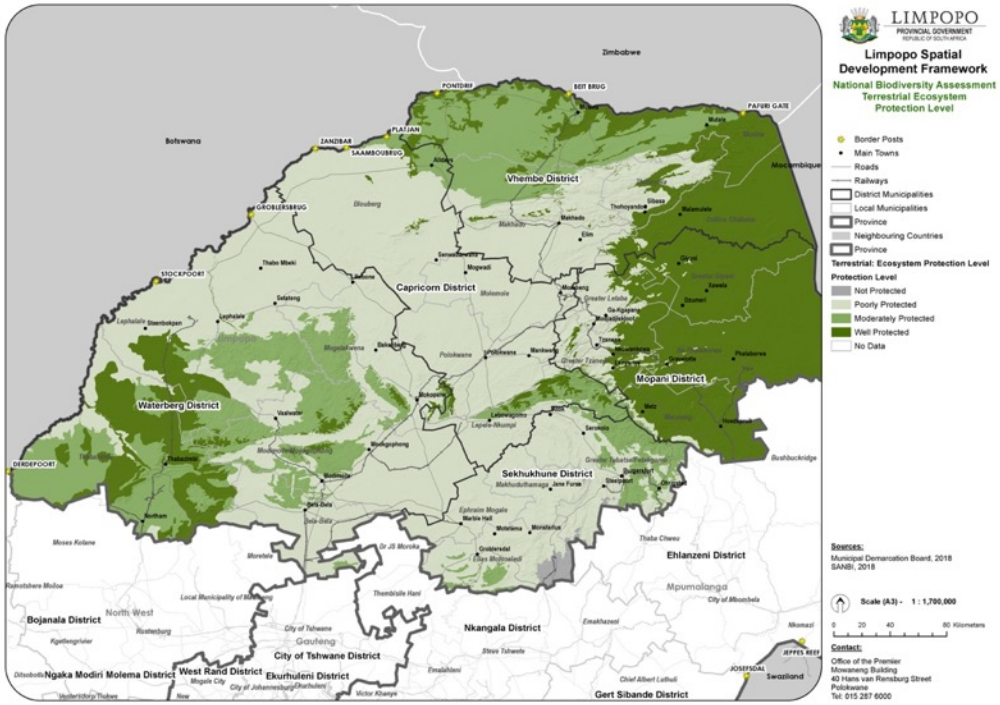


Figure 9: Terrestrial ecosystem protection level

Specific areas under threat include the following:

- The Leolo mountain range, where a number of endemic plant species are threatened by mining in the Sekhukhune district (SANBI, 2019)
- The high-altitude grasslands of the Soutpansberg, Waterberg and Strydpoort-Wolkberg complex, which are home to a high number of endemic and threatened terrestrial plant and butterfly species

While some of these areas are protected, livestock grazing is still causing significant habitat degradation. Improving the effectiveness of conservation management, especially in the grasslands of the Wolkberg area, is the most important action needed to reverse the recent trend of increasing risk of extinction for plant species in the province (SANBI, 2019).

While protection levels of the threatened ecosystems are fair, with 50% of the ecosystem types being considered well protected; the extent of the threatened ecosystems continues to decline, with all except the Tzaneen Sour Bushveld showing a decrease in extent since 2014. The protection levels are indicated in Table 4.

Aquatic ecosystems

Aquatic ecosystem threat and protect levels are shown in

and Figure 11 respectively.

As a whole, aquatic ecosystems in the province are under considerable threat, both in terms of ecosystem type and overall extent (SANBI, 2019). Around 75% of river ecosystem types are threatened, as shown in Figure 12, and most of the river systems are in a poor condition, as indicated in Figure 5. The most threatened river ecosystems are in the southern and central parts of the province (particularly the Olifants and its catchment), although most of the Crocodile and Luvuvhu systems are also critically endangered. The least threatened river ecosystems are the Letaba, most of the Singwidzi, some rivers along the northern borders to the west of Musina and the headwaters of the Mokolo and Lephalala. Most of these less threatened ecosystems lie within protected areas and are classified as moderately to well protected (Figure 11).

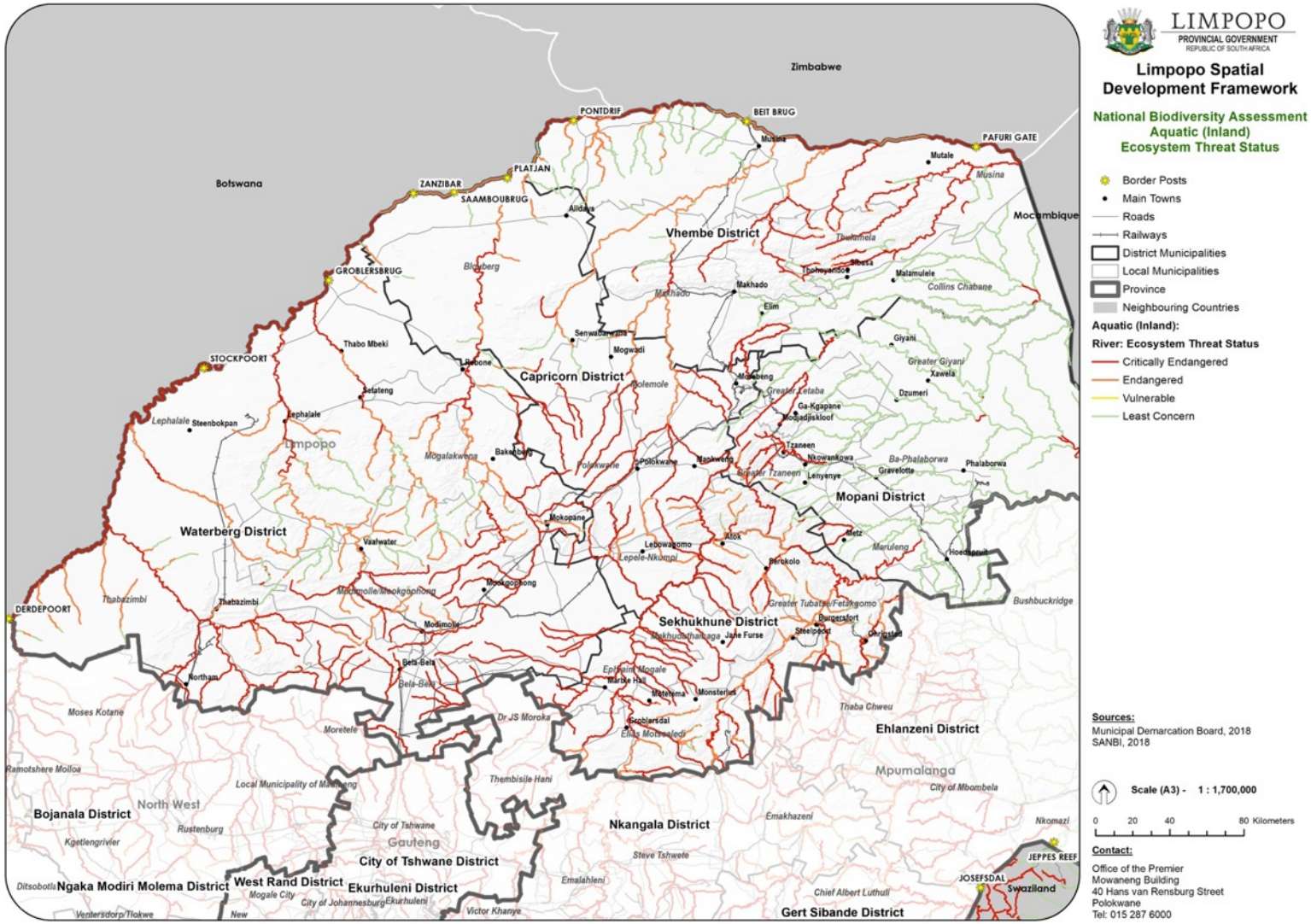


Figure 10: Aquatic ecosystem threat status

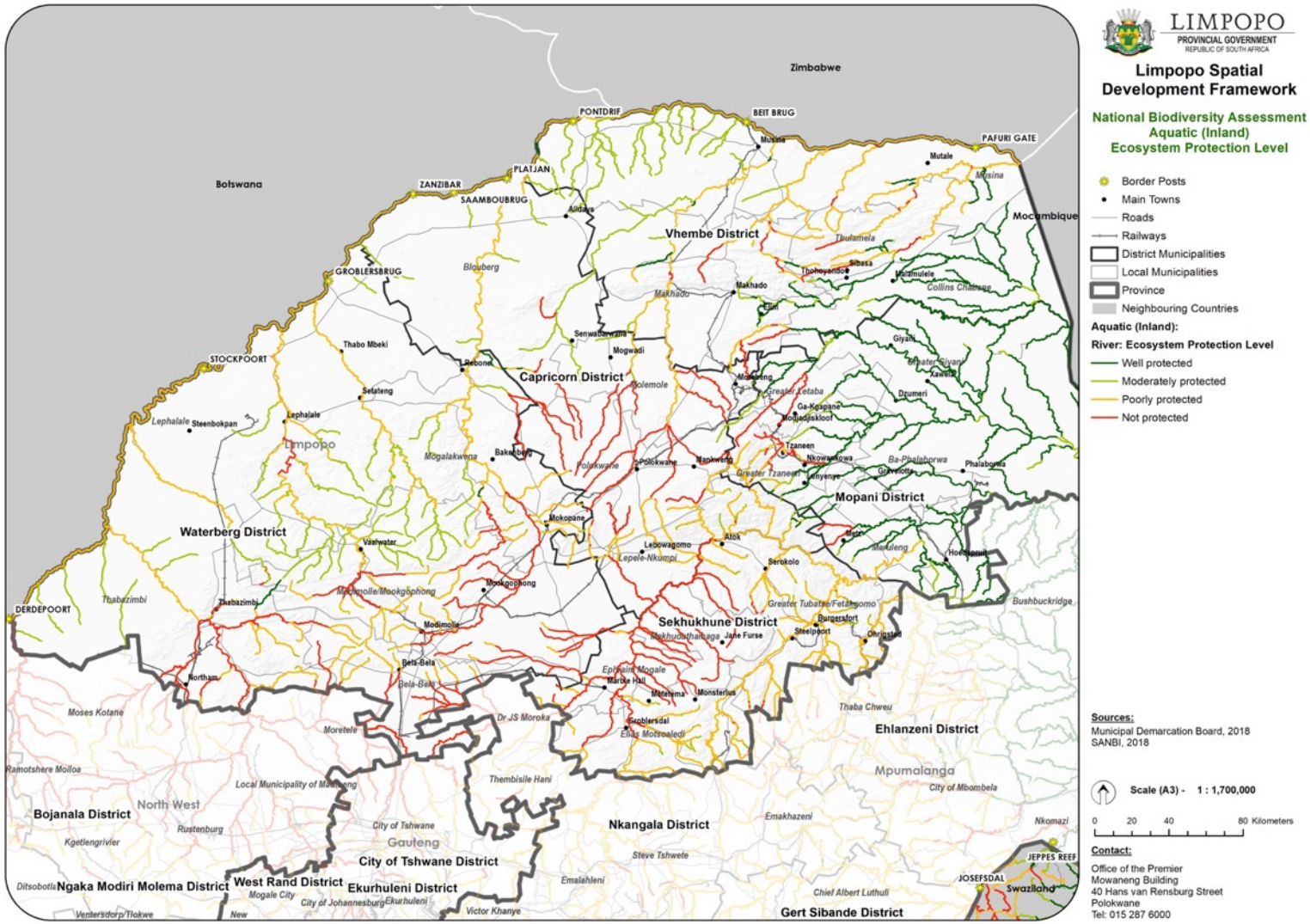


Figure 11: Aquatic ecosystem protection levels

Table 4: Summary of threatened terrestrial ecosystems in the province and their protection levels

Ecosystem type and Bioregion	Threat Status	% natural area remaining			Protection level and % protected	Classification reason
		2014	2018	2040		
Woodbush Granite Grassland (Mesic highveld grassland bioregion)	CR	27	25	21	Well Protected (80.3%)	The ecosystem type is narrowly distributed with high rates of habitat loss in the past 28 years (1990–2018), placing the ecosystem type at risk of collapse. Key pressures are plantations and agriculture. There have also been impacts from erosion, infrequent fires, bush encroachment and alien invasions. Although protection levels in Limpopo are good, there has still been a continued decline in natural area since 2014.
Sekhukhune Plains Bushveld (Central bushveld bioregion)	EN	48	46	35	Poorly Protected (43%)	The ecosystem type is narrowly distributed with high rates of habitat loss in the past 28 years (1990–2018), placing the ecosystem type at risk of collapse. Key pressures are agriculture, urban development and mining. There have also been impacts from overharvesting, alien invasion and erosion. Protection levels are poor and there has been a continued decline in natural area since 2014.
Tzaneen Sour Bushveld (Lowveld bioregion)	EN	53	53	48	Well Protected (35.4%)	The ecosystem type is narrowly distributed with high rates of habitat loss in the past 28 years (1990–2018), placing the ecosystem type at risk of collapse. It is considered well protected, and there has been no further loss of this type in the province since 2014.
Northern Escarpment Dolomite Grassland (Mesic highveld grassland bioregion)	EN	39	38	34	Well Protected (73.6%)	Northern Escarpment Dolomite Grassland is narrowly distributed with high rates of habitat loss in the past 28 years (1990–2018), placing the ecosystem type at risk of collapse. It is considered well protected, but still shows a slight continued decline in natural area.
Legogote Sour Bushveld (Lowveld bioregion)	EN	34	32	28	Poorly Protected (3.1%)	This ecosystem type is threatened mainly by plantations. Other pressures have been agriculture (croplands), urban settlements, erosion and alien plant invasions. Protection levels are poor, and it shows a continued decline in natural area since 2014.
Springbokvlakte Thornveld (Central bushveld bioregion)	VU	46	45	41	Not Protected (0.6%)	National land cover data shows that this ecosystem type has experienced extensive spatial declines of approximately 55% since 1750. It is not protected and shows a slight continued decline in natural area since 2014.
Lowveld Riverine Forest (Azonal forests)	VU	76	75	68	Well Protected (38.9%)	This ecosystem type is narrowly distributed with high rates of habitat loss in the past 28 years (1990- 2018), placing the ecosystem type at risk of collapse. It is considered well protected, but continues to show a slight continued decline in natural area since 2014.
Rand Highveld Grassland (Mesic highveld grassland bioregion)	VU	45	43	38	Not Protected (0.8%)	National land cover data shows that this ecosystem type has experienced spatial declines of approximately 57% since 1750. It is narrowly distributed and the high rates of habitat loss place it at risk of collapse. It is not protected.

Sources: Revised national list of terrestrial ecosystems that are threatened and in need of protection 2021 (Government Gazette No 2747 of 18 November 2022); (SANBI, 2022)

Wetland systems are also under threat, with 90% of the ecosystem types being threatened, as shown in Figure 12, and the majority of these either not protected or only partially protected.

The greatest pressures on the aquatic systems are increasing disruptions to the hydrological regime and deteriorating water quality. The over-abstraction of water and building of dams (primarily for crops, human settlements and mining) results in direct negative impacts on species and ecosystems, and also disrupts important ecological processes. The pollution of inland aquatic ecosystems by a combination of mining, industrial and urban wastewater and agricultural return flows negatively impacts water quality (SANBI, 2019).

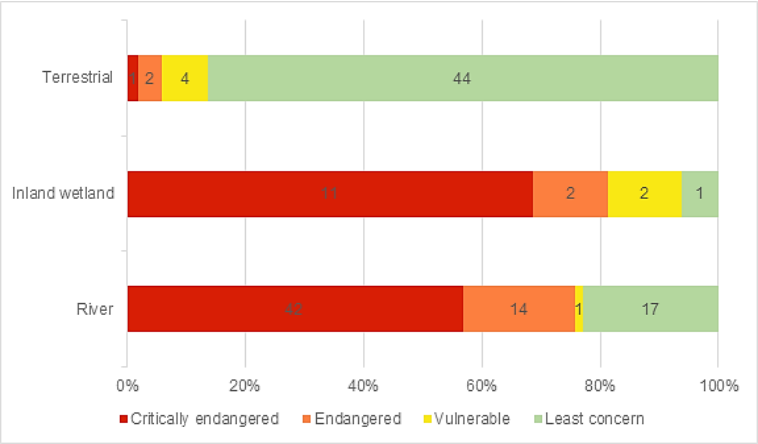


Figure 12: Percentage of threatened ecosystem types in each threat category

Data labels show the number of ecosystem types in each category. Source: (SANBI, 2019)

2.1.3.2 Critical Biodiversity Areas

The Critical Biodiversity Areas (CBA) Map produced in 2013 as part of the Limpopo Conservation Plan V2 was updated in 2018 based on input from the bioregional plans for the Waterberg (2015), Mopani (2016), Vhembe (2017), Sekhukhune (2018) and Capricorn (2018) district municipalities. The updated map is depicted in Figure 13.

The 2018 map is very similar to the previous version but has been refined in scale. There has a been a slight increase in CBA 1 and CBA 2 areas due largely to the declaration of additional protected areas, but a decrease in Ecological Support Area (ESA)1 due to continued habit loss.

The Conservation Plan and associated CBA map are important tools aimed at informing strategic decision-making and facilitating biodiversity conservation. The CBA Map is also linked to a set of land-use guidelines which describes the compatible and incompatible land uses associated with each biodiversity category. A summary of the generic CBA classification categories and land use guidelines is provided in Table 5.

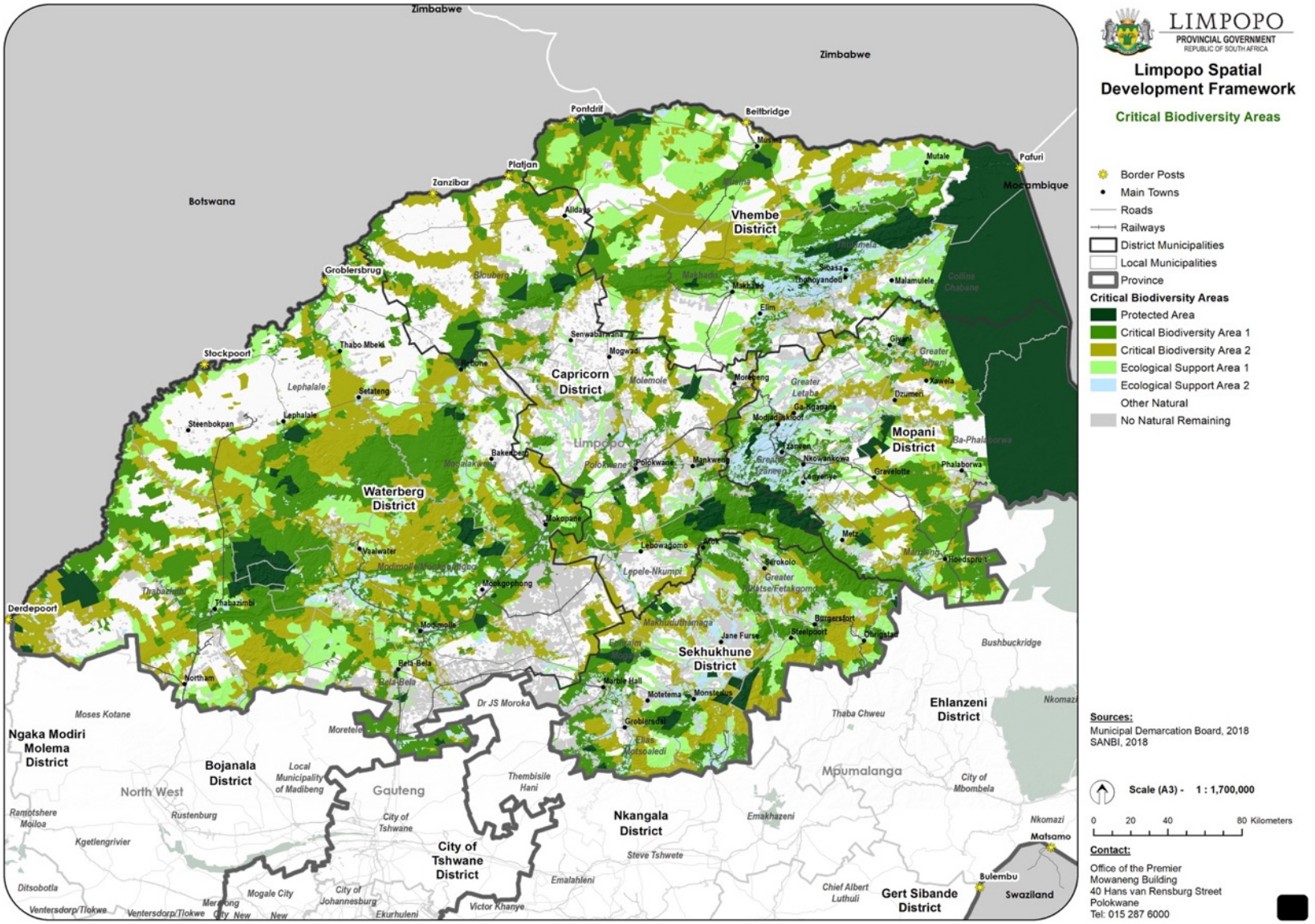


Figure 13: Map of Critical Biodiversity Areas

Table 5: CBA classifications and land uses (modified from SANBI, 2018)

CBA map category	Description	Desired ecological state	Examples of likely compatible land use
Protected area	Areas formally protected in terms of legislation. Each protected area has a management plan.	As per the protected area's management plan.	Conservation
Critical Biodiversity Area 1 (CBA1)	Areas irreplaceable for meeting biodiversity targets. No other options for conserving the ecosystems, species or ecological processes in these areas.	Maintain in natural or near natural state	Open space, low impact ecotourism or recreation
Critical Biodiversity Area 2 (CBA 2)	Areas that are the best option for meeting biodiversity targets, in the smallest area, while avoiding conflict with other land uses.		
Ecological Support Area 1 (ESA 1)	Areas that support the ecological functioning of protected areas or CBAs or provide important ecological infrastructure. May include biodiversity corridors or buffer zones.	Maintain in at least semi-natural ecological condition.	Low-impact ecotourism or recreation, sustainably managed rangelands, certain forms of low-density housing
Ecological Support Area 2 (ESA 2)		No further intensification of land use.	Intensive agriculture
Other natural area (ONA)	Natural or semi-natural areas that are not required to meet biodiversity targets or support natural ecological processes.	Best determined through multi-sectoral planning processes.	Range of intensive land uses such as industry or dense settlement
No natural remaining (NNR)	Areas in which no natural habitat remains.		

The following extracts from the various district bioregional plans (LEDET, 2016a, 2016b; 2017; 2019a, 2019b) highlight areas where there is potential conflict between planned development and the CBA map:

- **Polokwane Nature Reserve:** Future development is earmarked within the buffer and future development zone of the Polokwane Nature Reserve in the urban edge to the south-west and east of the reserve. Land use planning here takes no cognisance of the PA buffer nor does it consider landscape connectivity between this area and areas to the south, east and west. This conflict will need to be addressed in future iterations of the Polokwane LM SDF (Capricorn Bioregional Plan, 2019).

- **Polokwane-Moria Development Corridor**: Urban expansion is impacting biodiversity (e.g. Polokwane Nature Reserve buffer and future expansion options) as well as landscape connectivity. Greater recognition needs to be given to CBAs and avoiding development in these areas in and around the greater Polokwane-Moria area (Capricorn Bioregional Plan, 2019).

- **Kruger to Kalahari Corridor:** Zebedelia/Makapan/Waterberg Critical Landscape Link. This area is earmarked for future platinum development. Ensuring that this landscape linkage remains intact is critical for ensuring the long-term viability of this ecological corridor. Biodiversity offsets related to mining and settlement development will be important for setting aside areas to retain and enhance this critical landscape linkage (Capricorn and Sekhukhune Bioregional Plans).

- **Fetakgomo Tubatse Local Municipality**: This is the Sekhukhune Centre of Endemism, as well as the eastern arms of the platinum belt. It has seen some of the highest rates of land use change in the province. The town of Burgersfort is a particular problem area, as several critical biodiversity sites are located in and around the town that are at very high risk of being lost entirely due to urban sprawl. Special attention needs to be given to land use planning interventions to mitigate loss of landscape connectivity (Sekhukhune Bioregional Plan).

- **Kwamlhanga – Siyabuswa – Elandsdoring Rural Settlement**: Since the development of the 2013 Limpopo Conservation Plan, a large settlement was built in the last remaining biodiversity corridor along the Elands River. Options for landscape linkages connecting the Dinokeng biodiversity node in Gauteng eastwards into Mpumalanga or Limpopo are rapidly disappearing. This area is a priority for planning intervention in Limpopo, however, a strategy for managing and guiding rural “urban sprawl” in tribal areas is urgently needed in Limpopo (Sekhukhune Bioregional Plan).

- **The upper Limpopo Valley, between the Waterberg District and the Vhembe District that borders on Botswana:** This is the only remaining area in South Africa that supports free-ranging natural populations of wildlife, such as the African wild dog and cheetah. These areas cut across CBAs and therefore landscape management programmes that represent viable population ranges are critical. Land-use planning has to take cognisance of these species and be very careful not to fragment the natural landscape or construct barriers (fences, roads, canals) to the movement of these species. Currently, the rapid expansion of extreme forms of game fencing being installed by game breeders in the upper Limpopo valley is creating very large and significant barriers to the movement of these animals (Waterberg Bioregional Plan).

2.1.3.3 Protected areas

The province has a number of formally protected areas, including, amongst others, national parks, provincial nature reserves and World Heritage sites, as shown in Figure 14.

Data for the protected areas is drawn from the South African Protected Areas Database (SAPAD) and the South African Conservation Areas Database (SACAD) (2022, Quarter 3).

SACAD includes the following conservation areas: biosphere reserves, Ramsar sites, stewardship agreements, botanical gardens, transfrontier parks and conservation areas, military conservation areas and conservancies. SAPAD, on the other hand, includes national parks, nature reserves (provincial, private, wilderness, bird sanctuary), special nature reserves, mountain catchment areas, World Heritage sites (core and buffer), other protected environments, forest, nature and wilderness reserves, specially protected forest areas and marine protected areas.

Nature reserves make up the bulk of protected areas, followed by the biosphere reserves. Of the current protected areas, which are indicated in Table 6, twenty-two have been declared since the LSDF, 2016 (Table 7). That is an increase of 22,042 hectares in protected area since 2016. Significant additions include the De Hoop Dam Protected Environment, the Lapalala Nature Reserve and the Mphaphuli Protected Environment.

Table 6: Declared protected areas in the province (2022)

Protected area type	Number	Total hectares
Biosphere reserve	3	1,921,219
Botanical garden	1	83
Forest reserve	6	41,271
National park	3	29,089
Nature reserve	399	8,570,027
Protected environment	10	90,057
Ramsar site	2	2,889
World Heritage site	2	4,771
Total	**426**	**10,659,403**

Source: SACAD and SAPAD, 2022

Table 7: Protected areas declared after 2016

Protected area type	Number	Total hectares
Botanical garden	1	83
Nature reserve	13	113,237
Protected environment	8	107,142
Total	**22**	**220,462**

Source: SACAD and SAPAD, 2022

Significant protected areas in the province include the following:

- **Parks, reserves and wilderness areas**. There are three national parks (the Kruger National Park, the Limpopo National Park and the Marakele National Park), as well as numerous provincial and local nature reserves. There are also six forest reserves.

- **Ramsar wetlands**. There are two Ramsar wetlands in the province:

- The Nylsvley wetland complex comprises a seasonal river wetland with an associated grassland floodplain and was designated as a Ramsar site in 1998. The wetland supports an exceptionally high number of bird species and provides habitat for endangered species such as the roan antelope.
- The Makuleke wetlands are of the floodplain vlei type and are located in the Kruger National Park. They were designated as a Ramsar site in 2007 and play an important role in flood attenuation, streamflow regulation and groundwater recharge.

- **World Heritage Sites**. There are two UNESCO World Heritage sites in the province, namely the Mapungubwe Cultural Landscape site and the Makapan Valley. The Mapungubwe Cultural Landscape World Heritage Site is an important Iron Age site and was awarded World Heritage Site status in 2003, while the Makapan World Heritage Site supports a complex of caves that contains thousands of fossils that define the origin and evolution of humanity. It was declared a World Heritage Site in 1999.

- **Transfrontier Parks and Conservation Areas**. Transfrontier Parks and Conservation Areas are based on the principle that natural resources that straddle international boundaries are a
- .

shared asset with the potential to meaningfully contribute towards conservation as well as to the upliftment of rural communities. Two such sites share a border with the province:

- The Greater Mapungubwe Transfrontier Conservation Area which measures 5,909 km² and shares borders with Botswana and Zimbabwe.
- The Great Limpopo Transfrontier Park which straddles the borders of Mozambique, South Africa and Zimbabwe and has an area of 37,572 km². A future expansion of the park is planned.

- **Biosphere reserves**. Three of South Africa's ten biosphere reserves are located in the province, namely the Waterberg Biosphere Reserve, the Kruger to Canyons Biosphere Reserve and the Vhembe Biosphere Reserve. Their locations are shown in Figure 15. Biosphere reserves are designated regions that represent priority ecosystems and promote the co-existence of conservation and human settlement in those areas. They are internationally recognised by declaration through UNESCO. They consist of a formally protected core zone, a buffer zone and a transitional zone, each with their own set of land-use guidelines

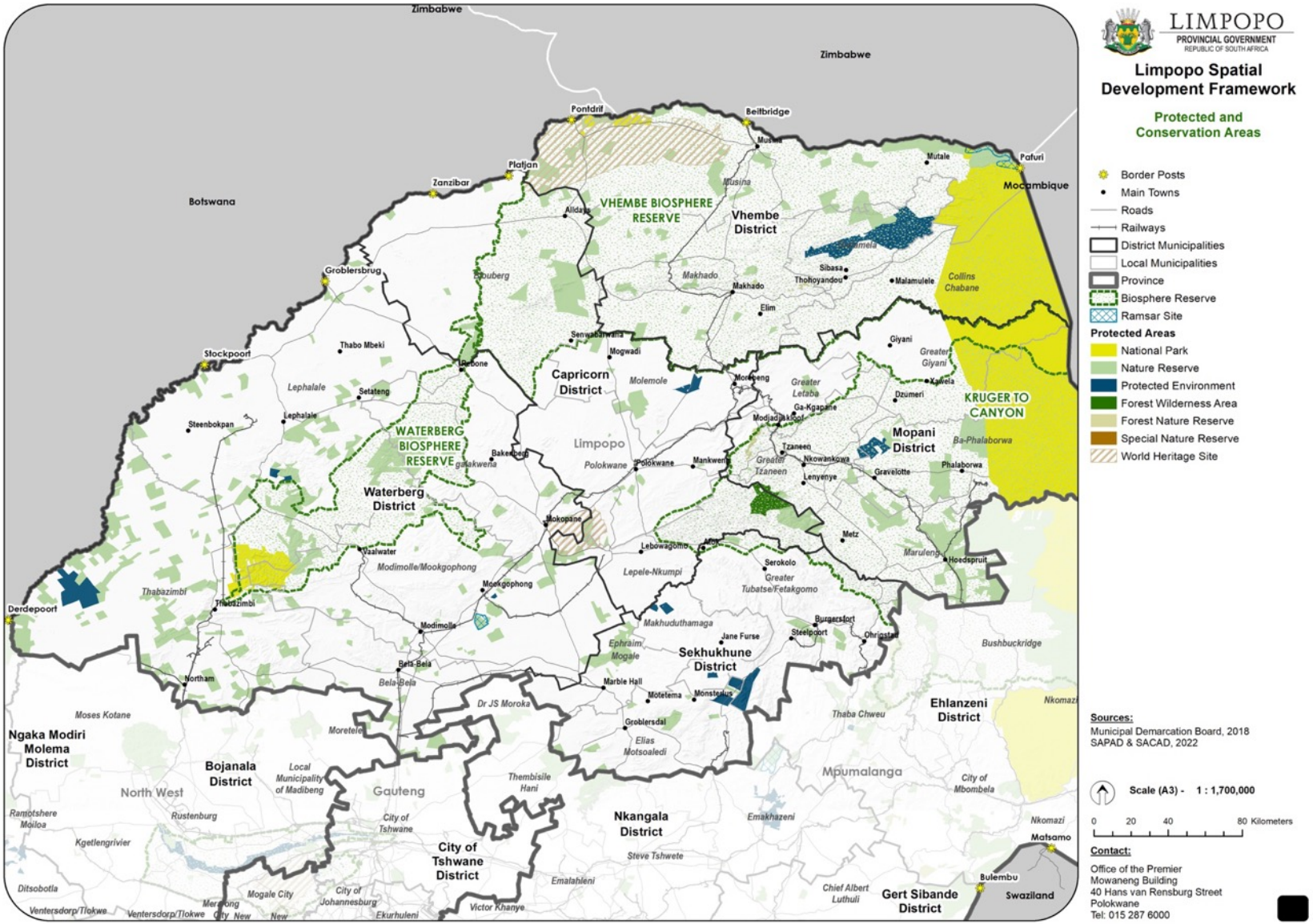


Figure 14: Protected areas

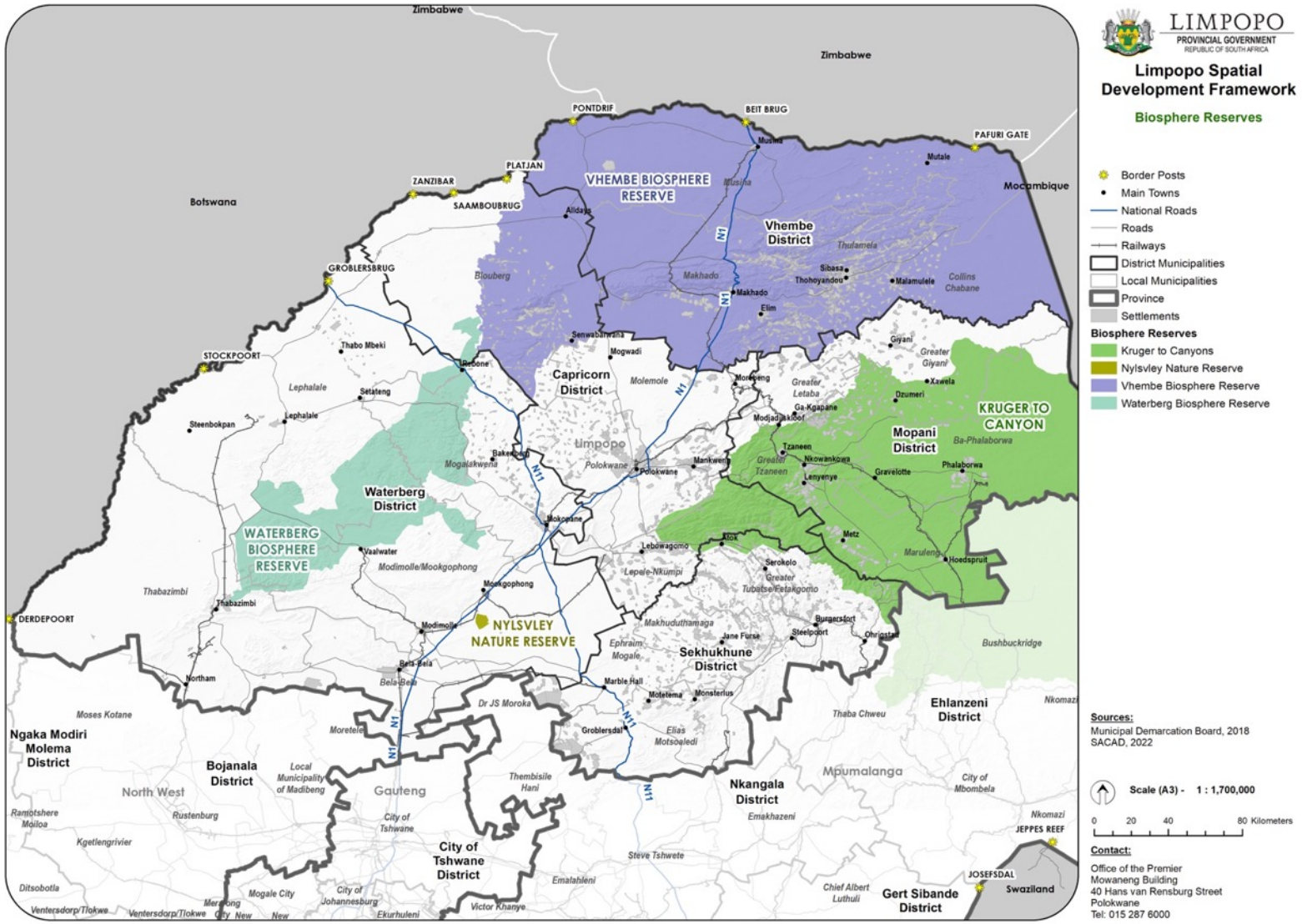


Figure 15: Biospheres

2.1.4 National Protection Areas Expansion Strategy

The expansion of protected areas is important to improve the variety of ecosystems under protection, to preserve high-value sites under threat, to encourage ecological sustainability and to promote resilience to climate change (DEA, 2018). To this end, Protected Area Expansion Strategies have been developed, both at a national and at a provincial level. These strategies are important for spatial planning as they help to proactively guide development plans by identifying areas that should be prioritised for conservation type land uses in the near future. This helps to minimise potential future land-conflicts.

The priority areas identified in the National Protection Areas Expansion Strategy (NPAES) for expansion are shown in

Figure 16. These include the high-value sites under threat in the Haenertsburg-Modjadji, the Blouberg (and adjacent Makgabeng) and the Nyslvlei (and adjacent Makapan) areas. Further priority areas include the areas around Wolkberg, Makuya and the Drakensberg-Strydpoortberge region. Other prioritised areas include those where there is either high land-owner willingness (e.g. Waterberg and Soutpansberg) or committed protected area champions (e.g. in the biosphere reserves) (DEA, 2018). These highlighted priority areas remain the same as those identified in the 2016 version of the NPAES.

2.1.5 Flora and fauna

Plant diversity in the province is high, with 92 vegetation types being represented, as shown in Figure 17. Of these types, one is considered Critically Endangered (Woodbush Granite Grassland); two are Endangered (Legogote Sour Bushveld; Sekhukhune Plains Bushveld); and four are Vulnerable (Northern Escarpment Dolomite Grassland; Rand Highveld Grassland; Springbokvlakte Thornveld; Lowveld Riverine Forest). Of these, only the Lowveld Riverine Forest is well protected, the others are all poorly protected.

The vegetation types most threatened belong primarily to the grassland and savanna biomes. The grasslands on the Waterberg plateau in particular are ecologically unique and represent isolated remnants of the grassland biome, which could make them an important climate change refuge in the future (LEDET, 2016a)

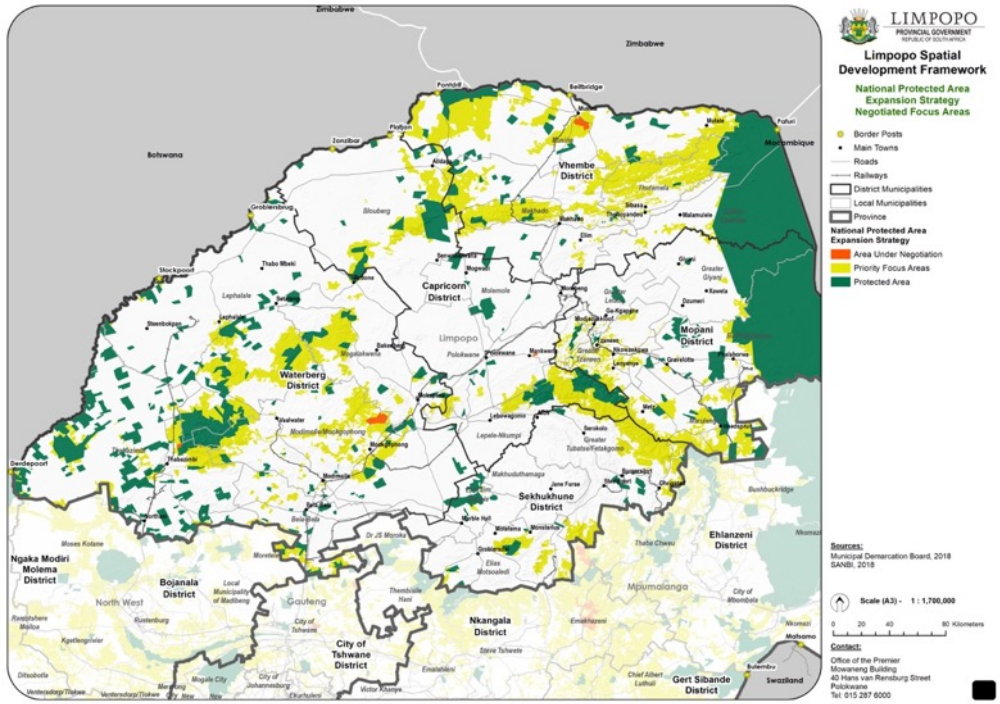


Figure 16: National Protected Area Expansion Strategy areas

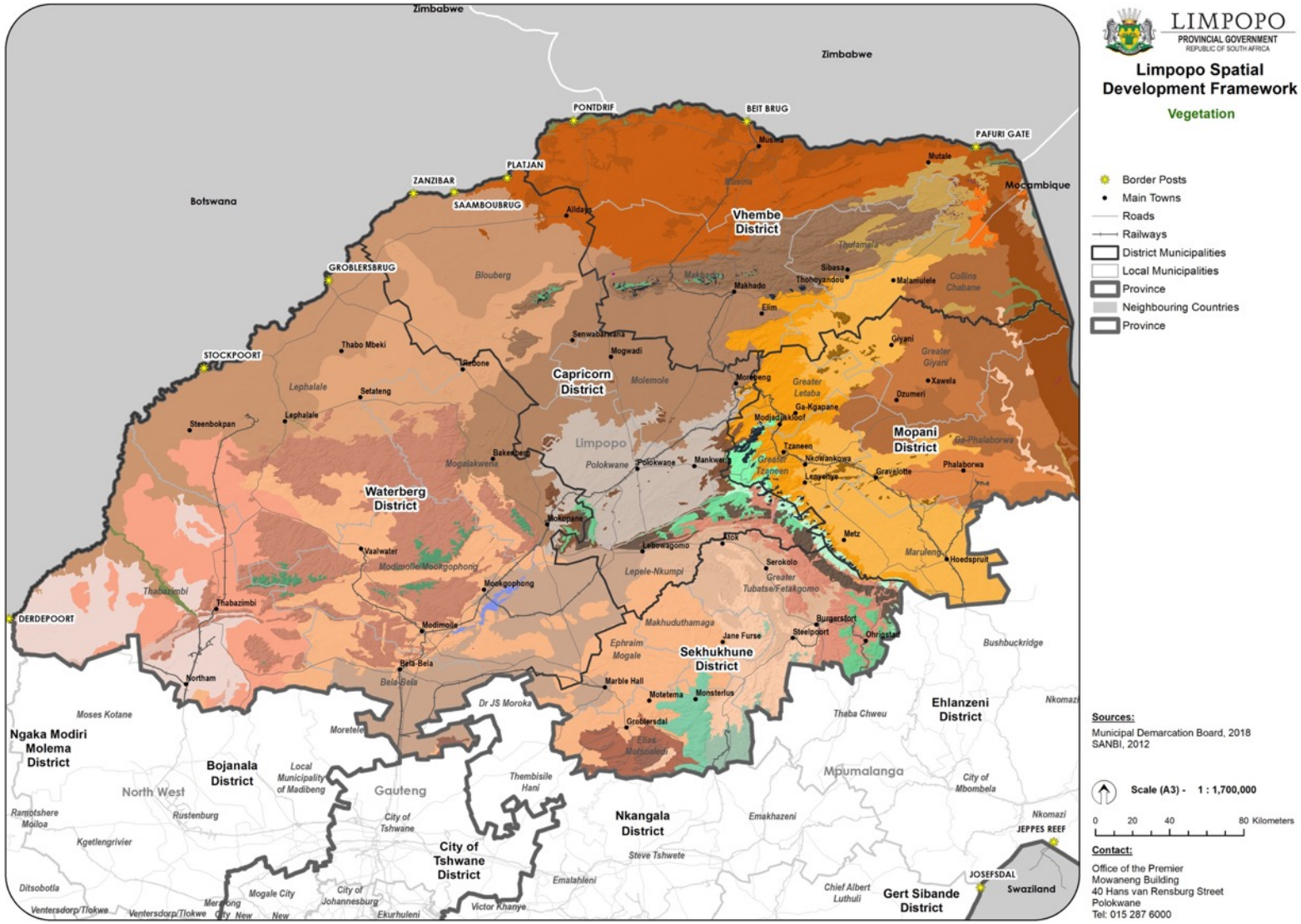
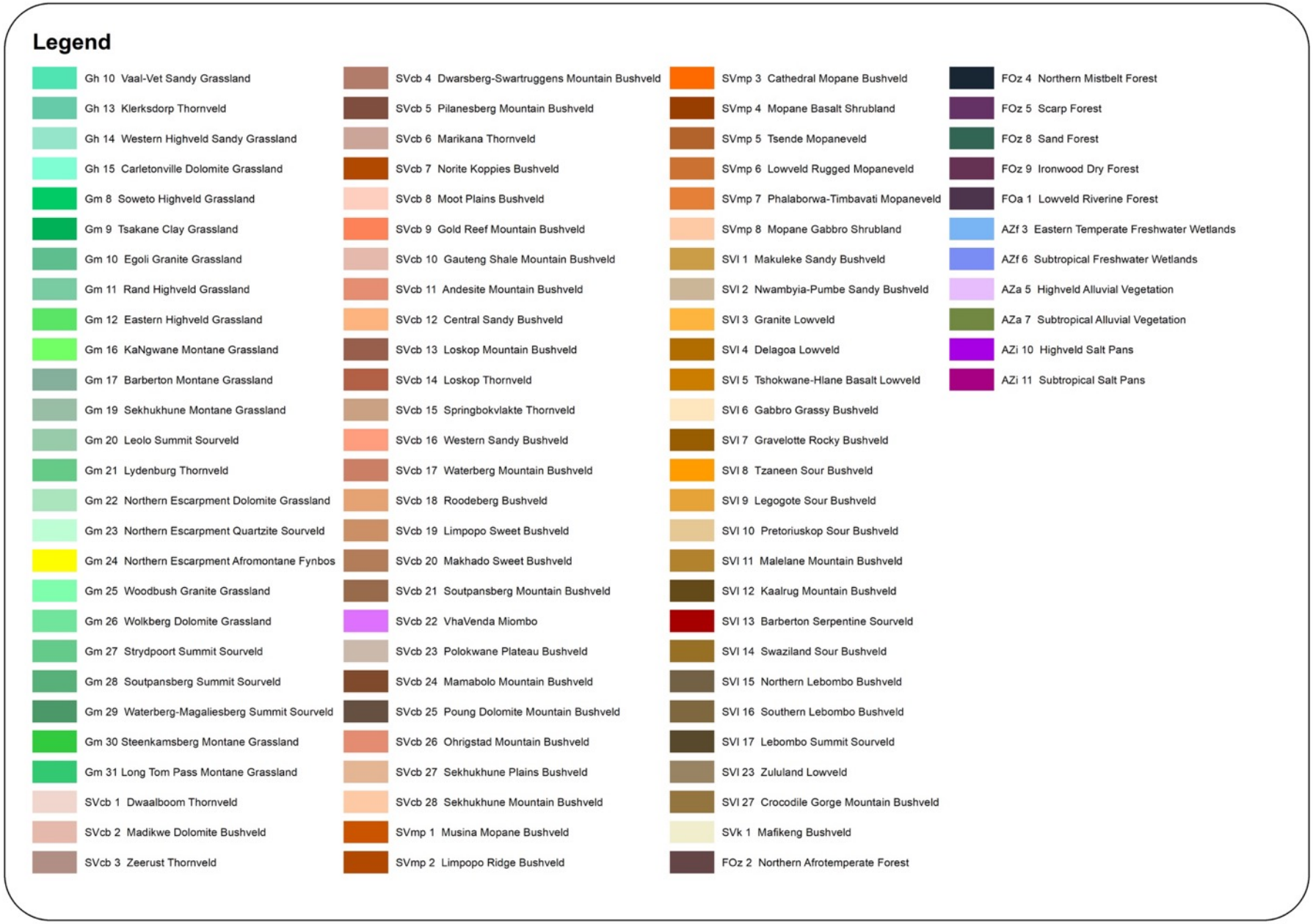


Figure 17: Vegetation


Legend
Gh 10 Vaal-Vet Sandy Grassland
Gh 13 Klerksdorp Thornveld
Gh 14 Western Highveld Sandy Grassland
Gh 15 Carletonville Dolomite Grassland
Gm 8 Soweto Highveld Grassland
Gm 9 Tsakane Clay Grassland
Gm 10 Egoli Granite Grassland
Gm 11 Rand Highveld Grassland
Gm 12 Eastern Highveld Grassland
Gm 16 KaNgwane Montane Grassland
Gm 17 Barberton Montane Grassland
Gm 19 Sekhukhune Montane Grassland
Gm 20 Leolo Summit Sourveld
Gm 21 Lydenburg Thornveld
Gm 22 Northern Escarpment Dolomite Grassland
Gm 23 Northern Escarpment Quartzite Sourveld
Gm 24 Northern Escarpment Afromontane Fynbos
Gm 25 Woodbush Granite Grassland
Gm 26 Wolkberg Dolomite Grassland
Gm 27 Strydpoort Summit Sourveld
Gm 28 Soutpansberg Summit Sourveld
Gm 29 Waterberg-Magaliesberg Summit Sourveld
Gm 30 Steenkamsberg Montane Grassland
Gm 31 Long Tom Pass Montane Grassland
SVcb 1 Dwaalboom Thornveld
SVcb 2 Madikwe Dolomite Bushveld
SVcb 3 Zeerust Thornveld
SVcb 4 Dwarsberg-Swartruggens Mountain Bushveld
SVcb 5 Pilanesberg Mountain Bushveld
SVcb 6 Marikana Thornveld
SVcb 7 Norite Koppies Bushveld
SVcb 8 Moot Plains Bushveld
SVcb 9 Gold Reef Mountain Bushveld
SVcb 10 Gauteng Shale Mountain Bushveld
SVcb 11 Andesite Mountain Bushveld
SVcb 12 Central Sandy Bushveld
SVcb 13 Loskop Mountain Bushveld
SVcb 14 Loskop Thornveld
SVcb 15 Springbokvlakte Thornveld
SVcb 16 Western Sandy Bushveld
SVcb 17 Waterberg Mountain Bushveld
SVcb 18 Roodeberg Bushveld
SVcb 19 Limpopo Sweet Bushveld
SVcb 20 Makhado Sweet Bushveld
SVcb 21 Soutpansberg Mountain Bushveld
SVcb 22 VhaVenda Miombo
SVcb 23 Polokwane Plateau Bushveld
SVcb 24 Mamabolo Mountain Bushveld
SVcb 25 Poung Dolomite Mountain Bushveld
SVcb 26 Ohrigstad Mountain Bushveld
SVcb 27 Sekhukhune Plains Bushveld
SVcb 28 Sekhukhune Mountain Bushveld
SVmp 1 Musina Mopane Bushveld
SVmp 2 Limpopo Ridge Bushveld
SVmp 3 Cathedral Mopane Bushveld
SVmp 4 Mopane Basalt Shrubland
SVmp 5 Tsende Mopaneveld
SVmp 6 Lowveld Rugged Mopaneveld
SVmp 7 Phalaborwa-Timbavati Mopaneveld
SVmp 8 Mopane Gabbro Shrubland
SVl 1 Makuleke Sandy Bushveld
SVl 2 Nwambyia-Pumbe Sandy Bushveld
SVl 3 Granite Lowveld
SVl 4 Delagoa Lowveld
SVl 5 Tshokwane-Hlane Basalt Lowveld
SVl 6 Gabbro Grassy Bushveld
SVl 7 Gravelotte Rocky Bushveld
SVl 8 Tzaneen Sour Bushveld
SVl 9 Legogote Sour Bushveld
SVl 10 Pretoriuskop Sour Bushveld
SVl 11 Malelane Mountain Bushveld
SVl 12 Kaalrug Mountain Bushveld
SVl 13 Barberton Serpentine Sourveld
SVl 14 Swaziland Sour Bushveld
SVl 15 Northern Lebombo Bushveld
SVl 16 Southern Lebombo Bushveld
SVl 17 Lebombo Summit Sourveld
SVl 23 Zululand Lowveld
SVl 27 Crocodile Gorge Mountain Bushveld
SVk 1 Mafikeng Bushveld
FOz 2 Northern Afrotemperate Forest
FOz 4 Northern Mistbelt Forest
FOz 5 Scarp Forest
FOz 8 Sand Forest
FOz 9 Ironwood Dry Forest
FOa 1 Lowveld Riverine Forest
AZf 3 Eastern Temperate Freshwater Wetlands
AZf 6 Subtropical Freshwater Wetlands
AZa 5 Highveld Alluvial Vegetation
AZa 7 Subtropical Alluvial Vegetation
AZi 10 Highveld Salt Pans
AZi 11 Subtropical Salt Pans

The province contains a large number of endemic plant species (i.e. species that occur nowhere else in the world) and is home to three Centres of Floristic Endemism. These are areas that are scientifically recognised as having an exceptionally high concentration of unique plant species. The three Centres of Endemism in the province are as follows (Van Wyk & Smith, 2001):

- The Sekhukhuneland Centre of Endemism, which contains over 2,200 species of plants, of which more than 100 (4.5%) are endemic
- The Soutpansberg Centre of Endemism, which has over 3,000 species, of which 45 (1.5%) are endemic
- The Wolkberg Centre of Endemism, which contains around 2,500 species, of which more than 130 (5.2%) are endemic

These Centres of Endemism fall largely within the already highly threatened vegetation type areas, making conservation in these centres a very high priority. The grasslands in the Wolkberg area in particular need to be protected, as most conservation efforts have been focused only on the relatively species-poor Afromontane forests (Van Wyk, 2001).

With regards to fauna, the province is home to a number of threatened and endemic species. These include reptiles such as:

- The unexpected flat lizard (*Platysaurus intermedius inopinus*) and the Waterberg dwarf gecko (*Lygodactylus waterbergensis*)
- Invertebrates such as the endangered Waterberg copper (*Erikssonia edgei*) and Lotana blue (*Lepidochrysops lotana*) butterflies
- Mammals such as the endangered roan antelope (*Hippotragus equinus*)
- Amphibians such as the endemic northern forest rain frog (*Breviceps sylvestris)*
- Birds such as the Critically Endangered Wattled Crane (*Bugeranus carunculatus*)

The province also has several Important Bird and Biodiversity Areas (IBAs). These are areas established under the international Important Bird and Biodiversity Areas Programme, which identifies and works to conserve a network of sites critical for the long-term survival of bird species that are globally threatened or restricted to specific habitats. While IBAs are generally already taken into consideration when establishing Critical Biodiversity Areas, additional buffers may also need to be maintained around them in the case of bird-sensitive developments such as windfarms.

Buffer recommendations for windfarms have been developed for only a limited number of bird species and would need to be considered on a case-by-case basis. Of note, however, is the recommendation that a 50 km buffer zone be maintained around Cape Vulture breeding sites for windfarm developments (Birdlife South Africa, 2018).

Cape vultures occur in the following IBAs in the province: Waterberg, Soutpansberg, the Polokwane Nature Reserve, the Kruger National Park and surrounds, the Blyde River Canyon and Blouberg, which has the world's largest breeding colony (Marnewick MD, 2015). Considering the number of vultures in the province, and the recommendation regarding vulture breeding grounds, large areas of the province are poorly suited to wind farm development.

Table 8: Number of threatened plants and animals in the province

	Taxonomic Group							
Category	**Mammals**	**Birds**	**Reptiles**	**Amphibians**	**Freshwater fishes**	**Dragonflies**	**Butterflies**	**Plants**
Extinct								2
Critically Endangered		3					5	20
Endangered	9	13				1	5	26
Vulnerable	15	15	3		1	4	2	56
Subtotal Threatened species	**24**	**31**	**3**	**0**	**1**	**5**	**12**	**102**
Near Threatened	17	18	2	1	3	7	1	30
Data Deficient	2		2		1			56
Least Concern	140	478	176	45	42	107	381	3728
Rare							4	53
Grand Total	**183**	**527**	**183**	**46**	**47**	**119**	**398**	**3971**

Source: SANBI, 2019

Overall, the most threatened taxonomic groups in the province are plants (102 threatened species), followed by birds (31 species), mammals (24 species) and butterflies (12 species), as indicated in Table 8. The key threat to these species is loss of habitat (SANBI, 2019).

2.1.6 Heritage

The South African Heritage Resources Act, 1999, defines a heritage resource as any place or object of cultural significance. This is a broad definition and encompasses, amongst other things, archaeological, palaeontological and meteoritic (APM) resources; burial grounds and graves (BBG); heritage objects; the built environment and the national estate.

Registered heritage sites in the province (i.e. those on the South African Heritage Resource Agency database) are indicated in Figure 18 and listed in Table 9. There are also two World Heritage sites in the province that form part of the protected areas network. The province also contains other heritage sites that are of local or regional importance (e.g. graves) but that have not yet been formally declared as protected in terms of the South African Heritage Resources Act. Those sites will need to be identified at a local municipal planning level and integrated into local spatial planning documents as required.

Heritage resources can be a useful drawcard for tourists. Tourism in the province is discussed in Section 3.4.5 of the Socio-Economic Analysis.

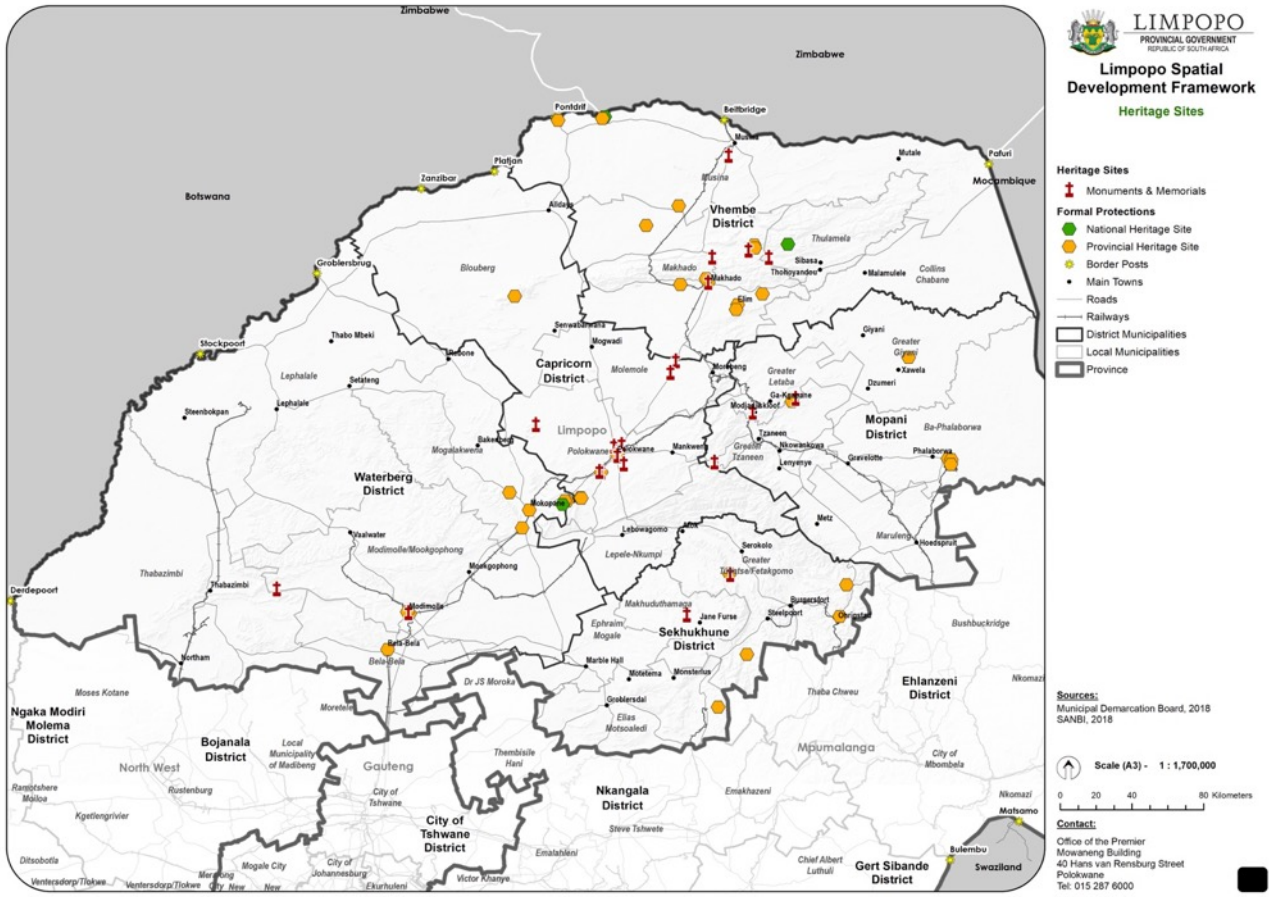


Figure 18: Declared heritage sites

Table 9: List of national and provincial declared heritage sites

Site Name	Site Type	Declaration Type
Mapungubwe Cultural Landscape	Archaeological, cultural landscape, rock art, deposit, artefacts, settlement, ruin > 100 years	National
Makapans Valley, Makapansgat, Potgietersrus District	Archaeological	National
Lake Fundudzi, Vhembe District Municipality	Living heritage/sacred sites, natural	National
Cycads, Modjadjiskraal, Bolobedu District	Natural	Provincial
Baleni-Soutini Salt Works, Giyani	Cultural landscape, archaeological, living heritage/sacred sites	Provincial
Iron Age smelting oven, Schiettocht 25, Letaba District	Artefacts, deposit	Provincial
Remains of Old Voortrekker Fort, Ohrigstad, Lydenburg	Building	Provincial
Dwars River Geological Occurrence, Lydenburg District	Geological	Provincial
Echo Caves, Klipfonteinhoek, Lydenburg District	Natural	Provincial
Mapungubwe Cultural Landscape	Archaeological, cultural landscape, rock art, deposit, artefacts, settlement, ruin > 100 years	Provincial
Archaeological Site K2, Greefswald, Messina District	Archaeological	Provincial
Baobab Trees, Messina District	Natural	Provincial
Verdun Ruins, Verdun, Messina District	Stone walling	Provincial
Mapoch's Caves, Roos Senekal, Middelburg District	Archaeological	Provincial
Ana Trees, Rietfontein, Mokerong District	Natural	Provincial
Kgopolwe Koppie, Spekboom Road, Phalaborwa	Archaeological	Provincial
Sealeng Iron Age Site, Schiettocht, Phalaborwa District	Archaeological	Provincial
Irish House (Rheingold Building), Market Street, Polokwane	Building	Provincial
First Gold Crushing Site, Eersteling, Polokwane District	Structures	Provincial
First Gold Power Plant Site, Eersteling, Polokwane District	Building	Provincial
Fort Louis Campbell, Marabastad, Polokwane District	Ruin > 100 years	Provincial
Moorddrift Monument, Mokopane District	Monuments and memorials	Provincial

Site Name	Site Type	Declaration Type
Makapans Cave, Makapansgat, Potgietersrus District	Archaeological	Provincial
Limeworks at Makapansgat, Potgietersrus District	Palaeontological	Provincial
Old Stone School, 97 Voortrekker Street, Potgietersrus	Building	Provincial
Tjate, Sekhukhuneland District, Ntswaneng Village, Djata	Place, monuments and memorials	Provincial
Schoemansdal, Louis Trichardt, Soutpansberg District	Place	Provincial
Fossilised Footprints, Pontdrift, Soutpansberg District	Palaeontological	Provincial
Fort Hendrina, Louis Trichardt, Soutpansberg District	Building	Provincial
Machemma Ruins, Soutpansberg District	Stone walling	Provincial
Stonehenge, Bergvliet, Soutpansberg District	Building	Provincial
Swiss Mission: Elim	Place	Provincial
Dzata, Vhembe District	Place, archaeological	Provincial
Valdezia Mission Station, Soutpansberg District	Place	Provincial
Lemma College of Education, Elim, Soutpansberg District	Place	Provincial
Blockhouse, Paul Sauer Road, Warmbaths	Building	Provincial
Old Reformed Church, Nylstroom	Building	Provincial
Strijdom House, Nylstroom	Building	Provincial
Dzata Ruins II, District Zoutpansberg	Stone walling	Provincial
Malebobo-Boer War Battlefields, Capricorn District	Battlefield	Provincial

Source: ***www.sahris.org.za***

2.2 Ecosystem services

2.2.1 Water Management Areas

Revised Water Management Areas (WMA) were declared in 2016 (Government Gazette Notice 1056 of September 2016) and, as indicated in

Figure 4, the province now encompasses two Water Management Areas, namely the Limpopo and the Olifants. The Limpopo WMA covers primary drainage region A (major rivers being the Limpopo, Matlabas, Mokolo, Lephalala, Mogalakwena, Sand, Nzhelele, Mutale and Luvuvhu), while the Olifants WMA covers primary drainage region B (major rivers being the Elands, Wilge, Steelpoort, Olifants and Letaba).

2.2.2 REDZs and power transmission corridors

In 2015 and 2019, Strategic Environmental Assessments (SEAs) were carried out nationally to identify areas where large-scale wind and solar photovoltaic (PV) energy facilities could be developed with least environmental impact and maximum socio-economic benefits. The outcome of these SEAs was the establishment of Renewable Energy Development Zones (REDZs). None of these REDZ falls within the province, which suggests that there are some environmental constraints for large-scale wind or solar farm developments in the province. Wind farms in particular may be of concern given the number of Important Bird Areas and vulture breeding colonies in the province, as guidelines from Bird Life South Africa (2018) recommend that a buffer of at least 50 km be kept between breeding sites and wind farms. Such a buffer zone will exclude significant areas of the province. That is not to say that wind farms will categorically not be allowed in the buffer areas, but rather that there might be more appropriate renewable energy options.

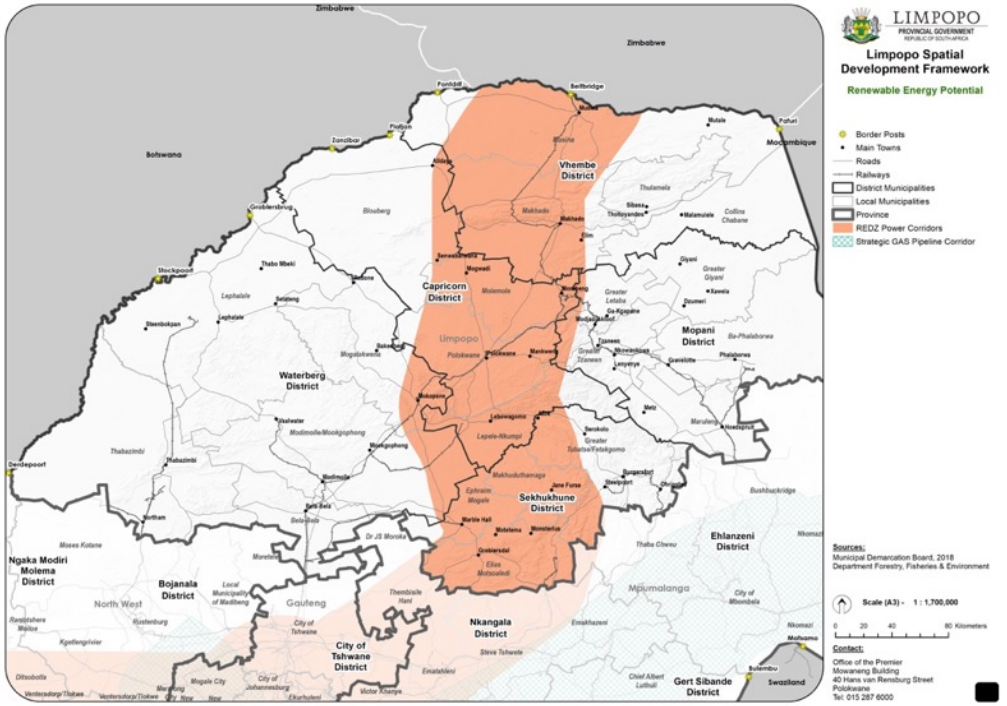


Figure 19: Renewable Energy Development Zone power corridors and gas pipeline corridor

Further SEAs were undertaken in 2016 and 2019 to identify power corridors where strategic electrical transmission infrastructure could be located and in 2019 one was undertaken for a strategic gas pipeline. One of the electricity corridors that were identified traverses the province and will provide an important cross-border power linkage with Zimbabwe, as shown in Figure 19.

The corridor should be incorporated into spatial plans to allow for proactive planning to avoid potential conflicts between power lines and other land uses in the future.

The establishment of the above-mentioned corridors brings certain benefits in terms of a conditional exemption (Government Gazette Notice 2313 of 27 July 2022) from having to obtain environmental authorisation in terms of the Environmental Impact Assessment Regulations, 2014, as amended.

2.2.3 Renewable energy potential

According to the Limpopo Environmental Outlook Report (LEDET, 2016), the most feasible priority renewable energy sources for the province are solar (both photovoltaic and Concentrated Solar Power) and biogas. Other potential renewable energy sources identified in the report are the conversion of waste to energy and possibly hydroelectric power. This latter option will need to be carefully considered given the stressed state of the current water resources and vulnerable environment in the mountains, where dams for hydroelectric schemes will most likely need to be built.

Wind energy does not appear to be the best option for the province given that wind speeds are generally too low and there are some significant environmental constraints. Wind turbines generally require a minimum wind speed of 4 m/sec to start generating power, but become more economically viable at average wind speeds of 7 m/sec. At wind speeds of over 25 m/sec, the turbines will cut out. A wind resource map that shows average wind speeds for the country has been developed as part of the Wind Atlas for South Africa (WASA) project[1] and is shown in Figure 20.

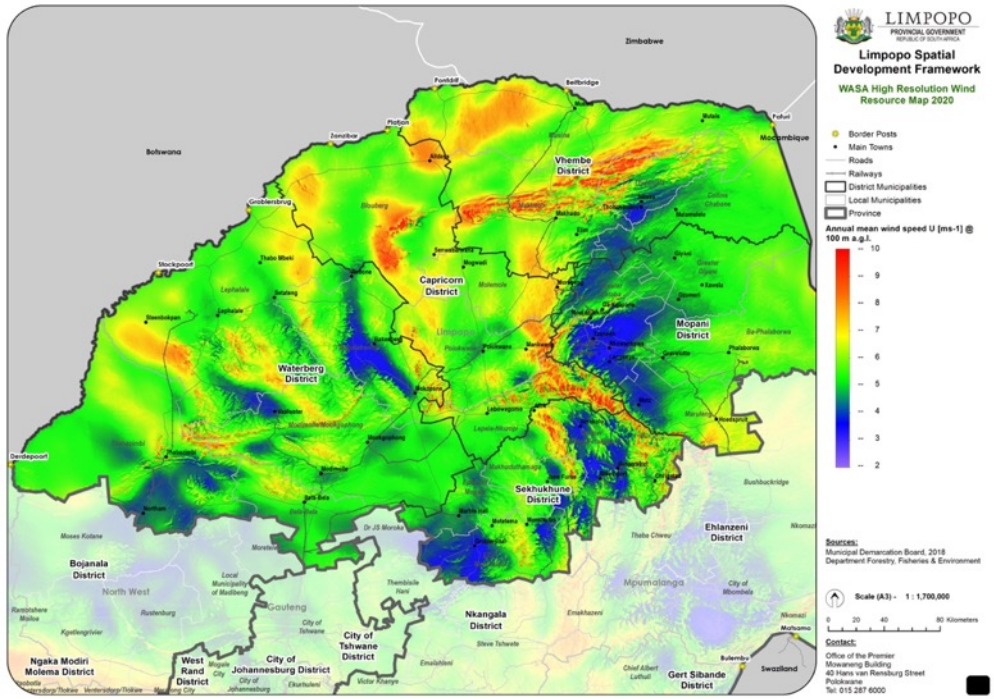


Figure 20: Wind resource map

As the green and blue areas in the figure indicate, the vast majority of the province has mean speeds of less than 7 m/sec. The highest wind speeds are largely in the mountainous regions of the Drakensberg, Soutpansberg, Wolkberg, Blouberg and parts of the Waterberg, where there are significant terrain and environmental sensitivity constraints. There is some potential in the area near Steenbokpan and also to the west of Beit Bridge that might be able to tie in with the Musina-Makhado Special Economic Zone.

[1] WASA High Resolution Wind Resource Map: mean wind speed [ms-1] @ 100 m a.g.l. Dec 2020 (3.3 km WRF + 250 m WAsP modelling). Online: https://www.wasaproject.info/docs/WASA_3_Resource_Map_March_2021.png

In terms of solar power, Figure 21 depicts the Photovoltaic Power Potential (PVOUT) for Limpopo, which indicates the estimated solar photovoltaic (PV) power generation potential in an area. It represents a long-term average of yearly/daily potential electricity production from a 1 kW-peak grid-connected solar photovoltaic (PV) power plant. The map is derived from the Solar Global Atlas (published by the World Bank Group, funded by ESMAP, and prepared by Solargis[2]).

As the green areas in the figure show, potential for solar PV development is high across most of the province. A linked beneficiation opportunity for solar PV development is that the province has silicon mineral resources and a silicon smelter (in Polokwane) that can be used to make solar panels and solar chargers and small-scale electrical devices (LEDET, 2013).

Biopower is also an option that could be explored, although the generation of biopower through the burning of biomass (e.g. to drive steam turbines via a biomass-fired energy plant) may not be the best option in terms of the potential to generate PM_{10} emissions, which are already a potential problem, especially around mining areas. (Refer to following section on air quality). Other biopower options, such as waste-to-biogas conversion, may be feasible but will require more detailed feasibility studies.

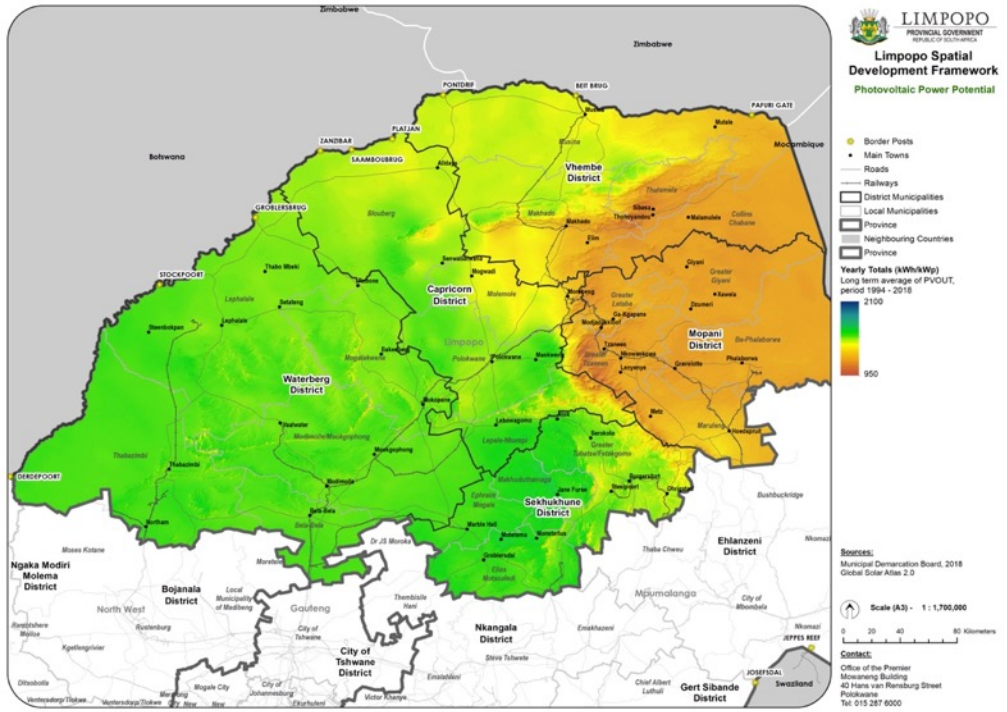


Figure 21: Long-term yearly average of potential photovoltaic electricity production (PVOUT)

[2] https://solargis.com/maps-and-gis-data/overview

2.2.4 Air quality

The main air quality concerns for Limpopo are related to Particulate Matter (PM_{10}), Sulphur Dioxide (SO_2) and Nitrous Oxides (NO_x). The main sources of these pollutants are power generation activities, mining, metallurgical industries and biomass burning. Other contributors, to a lesser extent, are domestic fuel burning and vehicle emissions (LEDET, 2016). Areas of particular concern include:

- SO_2 and NO_x levels around the power generation activities in the Waterberg district
- PM_{10} from the mining sector (mainly open-cast mines) around Lephalale, Steelpoort and Phalaborwa

Another important concern is the release of greenhouse gasses, which contribute towards climate change. The industry contributing the most towards greenhouse gas emissions is the energy generation sector.

The concentration of power generation and mining activities in the Waterberg and Bojanala districts led to the establishment of an Air Quality Priority Area for the Waterberg-Bojanala region (Government Gazette Notice 495 of 2012). The Waterberg-Bojanala Priority Area borders Botswana and covers an area of 67,837 km². It includes the Waterberg District Municipality in Limpopo and parts of the Bojanala Platinum District Municipality in the North West.

The declaration of the Priority Area was followed by an Air Quality Management Plan and Threat Assessment in 2015 (Government Gazette Notice 1207 of 2015). Based on the results of the assessment, it is estimated that, by 2030, SO_2 and PM_{10} levels in the priority area will exceed the acceptable levels stipulated in the National Ambient Air Quality Standards, especially around Lephalale.

The declaration of the Priority Area allows the national government to implement specific air quality control measures in the identified region. These include the following:

- An Air Quality Management Plan (drafted by the National Air Quality Official) must be implemented. Draft regulations to enforce this requirement were published for comment in February 2022 (Government Gazette Notice 1738 of February 2022) as pollution levels in the country's various priority areas regularly exceed the National Ambient Air Quality Standards.
- The Air Quality Management Plan objectives must be included in all Integrated Development Plans
- The cumulative impact of listed industries' activities on air quality must be considered.

In the future, the national government may also set special air quality limits that will apply to the area. That possibility must be considered when planning for development in the area (e.g. for the proposed mining development of the platinum belt from Thabazimbi to Bojanala). In particular, industries that release significant amounts of SO_2 and PM_{10} (e.g. those that burn fossil fuels) may need to be limited.

2.3 Climate change

2.3.1 Rainfall

Annual rainfall varies significantly across the province. For instance, the low rainfall areas of the Musina and Makhado municipalities and parts of the Blouberg municipality experience annual rainfall of around 400 mm (Dent, Lynch & Schulze, 1987), while parts of the Thulamela and Tzaneen municipalities along the northern Drakensberg receive over 1,000 m per annum, as shown in Figure 22. The annual provincial average is 527 mm (Dent et al., 1987). This indicates that most of Limpopo receives low rainfall, which means that agriculture may not be sustainable in all areas of the province.

Climate change projections (CSIR, 2019) indicate that an increase in rainfall can be expected over the Southern Waterberg district as well as the

Vhembe, Capricorn and Mopani districts, as indicated in Figure 23. The projected increase (year 2050) is generally low, however, with most affected areas experiencing an annual rainfall increase of only 100 mm. The gains from this increase are largely offset by the predicted rise in temperature, which would lead to higher levels of evaporation.

Another rainfall-related climate change risk is the occurrence of extreme rainfall (high rainfall over a short period of time), as shown in Figure 24. These extreme rainfall events can lead to flooding, which can damage buildings and other infrastructure and obstruct access to the area, especially in rural areas. In addition to the immediate health hazards associated with flooding, other hazards such as waterborne disease outbreaks and water intrusion into buildings can appear once a storm has passed. Damp buildings can also result in mould contamination, leading to health and indoor air quality problems (CDC, 2020).

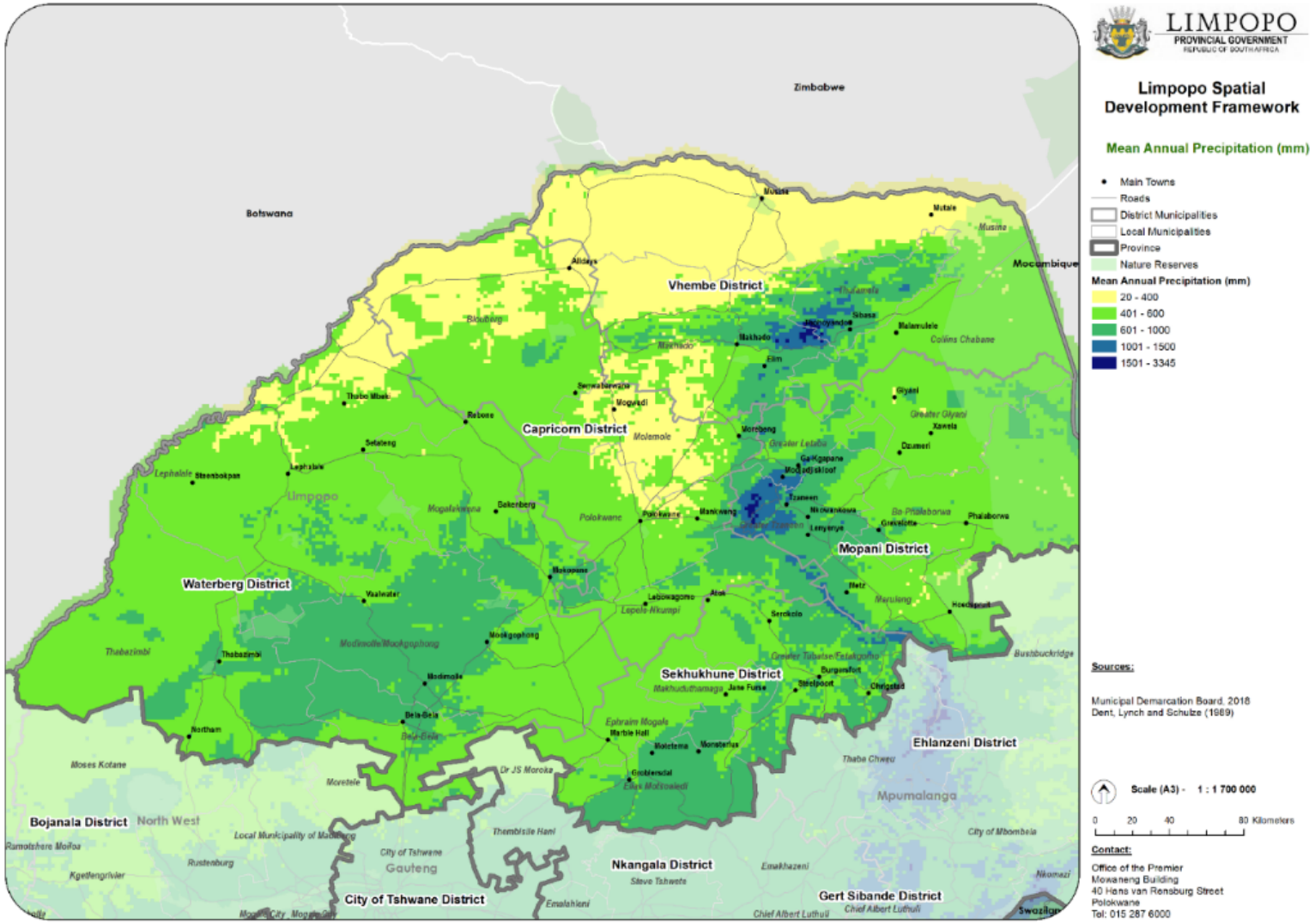


Figure 22: Mean annual precipitation (mm)
Source: Dent et al., 1987

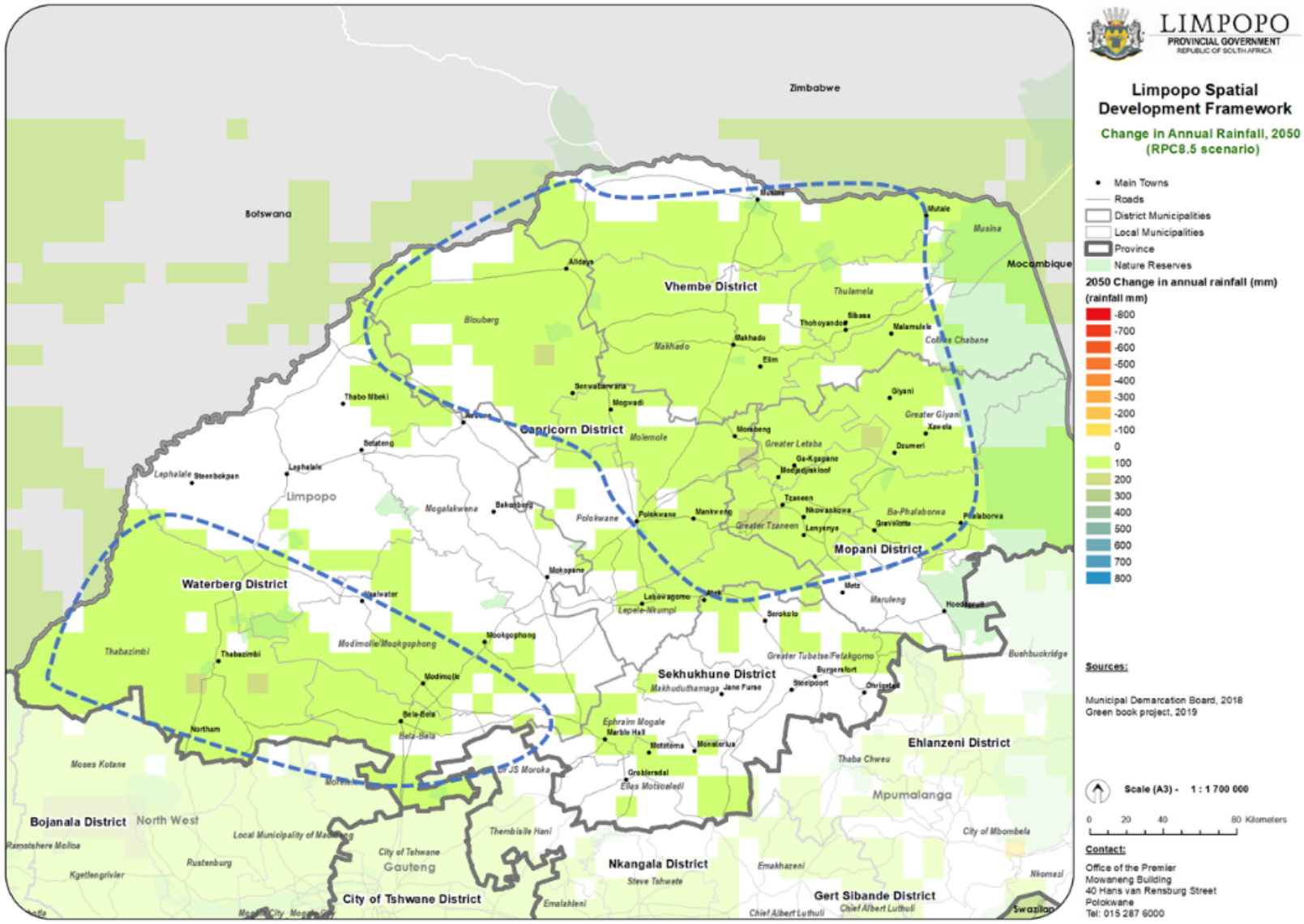


Figure 23: Change in annual rainfall, 2050 (RPC8.6 scenario)
Source: Green Book, 2019

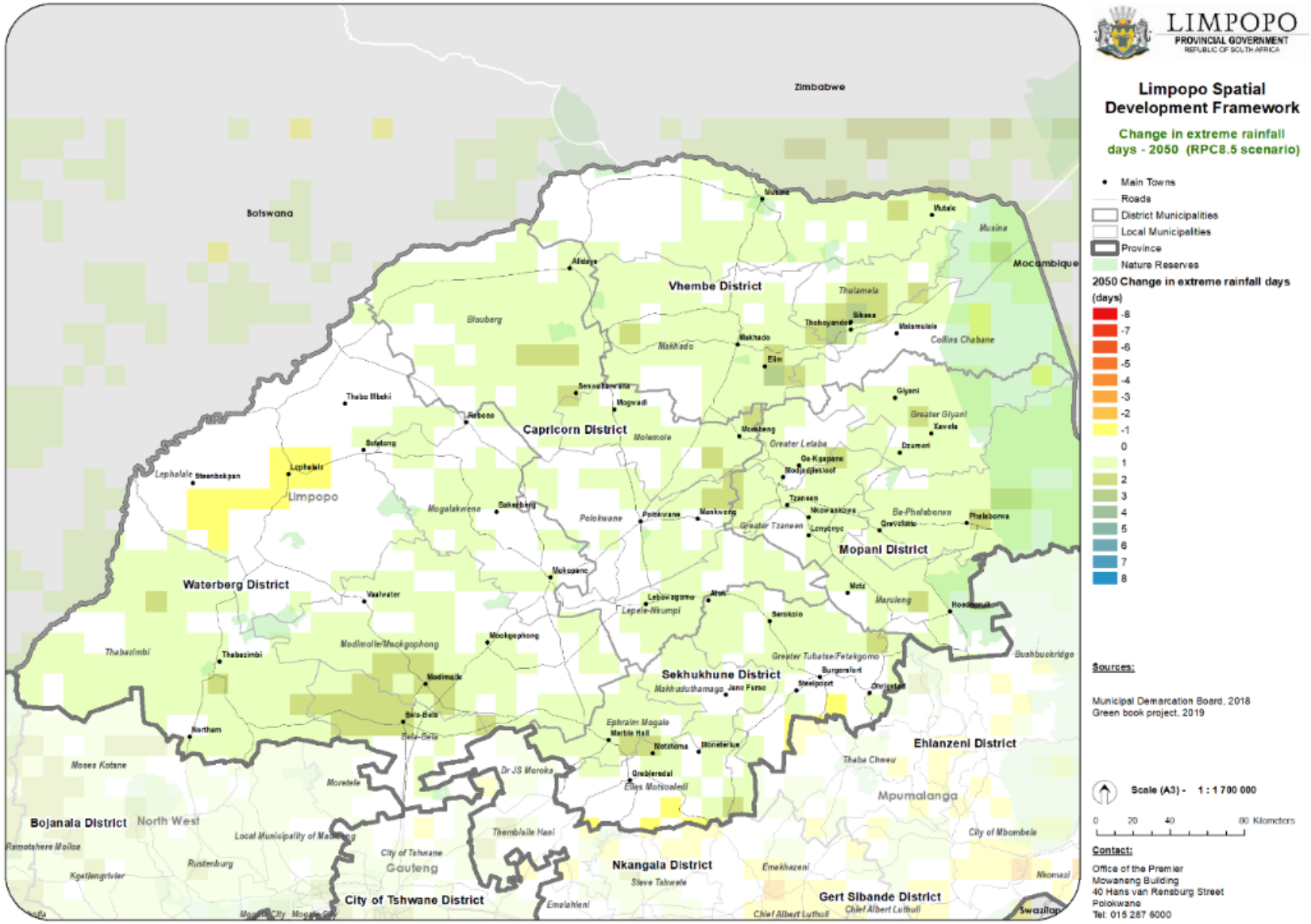


Figure 24: Change in extreme rainfall days – 2050

Source: Green Book, 2019

2.3.2 Temperature

For Limpopo, a temperature increase of approximately 3.5˚C can be expected by 2050 for the western part of the province (the Waterberg district and a portion of the Sekhukhune district), as indicated in Figure 25. The central and north-eastern parts of the province are expected to experience an increase of around 2.5˚C. Several areas along the western escarpment are projected to experience a decrease of approximately 2˚C.

Another temperature phenomenon that is projected to increase drastically by 2050 is the occurrence of very hot days (days when the maximum temperature exceeds 35°C). Very hot days are projected to increase by 40 to 60 days per year in the valley of the Limpopo River (CSIR, 2019) and by up to 100 days in areas along the Limpopo River and adjacent regions, as shown in Figure 26. Such extreme events place stress on human, plant and animal life. High temperatures can also pose a risk to vulnerable people such as the very young and old and can result in heat stroke and even death.

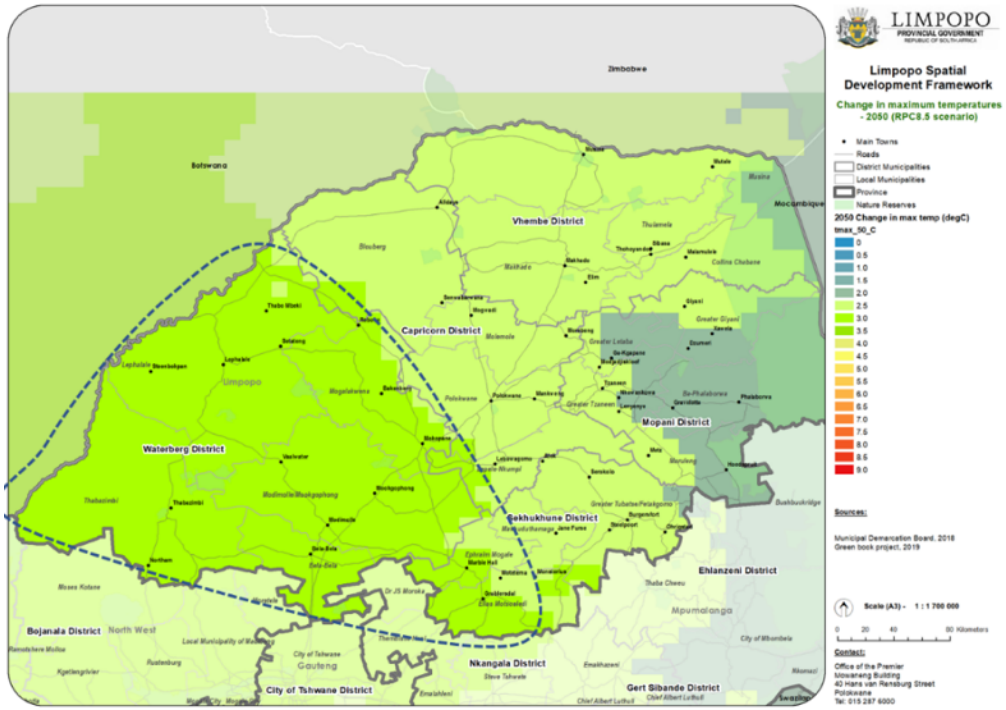


Figure 25: Change in maximum temperatures – 2050 (RCP8.5 scenario)
Source: Green Book, 2019

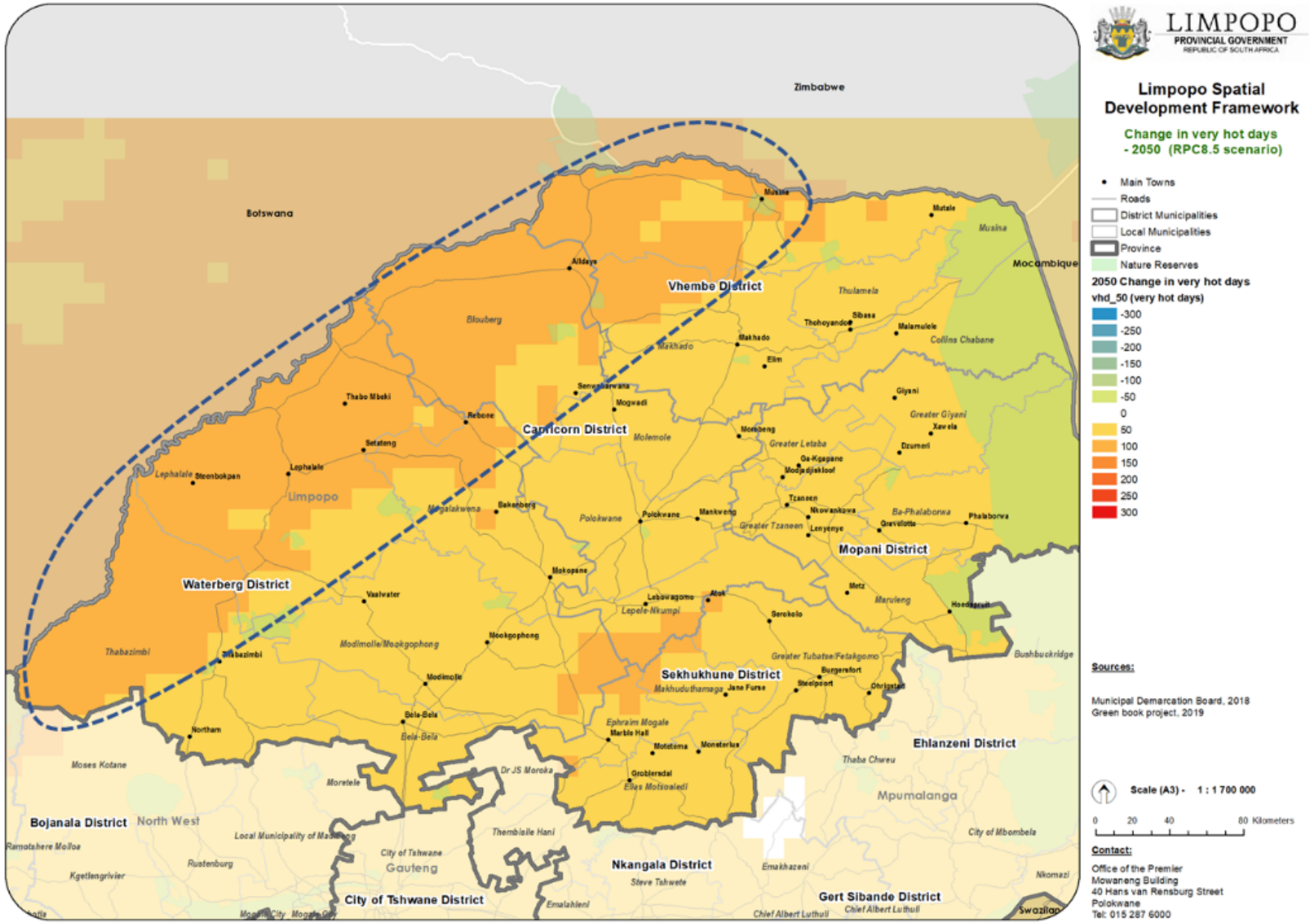


Figure 26: Change in very hot days – 2050 (RCP8.5 scenario)
Source: Green Book, 2019

2.3.3 Impact on water resources

A key impact of climate change on water resources is the likelihood of an increase or decrease in drought tendency. While the primary impact of drought is on water availability, it can also increase exposure to hazards such as flash flooding and degraded water quality. Areas at higher risk of drought in the future, including the Waterberg and Mopani districts, are shown in Figure 27.

Another key water resource that can be impacted on by climate change is groundwater. Groundwater plays a key strategic role in supporting economic development and sustaining water security, especially in rural and urban settlements that are either entirely or partially dependent on groundwater supply.

In terms of climate change, predictions are that lower levels of groundwater recharge can be expected, thereby decreasing the amount of groundwater available. This will impact particularly on:

- Areas where there is high water balance vulnerability (i.e. the areas that are already water-stressed and demand cannot meet supply) and where groundwater use is high (more than 80% of needs are met by groundwater)
- Strategic groundwater resource areas as well as all major aquifer areas

Areas where these conditions coincide are depicted in Figure 28. High-risk areas are parts of the Mogalakwena municipality and the Polokwane, Blouberg and Molemole municipalities. These areas include a number of large settlements (provincial growth points) such as Polokwane, Thabazimbi, Mookgopong and Mokopane.

The implication is that groundwater utilisation in these areas should be managed to ensure its sustainable use, especially when considering likely decreases in groundwater recharge due to climate change.

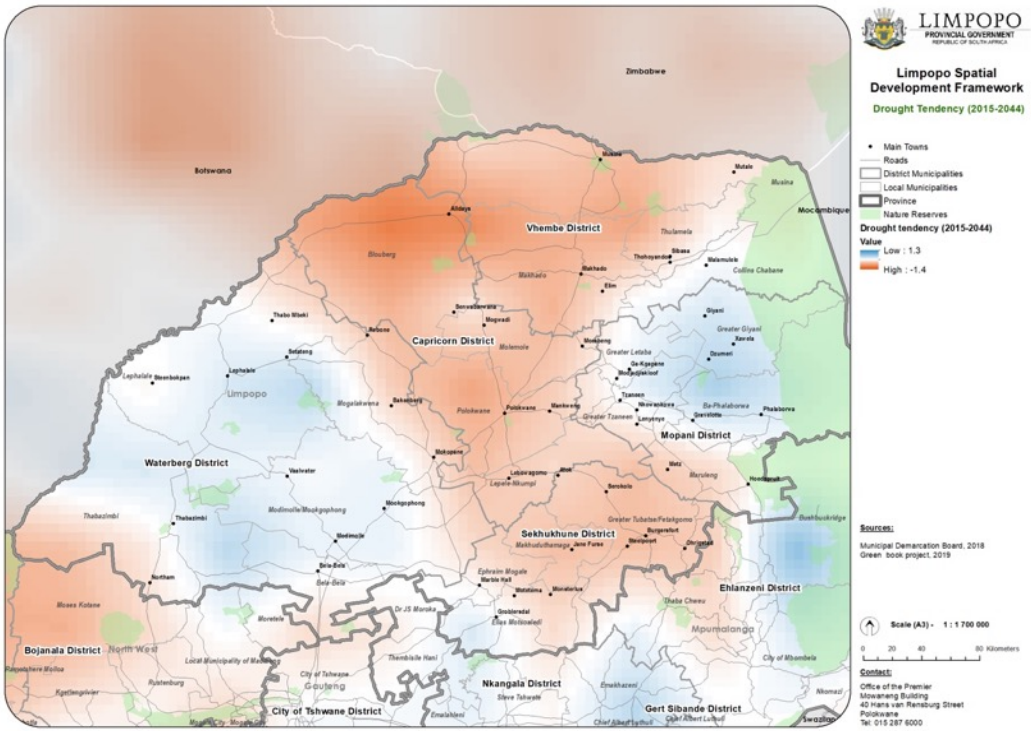


Figure 27: Drought tendency (2015–2044)
Source: Green Book, 2019

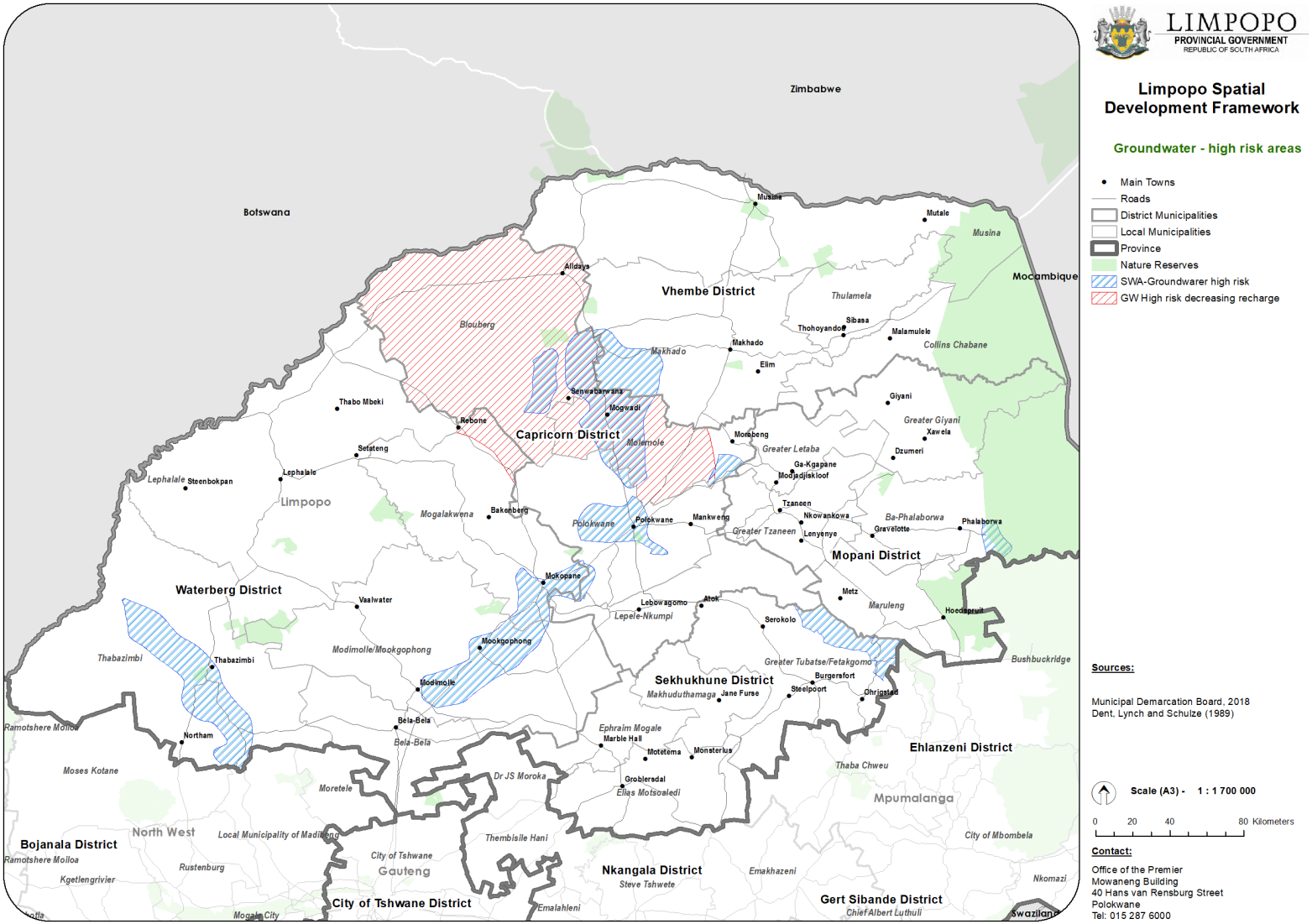


Figure 28: Largest risk area to groundwater (analysis)
Source: Mvandaba et al., 2019

2.3.4 Flood risk

Flooding is the most prevalent type of recorded disaster in South Africa and can result in loss of life and livelihoods and extensive damage to infrastructure. Rainfall and especially extreme or prolonged rainfall can result in flooding. The Flood Hazard Index (FHI) for the province is shown in Figure 29. The FHI is based on the catchment characteristics and design rainfall and is reflected at the quinary catchment level. Given the predicted increase in extreme rainfall events, sudden peaks in run-off can be expected, which means that certain areas will become more susceptible to flooding.

Areas in the province at greatest risk of flooding include large areas of the Sekhukhune district as well as parts of the Greater Tzaneen and Polokwane municipalities. A second risk cluster is located in the Makhado and Thulamela municipalities. These areas also contain a large number of settlements (traditional settlement areas), which could be at risk especially where settlements and their infrastructure are not sufficiently designed to withstand flooding.

The risk of flooding can be considerably mitigated by reducing the hardening of catchments (i.e. when areas are covered with hard, impermeable surfaces such as buildings that promote run-off) and by protecting and rehabilitating wetlands, which are natural regulators of stream flow and help with flood attenuation.

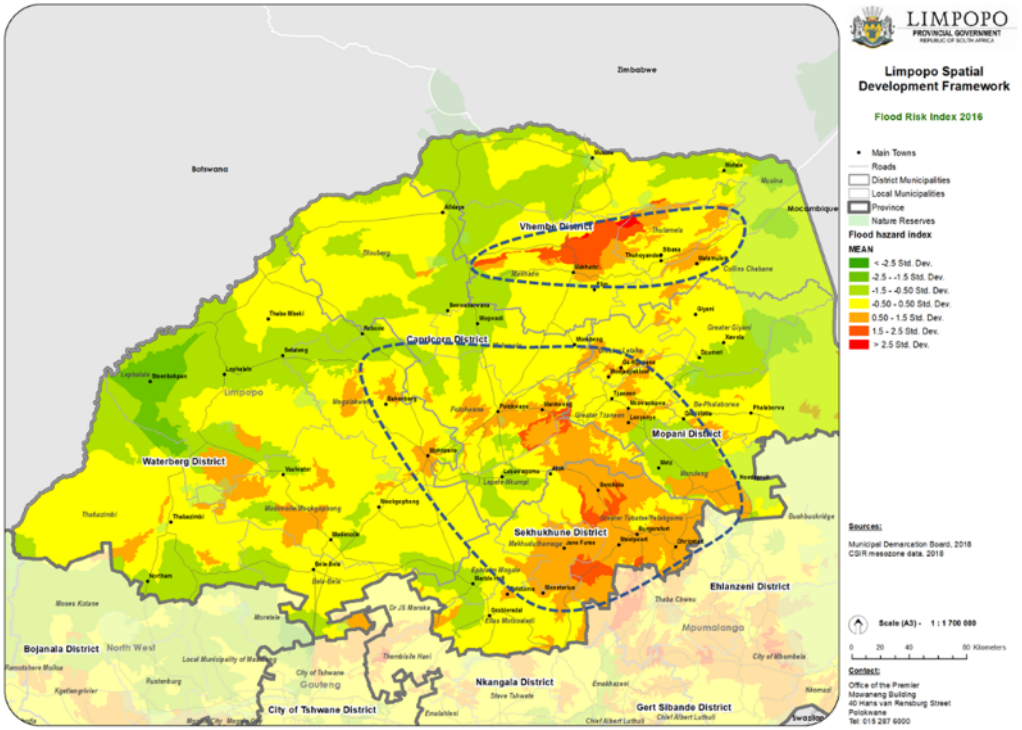


Figure 29: Flood risk index 2016

Source: Green Book, 2019

2.3.5 Fire hazard

While hot, dry and windy weather combined with fuel accumulation are key contributing factors to the damage caused by wildfires, the risk is being compounded by spatial development trends (Forsyth et al., 2019). These trends include the increasing placement of people and infrastructure at the boundary between developed land and fire-prone vegetation. Climate and vegetation characteristics that are conducive to fires, combined with growing human exposure, result in significant wildfire risk across the province, especially in the western parts of the Waterberg and Sekhukhune districts, as indicated in Figure 30. The situation is unlikely to improve because climate change will result in more frequent and extended high fire danger periods and, therefore, an increased likelihood of severe fires.

Some mitigation measures include establishing Fire Protection Associations, locating vulnerable infrastructure and settlements outside of high-risk areas, and removing alien invasive vegetation (which increases fuel availability and fire intensity).

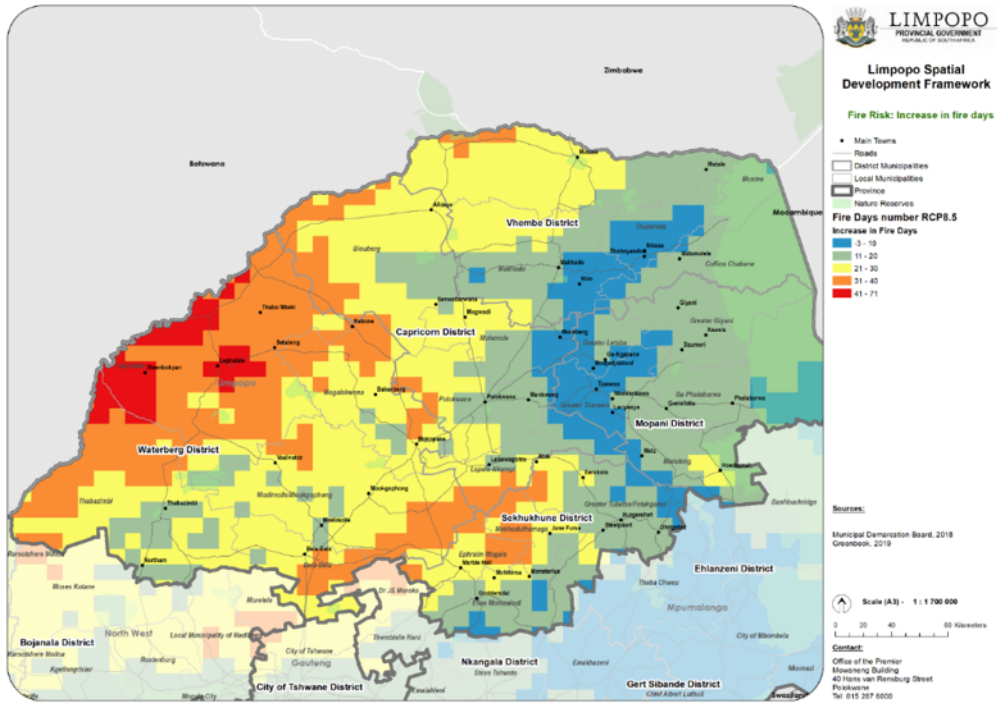


Figure 30: Increase in fire danger days, current to 2050
Source: Forsyth et al., 2019; CSIR, 2019

2.3.6 Impact on food security

Change in climate is linked to food security in that climatic factors such as rainfall and temperature impact directly on agriculture. Extreme weather events can, for example, result in crop failure, and increasing temperatures can cause some areas to become too hot for traditional crops.

This link is important to bear in mind, as agricultural activity in the province is significant and takes place at various levels and intensities, from large-scale commercial ventures to subsistence level agriculture, as indicated in Figure 31.

The percentage of agriculture cultivation that takes place in each municipality, as well as the main climate challenges faced, is provided in Table 10.

Small-scale traditional and subsistence farming predominates in more than half of the municipalities, indicating the importance of agriculture at a subsistence level. These areas are particularly vulnerable to negative impacts on agriculture from climate change, such as crop losses to drought or extreme weather events. Ensuring food security in these areas is important. Municipalities that have a high level of subsistence agriculture and that are therefore at particular risk are the Blouberg, Collins Chabane, Greater Letaba, Fetakgomo Tubatse, Lepelle-Nkumpi, Makhuduthamaga, Maruleng, Mogalakwena and Molemole municipalities.

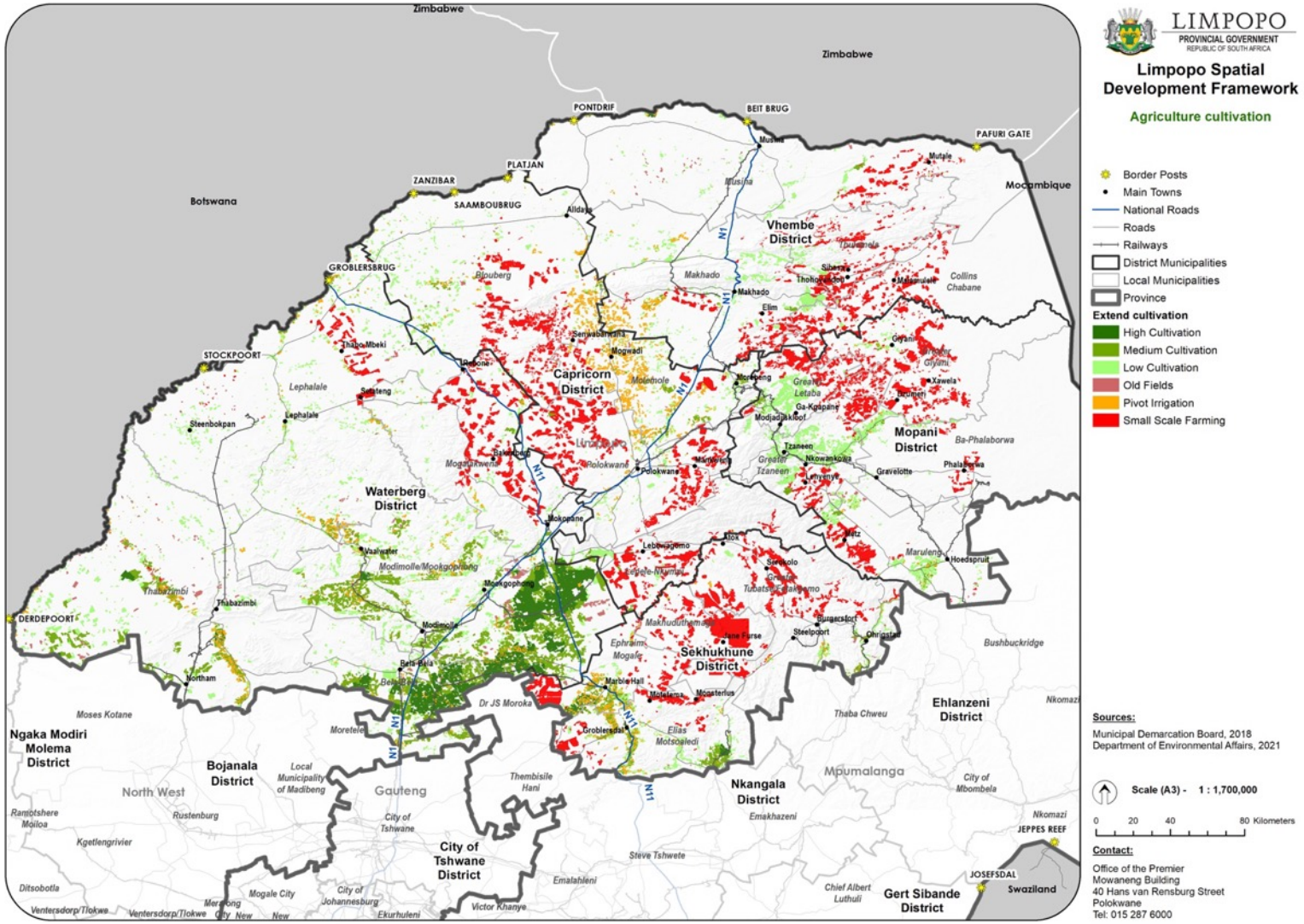


Figure 31: Cultivation extent

Source: Department of Environmental Affairs, 2021

Table 10: Cultivation and main climate issues per municipality

Local Municipality	Cultivation level (%)			Type (%)			Main climate factors
	High	Low	Med	Old fields	Pivot irrigation	Small-scale subsistence	
Ba-Phalaborwa	0	52	6	0	3	39	Hotter and wetter with more extreme rainfall events.
Bela-Bela	47	11	32	1	9	1	More rainfall and increased extreme rainfall, warmer
Blouberg	0	23	3	1	15	57	Hotter with very hot days, high groundwater use and negative water balance, with increased drought tendency
Collins Chabane	0	5	0	0	0	94	Hotter and drier with higher drought tendency and more fire risk
Elias Motsoaledi	4	21	22	1	18	34	Warmer with higher drought tendency
Ephraim Mogale	8	8	13	0	21	50	Warmer with drought tendency on parts and more extreme rainfall
Greater Giyani	0	6	1	0	1	92	Higher rainfall, negative water balance
Greater Letaba	0	40	2	0	0	57	Higher rainfall, and more extreme rainfall, high groundwater use and negative water balance
Fetakgomo Tubatse	0	10	4	1	5	79	Warmer with increased drought tendency with high flood risk areas and high groundwater dependence
Greater Tzaneen	0	55	4	0	1	40	Wetter and warmer with increased flood risk
Lepelle-Nkumpi	4	13	9	0	1	73	Warmer with more extreme hot days, with increased drought tendency
Lephalale	0	45	5	3	16	31	Warmer with more extreme hot days, higher drought tendency and more fire days
Makhado	0	41	3	1	18	37	Wetter with more extreme rainfall, and flooding, high groundwater dependence, with increased drought tendency
Makhuduthamaga	0	1	0	0	0	99	Hotter with increased drought tendency with more flood risk. High groundwater dependence and negative water balance
Maruleng	0	40	5	3	7	45	Hotter, flood risk and extreme rainfall. Negative water balance
Modimolle/ Mookgophong	35	14	40	3	8	0	High groundwater dependence
Mogalakwena	1	15	6	2	4	72	Hotter, wetter, droughts, high groundwater dependence, negative water balance
Molemole	0	13	8	0	42	37	Hotter, wetter, negative water balance
Musina	2	29	6	5	6	51	Hotter and drier with increased drought tendency
Polokwane	0	6	1	0	3	89	Warmer, drier, with increased drought tendency, high groundwater use
Thabazimbi	5	36	35	7	16	0	Hotter, extreme hot days increase, droughts in parts
Thulamela	0	11	0	0	0	89	Hotter with increased drought tendency but wetter towards end of century with more extreme rainfall events.
Grand total	**11**	**20**	**16**	**2**	**10**	**41**	

2.4 Natural resource economic base

2.4.1 Agriculture and land capability

The varied biophysical environment of the province provides for a diverse agricultural sector, which includes crop cultivation (both irrigated and rainfed), planted pasture, rangeland and horticulture. Large areas of the province are also given over to subsistence farming, as shown in Figure 32.

Agricultural land use has been strongly influenced by historical political factors, in particular the creation of the previous homeland areas. Agriculture in these regions has traditionally been marked by subsistence farming and limited infrastructure, whereas the non-homeland areas tend to be represented by commercial agriculture and greater infrastructural development. Evening out these differences and ensuring equal socio-economic development are key spatial planning challenges.

Agricultural land use is closely linked to land capability, which can be defined as the most intensive long-term use of land for purposes of rainfed farming. Land capability varies across the region, as indicated in Figure 33, and is closely interlinked with soils, climate and terrain. Areas of greatest capability are in the higher rainfall areas along the escarpment and in the south of the province.

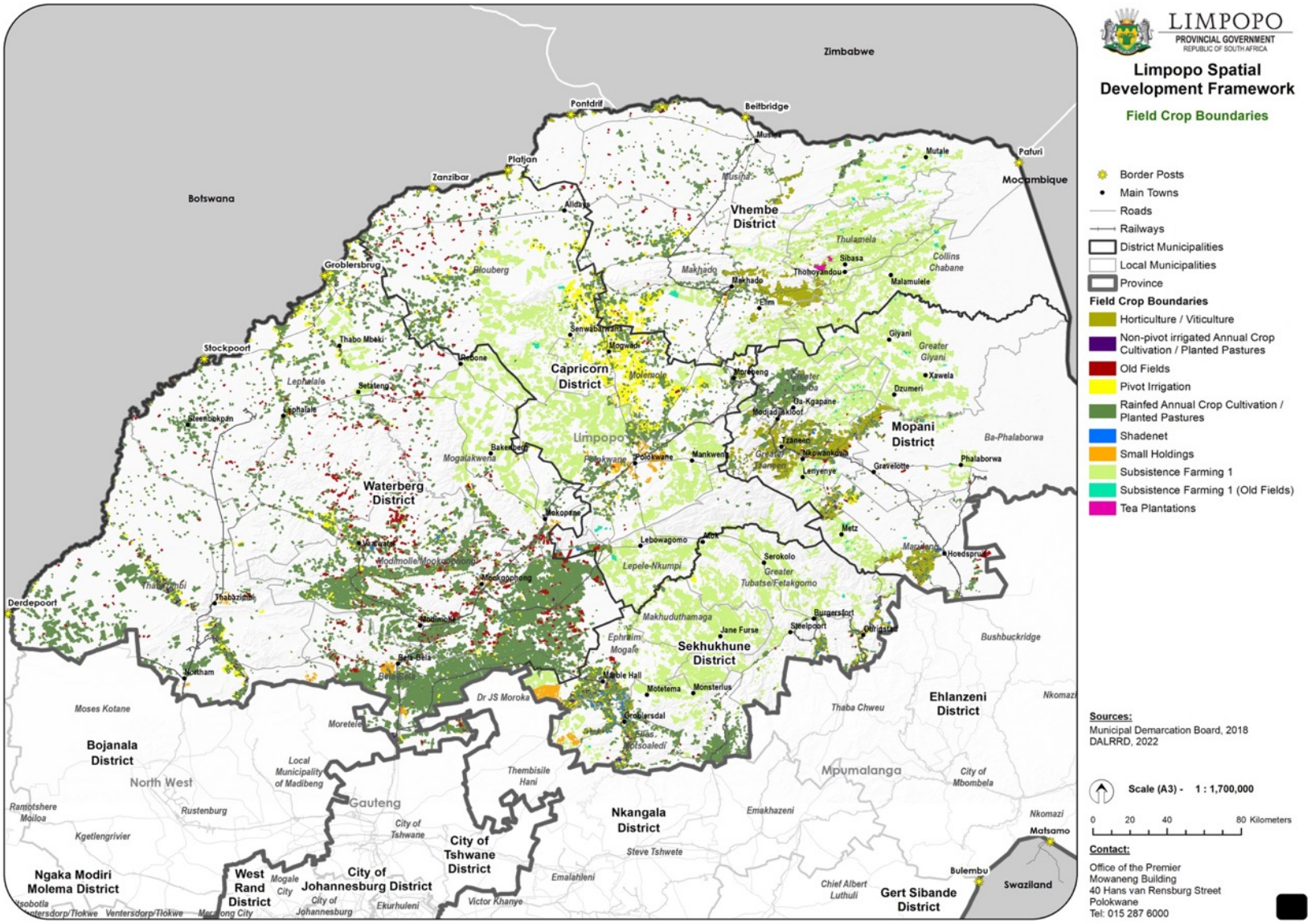


Figure 32: Agricultural activities

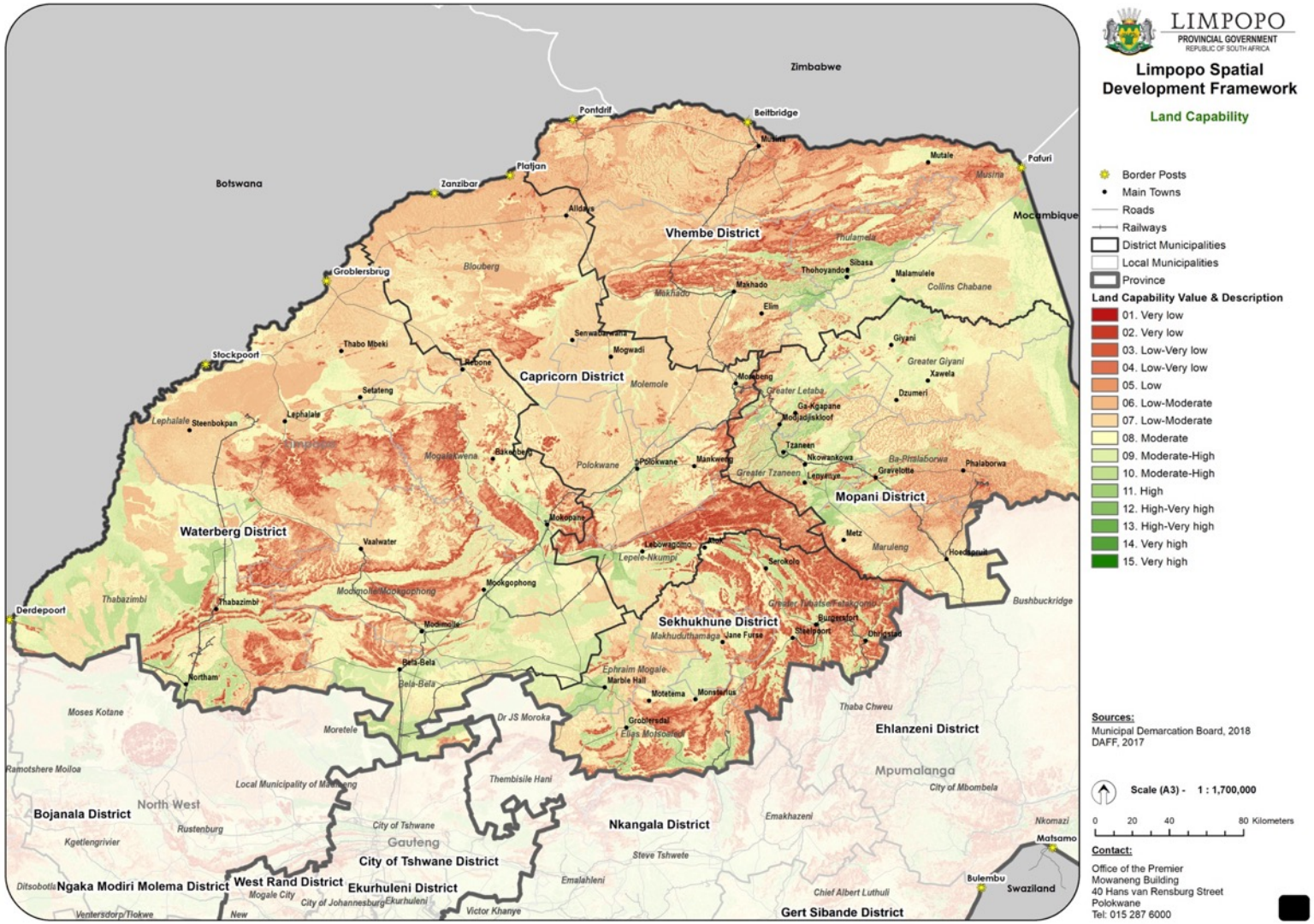


Figure 33: Land capability

2.4.2 High Potential Agricultural Areas

A key agricultural land capability initiative that is currently being undertaken is the national identification and demarcation of high-value agricultural areas that are suitable for continued long-term cultivation purposes. The intention is to protect these demarcated high-potential areas from non-agricultural uses by gazetting them in terms of the Conservation of Agricultural Resources Act, 1983 (Act no. 43 of 1983) and publishing regulations to regulate their use. Once gazetted, these areas will be called Protected Agricultural Areas (PAAs), but until then are referred to as High Potential Agricultural Areas (HPPAs). For the sake of convenience, they are hereafter referred to as HPAAs in this report.

HPAAs can be regarded as large, relatively homogeneous portions of high-value agricultural land that has the potential to sustainably contribute significantly to the production of food in the long term. It is important that the proposed HPAAs be considered in spatial planning and rural development documents.

The proposed HPAAs are shown in Figure 34. The areas can be divided into ones suited to irrigation (and shown in Figure 35) and ones suited to rainfed agricultural activities (and shown in Figure 36).

Each of the HPAA classification types has been assigned a priority rating:

- For rainfed HPAAs, the priority ratings range from A to F, with A being the highest priority rating and F the lowest
- For irrigated HPAAs, the priority ratings range from A to D, with A being the highest priority rating and D the lowest

While the identification and protection of valuable agricultural land are key, it must be taken into consideration that the HPAAs were identified primarily based on land capability; environmental planning initiatives such as the Bioregional Plans and the subsequent CBA maps, the identification of Strategic Water Source Areas, and the proposed Protected Area Expansion Strategy were not taken into account. As a result, some of the proposed Protected Agricultural Areas may conflict with existing or proposed land uses, such as those areas already designated as protected or under severe ecological pressure. Such areas include the following:

- Critical Biodiversity Areas, especially in the Waterberg district and along the provincial borders with neighbouring provinces and Botswana. The HPAA along the border between the Capricorn and Vhembe districts breaks up a proposed critical biodiversity corridor.
- Areas close to the Nylsvley Ramsar wetland
- Strategic Water Source Areas, such as those shown in Figure 7, where it will be critical to manage water use and prevent irrigation run-off that is potentially contaminated with fertilisers or pesticides
- Severely water-stressed areas (where water demand already exceeds supply) in the Sekhukhune and Greater Letaba municipalities as well as around Mogwadi, as indicated in Figure 66 in Section 3.5.2.8 of the Socio-Economic Analysis.

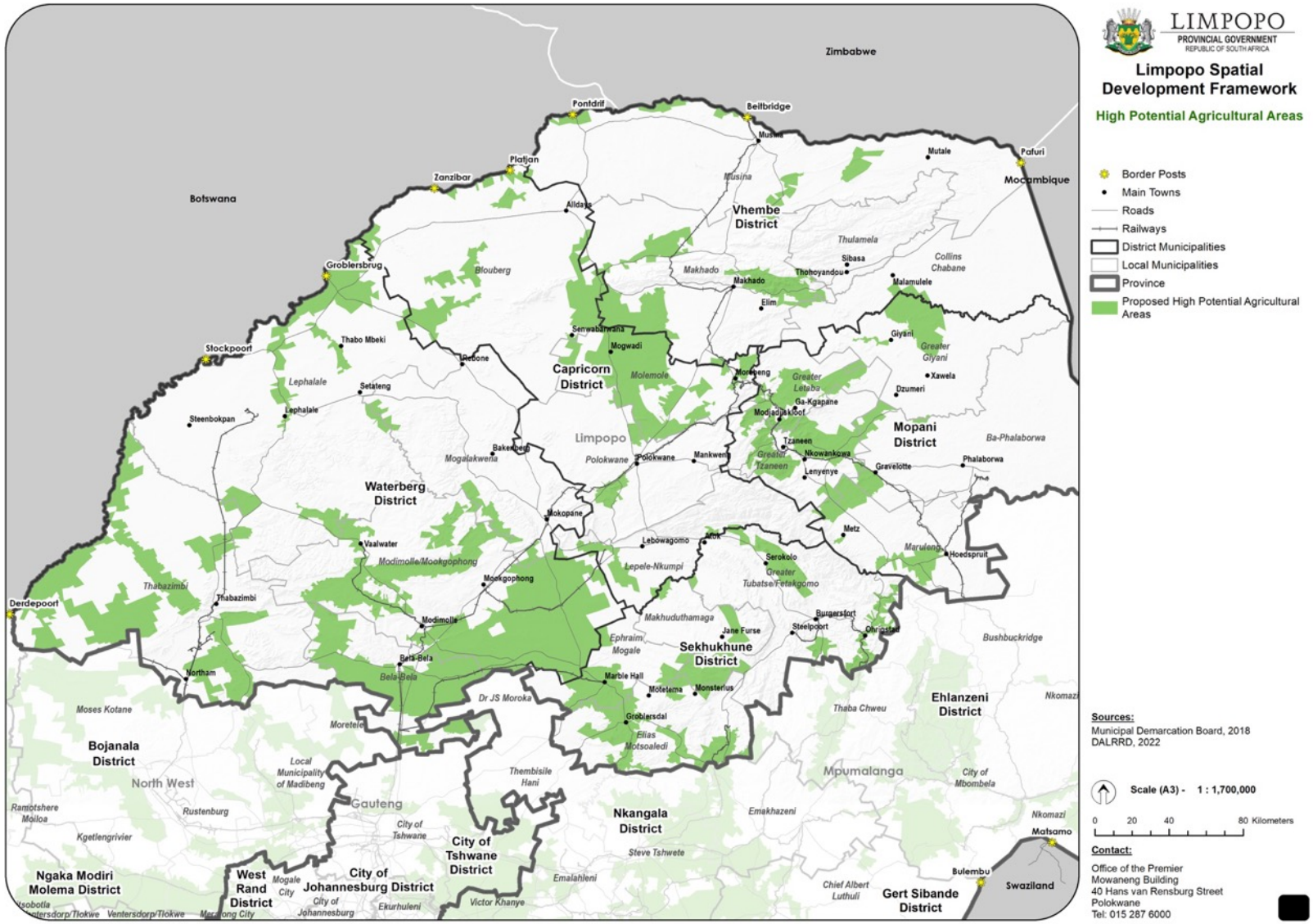


Figure 34: Proposed High Potential Protected Agricultural Areas (HPPAs)

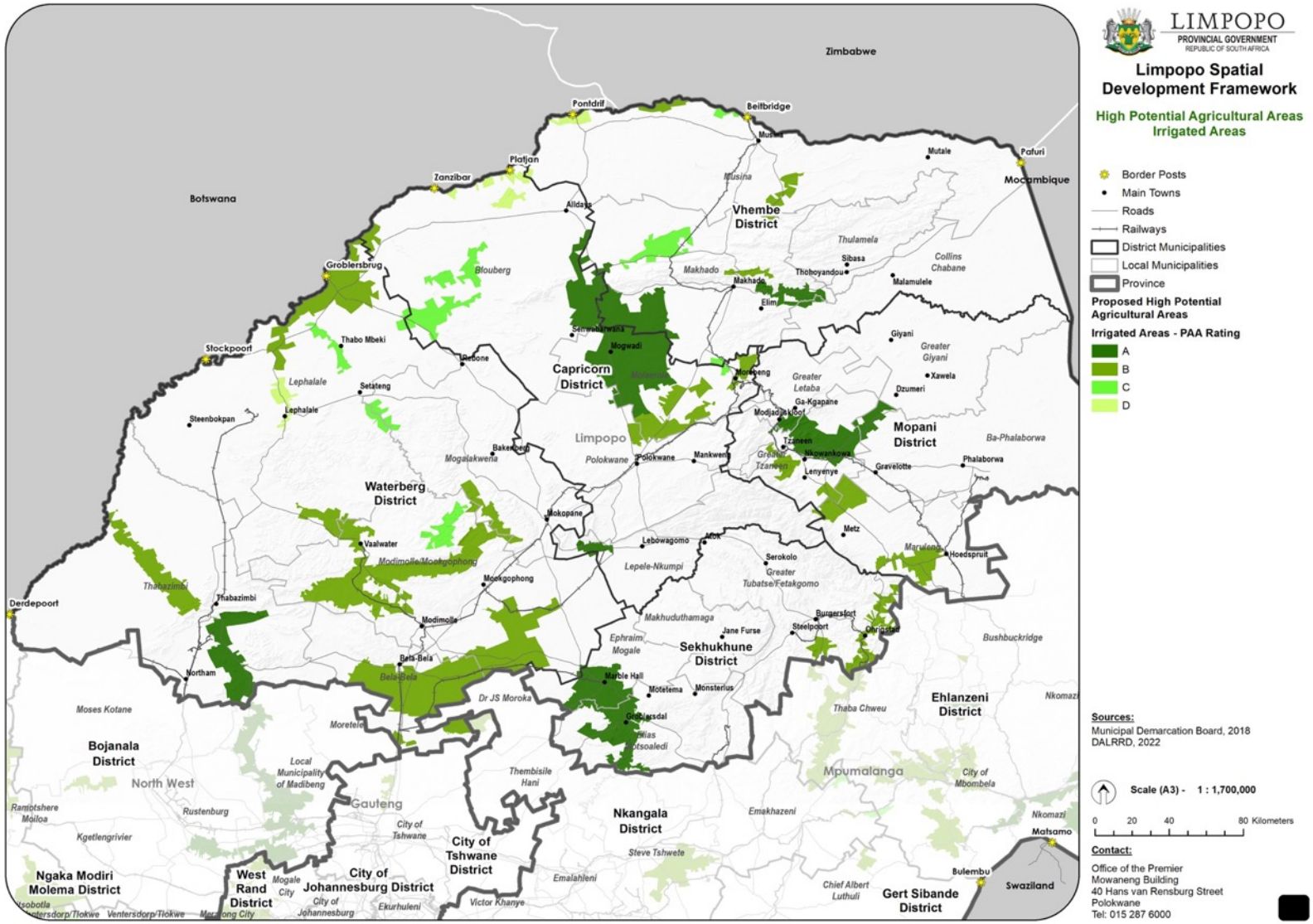


Figure 35: Priority ratings for irrigation High Potential Agricultural Areas

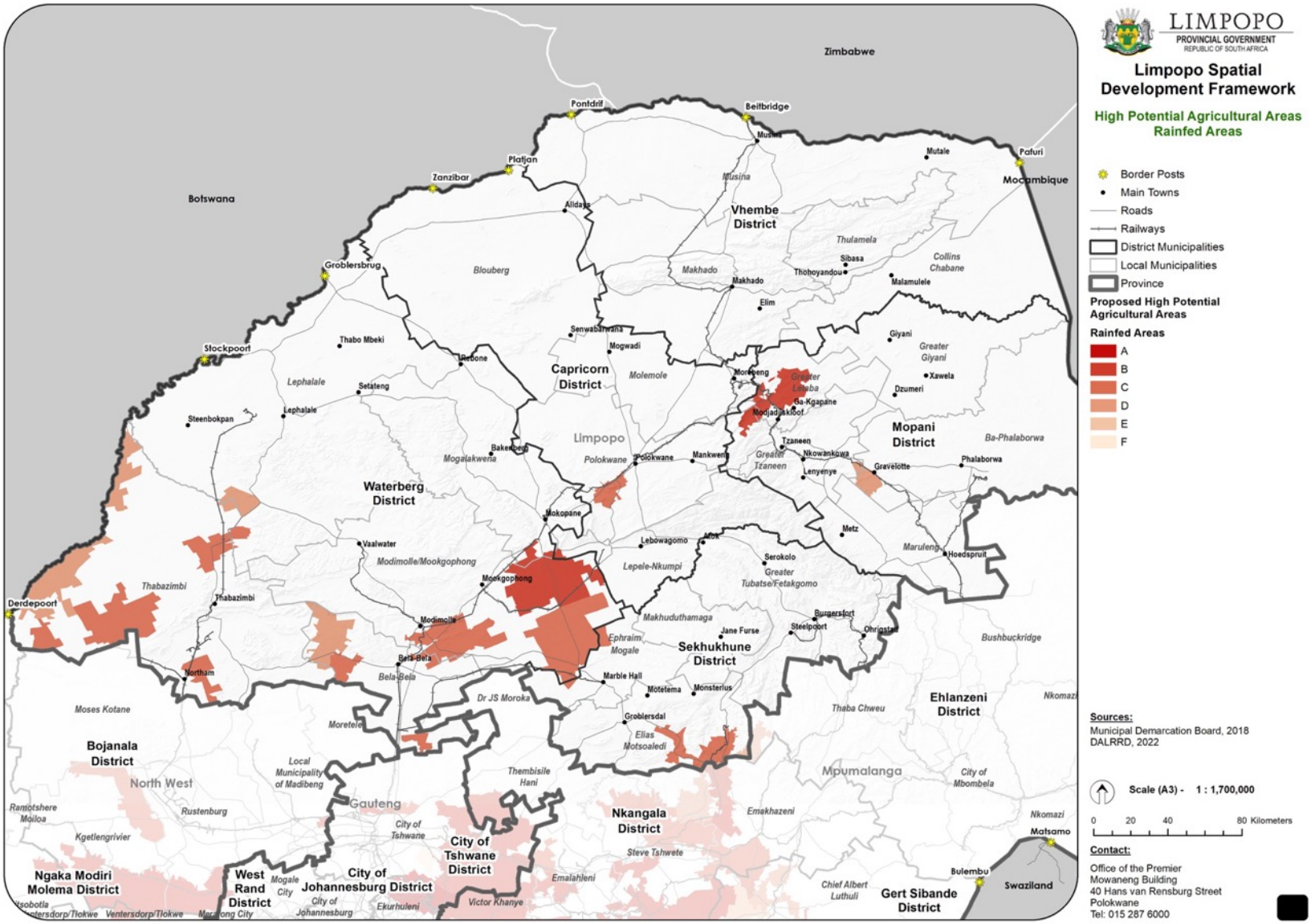


Figure 36: Priority ratings for rainfed High Potential Agricultural Areas

2.4.3 Mineral resources

The province has a wealth of mineral resources. Some of the most significant ones include the following:

- The Eastern Limb of the Bushveld Igneous Complex (BIC), which contains the world's largest reserves of platinum-group metals along with quantities of titanium, vanadium, iron and tin. The Merensky and UG-2 reefs in the BIC contain significant chromatite deposits. Gabbro (dimension stone) is also present. The Eastern Limb include the areas around Mokopane, and the platinum and chrome mines around Burgersfort and Steelpoort.
- The Waterberg coalfield, located to the west of Lephalale, which contains almost half of the country's coal reserves.
- The diamond-yielding Kimberlite deposits in the Vhembe district (at the Venetia mine).
- Other important minerals that are found in the province include copper, precious stones, gold, limestone and sand.

The Department of Mineral Resources and Energy (DMRE) lists 149 mines as operational in the province, which is an increase of 79 mines since 2016.

The mines listed by DMRE as operational are shown in Table 11. Most current mining activities are clustered in the Bushveld Igneous Complex areas, where the main mineral resources are, as indicated in Figure 37. The majority of the mines are opencast, which, if not managed properly, can result in significant biodiversity loss as well as air quality problems, with the release of particulate matter being of the most concern. Biodiversity offsets should be encouraged where possible.

There is an increasing threat to the sterilisation of mineral resource potentials and feasibility due to expanding settlements and land invasion surrounding mining activity. This phenomenon is a risk to the Platreef at Mogalakwena and the Eastern Limb of the Bushveld Igneous Complex in Sekhukhune district area.

The rehabilitation of old mines is also important, especially given the large number of abandoned mines in the province, located mainly in the central, northern and eastern parts of the province.

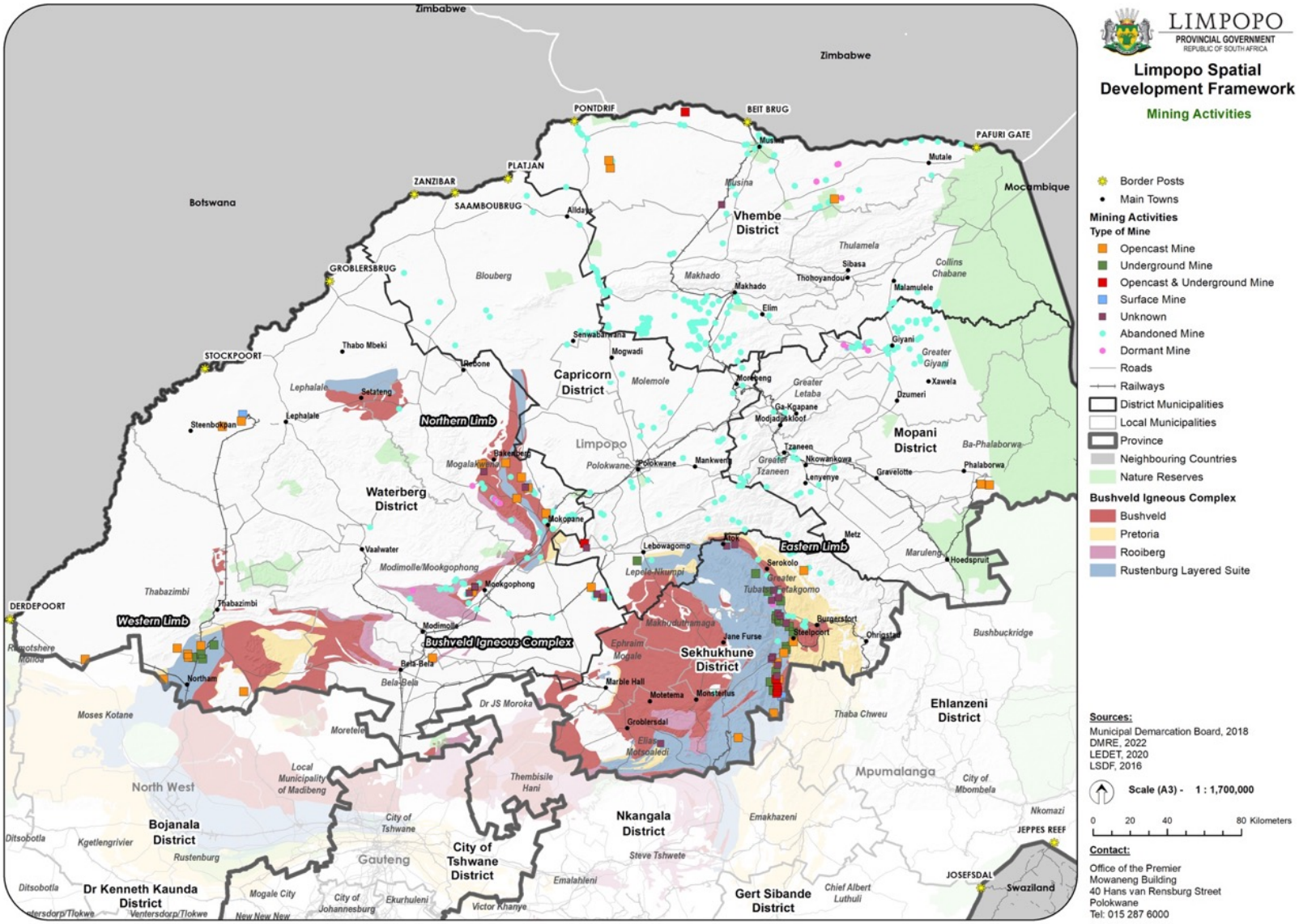


Figure 37: Mines and mining areas

Table 11: Operational mines in the province (2022)

Mine Name	Magisterial District	Type of Mine	Commodity
Mokgamela Multiminerals	Dzanani	Opencast	Aggregate, sand natural
Kondoa 191 Mt	Dzanani	Opencast	Sand natural
Exxaro Reductants	Lephalale	Surface	Coal bituminous
Grootegeluk Mine	Lephalale	Opencast	Coal bituminous
Baloyi Khazamola George	Lephalale	Opencast	Sand natural
Pontes Abelino	Lephalale	Opencast	Sand natural
River Deep Construction	Lephalale	Opencast	Sand natural
Scenic Route Trading 906 Cc	Lephalale	Opencast	Sand natural
Regison Mining (Pty) Ltd	Giyani	Opencast	Magnesite, Aggregate
Adit Mining Consultants & Trading Cc	Letaba	Underground	Semi-precious stones
Madife Kgonopele Agric & Indus (Pty)	Letaba	Opencast	Semi-precious stones
Stibium Mopani (Pty) Ltd	Letaba	Underground	Antimony Metal IC, Gold
Tivani (Pty) Ltd	Letaba	Opencast	Titanium, Titanium Concentrate
Maranda Mining Co (Pty) Ltd	Letaba	Underground	Zinc metal IC
Bathlabeni Brick Yard	Letaba	Opencast	Clay brickmaking, shale brickmaking
Lamei Stone	Letaba	Opencast, Surface	Dimension stone other
Gelletich Mining Industries	Letaba	Opencast	Mica, Feldspar, Silica, Aggregate
Mahale Silica Stone	Letaba	Opencast	Silica
Letaba Crushers	Letaba	Opencast	Aggregate, Sand natural
WG Wearne - Tzaneen	Letaba	Opencast	Aggregate, Sand natural
Antimony Product Ltd	Letaba	Works Surface	Antimony trioxide
Nkwe Platinum	Burgersfort	Opencast	PGM, Gold, Silver, Cobalt Metal IC, Copper, Nickel
PGM Plant	Burgersfort	Works OMS Surface	PGM, Gold

Mine Name	Magisterial District	Type of Mine	Commodity
Tamboti Platinum (Pty) Ltd	Burgersfort	Surface	PGM, Gold, Cobalt Metal IC, Copper, Nickel, Sulphur
Sefateng Chrome	Burgersfort	Opencast	Chrome ore
Gracelica Mining (Pty) Ltd	Burgersfort	Opencast	Silica
Vhembe District – Landbou	Messina	Opencast	Semi-precious stones
Vhembe District – Uitenpas	Messina	Opencast	Semi-precious stones
Hope Bricks	Messina	Opencast	Clay brickmaking, shale brickmaking
Central Africa Crushers (Pty) Ltd	Messina	Opencast	Aggregate, Sand natural
Greater Musina TIC Quarry	Messina	Opencast	Sand natural
Ivanplats Limited (Pty) Ltd	Mokerong	Opencast	PGM
Mogalakwena Platinum	Mokerong	Opencast	PGM, Gold, Cobalt Metal IC, Copper, Nickel, Sulphur
Bestaf Granite (Pty) Ltd	Mokerong	Opencast	Dimension stone, Granite
Kelgran Equipment Pty Ltd (African Red Granite (Pty) Ltd	Mokerong	Opencast	Dimension stone, Granite
Fred Cooper Sand & Klip	Mokerong	Opencast	Sand natural
Gravelotte Emerald	Phalaborwa	Opencast	Semi-precious stones
Palabora Mining Co Ltd	Phalaborwa	Opencast, Underground	Copper, Gold, Silver, PGM, Iron ore, Nickel, Sulphur, Vermiculite
Magvanti	Phalaborwa	Opencast	Titanium, Titanium Concentrate
Foskor Zirconia (Pty) Ltd	Phalaborwa	Works OMS Opencast	Zircon, Zircon Concentrate, Silica
Idwala Magnetite	Phalaborwa	Surface	Iron ore
Baderoukwe(Pty) Ltd	Phalaborwa	Opencast	Dimension stone slate, Dimension stone other, Aggregate
Pegmin (Pty) Ltd	Phalaborwa	Opencast	Feldspar, Mica, Silica
Rob5 Milling (Pty) Ltd	Phalaborwa	Works surface	Feldspar
Rob5 Mining (Pty) Ltd (Maori)	Phalaborwa	Underground	Feldspar
Rob5 Quarries (Pty) (Morelag)	Phalaborwa	Opencast	Feldspar
Foskor Ltd	Phalaborwa	Opencast	Phosphate, Iron ore, Phosphate concentrate

Mine Name	Magisterial District	Type of Mine	Commodity
Bosveld Phosphates	Phalaborwa	Works surface	Phosphoric acid
Clay Brick Manufacturing	Polokwane	Opencast	Clay brickmaking, shale brickmaking
Terra Bricks	Polokwane	Opencast	Clay brickmaking, shale brickmaking
IPFI Corundum	Polokwane	Opencast	Corundum
Earthstone Granite Trading 9	Polokwane	Opencast	Dimension stone granite
Kelgran Africa (Pty) Ltd	Polokwane	Opencast	Dimension stone granite
Kelgran Africa: Tropicale JV	Polokwane	Opencast	Dimension stone granite
Rebone Mining (Pty) Ltd	Polokwane	Opencast	Silica
Thaba Chueu Mining (Pty) Ltd	Polokwane	Opencast	Silica, Aggregate, Sand natural
Janniek Mining (Pty) Ltd T/A Roodepoort Crusher	Polokwane	Opencast	Aggregate, Sand natural
Knott	Polokwane	Opencast	Aggregate, Sand natural
WG Wearne (Pty) Ltd – Polokwane	Polokwane	Opencast	Aggregate, Sand natural
Dikwena St Mining Co-Op Ltd	Polokwane	Opencast	Sand natural
Hlogo Construction Cc	Polokwane	Opencast	Sand natural
Pauer Sand	Polokwane	Opencast	Sand natural
Sand Hawks (Pty) Ltd	Polokwane	Opencast	Sand natural
Solmen (Pty) Ltd	Polokwane	Opencast	Sand natural
Steyser Sand	Polokwane	Opencast	Sand natural
Silicon Smelters (Pty) Ltd	Polokwane	Opencast	Silicon alloys, Silica
Silicon Smelters (Pty) Ltd (Works)	Polokwane	Works OMS Surface	Silicon alloys, Silica
De Beers - The Oaks	Mopokane	Opencast	Diamonds kimberlite
Kegakilwe Trading (Pty) Ltd	Mopokane	Opencast	Diamonds alluvial, Diamonds any
Klipspringer	Mopokane	Opencast, Underground	Diamonds kimberlite

Mine Name	Magisterial District	Type of Mine	Commodity
Vanadium and Magnetite Expl & Dev Co (Pty) Ltd	Mopokane	Opencast	Iron ore
Arleco Mining (Pty) Ltd	Mopokane	Opencast	Attapulgite
Terra Clay	Mopokane	Opencast	Clay brickmaking, shale brickmaking
Zebediela Bricks	Mopokane	Opencast	Clay brickmaking, shale brickmaking
Granbis	Mopokane	Opencast	Dimension stone granite
Marlin – Abiqua Quarry	Mopokane	Opencast	Dimension stone granite
Red Stone Mining	Mopokane	Opencast	Dimension stone granite
Royal Granite Supplies Red (Pty) Ltd	Mopokane	Opencast	Dimension stone granite
African Spirit Trading 185 (Pty) Ltd	Mopokane	Opencast	Dimension stone sandstone, Dimension stone granite
Inca Mining	Mopokane	Opencast	Limestone, Lime
Leo Limestone	Mopokane	Opencast	Limestone, Lime
Grassvalley Crushers	Mopokane	Opencast	Aggregate, Sand natural
Bafedile Mining & Construction	Mopokane	Opencast	Sand natural
Water Vaal 669 Ls	Sekgosese	Opencast	Sand natural
Bokoni Platinum s (Pty) Limited	Sekhukhune	Underground	PGM, Gold, Cobalt metal IC, Copper, Nickel, Sulphur
Marula Platinum(Pty) Ltd	Sekhukhune	Underground	PGM, Gold, Cobalt metal IC, Copper, Nickel, Sulphur
Modikwa Platinum	Sekhukhune	Underground	PGM, Gold, Chrome ore, Cobalt metal, Copper, Nickel, Sulphur
Smokey Hills Platinum	Sekhukhune	Opencast	PGM, Gold, Cobalt metal IC, Copper, Nickel, Sulphur
Twickenham Platinum	Sekhukhune	Surface, Underground	PGM, Gold, Cobalt metal IC, Copper, Nickel, Sulphur
Tshepong Chrome	Sekhukhune	Opencast	Chrome ore
Rakhoma Mining Resources Pty Ltd	Sekhukhune	Opencast	Iron ore, Iron Bp, Manganese
Lepatswa Brick T/A Matjipa Brickyard	Sekhukhune	Opencast	Clay brickmaking, shale brickmaking
Motlokwa Solomon Thobejane	Sekhukhune	Opencast	Sand natural
Pelgrimshoop	Seshego	Opencast	Sand natural
De Beers - Venetia	Soutpansberg	Opencast, Surface	Diamonds kimberlite

Mine Name	Magisterial District	Type of Mine	Commodity
Krone-Endora	Soutpansberg	Opencast	Diamonds alluvial
Collateral Trading 551 Cc	Soutpansberg	Opencast	Semi-precious stones
Vele Colliery	Soutpansberg	Opencast	Coal bituminous
Syferfontein Dolomite (Pty) Ltd	Soutpansberg	Opencast	Limestone, Lime
Bloemhof Salt & Chemicals	Soutpansberg	Opencast	Salt
The Crystal Salt Cc	Soutpansberg	Opencast	Salt
Pakama Crusher – Vogelensang	Soutpansberg	Opencast	Aggregate, Sand natural
WG Wearne – Makhado	Soutpansberg	Opencast	Aggregate, Sand natural
Messina Platinum s Ltd	Thabamoopoo	Underground	PGM, Gold, Cobalt metal IC, Copper, Nickel, Sulphur
Amandelbult Production Services	Thabazimbi	Opencast	PGM
Anglo Platinum – Dishaba	Thabazimbi	Opencast, Underground	PGM, Gold, Cobalt metal IC, Copper, Nickel, Sulphur
Anglo Platinum – Tumela	Thabazimbi	Opencast, Underground	PGM, Gold, Chrome ore, Cobalt metal IC, Copper, Nickel, Sodium Sulphate, Sulphur
Anglo Platinum Amandelbult Concentrators	Thabazimbi	Works surface	PGM, Gold, Cobalt metal IC, Copper, Nickel, Sulphur
Northam Platinum – Zondereinde	Thabazimbi	Underground	PGM, Gold, Silver, Chrome ore, Cobalt metal IC, Copper, Nickel, Sulphur
Siyanda Bakgatla Platinum	Thabazimbi	Surface	PGM, Gold, Chrome ore, Cobalt metal IC, Copper, Nickel, Sulphur
Destiny Springs Investment 11 (Pty) Ltd	Thabazimbi	Opencast	Chrome ore
Nooitgedacht Chrome	Thabazimbi	Opencast	Chrome ore
Thaba Chronimet Chrome	Thabazimbi	Opencast	Chrome ore
Aquila Steel (South Africa) (Pty) Ltd	Thabazimbi	Opencast	Iron ore
Thabazimbi Iron Ore(Pty) Ltd	Thabazimbi	Opencast	Iron ore
Andalusite Resources (Pty) Ltd	Thabazimbi	Opencast	Andalusite
Rhino Andalusite	Thabazimbi	Opencast	Andalusite
Continental Limestone Quarry	Thabazimbi	Opencast	Limestone

Mine Name	Magisterial District	Type of Mine	Commodity
Ppc - Dwaalboom	Thabazimbi	Opencast	Limestone, Lime, Shale for cement
Stony Lime (Pty) Ltd	Thabazimbi	Opencast	Limestone, Lime
Ganbei Enterprises	Thabazimbi	Opencast	Aggregate, Sand natural
Blue Nightingale Trading 228 (Pty) Ltd	Thabazimbi	Opencast	Sand natural
Quatcon Cc	Thabazimbi	Opencast	Sand natural
Sanmar Sands Cc	Thabazimbi	Opencast	Sand natural
Tshikondeni Coal	Thohoyandou	Underground	Coal bituminous
Vhavenda Brickworks (Pty) Ltd	Thohoyandou	Opencast, Surface	Clay brickmaking, shale brickmaking
Folovhodwe Mining (Pty) Ltd	Thohoyandou	Opencast	Magnesite
Magnesite Mining Cc	Thohoyandou	Opencast	Magnesite
Mukula Stone Crushers Co-Op Ltd	Thohoyandou	Opencast	Aggregate, Sand natural
Palmietgat	Bela-Bela	Opencast	Diamonds alluvial
AP Becker	Bela-Bela	Opencast	Aggregate, Sand natural
B Cohen Vellefontein	Bela-Bela	Opencast	Aggregate, Sand natural
Bospoort 450 Kr	Bela-Bela	Opencast	Aggregate, Sand natural
Rooiberg Stone (Pty) Ltd	Bela-Bela	Opencast	Aggregate, Sand natural
Leeuwpoort Quarry	Bela-Bela	Opencast	Sand natural, Aggregate
Mortimer Smelter	Waterberg	Works OMS Opencast	PGM
Ledjadja Coal (Pty) Ltd	Waterberg	Opencast	Coal bituminous
Sekoko Coal (Pty) Ltd	Waterberg	Opencast	Coal bituminous
Waterberg Cbm Pilot Plant	Waterberg	Surface	Natural gas
Lephalale Siyanda Resources	Waterberg	Opencast	Clay brickmaking, shale brickmaking
Nylstene	Waterberg	Opencast	Clay brickmaking, shale brickmaking
Ceramic Industries – Cyferfontein	Waterberg	Opencast	Fireclay
Krokodilkraal Quarry	Waterberg	Opencast	Limestone, Lime, Aggregate

Mine Name	Magisterial District	Type of Mine	Commodity
Kuipersbult	Waterberg	Opencast	Aggregate, Sand natural
Nylstroom Crushers	Waterberg	Opencast	Aggregate, Sand natural
580 MP	Waterberg	Opencast	Sand natural
Eloff Sandwerke Bk	Waterberg	Opencast	Sand natural, Aggregate
Van Gills Plant Hire	Waterberg	Opencast	Sand natural
Zandrivier	Waterberg	Opencast	Sand natural

Source: ***https://www.dmr.gov.za/mineral-policy-promotion/operating-mines (2022)***

2.5 National resource risk areas

The National Spatial Development Framework (NSDF) 2022 identified the Waterberg River Catchment and the Olifants River Catchment as National Resource Risk Areas (NRRAs). The NRRAs are the most stressed sub-national regions or areas in terms of current, rising and anticipated national risks.

A number of actions and interventions are listed in the NSDF (DALRRD, National Spatial Development Framework, 2022) framework for the NRRAs.

Some key steps taken in Limpopo towards achieving these NRRA goals are as follows:

- The CBA map for the province has recently been updated (2018) in line with the bioregional plans completed for each district. This includes the integration of the SWSAs and the outcomes of the latest National Biodiversity Assessment (2018). In order to be effective, the CBA map must be integrated into local spatial planning documents and used to guide development planning.
- A provincial climate change response strategy has been developed.
- The Working for Wetlands Programme, which is an initiative of the DFFE, is still active in the province. A 5-year strategic plan (2019–2024) has been compiled to identify and prioritise wetlands for rehabilitation (DEA, 2019).
- Water Resource Quality Objectives and Water Quality Classes have been gazetted for the Olifants, Letaba, Mokolo, Matlabas, Crocodile (West) and Marico catchments. These objectives will guide water use licensing decisions.

However, unless the CBA map and other environmental planning initiatives are integrated at a local level and applied at all levels of government when development decisions are made, NRRA interventions will be achieved only partially.

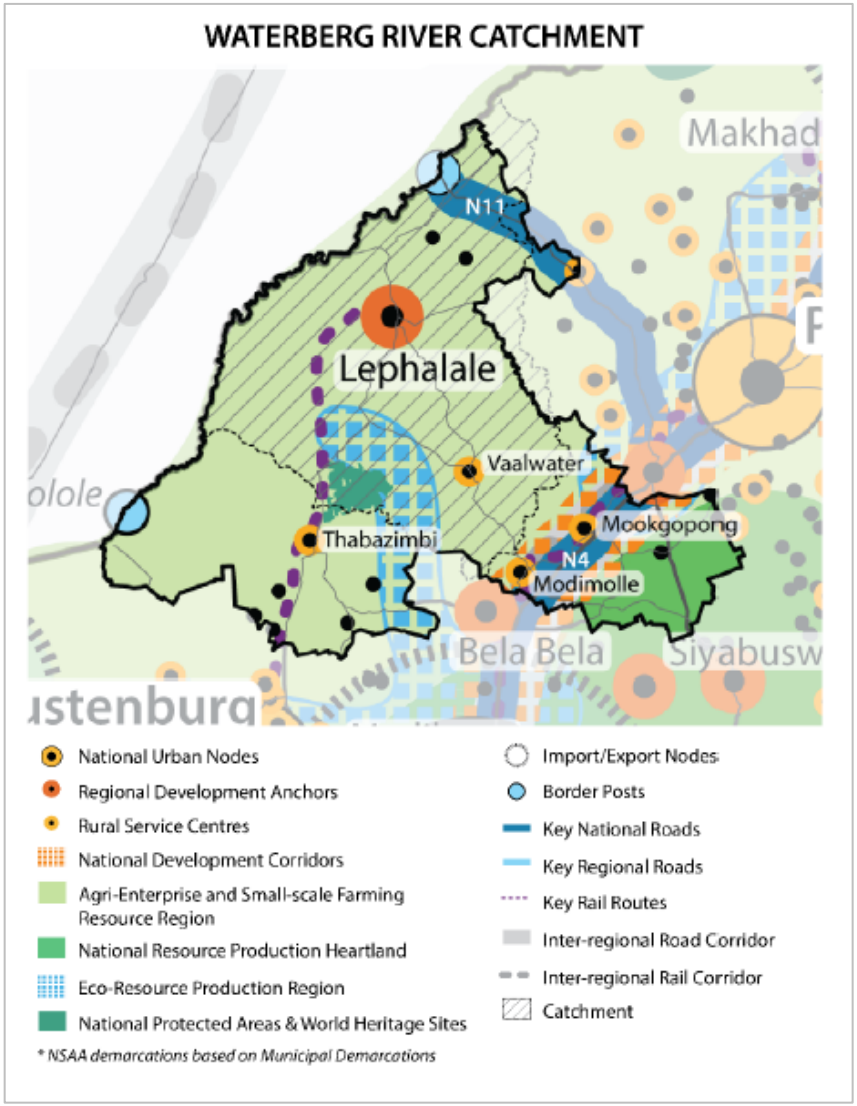


Figure 38: Waterberg river catchment NRRA

Source: (DALRRD, National Spatial Development Framework, 2022)

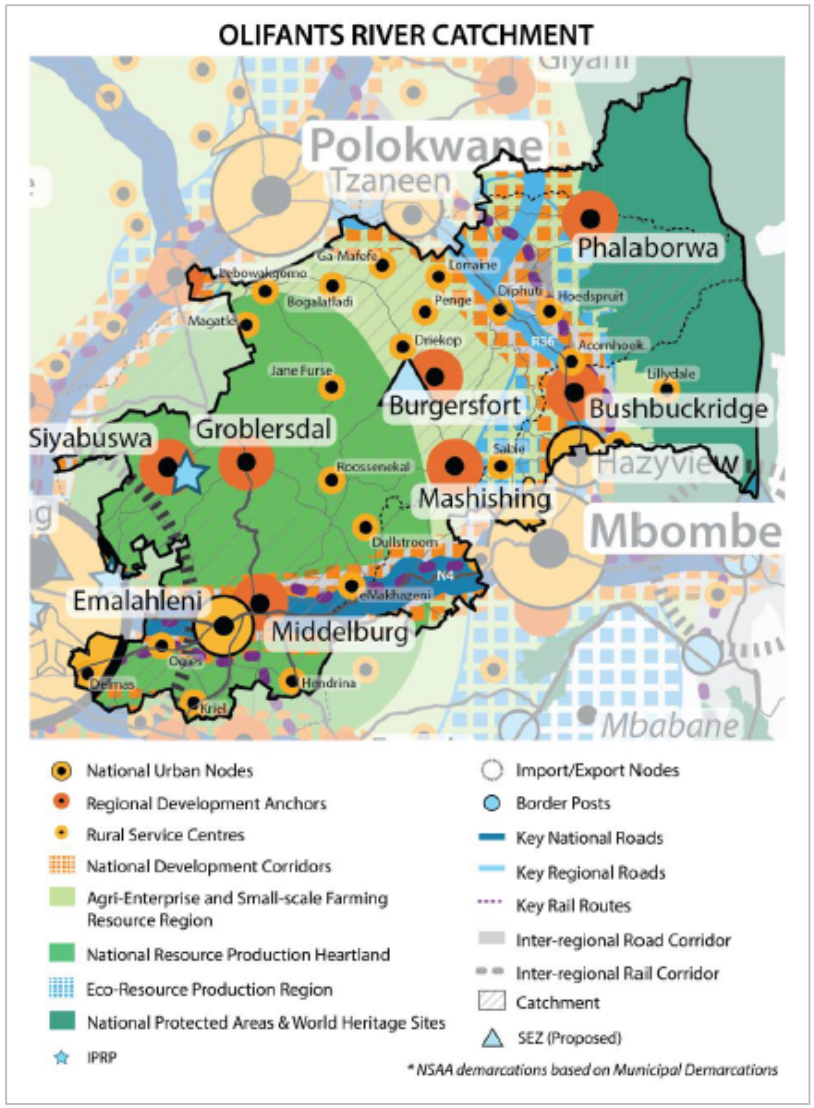


Figure 39: Olifants River catchment NRRA

Source: (DALRRD, National Spatial Development Framework, 2022)

2.6 Key spatial issues and synthesis from the bio-physical environment

2.6.1 Topography and geology

The diverse topography of the province is reflected in the variations in climate, biodiversity, distribution of natural resources and subsequent settlement patterns. The mountain ranges of the Drakensberg, Blouberg, Soutpansberg, Waterberg and Wolkberg are significant topographical features that constrain development but also provide valuable biophysical assets. They should be prioritised for conservation land uses.

The complex geology of the province results in a wide range of mineral resources being available. Dolomite and limestone areas need to be developed with caution as they are prone to sinkhole development, especially where there is poor water management or over-abstraction of groundwater.

2.6.2 Hydrology and water resources

The majority of rivers in the province are under severe ecological pressure, with only 35% of the total river reach being considered to be in a natural or near-natural condition.

Water is a key constraining issue to development. Overall demand in the province already exceeds supply, and forecasts in the Limpopo Water Master Plan indicate that even if water-saving and re-use measures are implemented in the future (2045), the water balance will still be negative. Further dam development and abstraction schemes cannot be recommended as ecologically sustainable in the long term. The focus should be on low water-use developments, water conservation and demand management, water reallocation between sectors and the re-use of wastewater rather than the development of additional large-scale abstraction or transfer schemes.

The three flagship free-flowing rivers in the province, the Luvuvhu, Mohlapitse and Mutale, should retain their free-flowing status and should not be impounded.

The further development of groundwater should be done with caution in areas where there is already high groundwater use and dependency, where supply already exceeds demand, and where groundwater recharge is likely to decrease in the future due to climate change. Risk areas include the Blouberg and Molemole municipalities. Other areas of concern where the use of groundwater is already high and supply cannot meet demand are Greater Letaba, Makhuduthamaga, Mogalakwena and Molemole. Groundwater abstraction in dolomitic areas should also be limited to prevent excessive draw-down, which could contribute to the formation of sinkholes.

Important Strategic Water Source Areas (SWSAs) in the province include the Wolkberg, Soutpansberg and Waterberg and Drakensberg areas for surface water and the Upper Sand (Polokwane) aquifer, Vivo Dendron, Blouberg, Phalaborwa, Crocodile River Valley and Giyani areas for groundwater. Water resource protection in these areas should be a high priority and conservation land uses preferred. The groundwater SWSAs in the central parts of the province are especially poorly protected (not designated as Critical Biodiversity Areas) and are thus more vulnerable to development-related impacts such as over-abstraction and pollution.

2.6.3 Biodiversity

The high level of terrestrial biodiversity in the province can be regarded as a natural asset that can be capitalised on for tourism and nature-based developments. In addition to National Parks, World Heritage Sites and Ramsar wetlands, the province has an exceptionally high level of floristic endemism (many plants that are found nowhere else in the world) with three Centres of Floristic Endemism. Bird diversity is also very high. These assets could form the core for special-interest tourism offerings for birdwatchers

and botanists, for instance. The diversity of unique plant species also offers opportunities for research in areas such as traditional plant medicine.

The key threat facing terrestrial ecosystems in the province is continued habitat loss. An estimated 286,455 hectares of natural habitat was lost to mining, cultivation, afforestation and urban settlement between 2014 and 2020 (DFFE, 2022). This habitat loss needs to be managed to prevent the loss of the province's biodiversity assets. The Critical Biodiversity Areas as identified in the province's bioregional planning process need to be prioritised for conservation land uses.

Aquatic systems in the province are under severe threat and in poor condition: 75% of the river ecosystem types and 90% of the wetland ecosystem types are threatened and 65% of the river length is moderately to critically modified. The greatest pressures on the aquatic systems are increasing disruptions to the hydrological regime (e.g. abstraction and dams) and deteriorating water quality. The most threatened river ecosystems are in the southern and central parts of the province (particularly the Olifants River and its catchment), although most of the Crocodile and Luvuvhu systems are also critically endangered. Water resource protection needs to be prioritised.

2.6.4 Bioregional plans (Critical Biodiversity Areas)

Since 2016, bioregional plans have been completed for all five district municipalities and the outputs used to revise the Critical Biodiversity Area (CBA) plan produced as part of the Limpopo Conservation Plan v2, 2013. The CBA map provides a critical synthesis of environmental planning initiatives and should be used to inform all spatial planning decisions.

Some potential areas of conflict between proposed development and the CBA map that were noted in the bioregional plans include the following:

- Polokwane Nature Reserve – development proposed in reserve buffer zone
- Polokwane-Moria Development Corridor – urban sprawl breaking up landscape connectivity
- Kruger to Kalahari Corridor – Zebediela/Makapan/Waterberg Critical Landscape Link – mining proposed in critical biodiversity landscape corridor (The landscape link must be kept.)
- Fetakgomo Tubatse Local Municipality – urban sprawl is threatening biodiversity and the Sekhukhune Centre of Endemism (Landscape connectivity must be retained.)
- KwaMhlanga-Siyabuswa-Elandsdoring Rural Settlement – urban sprawl is threatening biodiversity corridor links to neighbouring provinces
- Upper Limpopo valley between the Waterberg district and the Vhembe district, which borders Botswana – game fencing and other barriers are stopping the free-ranging wildlife between South Africa and Botswana (Landscape connectivity must be retained.)

2.6.5 Renewable energy

The potential for solar photovoltaic energy in the province is high. There is a linked beneficiation opportunity for the manufacturing of solar panels and chargers given the silicon reserves in the province and the existence of a silicon smelter in Polokwane.

Wind speeds in the province are generally too low to make wind energy an economically viable option except in a few, limited areas. Environmental concerns such steep terrain and the need to maintain extensive buffer zones from Important Bird Areas also limit this option.

Biopower, such as the conversion of waste to energy, could be investigated further, although options that involve the burning of biomass (e.g. driving steam turbines) should be implemented with caution, as they could result in further particulate matter emissions, which are already a concern in parts of the province.

Given the stressed state of the province's water resources, and the vulnerable environment in the mountains where dams for hydroelectric

schemes will be most likely built, will have to be carefully considered as an option for renewable energy.

The strategic electricity transmission corridor should be incorporated into spatial plans to allow for proactive planning to prevent potential conflicts between power lines and other land uses in the future.

2.6.6 Air quality

The main air quality concerns for Limpopo are related to Particulate Matter (PM_{10}), Sulphur Dioxide (SO_2) and Nitrous Oxides (NO_x). The main sources of these pollutants are power generation activities, mining, metallurgical industries and biomass burning. Areas of particular concern include the following:

- SO_2 and NO_x levels around the power generation activities in the Waterberg district
- PM_{10} from the mining sector (mainly open-cast mines) around Lephalale, Steelpoort and Phalaborwa

The concentration of power generation and mining activities in the Waterberg and Bojanala districts led to the establishment of an Air Quality Priority Area for the Waterberg-Bojanala region (Government Gazette Notice 495 of 2012). It is estimated that, by 2030, SO_2 and PM_{10} levels in the priority area will exceed the acceptable levels stipulated in the National Ambient Air Quality Standards, especially around Lephalale.

2.6.7 Climate change risk areas

There are high flood risk areas in the Sekhukhune district and parts of the Greater Tzaneen, Polokwane, Makhado and Thulamela municipalities. Traditional settlement areas are particularly at risk where infrastructure may not be sufficiently designed to withstand flooding. Flood risk can be mitigated by reducing the hardening of catchments and prioritising the conservation of the wetlands and natural grasslands in the upstream catchment areas, as these will help regulate stream flow.

The western areas of the province along the Limpopo River valley are at risk of severe future heat stress (increasing temperatures and number of extreme hot days). Agricultural and other activities proposed in these areas should be drought- and heat-tolerant. Activities such as game farming will be more suitable than irrigated crops.

Areas most at risk of food security issues due to climate change are those that have a high level of subsistence agriculture or reliance on limited crop types. These areas include the Blouberg, Collins Chabane, Greater Letaba, Fetakgomo Tubatse, Lepelle-Nkumpi, Makhuduthamaga, Maruleng, Mogalakwena and Molemole municipalities.

Agricultural resilience to climate change can be improved by focusing on crops/activities with low water demand and by diversifying the types of crops produced. Agro-processing should not be focused on a single specialised crop or product that is not climate-resilient.

Areas most at risk of groundwater depletion due to reduced recharge are those that currently rely heavily on groundwater, are already under water stress (demand exceeds supply) or are located in strategic groundwater source areas or on major aquifers. These high-risk areas include parts of the Mogalakwena municipality and the Blouberg, Molemole, Thabazimbi, Mookgopong and Polokwane municipalities. Further development of groundwater resources in these areas should be managed carefully and high water use developments discouraged.

2.6.8 Natural resource economic base

The diversity of the biophysical environment (e.g. terrain, climate and soil) lends itself to a diversity of agricultural opportunities, from the production of subtropical fruit to game farming, for instance. Diversifying agriculture will help improve adaptability to climate change by reducing reliance on only a few crop types.

A number of High Potential Agricultural Areas (HPPAs) have been identified in the province. They were identified based on land capability; and did not

take other environmental planning initiatives such as the CBA maps, Protected Area Expansion Strategies or climate change predictions into account. Potential land use conflicts could exist and need to be assessed at a local level before an HPPA is earmarked for development. Potential conflict areas include the following:

- Critical Biodiversity Areas, especially in the Waterberg district and along the borders with neighbouring provinces and Botswana. A Critical Biodviersity Area corridor is broken up by the HPAA that lies on the border between the Capricorn and Vhembe districts.
- Areas close to the Nylsvley Ramsar wetland
- Strategic Water Source Areas, where it will be critical to manage water use and prevent irrigation run-off that is potentially contaminated with fertilisers or pesticides
- Severely water-stressed areas (where water demand already exceeds supply) in the Sekhukhune and Greater Letaba municipalities as well as around Mogwadi
- The proposed HPPA for irrigation along the Limpopo River in the Lephalale municipality, as climate change predictions indicate an increase in drought tendencies and heat stress, making irrigation potentially unsustainable in the long-term.

The rich mineral resources of the province are an important natural asset, but further development must be undertaken in line with the Limpopo Conservation Plan (Critical Biodiversity Areas) and with due cognisance of the severe water constraints in the province.

The potential to develop the mineral resources are threatened to be sterilised by land invasion and uncontrolled occupation of land surrounding mining activity.

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