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Overview of the Olifants Catchment (2014)

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1.1 Bio-physical general overview of the Olifants catchment in South Africa

The upper part of the Olifants River catchment forms part of the Highveld and is composed of undulating plains and pans, and a large open flat area, referred to as the Springbok Flats. These areas are divided from the Lowveld by the escarpment, which consists of various hills and mountainous terrain. The Lowveld consists mainly of plains and undulating plains. The catchment contains all three basic rock types which are sedimentary, igneous and metamorphic. There is also a wide variety of soil types distributed throughout the catchment. Within the South African part of the catchment three terrestrial biomes occur, namely savanna, forest and grassland, while Mozambique contains savannah, forest and Indian Ocean Coastal belt biomes. The three biomes within South Africa contain 52 vegetation types. The grassland mainly comprises the Highveld as well as the southern and western part of the escarpment, the savanna biome comprises the greater part of the Springbok Flats and the Lowveld, as well as the north-eastern parts of the escarpment, and the forest biome covers a small portion of the catchment and is more or less centred on the escarpment. There are two centres of endemism within the Olifants catchment, namely the Sekhukhuneland and Wolkberg Centres of Endemism in South Africa. Each centre has unique characteristics and vegetation composition found nowhere else.

1.2 The Physical Environment in Olifants catchment in South Africa

1.2.1 Geology

The geology of the study area is widely varied. The area contains exposed rocks from the early Precambrian Era 4600 million years ago (MY) all the way through to the Cenozoic Era 1.65 MY. Archaean Granite and Gneiss Basal Complex is the oldest exposed rock formations in the area. This igneous rock was formed around 4600 MY to 2500 MY (see Figure 1). It forms the basement rock complex for other rock systems. It occurs in the eastern Lowveld part of the study area and consist mainly of old Granite and Gneis formations and primitive groups of schistose rocks including metamorphosed sediments such as phyllites, banded ironstone, quartzite, conglomerate and limestone, together with rocks of igneous origin such as amphibolites, greenstone lavas, and chlorite-schists. The most important economic potential lies in the mining of granite and gneiss for use as polished stone and the occurrence of gold and other minerals in the greenstone lavas.

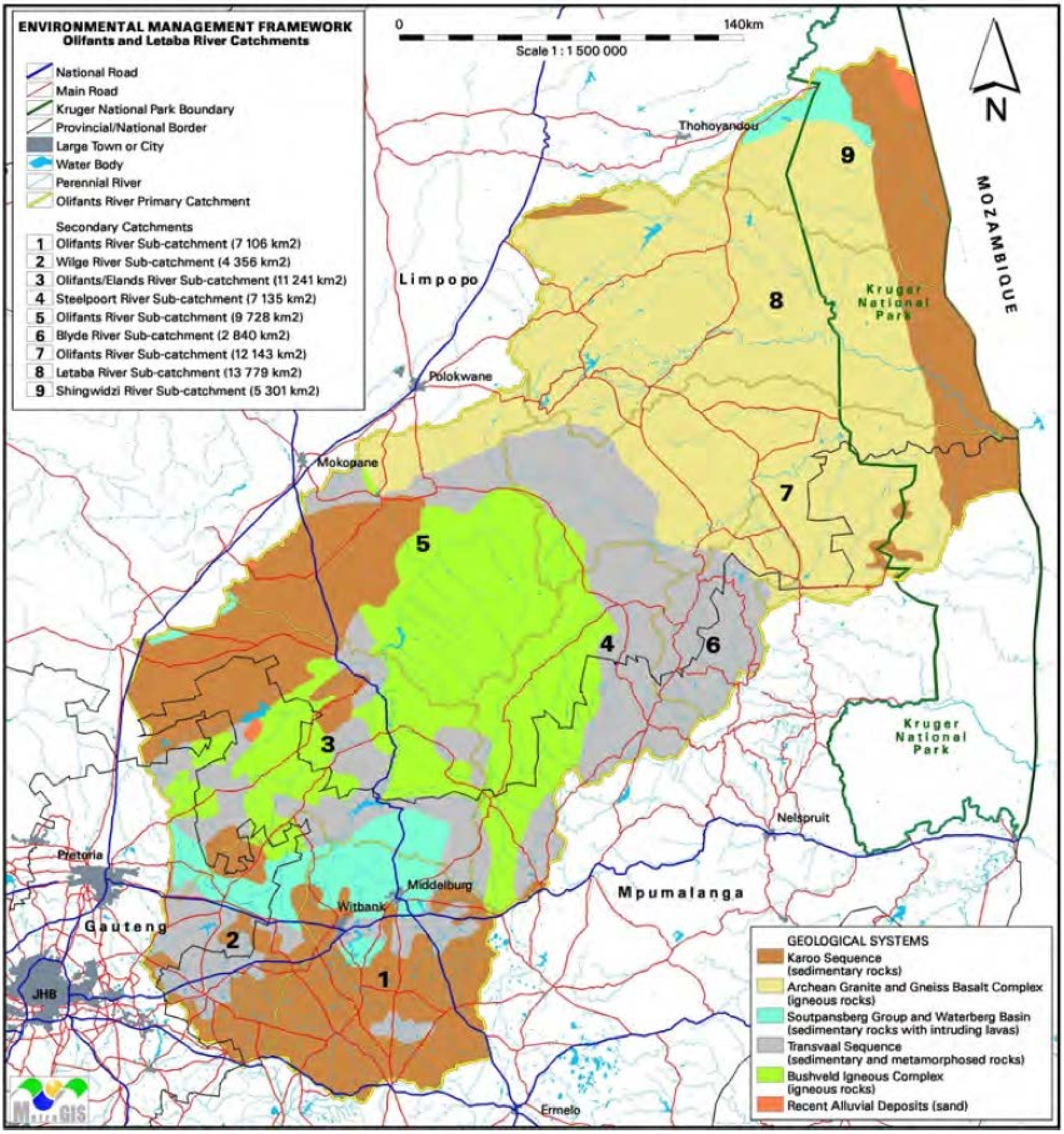


Figure 1: Map of the major geological systems of the Olifants catchment (including Shingwedzi and Letaba catchments) in South Africa (source: EMF, 2009).

The Transvaal Sequence was formed around 2400 MY to 1800 MY. It consists of sedimentary rock laid down in a basin. There are igneous intrusions in places as well as fault lines, which caused the formation of metamorphic rock. In the study area it consists of the so-called Pretoria Series (after its typical form in the Pretoria area) composed of three quartzite layers (Timeball Hill, Daspoort and Magalies) with intervening shales and lavas. It forms the mountains of Sekhukhuneland (eastern Bankenveld) at the edge of the Bushveld Basin as well as the bold escarpment of the Transvaal Drakensberg consisting of Black Reef Quartzite where the dramatic change in topography gives rise to dramatic scenic views and vistas.

The Bushveld Igneous Complex was formed in a series of magma surges around 2100 MY to 1800 MY. It is spread over the central part of the Transvaal basin. The area contains Red Granites and the Rooiberg Series in the central parts, as well as Norite in the east. The Bushveld Igneous Complex contains important minerals such as large quantities of platinum, small quantities of gold and silver and a variety of base metals.

The rocks of the Soutpansberg Group and Waterberg Basin were formed around 1800 MY. The rocks of the Soutpansberg Group are mostly sedimentary, but may have intrusive volcanic rocks in places. The Waterberg Basin is also composed mostly of sedimentary rocks and is covered in several localities by outliers of Karoo rocks. Intrusive volcanic rocks may also be present in the Waterberg Basin.

The Karoo Sequence was formed around 400 MY to 120 MY. It consists mainly of sedimentary rocks deposited horizontally in a vast basin, with a few satellite basins to the north. It is a relatively young plateau system that is in the slow process of being removed by erosion from the sub-Karoo surface. The Karoo Sequence contains bands of coal within the central sedimentary layers.

Karoo-related volcanic and intrusive rocks are found in the Mozambique part of the Olifants. They consist mafic and felsic extrusive rocks which are associated with and represent the capping stratigraphic units of the seaward-dipping volcanic succession of the Lebombo Monocline. The Lebombo mountain range along the border of Mozambique and South Africa is mostly composed of a bimodal association of rhyolitic ash-flow tuffs and ignimbrites and basaltic to andesitic lava flows. Alluvial Deposits in the area have been formed as recently as 65 MY. They consist of sand created by the weathering of older rocks. The composition of these small loose grains varies depending on the source of rock (DEA, 2009).

1.2.2 Topography

Topographically, on the basis mainly of altitude and relief, the catchment can be divided into four zones within South Africa, and two zones within Mozambique namely:

The Highveld in the south at 1200 – 1800 m above sea level	•South Africa
The Springbok Flats in the west at 900 – 1 200 m above sea level	•South Africa
The escarpment zone in the centre of the basin at 1 500 – 2 400 m above sea level	•South Africa
The Lowveld in the east at 150-900 m above sea level	•South Africa & Mozambique
The Mozambican coastal plain adjoining the Indian Ocean in the east, at 0 – 150 m above sea level	•Mozambique

The Highveld is composed of undulating plains and pans, and the Springbok Flats is a large, open and flat area. These areas are divided from the Lowveld by the escarpment, which consists of various hills and mountain terrain (Figure 2). The Lowveld consists mainly of plains with undulating plains found along the Olifants river course. The higher western parts (600 – 900 m) of these plains form the piedmont zone adjoining the escarpment, and consist of eroded foot slopes. Prominent secluded hills are also found in the north-western part of the Lowveld section of the catchment (Figure 3) (DEA, 2009).

The general decrease in altitude towards the east continues across the Lowveld plains up to the Lebombo Mountains/Hills. This range of mountains separates the South African and Mozambican Lowveld plains, and is formed by a cuesta, or a tilted plateau with a steep escarpment in the west and a gradual dipslope of about 5 percent descending east into the coastal plains of Mozambique. The Mozambican Coastal plain is composed of beach ridge dunes and sandy plains with swampy swales, or sandy depressions adjacent to the coast. This area also contains the extensive Limpopo river coastal floodplain.

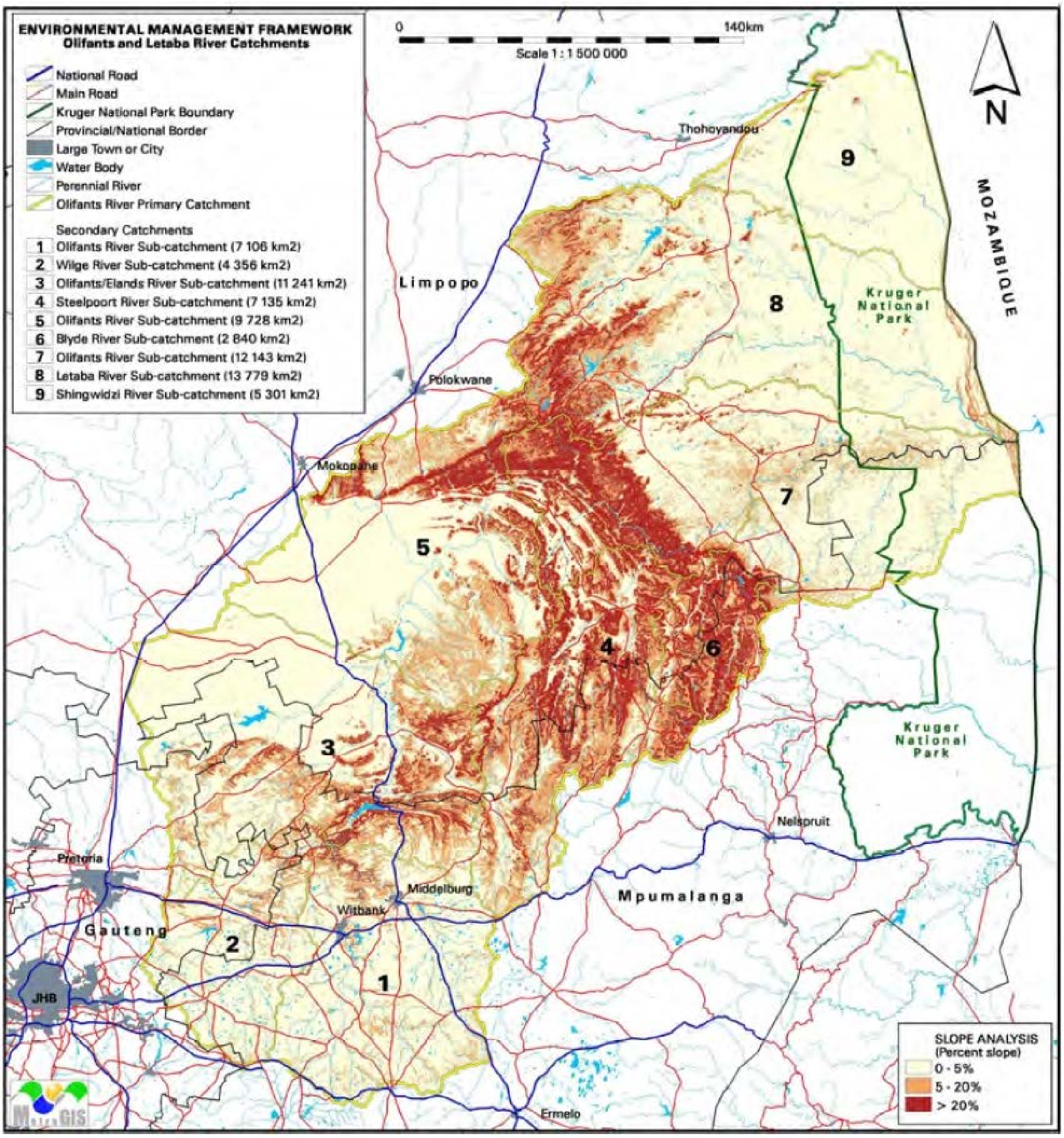


Figure2: Map of slopes within the Olifants catchment (including Shingwedzi and Letaba catchments) in South Africa (source: EMF, 2009).

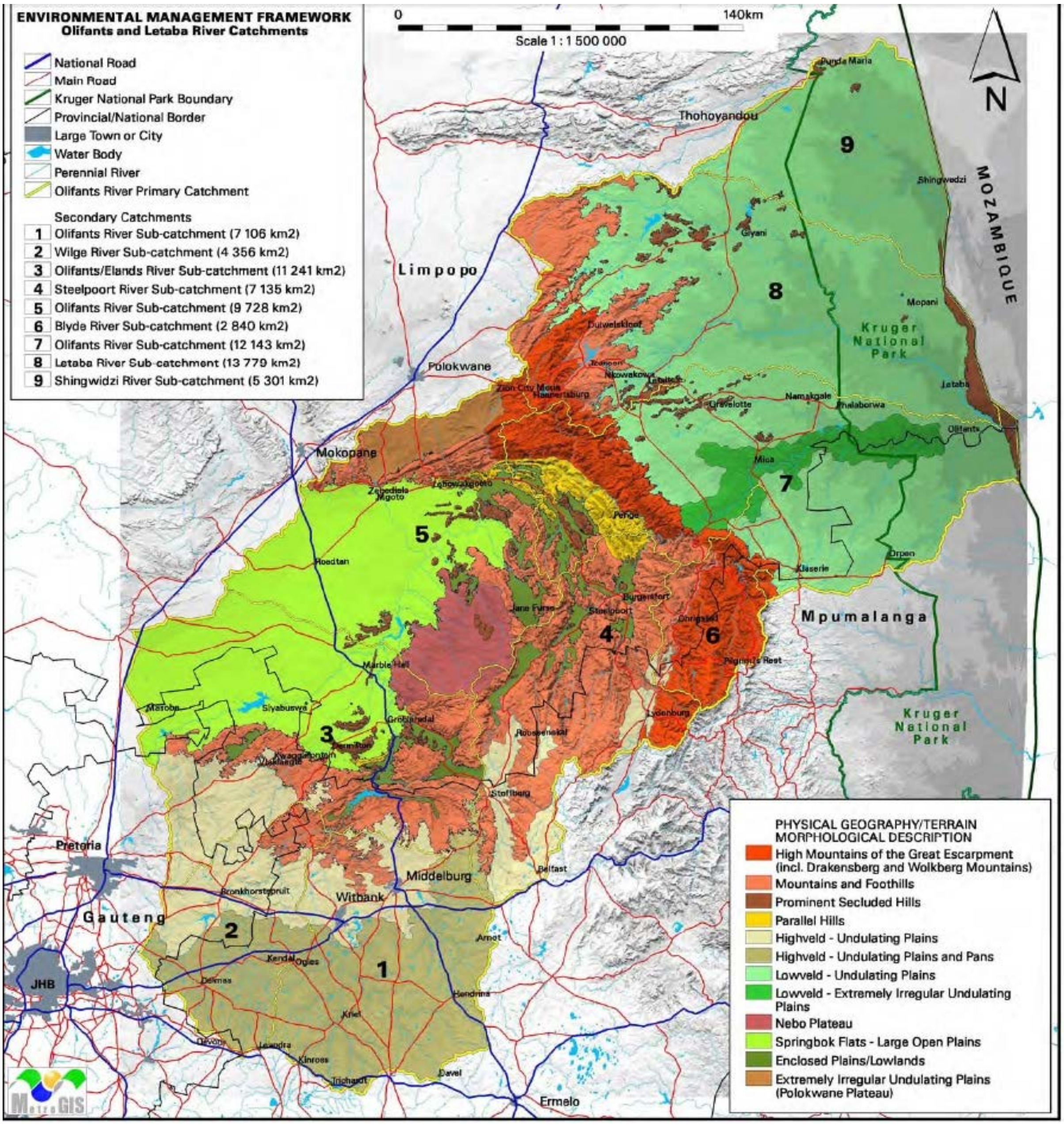


Figure 3: Map of the physical geography of the Olifants catchment (including Shingwedzi and Letaba catchments) in South Africa (source: EMF, 2009).

1.2.3 Soils and soil suitability for agriculture

The soils that occur in the catchment are closely related to the geology and landforms of the area, except for the Mozambican coastal plain. Within the South African side of the catchment there is a wide variety of soil types distributed throughout (Figure 4). Soils common in the Mozambican coastal plain are hydromorphic soils, which are poorly drained and swampy soils characterised by sandy texture and wetness, and organic peat soils, which are very young soils characterised by little or no soil formation. The land use for various activities is dependent on the soil type. The soils are listed in the table below (DEA, 2009).

TABLE 1: SOILS THAT OCCUR IN THE OLIFANTS EMF AREA (INCLUDING SHINGWEDZI AND LETABA CATCHMENTS) (DEA, 2009).

SOIL DESCRIPTION	AREA (KM^2)	PERCENTAGE (%)
Glenrosa and/or Mispah forms (other soils may occur)- lime generally present in the entire landscape	697.01	0.95%
Glenrosa and/or Mispah forms (other soils may occur)- lime rare or absent in the entire landscape	7 601.97	10.33%
Glenrosa and/or Mispah forms (other soils may occur)- lime rare or absent in upland soils but generally present in low-lying soils	11 831.19	16.07%
Grey regic sands and other soils	126.36	0.17%
Miscellaneous land classes- rocky areas with miscellaneous soils	8 766.57	11.91%
Miscellaneous land classes- undifferentiated deep deposits	1 158.20	1.57%
Miscellaneous land classes- very rocky with little or no soils	498.33	0.68%
One or more of: vertic- melanic- red structured diagnostic horizons- undifferentiated	6 768.32	9.19%
Plinthic catena: dystrophic and/or mesotrophic; red soils not widespread- upland duplex and margalitic soils rare	6 160.34	8.37%
Plinthic catena: dystrophic and/or mesotrophic; red soils widespread- upland duplex and margalitic soils rare	6 974.62	9.47%
Plinthic catena: eutrophic; red soils not widespread- upland duplex and margalitic soils rare	2 484.12	3.37%
Plinthic catena: eutrophic; red soils widespread- upland duplex and margalitic soils rare	1 159.25	1.57%
Plinthic catena: undifferentiated- upland duplex and/or margalitic soils common	541.70	0.74%
Prismacutanic and/or pedocutanic diagnostic horizons dominant- B horizons mainly not red	514.00	0.70%
Prismacutanic and/or pedocutanic diagnostic horizons dominant. In addition- one or more of: vertic- melanic- red structured diagnostic horizons	608.33	0.83%
Red-yellow apedal- freely drained soils- red- high base status- < 300 mm deep	335.64	0.46%
Red-yellow apedal- freely drained soils; red and yellow- dystrophic and/or mesotrophic	1 846.66	2.51%
Red-yellow apedal- freely drained soils; red and yellow- high base status- usually < 15% clay	1 378.58	1.87%
Red-yellow apedal- freely drained soils; red- dystrophic and/or mesotrophic	2 621.67	3.56%
Red-yellow apedal- freely drained soils; red- high base status- > 300 mm deep (no dunes)	11 479.37	15.59%
Red-yellow apedal- freely drained soils; yellow- dystrophic and/or mesotrophic	37.37	0.05%
No data/surface waterlime generally present in the entire landscape	33.39	0.05%
Total	73 622.98	100.00%

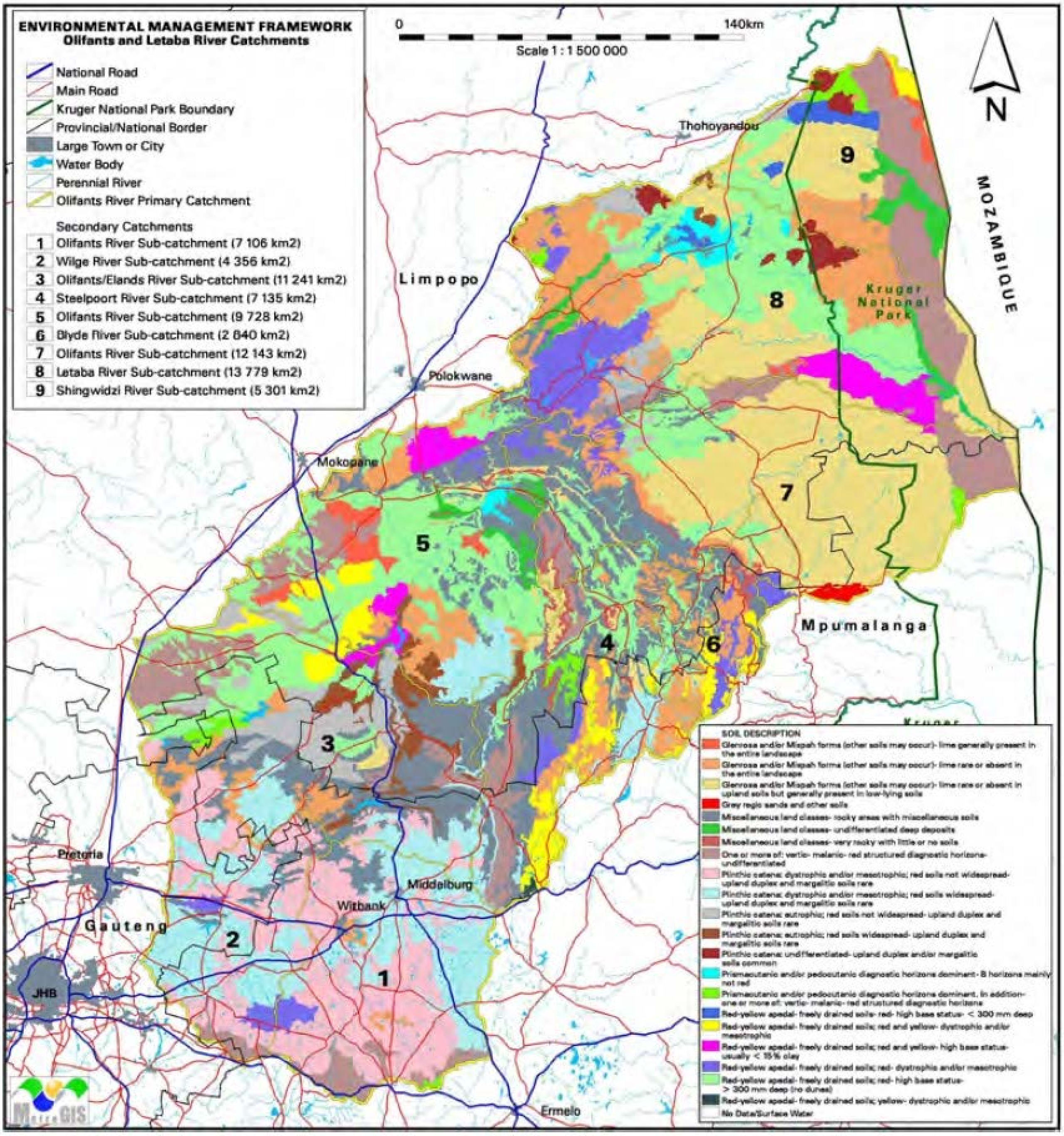


Figure 4: Map of the soils within the Olifants catchment (including Shingwedzi and Letaba catchments) in South Africa (source: EMF, 2009).

The soil type of a specific area has a large influence on the potential of agricultural- and other land tenure activities (Figure 5). The following table specifically summarises the land capability for arable agriculture in the Olifants in South Africa. It is important to note that land capability is of course a composite of various factors which may influence this, including amongst other soil, slope/topography, and climate. In Mozambique the Limpopo river floodplain is very important for agriculture.

TABLE 2: LAND CAPABILITY OF ARABLE AGRICULTURE (DEA, 2009)

LAND TYPE/SOIL CAPABILITY INDEXARABLE LAND (CLASSES BELOW)	SURFACE AREA IN (KM2)	PERCENTAGE %
Higher capability for arable agriculture	7255.460	9.85%
Medium capability for arable agriculture	17760.296	24.12%
Lower capability for arable agriculture	13380.454	18.17%
Higher capability for grazing	10122.695	13.75%
Medium capability for grazing	14727.933	20.00%
Lower capability for grazing	1081.910	1.47%
Wildlife	9263.952	12.58%
Water (included in dataset)	35.850	0.05%
Total area **Irrigated agriculture (agricultural field boundaries)**	**73628.550** **1571.934**	**100.00**

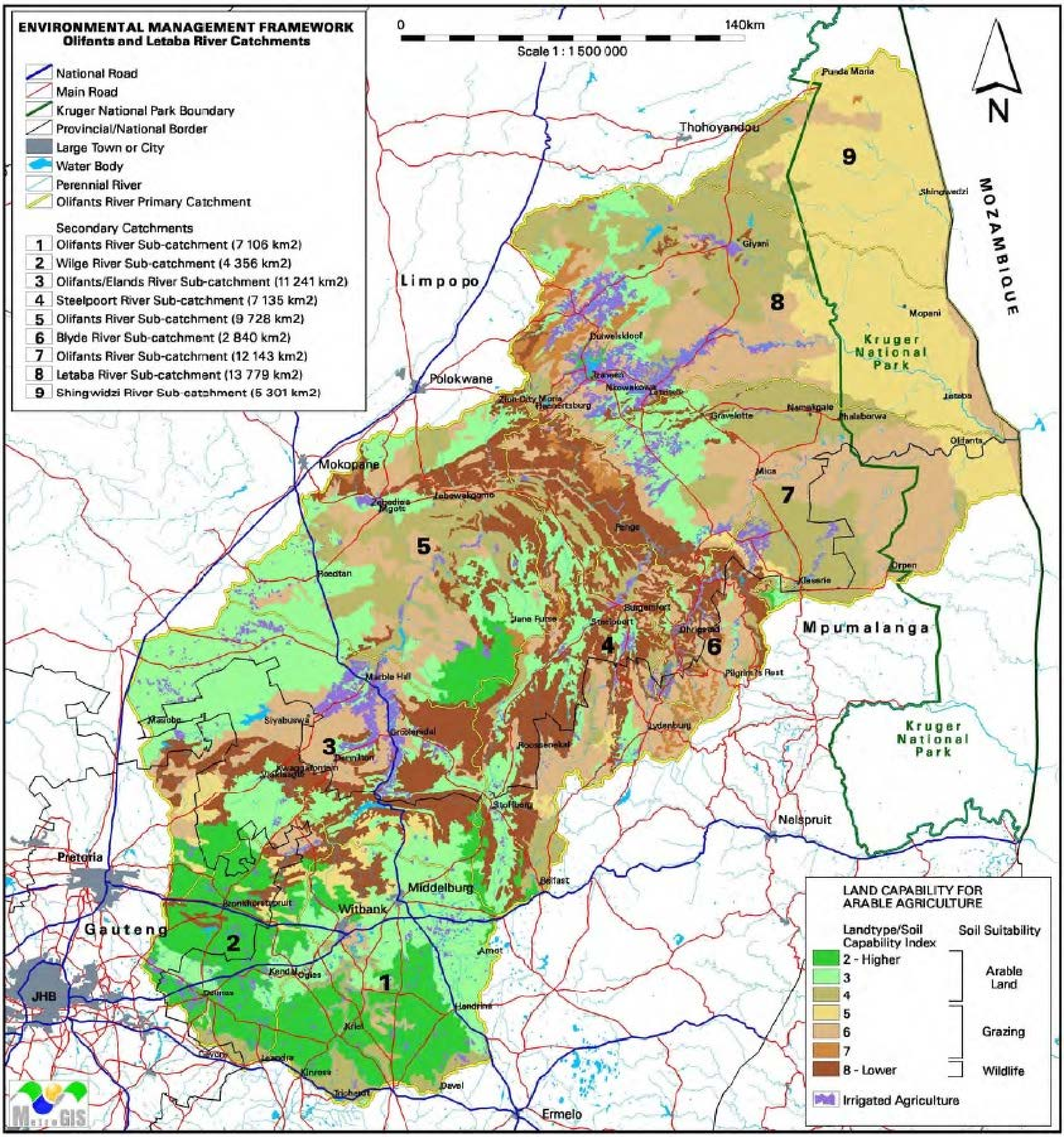


Figure 5: Map indicating land capability for arable agriculture within the Olifants catchment (including Shingwedzi and Letaba catchments) in South Africa (source: EMF, 2009)

1.3 The Biological Environment in the Olifants Catchment in South Africa

1.3.1 Biomes

Three of the major nine terrestrial biomes in South Africa occur in the Olifants river catchment area, namely grassland, savanna and forest. The Mozambican part of the catchment is also composed of three major biomes namely savannah, forest and Indian Ocean Coastal belt.

The grassland mainly comprises the Highveld as well as the southern and western part of the escarpment. The mesic Highveld grassland covers much of the Mpumalanga section of the catchment (SANBI, 2013). The grass canopy cover decreases with lower rainfall. Sweet grass occurs in drier regions, while the wetter areas (rainfall > 625 mm per annum) are characterised by sour grass. Trees are uncommon, although they do occur in the high altitude areas east of the escarpment.

The savanna biome comprises the greater part of the Springbok Flats and the Lowveld (on both the South African and Mozambican sides), as well as the north-eastern parts of the escarpment. The vegetation consists of graminoid hemi-cryptophytes and perennial woody plants. These plants are well adapted to withstand both drought and fire.

The forest biome, mainly composed of Afro-montane forest (or Afro-temperate forest) covers a small portion of the catchment and is more or less centred on the escarpment. The vegetation consists mainly of evergreen woody plants. A multi-layered structure can be distinguished, with perennial woody plants and herbaceous species as the understorey, while epiphytes, ferns and lianas comprise the sub-canopy cover. Outside of the escarpment the forest biome further includes smaller patches of Lowveld Riverine forest along the major rivers, as well as mangrove forest at the mouth of the Limpopo river. There are also four azonal vegetation types namely subtropical alluvial vegetation, subtropical freshwater wetlands, subtropical salt pans and the Eastern temperate freshwater wetlands (DEA, 2009).

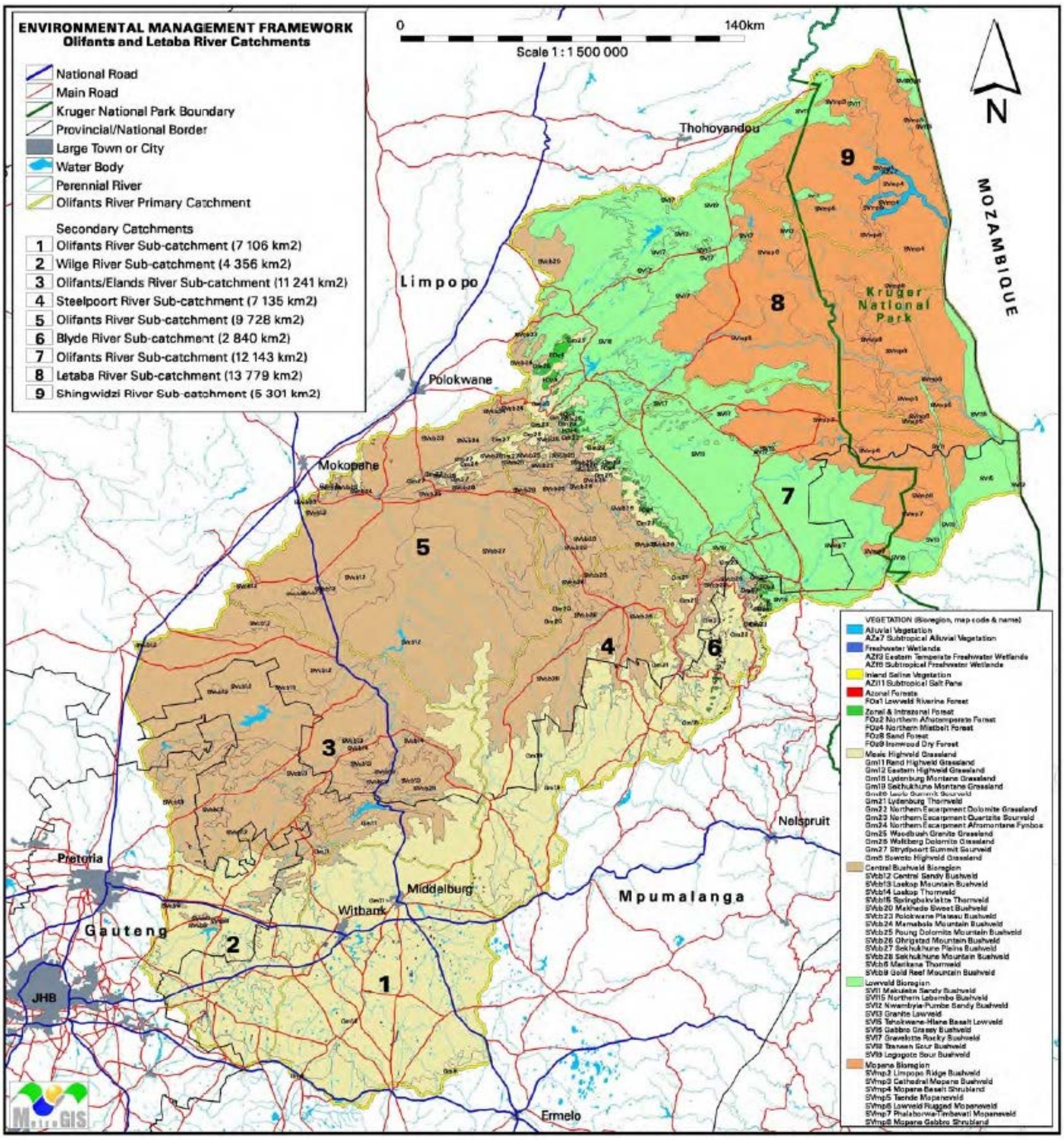


Figure 6: Map of the vegetation bioregions within the Olifants catchment (including Shingwedzi and Letaba catchments) in South Africa (source: EMF, 2009).

1.3.2 Vegetation types

There are 52 vegetation types occurring within the Olifants and Letaba catchments in South Africa. Of these, 29 occur in the Savanna Biome, 13 in the Grassland Biome and 5 in the Forest Biome. There are also 4 wetland vegetation types that are considered to be azonal or not limited to a single biome (Fig. 6). For the portion of the Olifants catchment based in Mozambique, Mopane and undifferentiated (mixed thorn & broadleaf) savanna woodlands cover extensive areas. Parallel to the Mozambican coast the Indian Ocean Coastal belt biome is found which is composed of a mosaic of vegetation types that include dune forest, savannah woodland, grassland and mangrove forest (MICOA, 2009). This area also contains the extensive Limpopo river floodplain with its associated vegetation. The biomes and vegetation types occurring within the Olifants Letaba EMF area in South Africa are summarised in Table 3 below (the table also contains their conservation status).

TABLE 1. CONSERVATION STATUS AND COVERAGE OF VEGETATION IN THE OLIFANTS CATCHMENT IN SOUTH AFRICA (INCLUDING SHINGWEDZI AND LETABA CATCHMENTS) (SOURCE: DEA, 2009)

Vegetation type	Biome	Coverage (Km^2)	Coverage in %	Cons. target	Protected	Remain	Conservation stat
Cathedral Mopane Bushveld	Savanna	180.633	0.245	19%	100%	99.60%	Least threatened
Central Sandy Bushveld	Savanna	7 906.65	10.738	19%	75.90%	2.4% (+2.2%)	Vulnerable
Eastern Highveld Grassland	Grassland Biome	6 264.644	8.508	24%	0.30%	56%	Endangered
Eastern Temperate Freshwater Wetlands	Azonal vegetation	49.263	0.067	24%	4.60%	85.10%	Least threatened
Gabbro Grassy Bushveld	Savanna Biome	219.909	0.299	19%	95.9% (+3.7%)	99.60%	Least threatened
Gold Reef Mountain Bushveld	Savanna Biome	58.474	0.079	24%	22.1% (+1.2%)	84.60%	Least threatened
Granite Lowveld	Savanna Biome	8 470.518	11.504	19%	17.5%(+17.3%)	79.20%	Vulnerable
Gravelotte Rocky Bushveld	Savanna Biome	309.489	0.42	19%	0% (+6.9%)	85.50%	Least threatened
Ironwood Dry Forest	Forests	3.986	0.005	100%	77.80%	99.90%	Critically endangered
Legogote Sour Bushveld	Savanna Biome	124.243	0.169	19%	1.6% (+2.3%)	50.40%	Endangered
Leolo Summit Sourveld	Grassland Biome	20.344	0.028	24%		See text	Vulnerable
Limpopo Ridge Bushveld	Savanna Biome	0.463	0.0006	19%	18.1% (+1.8%)	99.10%	Least threatened
Loskop Mountain Bushveld	Savanna Biome	2 044.407	2.777	24%	14.5% (+1.9%)	97.60%	Least threatened
Loskop Thornveld	Savanna Biome	759.911	1.032	19%	11.30%	75.80%	Vulnerable
Lowveld Riverine Forest	Forests	5.528	0.008	100%	50% (+3%)	97.60%	Critically endangered
Lowveld Rugged Mopaneveld	Savanna Biome	3 154.105	4.284	19%	34.4% (+5.6%)	80.20%	Least threatened
Lydenburg Montane Grassland	Grassland Biome	2 122.306	2.882	24%	2.5% (+5.9%)	77.70%	Vulnerable
Lydenburg Thornveld	Grassland Biome	1 207.783	1.64	24%	1.90%	78.70%	Vulnerable
Makhado Sweet Bushveld	Savanna Biome	370.419	0.503	19%	0.80%	72.80%	Vulnerable
Makuleke Sandy Bushveld	Savanna Biome	512.62	0.696	19%	31.50%	73.30%	Vulnerable
Mamabolo Mountain Bushveld	Savanna Biome	395.141	0.537	24%	7.60%	93.90%	Least threatened
Marikana Thornveld	Savanna Biome	1.456	0.002	19%	0.7% (+1.5%)	52.10%	Endangered
Mopane Basalt Shrubland	Savanna Biome	2 761.235	3.75	19%	100%	99.60%	Least threatened
Mopane GabbroShrubland	Savanna Biome	310.462	0.422	19%	100%	99.70%	Least threatened
Northern Afrotemperate Forest	forests	1.22	0.002	31%	28.8% (+2.8%)	98.50%	Least threatened
Northern Escarpment Afromontane Fynbos	Grassland Biome	8.108	0.011	27%	56.1% (+5.8%)	99.30%	Least threatened
Northern Escarpment Dolomite Grassland	Grassland Biome	449.866	0.611	27%	2.1% (+8.5%)	47.70%	Endangered

Northern Escarpment Quartzite Sourveld	Grassland Biome	654.765	0.889	27%	15.3% (+9.2%)	61.60%	Vulnerable
Northern Lebombo Bushveld	Savanna Biome	548.704	0.745	24%	98.80%	99.80%	Least threatened
Northern Mistbelt Forest	Forests	280.783	0.831	30%	10% (+25.2%)	83.70%	Least threatened
Nwambyia-Pumbe Sandy Bushveld	Savanna Biome	94.438	0.1283	19%	98.70%	99.60%	Least threatened
Ohrigstad MountainBushveld	Savanna Biome	1 998.128	2.714	24%	7.6% (+4.2%)	90.70%	Least threatened
Phalaborwa-Timbavati Mopaneveld	Savanna Biome	2 225.556	3.023	19%	See text	95.10%	Least threatened
Polokwane Plateau Bushveld	Savanna Biome	1147.28	1.558	19%	1.4% (+0.7%)	83.20%	-
Poung Dolomite Mountain Bushveld	Savanna Biome	846.795	1.15	24%	9.9% (+6.2%)	94.10%	Least threatened
Rand Highveld Grassland	Grassland Biome	6 027.493	8.186	24%	0.90%	58.50%	Endangered
Sand Forest	Forests	6.736	0.009	100%	42.10%	98.50%	Critically endangered
Sekhukhune Montane Grassland	Grassland Biome	1 381.194	1.876	24%		72%	Vulnerable
Sekhukhune Mountain Bushveld	Savanna Biome	2 316.118	3.146	24%	(+0.4%)	86.30%	Least threatened
Sekhukhune Plains Bushveld	Savanna Biome	2 522.240	3.425	19%	0.8% (+1%)	74.50%	Vulnerable
Soweto Highveld Grassland	Grassland Biome	704.58	0.957	24%	0.20%	52.70%	Endangered
Springbokvlakte Thornveld	Savanna Biome	5 341.311	7.254	19%	1% (+2.6%)	50.70%	Endangered
Strydpoort Summit Sourveld	Grassland Biome	184.877	0.251	24%	17.2% (+1.7%)	99.40%	Least threatened
Subtropical Alluvial Vegetation	Azonal Vegetation	166.448	0.226	31%	See text	84.50%	Least threatened
Subtropical Freshwater Wetlands	Azonal Vegetation	12.939	0.176	24%	40%-50% (+10.5%)	96.40%	Least threatened
Subtropical Salt Pans	Azonal Vegetation	2.972	0.004	24%	42%	89.50%	Least threatened
Tsende Mopaneveld	Savanna Biome	5 274.542	7.164	19%	63.3% (+4.8%)	88.40%	Least threatened
Tshokwane-Hlane Basalt Lowveld	Savanna Biome	463.24	0.629	19%	64.4% (+3.4%)	83.50%	Least threatened
Tzaneen Sour Bushveld	Savanna Biome	3 123. 146	4.242	19%	1.3% (+2.1%)	59.20%	Endangered
Wolkberg Dolomite Grassland	Grassland Biome	260.845	0.354	27%	48.6% (+6.2%)	96.70%	Least threatened
Woodbush Granite Grassland	Grassland Biome	331.682	0.45	27%	0% (+14.9%)	-	Critically endangered

1.3.3 Centres of endemism

There are two Centres of Endemism that occur within the Olifants River catchment, namely the Sekhukhuneland and Wolkberg Centres of Endemism within South Africa. The Sekhukhuneland Centre of Endemism is entirely within the catchment. Approximately half of the Wolkberg Centre of Endemism is within the catchment. These Centres of Endemism contain high levels of diversity with many species restricted entirely to these areas.

As such they are of high priority in terms of conservation. The centres of Endemism found within the study area are of special concern. The high biodiversity and the many unique plant species restricted to these areas means that they are particularly vulnerable (DEA, 2009).

Wolkberg Centre

The Wolkberg Centre is extremely floristically rich, with more than 40 species endemic/near endemic to the dolomites and more than 90 to the quartz- and shale-derived substrates within in the area. These figures are conservative, with more taxa likely to be added as knowledge of the flora improves. The three families with the largest number of endemics on the quartzitic and related rock types are the Asteraceae, Iridaceae and Liliaceae. The asteraceous genus *Helichrysum,* with 10 species being the most prolific in producing endemics. *Gladiolus* has more than ten species endemic to the region as a whole. The Liliaceae is the family with the largest number of dolomite endemics to the region as a whole, followed by the Euphorbiaceae, Lamiaceae and Acanthaceae. For mosses, the Wolkberg Centre is one of the main southern African centres of diversity and a secondary centre of endemism. Significantly, nearly all the endemics (notably the quartzitic ones) are grassland species. Most of the taxa endemic to the Wolkberg Centre appear to be palaeoendemics. The Wolkberg Centre, especially the arid dolomite areas, shares many species with the adjacent Sekhukhuneland Centre, several of which are endemic to the combined region (DEA, 2009).

Threats

The high-rainfall grasslands of the Wolkberg Centre are seriously threatened by mainly commercial afforestation. Efforts to conserve the flora of the Wolkberg Centre have hitherto focused mainly on the protection of the patches of floristically poor Afromontane Forest, while the endemic-rich grasslands have been destroyed at an alarming rate, particularly by the timber industry. The little grassland that remains is also being threatened by invader alien plants (mainly from plantations) as well as lack of frequent burning, particularly in plantation areas. Frequent fires are essential for maintaining grassland structure and phytodiversity. Less than 1% of the montane grasslands, the vegetation type richest in Wolkberg Centre endemics, is conserved (DEA, 2009).

Sekhukhune Centre

The vegetation of the Sekhukhuneland Centre has never been studied in detail. It is usually mapped as Mixed Bushveld. However, floristically the bushveld of Sekhukhuneland Centre is quite unique and certainly deserves recognition as a separate type. The *Kirkia wilmsii*, a species that is relatively rare in other parts of the Mixed Bushveld is a characteristic tree of this area. Vegetation differences between the north- and south-facing aspects of the mountains are often striking. Intriguing vegetation anomalies associated with heavily eroded soils are present throughout the region. The flora of the Sekhukhuneland Centre is still poorly known, with many apparently endemic species awaiting formal description. Families particularly rich in Sekhukhuneland Centre endemics include the Anacardiaceae, Euphorbiaceae, Liliaceae, Lamiaceae and Vitaceae. A still-to-be-described monoptypic genus of the Alliaceae is endemic also. The area around Burgersfort is reputed to have the highest concentration of *Aloe* species in the world. The Leolo Mountains harbour relic patches of Afromontane Forest, Fynbos-type vegetation and several Sekhukhuneland Centre endemics. There are also some rare wetlands in the summit area (DEA, 2009).

Threats

The natural biodiversity of the Sekhukhuneland Centre of Endemism provides diverse important goods and services to the rural communities, such as traditional medicine, grazing and browse, fuel, food, housing materials. Its grassland ecosystems play an important role in the preservation of agricultural biodiversity. The area is however under threat from factors such as mining for heavy metals, inappropriate land management, rural sprawl and unsustainable use of natural resources. This affects the level of goods and services provided by the ecosystem (Victor et al, 2005).

1.3.4 Threatened ecosystems

Several areas within the catchment have been classified as critically endangered, endangered or vulnerable ecosystems at the South African level (NBA, 2011). Systematic biodiversity assessments have also been conducted at the provincial level in SA, which include the following categories (MBCP, 2007):

- Protected areas: already managed for biodiversity protection;
- Irreplaceable: 100% irreplaceable – no other options available to meet targets;
- Highly significant: 50 – 99% irreplaceable – very limited options available to meet targets;
- Important & necessary: lower irreplaceable value, less than 50% but still required to meet targets;
- Least concern: areas of natural habitat that could be used to meet some targets but not needed now, as long as other areas are not lost;
- No natural habitat remaining: virtually all natural habitat has been irreversibly lost as a result of cultivation, timber plantations, mining, urban development.

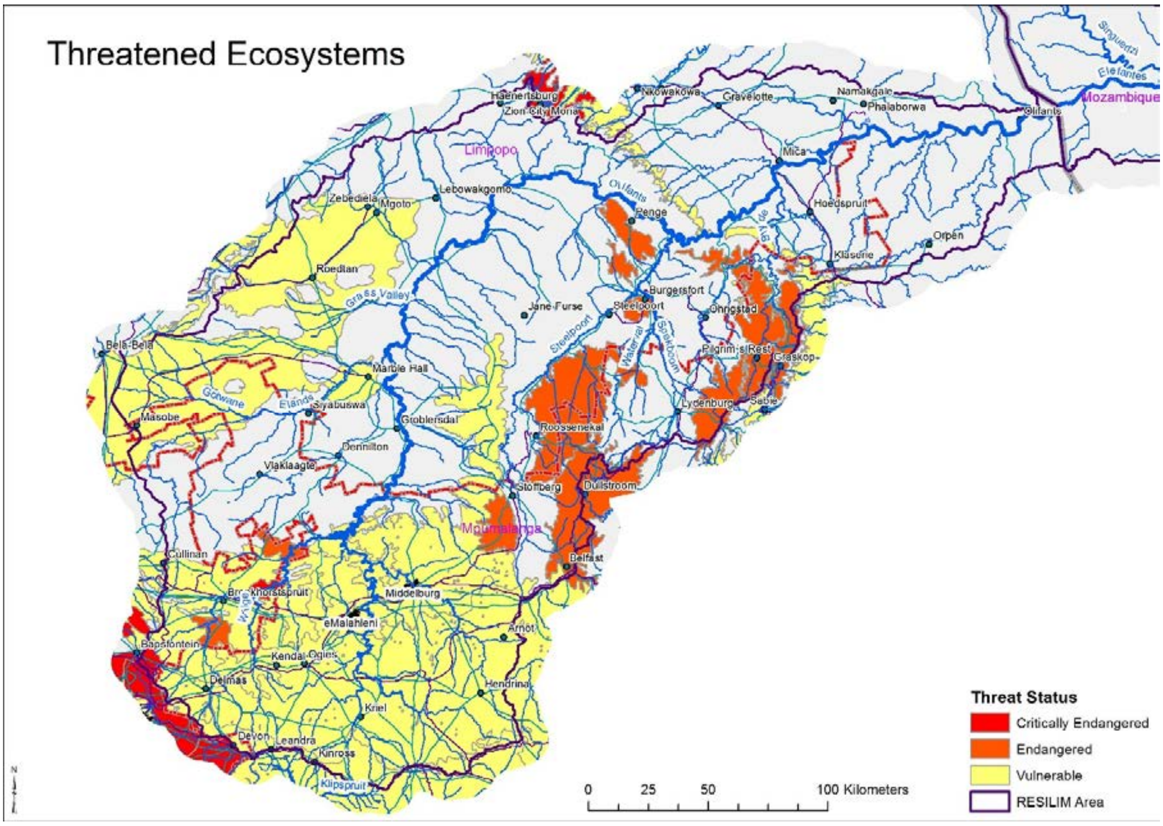


Figure 7: Map of the threatened ecosystems within the Olifants catchment (including Shingwedzi and Letaba catchments) in South Africa (source: EMF, 2009).

1.4 Summarized overviews of secondary catchments in the Olifants Catchment in South Africa

1. Upper Olifants River sub-catchment

- **Geological systems**: Karoo sequence (sedimentary rocks)
- **Lithology (Rock types):** Predominantly arenaceous rocks (sandstone, quartzitic sandstone, feldspathic sandstone, arkose, shale and grit); partly basic intrusive rocks (diabase & dolerite) and acid/intermediate/alkaline/intrusive & extrusive rocks
- **Topography**: Comprises the Highveld with undulating plains and pans
- **Soils**: Predominantly plinthic catena- dystrophic and/or mesotrophic; red soils not widespread- upland duplex and margalitic soils rare
- **Biome:** Grassland Biome
- **Bioregion:** Mesic Highveld Grassland Bioregion

2. Wilge River sub-catchment

- **Geological systems:** Karoo sequence (sedimentary rocks)
- **Lithology:** Predominantly arenaceous rocks (sandstone, quartzitic sandstone, feldspathic sandstone, arkose, shale and grit); predominantly diamictite; basic intrusive rocks (diabase & dolerite); predominantly carbonate rocks (limestone & dolomite); basic intrusive rocks (diabase & dolerite); predominantly meta-argillaceous rocks
- **Topography:** Highveld undulating plains and pans
- **Soils:** Plinthic catena: dystrophic and/or mesotrophic; red soils not widespread- upland duplex and margalitic soils rare; Plinthic catena: dystrophic and/or mesotrophic; red soils widespread- upland duplex and margalitic soils rare; Red-yellow apedal- freely drained soils- red- high base status- < 300 mm deep
- **Biome:** Grassland Biome
- **Bioregion:** Mesic Highveld Grassland Bioregion

3. Upper Olifants/Elands River sub-catchment

- **Geological systems:** Karoo sequence (sedimentary rocks); Bushveld Igneous Complex (Igneous rocks) and Transvaal sequence (sedimentary and metamorphosed rocks)
- **Lithology:** Acid/intermediate/alkaline intrusive rocks (various granitoids & syenite); acid/intermediate/alkaline intrusive & extrusive rocks (rhyolite, andesite, tuff, volcanic brecia, felsite & quartz porphyry)
- **Topography:** Springbok Flats – large open plains; Nebo plateau; Mountains and Foothills
- **Soils:** Glenrosa and/or Mispah forms; miscellaneous land classes; red-yellow apedal-freely drained soils; Prismacunatic and/or pedocunatic diagnostic horizons and Plinthic catena
- **Biome:** Savanna Biome
- **Bioregion:** Central Bushveld Bioregion

4. Steelpoort River sub-catchment

- **Geological systems:** Soutpansberg Group and Waterberg Basin (sedimentary rocks with intruding lavas) and Bushveld Igneous Complex
- **Lithology:** Intermediate/basic/ultra basic & mafic intrusive rocks and undifferentiated rocks & various mixed lithologies
- **Topography:** Mountains and foothills; high mountains of the escarpment
- **Soils:** Red-yellow apedal- freely drained soils; Glenrosa and/or Mispah forms; Prismacunatic and/or pedocunatic diagnostic horizons; Plinthic catena
- **Biome:** Savanna & Grassland Biome
- **Bioregion:** Central Bushveld Bioregion

5. Middle Olifants River sub-catchment

- **Geological systems:** Bushveld Igneous Complex (igneous rocks); Karoo sequence (sedimentary rocks); Transvaal sequence (sedimentary and metamorphosewd rocks) and Archean granite and Gneiss Basalt complex (sedimentary rocks with intruding lava)
- **Lithology:** Intermediate/basic/ultra basic & mafic intrusive rocks; Acid/intermediate/alkaline intrusive rocks (various granitoids and syenite); basic/intermediate/mafic extrusive rocks (basalt & andesitic lava); argillaceous & arenaceous rocks
- **Topography:** Springbok Flats – large open plains
- **Soils:** Glenrosa and/or Mispah forms; Grey regic; Miscellaneous land classes; vertic-melanic-red structured diagnostic horizons; Red-yellow apedal; Plinthic catena
- **Biome:** Savanna Biome
- **Bioregion:** Central Bushveld Bioregion

6. Blyde River sub-catchment

- **Geological systems:** Transvaal sequence (sedimentary and metamorphosed rocks) and Archean granite and Gneiss Basalt complex (sedimentary rocks with intruding lava)
- **Lithology:** Undifferentiated rocks and various mixed lithologies; predominantly carbonate rocks (limestone and dolomite); predominantly meta-arenaceous rocks (quartzite, gneiss & migmatite); alluvium (clay, sand, gravel & boulders) and basic/intermediate/mafic extrusive rocks (basalt & andesitic lava)
- **Topography:** High mountains of the Great Escarpment (incl. Drakensberg and Wolkeberg Mountains); mountains and Foothills; Lowveld (undulating plains & extremely irregular undulating plains)
- **Soils:** Glenrosa and/or Mispah forms; Miscellaneous land classes- rocky areas with miscellaneous soils; Red-yellow apedal- freely drained soils- red- high base status- < 300 mm deep; Red-yellow apedal- freely drained soils; red and yellow- dystrophic and/or mesotrophic
- **Biome:** Contains savannah, grassland and forest Biomes
- **Bioregion:** Lowveld, Mesic Highveld Grassland and Zonal & intrazonal Forest Bioregions

7. Lower Olifants River sub-catchment

- **Geological systems:** Archean granite and Gneiss Basalt complex (sedimentary rocks with intruding lava)
- **Lithology:** Predominantly meta-arenaceous rocks (quartzite, gneiss & migmatite); Acid/intermediate/alkaline intrusive rocks (various granitoids and syenite); predominantly (banded) iron formation; predominantly carbonate rocks (limestone & dolomite); predominantly pyroclastic rocks (tuff & agglomerate); intermediate/basic/ultra basic & mafic intrusive rocks)
- **Topography:** High Mountains of the Great Escarpment; Mountains & Foothills; Prominent secluded hills; Parallel Hills; Lowveld (undulating & extremely irregular undulating plains)
- **Soils:** Glenrosa and/or Mispah forms (other soils may occur)- lime rare or absent in upland soils but generally present in low-lying soils; Grey regic sands and other soils; Miscellaneous land classes; Red-yellow apedal- freely drained soils; red and yellow- dystrophic and/or mesotrophic; Red-yellow apedal- freely drained soils; Red and yellow- high base status- usually < 15% clay
- **Biome:** Savanna
- **Bioregion:** Lowveld & Mopane Bioregions

2 Water resources

2.1 Water resources overview of the Olifants catchment in South Africa

2.1.1 Surface Water: quality and quantity

Water quality

The key pressure on water quality in the Upper Olifants (B1) and Wilge (B2) secondary catchments is caused by intensive coal mining activities, where the discharge of mine effluents into the natural streamflow result in general acidification of the system, heavy metal concentrations, sulphates and other contaminants via acid mine drainage (Dabrowski and De Klerk, 2013; Hobbs et al., 2008; DWA, 2010). The water quality is under threat from past and present coal mining activities. Currently, it appears that acid mine drainage seeping from old abandoned coal mines are having a significant impact on the river system and is the most important source of metal concentrations in the river (Bell et al., 2001; CSIR, 2013). More specifically, badly affected tributaries of the Olifants River from AMD pollution include the Klipspruit, Blesbok Spruit, Kromdraai Spruit and Saalklap Spruit. During prolonged dry periods and winter seasons, the potential for the Olifants and Wilge rivers to dilute this AMD pollution can be significantly reduced and limited. Although current operational mines are not contributing as much to heavy metal concentrations in the river system in comparison to old abandoned mines, it will be important to develop appropriate management plans at mine closure in order to prevent further increase in AMD. Approximately 62 million m^3/a of contaminated water is predicted to decant from mines post closure in the Upper Olifants (DWAF, 2004).

Furthermore, water quality issues in these two secondary catchments also rise due to a combination of other anthropogenic activities such as coal-fired power generation (Williams et al., 2010), industrial activities (e.g. chemical manufacturers), irrigated agriculture (Dabrowski and De Klerk, 2013) and poorly operating wastewater treatment works (Oberholster et al., 2013). As a result, most of the water pollution in the Olifants WMA occurs in the Upper basin. These multiple sources of water pollution have led to raising concerns about ecological and human health risks in the Upper Olifants as well as further downstream in the catchment. Most of this contaminated water from the Upper catchment eventually reaches the Loskop dam, which acts as a sink from upstream pollutants (Oberholster et al., 2010; CSIR, 2013), before it flows further down to the Kruger National Park and into Mozambique. However, the study by Oberholster et al. (2010) suggested that the aquatic system of the Loskop dam is becoming hypertrophic and has been occasionally experiencing massive toxic blue-green algae blooms since 2008. The high concentration of metals, sulphates and nutrient and the change in trophic status has had adverse effect on the aquatic biodiversity (CSIR, 2013). For example, tumour formation and high concentrations of aluminium and iron were in fish organs as well as and severe liver necrosis in certain fish species in Loskop Dam (Oberholster et al., 2012).

In the Elands (B3), Steelpoort (B4) and Middle Olifants (B5) secondary catchments, water quality issues are primarily related to salinity, eutrophication, toxicity and sediment (DWAF, 2004). Mining activities and irrigated agriculture near the Steelpoort area are the main cause for salinity and eutrophication problems. Toxicity problems have been associated with the use pesticides and herbicides however this needs to be verified by further monitoring (DWA, 2010).

Land degradation, poor agricultural practices and overgrazing in the rural areas within the Middle Olifants are responsible for sediment pollution (DWAF, 2004). Moreover, this production of sediment causes operational problems at the downstream Phalaborwa Barrage. Sediment-laden water releases from the Phalaborwa Barrage into the KNP have been the cause for massive fish kills (Buermann et al., 1995; DWAF, 2004).

In the Lower Olifants (B7) secondary catchment, the major water quality issue is caused by discharges from the mining activities around Phalaborwa in the Ga-Selati River (DWAF, 2004; DWA, 2010). Consequently, the poor quality acidic water in the Ga-Selati River eventually impacts on the Olifants River in the KNP. However, the good water quality coming from the Blyde River (in Blyde secondary catchment) along with the Mohlapitse River (in Lower Olifants secondary catchment) help improve the water quality in the Olifants River, keeping the water quality at an acceptable quality for the KNP. The Blyde River is recognised as a relatively pristine river and is classified in a 'good to natural' ecological state (Ballance et al., 2001). Moreover, it has been shown that the Blyde River's contribution to diluting water pollution in the Olifants River results in important reduction in sulphate levels (Villiers and Mkwelo, 2009).

Finally, there is a large network of DWA water-quality monitoring sites across the Olifants WMA. More specifically, there is a moderate to good distribution of these monitoring sites in the Upper and Lower Olifants sub-catchments but a poor distribution in the Middle Olifants, especially in the former homeland areas (DWA, 2010).

Water quantity

The mean annual runoff is the amount of water on the surface of the land that can be utilised in a year, it is calculated as an average over several years (Nel et al., 2011). Therefore, areas with high mean annual runoff play an important role to the overall water supply of the system. The estimated total mean annual runoff (MAR) for the Olifants WMA is 2 042 million m^3/a (DWAF, 2004). Most the surface runoff originates from the higher rainfall southern and mountainous areas parts of the catchment (DWAF, 2003). Moreover, the preliminary estimations of ecological Reserve requirement is 460 million m^3/a (DWAF, 2004). The natural Mean Annual Runoff and requirements for the Ecological Reserve (million m^3/a) for the Upper, Middle, Lower Olifants and Steelpoort area are listed in Table 4 (delineation of sub-areas based on DWA, 2004).

TABLE 4: NATURAL MEAN ANNUAL RUNOFF AND ECOLOGICAL RESERVE REQUIREMENTS (MILLION M^3/A) IN THE OLIFANTS WMA (DWAF, 2004)

Sub-area	Natural MAR (1)	Ecological Reserve (2)
Upper Olifants	466	83
Middle Olifants	481	69
Steelpoort	396	94
Lower Olifants	699	214
Total	**2 042**	**460**

1. Quantities given are incremental, and refer to the sub-area under consideration only.
2. Total volume given, based on preliminary estimates of the Reserve determined with the Desktop methodology.

The National Freshwater Ecosystem Priority Areas project identified sub-quaternary catchments with high water yield areas. These high water yield areas are defined as areas where the mean annual run-off (MAR) is at least three times more than the average for the related primary catchment (Nel et al., 2011). Although these high water yield areas are not all considered FEPAs, it is important to maintain them in a good ecological condition as they contribute to the sustainable development of water resources in the catchment.

Figure 8 shows the area with the highest water yield in the Olifants catchment (shown on the map as >500% MAR) is within the Blyde sub-catchment. Furthermore, the southern part of the Steelpoort sub-catchment and the mountainous areas in the Lower Olifants sub-catchment are also considered high water yield areas (shown on the map as >300% MAR).

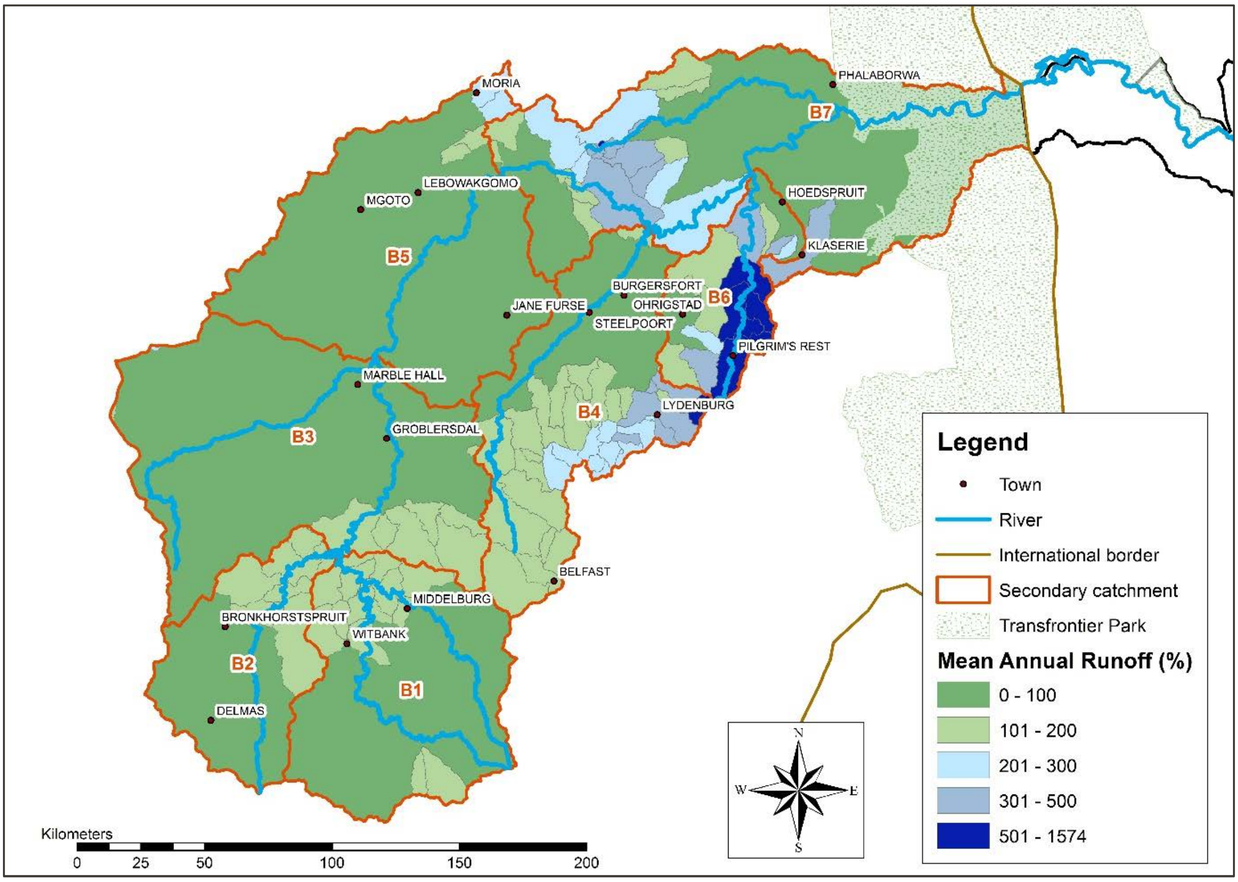


Figure 8: Olifants Catchment: Mean Annual Runoff per sub-quaternary catchment expressed as a percentage of the average of the primary catchment. Sub-quaternary catchment areas with a mean annual runoff about 300% are considered high water yield areas.

Since 2001, several Reserve studies have been carried out in the Olifants catchment. More specifically, a comprehensive determination of the Reserve was undertaken from 2001 to 2003 with the aim of quantifying environmental water requirements (EWR) in order to maintain and protect the aquatic ecosystem in such a way that they can continue to provide the goods and services to society (DWAF, 2001). This study selected 16 EWR sites which are located on the main stem of the Olifants river and its major tributaries (Figure 9 and Table 5). Additional Reserve determination studies have been carried out throughout the last few years in order to provide further information (DWA, 2011a). Table 5 lists all 16 EWR sites from the comprehensive Reserve study in the Olifants catchment.

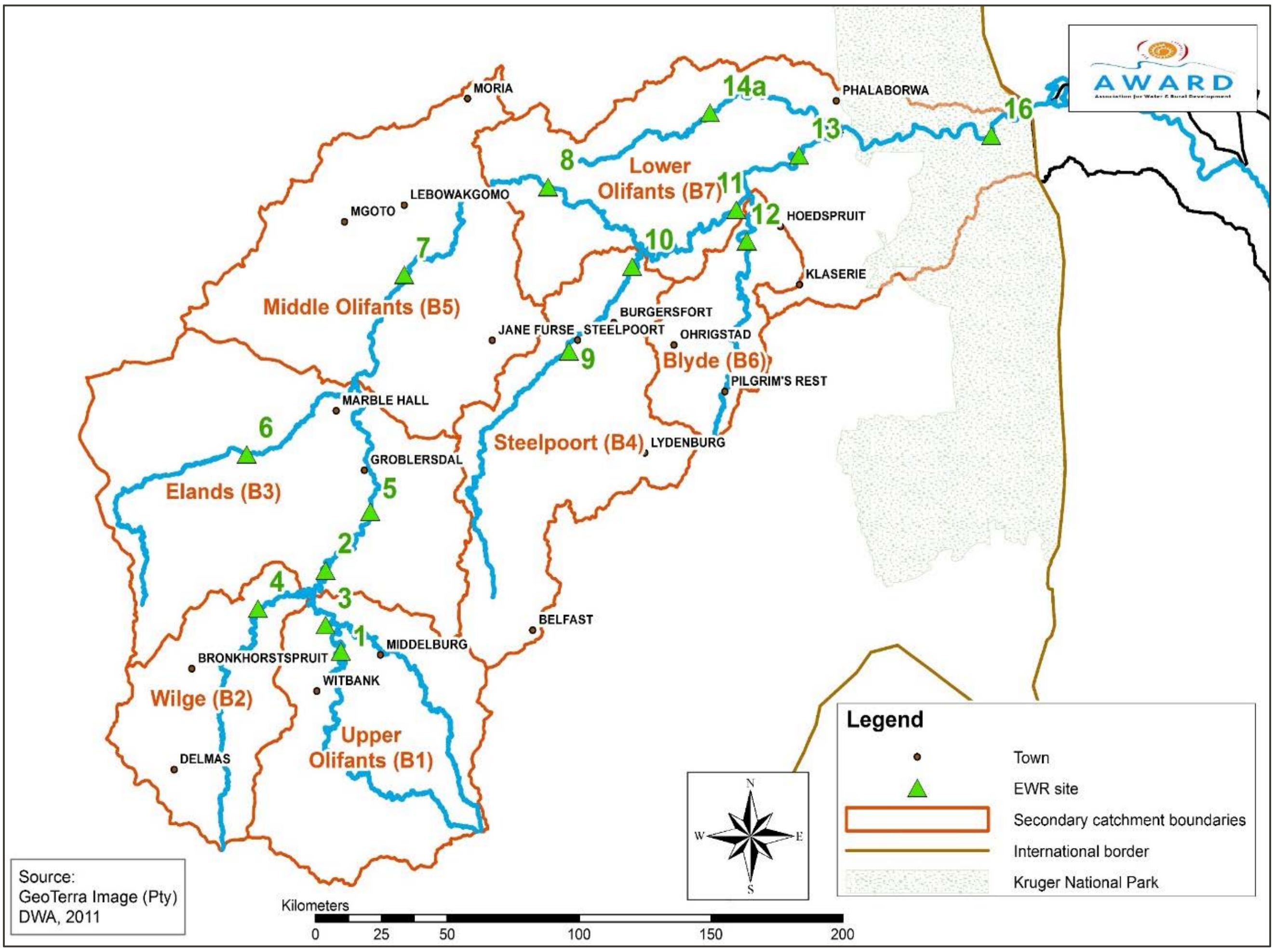


Figure 9: Location of EWR sites in the Olifants catchment in South Africa

TABLE 5: ENVIRONMENTAL WATER REQUIREMENTS (EWR) INFORMATION BASED ON PREVIOUS RESERVE STUDIES IN THE OLIFANTS CATCHMENT IN SOUTH AFRICA
(Table adapted from DWA 2011a)

EWR SITE	RIVER	SECONDARY CATCHMENT	MEAN ANNUAL RUNOFF (10^6M^3)	% EWR	LEVEL
EWR1	Olifants	Upper Olifants (B1)	184.52	18.6	Comprehensive
EWR2	Olifants	Elands (B3)	500.63	23.8	Comprehensive
EWR3	Klein Olifants	Upper Olifants (B1)	81.54	27.0	Comprehensive
EWR4	Wilge	Wilge (B2)	175.50	29.9	Comprehensive
EWR5	Olifants	Elands (B3)	570.98	19.1	Comprehensive
EWR6	Elands	Elands (B3)	60.30	17.9	Comprehensive
EWR7	Olifants	Middle Olifants (B5)	726.52	12.7	Comprehensive
EWR8	Olifants	Lower Olifants (B7)	813.04	15.2	Comprehensive
EWR9	Steelpoort	Steelpoort (B4)	120.17	15.2	Comprehensive
EWR10	Steelpoort	Steelpoort (B4)	336.63	12.1	Comprehensive
EWR11	Olifants	Lower Olifants (B7)	1321.80	13.7	Comprehensive
EWR12	Blyde	Blyde (B6)	383.70	34.5	Comprehensive
EWR13	Olifants	Lower Olifants (B7)	1760.70	23.6	Comprehensive
EWR14A	Ga-Selati	Lower Olifants (B7)	52.20	31.2	Comprehensive
EWR14B	Ga-Selati	Lower Olifants (B7)	72.74	24.8	Comprehensive
EWR16	Olifants	Lower Olifants (B7)	1916.90	21.6	Comprehensive

2.1.2 River characteristics

The main tributaries of the Olifants River in South Africa are the Wilge, Elands and Ga-Selati Rivers on the left bank and the Klein Olifants, Steelpoort, Blyde, Klaserie and Timbavati Rivers on the right bank (DWA, 2011b).

River ecoregional classification

River ecoregional classification groups rivers according to similarities generally based on attributes such as physiography, climate, rainfall, geology and potential natural vegetation. At a very broad scale, thirty-one ecoregions (Level 1) have been defined and described for South Africa (Kleynhans et al., 2005). Of these, 9 ecoregions occur in the Olifants WMA (Figure 10 and Table 6). Moreover, the dominant ecoregions are the Highveld in the Upper Olifants, the Bushveld and Eastern Bankenveld in the Middle Olifants and the Lowveld in the Lower Olifants (Figure 10). The characteristics of the 9 different river ecoregions in the Olifants catchment are described in Table 6.

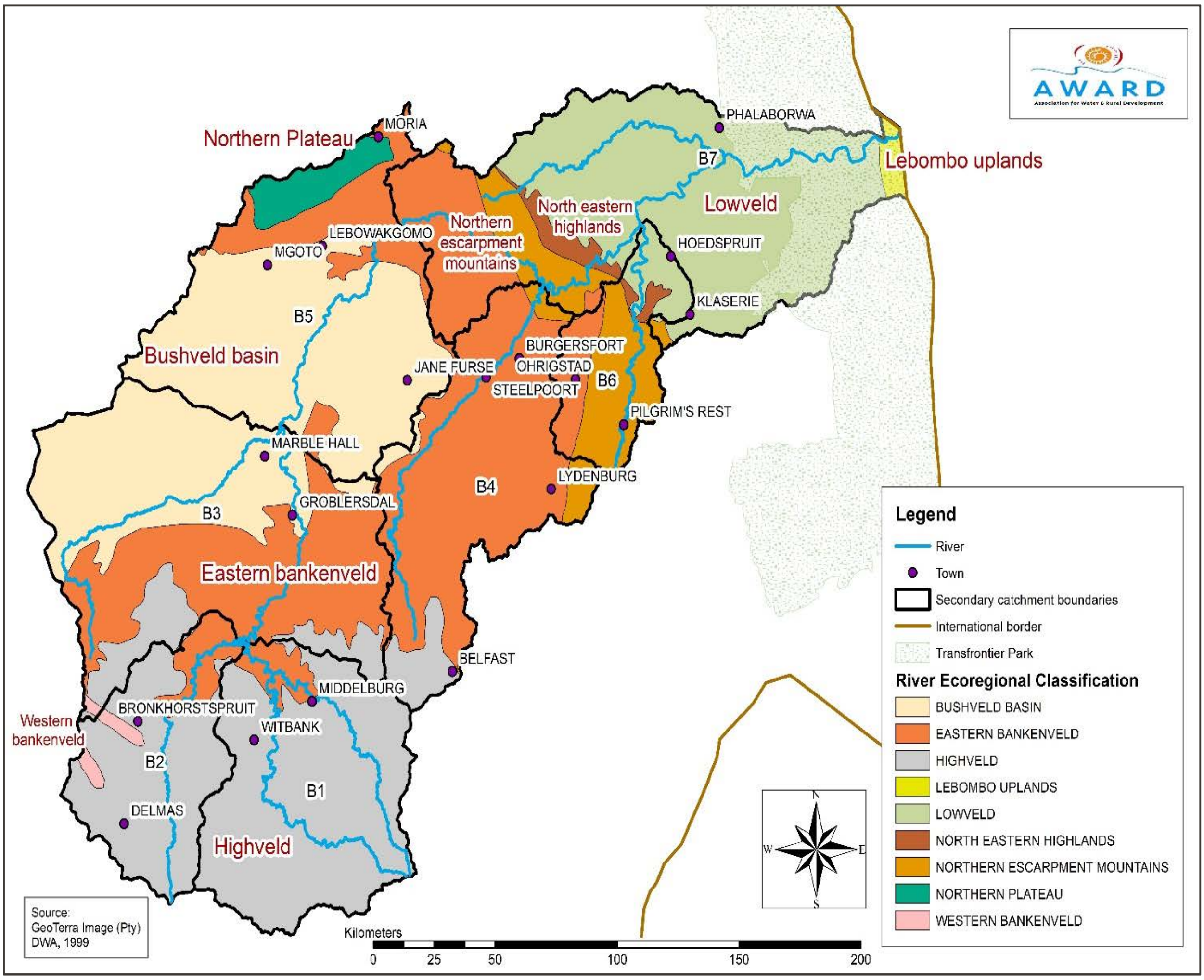


Figure 10: River Ecoregional classification in the Olifants catchment in South Africa.

TABLE 6:. CHARACTERISTICS OF THE RIVER ECOREGIONS WITHIN THE OLIFANTS CATCHMENT IN SOUTH AFRICA (ADAPTED FROM DWA (2010) AND KLEYNHANS ET AL. (2005))

ECOREGION	MEAN ANNUAL PRECIPITATION (MM)	TEMPERATURE (C)	MEAN ANNUAL RUNOFF (MM)	ALTITUDE (M)	TOPOGRAPHY	VEGETATION
LOWVELD	400-800	20-22	40-150	200-800	Plains with a low to moderate relief	Lowveld bushveld
NORTH EASTERN HIGHLANDS	400-1000	2-32	20 to >250	300-1300	Mountainous area containing closed hills and mountains with moderate to high relief	Highveld grassland and lowveld bushveld
NORTHERN PLATEAU	300-700	2-30	60-80	800-1700	Plains with low to moderate relief characteristic of this plateau	Mixed bushveld and mountaineous grassland
BUSHVELD BASIN	400-800	14-20	20-80	600-1500	Plains with a low relief	Mixed bushveld
EASTERN BANKENVELD	300-1000	0-30	20-250	500-2300	Closed hills and mountains with moderate and high relief	Northeastern mountain grassland and mixed bushveld
NORTHERN ESCARPMENT MOUNTAINS	400-1200	<8-20	10-250	800-2500	High lying area consisting of closed hills and mountains with moderate to high relief	Northeastern mountain grassland is the dominant vegetation type in the region with areas of sour lowveld bushveld and afromontane forest towards the east
HIGHVELD	400-1200	14-18	10-250	1250-1750	Plains with low to moderate relief	various grassland vegetation types
LEBOMBO UPLANDS	400-800	20-22	20-150	100-400	Closed hills and mountains with a moderate to high relief	Lebombo arid mountain bushveld
WESTERN BANKENVELD	400-700	14-22	20-100	900-1700	Complex topography varying from lowlands, hills and mountains to closed hills and mountains with the relief varying from moderate to high	Mixed Bushveld is the most definitive vegetation type of the region but bushveld and grassland types also occur

Present Ecological State (PES)

The Ecological Classification process (referred to as EcoClassification) is responsible for the determination and categorisation of the Present Ecological State (PES) of the rivers. The PES of rivers is determined based on various drivers (physico-chemical, geomorphology, hydrology) and biological responses (fish, riparian vegetation and aquatic invertebrates) (Kleynhans and Louw, 2007). The PES of rivers in the Olifants catchment was first estimated by DWAF in 1999 but it has been since updated in 2011. The PES of rivers is categorised into the following groups:

Class A	•Natural/unmodified
Class B	•Largely natural
Class C	•Moderately modified
Class D	•Largely modified

Furthermore, Classes E and F are considered as ecologically unacceptable and consequently remediation is necessary.

Figure 11 shows the PES of the rivers in the Olifants catchment in each secondary catchment, highlighting the Olifants River and its main tributaries. The section below is a brief summary of the PES of the main rivers in each secondary catchment and the main reasons for it:

- In the Upper Olifants (B1) secondary catchment, several rivers are considered as ecologically unacceptable (Class E/F) including a section of the main stem of the Olifants River. The poor condition of the rivers in this secondary catchment is primarily due to the intensive coal mining activities in the area, especially the impact of abandoned mines (DWA, 2010).
- The majority of rivers in the Wilge (B2) secondary catchment are classified as moderately modified (Class C) also due to the impact of coal mining activities in the area (DWA, 2010).
- In the Elands (B3) secondary catchment, a section of the main stem of the Olifants River and the Elands River are classified as largely modified (Class D). Furthermore, a small section of the main stem of the Elands River is even considered as degraded to unacceptable levels (Class E/F). The poor ecological state of the Olifants and Elands River in the Elands (B3) secondary catchment is due to the impact of land degradation and the large scale irrigated agricultural activities between Marble Hall and Groblersdal area (DEA, 2009).
- In the Steelpoort (B4) secondary catchment, the Steelpoort River is overall classified as largely modified (Class D) due to the impact of platinum mines in the area as well as irrigated agriculture (DWAF, 2004). However, the high rainfall and runoff in the south-eastern part of the catchment has allowed some of its rivers to remain largely natural.
- In the Middle Olifants (B5) secondary catchment, the Olifants River is overall classified as largely modified (Class D) mainly due to land degradation, poor agricultural practices and overgrazing in its rural areas (DWAF, 2004).
- The PES of the rivers in the Blyde (B6) secondary catchments vary between moderately modified (Class C) and largely natural (Class B). The high rainfall and runoff in the area as well as the limited land use activities (forestry is the main activity) have allowed the rivers to remain in a good ecological state.

- In the Lower Olifants (B7) secondary catchment, the PES of the Olifants River is moderately modified (Class C) which is mainly due to the impacts of the upstream developments on the Olifants River. A particular section of the Olifants River downstream of the Phalaborwa Barrage is classified as unacceptably degraded (Class E/F) because of operational problems from the dam mainly caused by sediment pollution (DWAF, 2004). Furthermore, a section of the Ga-Selati River is classified as degraded to unacceptable conditions (Class E/F) due to mining activities (mainly copper) around Phalaborwa (DWA, 2010). Consequently, the Ga-Selati negative impacts the Olifants River. However, most of the Olifants River tributaries inside the Kruger National Park are in a good ecological state (Class A and B).

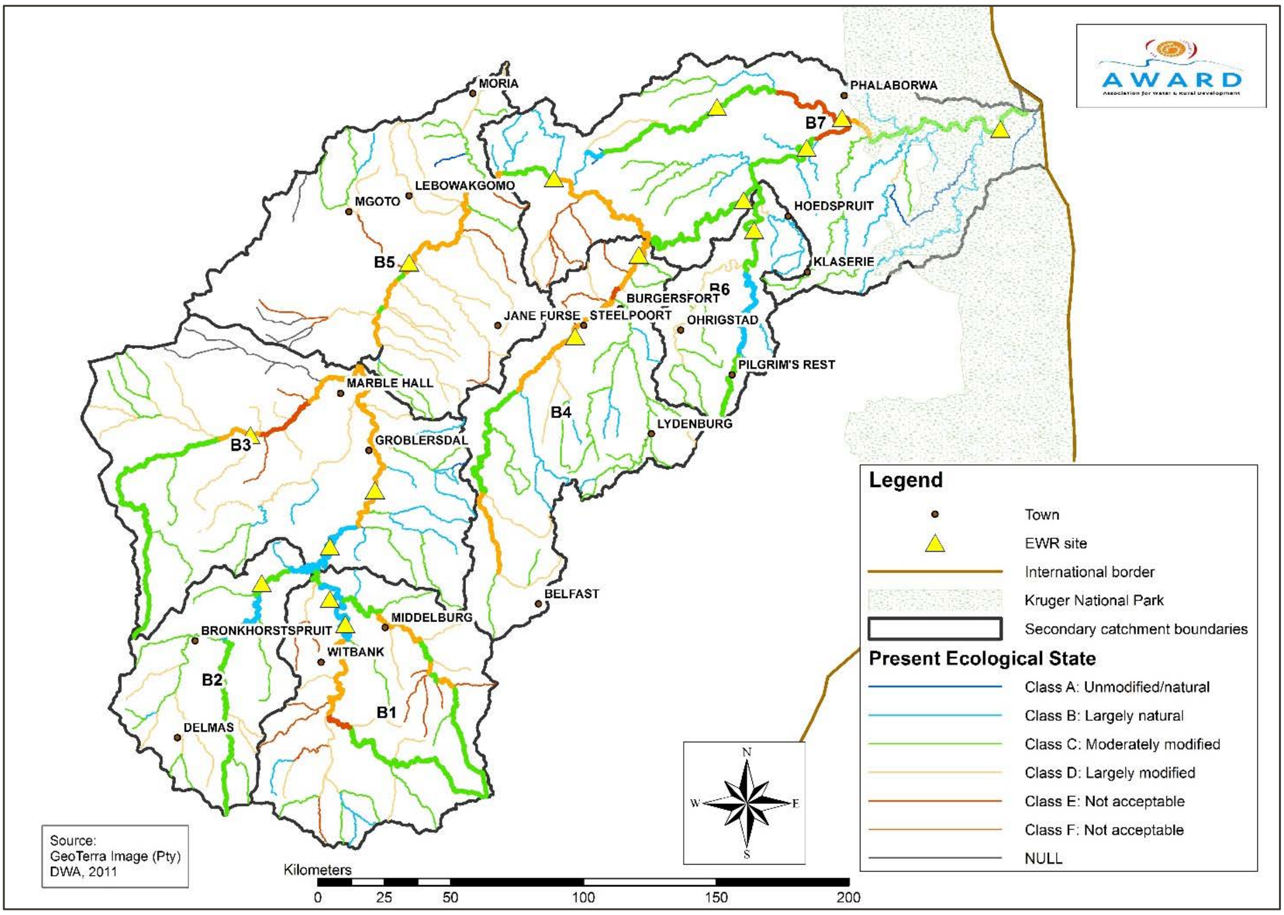


Figure 11: Present Ecological State of the rives in the Olifants catchment in South Africa.

National Freshwater Ecosystem Priority Areas

The National Freshwater Ecosystem Priority Areas project aims to provide strategic spatial priorities (referred to as Freshwater Ecosystem Priority Areas, or FEPAs) for protecting South Africa's freshwater ecosystems and supporting sustainable use of water resources (Nel et al., 2011). Figure 12 is a PES map combined with three important categories of FEPA in the Olifants catchment: River FEPA, Fish Support Area and Rehabilitation FEPA. Although the FEPA status applies to a specific river or fish sanctuary, the whole associated sub-quaternary catchment is shaded because the surrounding land and river streams also need to managed and protected accordingly.

River FEPA are rivers that are identified as in currently good conditions and need to remain so as they contribute to achieving national biodiversity targets for river ecosystems and threatened fish species (Nel et al., 2011). In Figure 12, most of the river FEPA in the Olifants catchment are located in the Steelpoort (B4) and Blyde (B6) secondary catchments. In addition, a few rivers have been identified as FEPA in the Elands (B3), Middle Olifants (B5) and Lower Olifants (B7) secondary catchments.

Another category of FEPA shown in Figure 12 are the Fish Support Areas which are non-pristine rivers that are essential for conserving threatened and near threatened freshwater indigenous fish (Nel et al., 2011). In the Olifants catchment, Fish Support Area are present only in the Steelpoort (B4), Blyde (B6) and Lower Olifants (B7) secondary catchments (Figure 12).

Rehabilitation FEPAs are moderately modified rivers which should not be degraded further as they may be in the future rehabilitated (once FEPAs in good conditions are recognised as fully rehabilitated and protected). In the Olifants catchment, rehabilitation FEPAs are mostly located in the Elands (B3) secondary catchments but there are also present in Upper Olifants (B1), Steelpoort (B4) and Lower Olifants (B7).

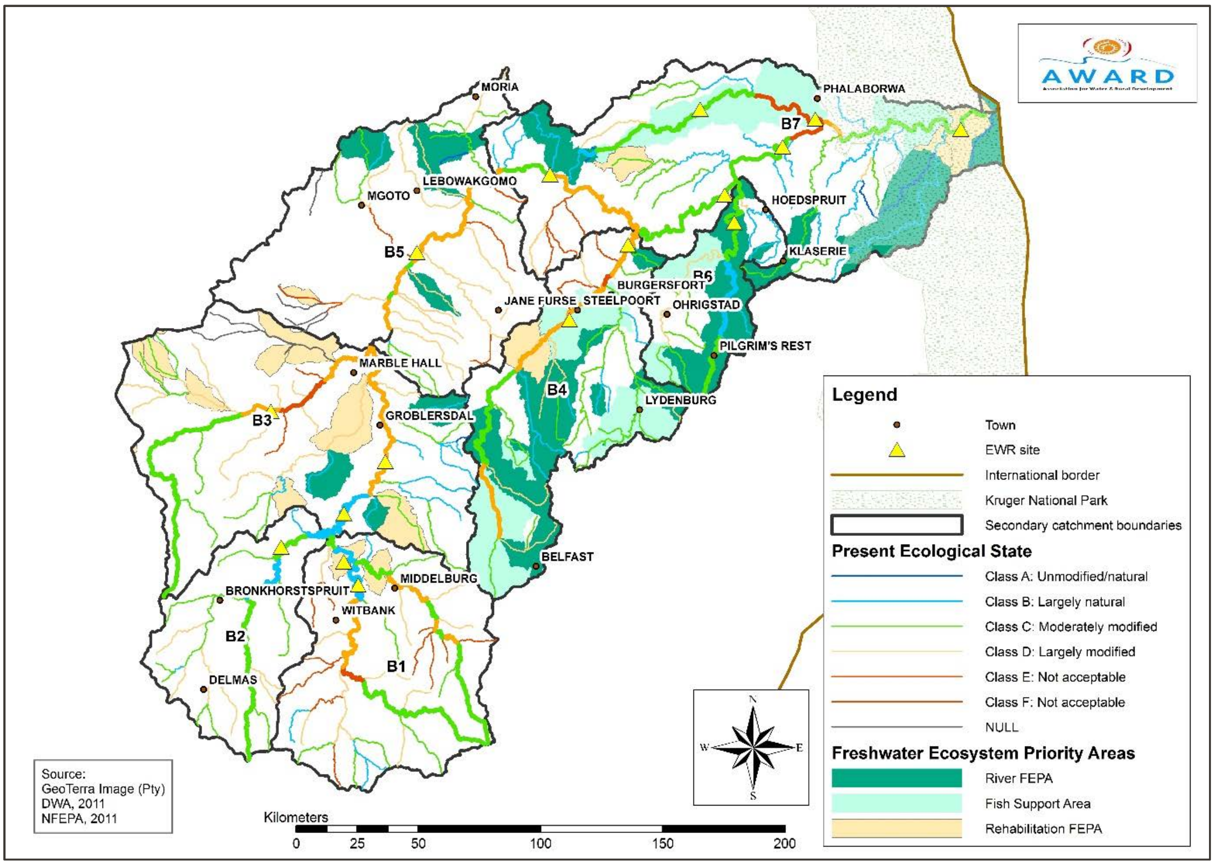


Figure 12: Present Ecological State and Freshwater Ecosystem Priority Areas of the rivers in the Olifants catchment in South Africa.

2.1.3 Wetlands

The NFEPA project also provides information about wetland distribution in South Africa. Figure 13 shows the distribution of wetlands in the Olifants catchment in South Africa based on NFEPA data. More specifically, there is a high concentration of wetlands located in the Upper Olifants (B1), Wilge (B2) and south-eastern section of Steelpoort (B4) secondary catchments. The intense coal mining activities in the Upper Olifants and Wilge secondary catchments pose a large threat to the important number of wetlands in the area. Furthermore, wetlands are regularly targeted for surface coal mining since they are present in low-laying areas and consequently are at short distance to coal deposits in comparison to other surrounding areas (Environmental Business Unit of Exigent Engineering Consultants, 2006). These surface mining activities have negative impacts on the wetlands, ultimately leading to their complete destruction (Environmental Business Unit of Exigent Engineering Consultants, 2006; Palmer et al., 2002).

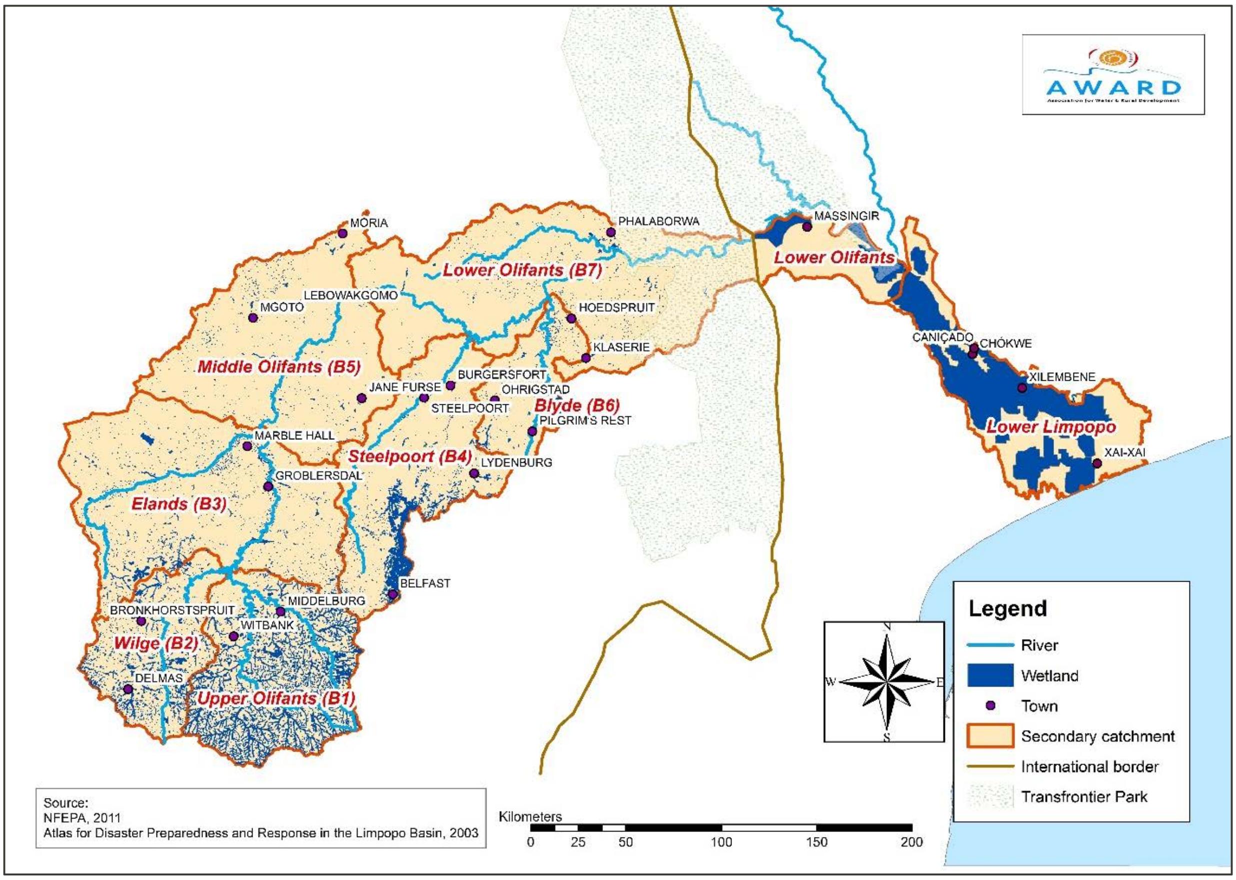


Figure 13: Wetlands in the Olifants catchment in both South Africa and Mozambique

Palmer et al. (2002) described the wetlands in the Upper Olifants (B1) secondary catchments using a typology of 17 wetland types. Moreover, the different wetlands were grouped into 6 main categories as shown in Table 7. Table 7 also provides information about the number of wetlands in each category, their distribution and area (ha).

TABLE 7: THE NUMBER, DISTRIBUTION (%) AND AREA (HA) OF THE DIFFERENT WETLANDS TYPES PRESENT IN THE UPPER OLIFANTS (B1) SECONDARY CATCHMENT IN SOUTH AFRICA (PALMER ET AL., 2002; DWA, 2010).

Wetland Type	Number of wetlands	% of total number of wetlands	Area (ha)	% of total wetland area
NON-FLOODPLAIN RIPARIAN				
1. Drainage lines with riparian zones	710	15.95	14 538	22.43
2. Channelled riparian wetlands	35	0.79	2 083	3.21
3. Non-channelled riparian wetlands	2	0.04	356	0.55
TOTAL	**747**	**16.78**	**16 977**	**26.19**
FLOODPLAIN RIPARIAN				
4. Seasonally inundated channelled valley bottom floodplains with footslope seepage wetlands	26	0.58	11 454	17.67
5. Seasonally inundated valley bottom floodplains without footslope seepage wetlands	3	0.07	483	0.74
6. Seasonally inundated non-channelled valley bottom floodplains	2	0.04	1 034	1.59
7. Temporarily to seasonally inundated channelled valley bottom foodplains	5	0.11	794	1.22
TOTAL	**36**	**0.81**	**13 765**	**21.24**
HILLSLOPE SEEPAGE				
8. Footslope seepage wetlands	192	4.31	8 382	12.93
9. Midslope seepage wetlands	370	8.31	7 824	12.07
10. Valleyhead seepage wetlands	108	2.43	2 037	3.14
11. Crest seepage wetlands	3	0.07	25	0.04
TOTAL	**673**	**15.12**	**18 268**	**28.19**
PANS				
12. Permanently wet pans	149	3.35	3 496	5.39
13 Non-permanently wet pans	498	11.19	2 479	3.82
14. Seepage wetlands associated with pans	65	1.46	1 346	2.08
TOTAL	**712**	**16.01**	**7 321**	**11.30**
OTHER NON-RIPARIAN				
15. Wet grasslands	7	0.16	1 066	1.64
TOTAL	**7**	**0.16**	**1 066**	**1.64**
ARTIFICIAL WETLANDS				
16. Dams and weirs	2 237	50.26	6 840	10.55
17. Other artificial wetlands	39	0.88	576	0.89
TOTAL	**2 276**	**51.13**	**7 416**	**11.44**
GRAND TOTAL	**4 451**		**64 813**	

2.1.4 Groundwater

Although groundwater is available throughout the Olifants catchment, there are important variations in its quantities depending on hydrogeological rock formations (Reconciliation doc – Groundwater). Figure 14 shows the variation in average borehole yield (l/sec) from groundwater resources throughout the Olifants catchment.

The groundwater resource generating the highest borehold yield are found within dolomitic areas (DWAF, 2004). More specifically, there are two important dolomite aquifers present in the Olifants catchment. The town of Delmas in the Wilge (B2) lies within an important dolomite aquifer (referred to as Delmas dolomite) and is reliant on it for its water supply (Groundwater occurrence report). This dolomite aquifer is noticeable in Figure 14 as it comprises the Delmas area with an average borehold yield of over 5 litre/second. However, the Delmas dolomite has been identified as a stressed aquifer with about 6 million m3/a being abstracted from this limited aquifer for irrigation purposes (DWA, 2011c). On the other hand the other important dolomite aquifer, occurring along the escarpment, remains mostly undeveloped (DWAF, 2004). The Escarpment dolomite forms an arc from the area surrounding the town of Lebowakgomo in the Middle Olifants (B5) secondary catchment (average borehole yield over 5 l/sec) and extends through the Lower Olifants (B7) secondary catchment (average borehole yield 2-5 l/sec) towards the surrounding area of the town of Pilgrim’s Rest in the Blyde (B6) secondary catchment (Figure 14). Since this domolite aquifer is undeveloped, it has been identified as a potential resource for future exploitation (DWA, 2011c). However, further exploitation of this groundwater resource is likely to directly impact on surface water flow and there are risks of contamination from agricultural practices and other land use activities (DWAF, 2004, 2003). Therefore the potential impacts of increased abstraction need to be fully understood and taken into account before further development takes place.

Groundwater plays an important role in supplying water, especially in rural areas where it is mainly used for domestic and stock watering purposes. In the Olifants catchment, groundwater utilisation is the greatest in the Elands (B3) and Middle Olifants (B5) secondary catchments where most of the rural population resides. The highest borehole yield in these two sub-catchments is found within the Escarpment dolomite aquifer and the Springbok Flats karoo aquifer. The Springbok Flats aquifer is located in the north-western part of the Elands (B3) secondary catchment (Figure 14). The groundwater in the Springbok Flat is used extensively for domestic and irrigation purposes. More precisely, about 8 to 12 million m3/a of groundwater is abstracted for irrigation (DWA, 2011c). However several studies have pointed out that this aquifer has been over-exploited over the last 20 years, resulting in a lowering of the water table and reduction in borehole yield (DWAF, 2004; DWA, 2011c).

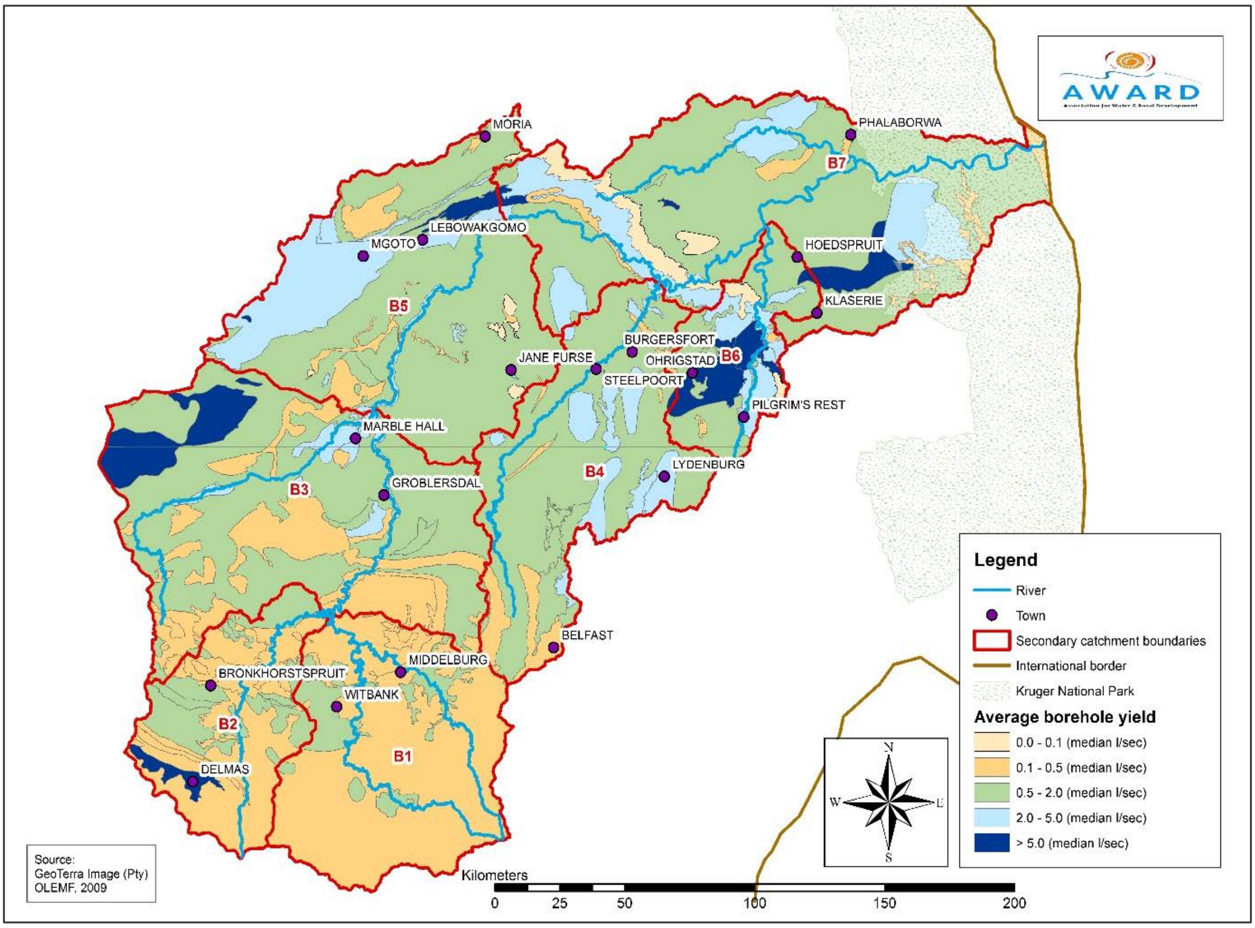


Figure 14: Average borehole yield (l/sec) in the Olifants catchment in South Africa.

2.2 Water resources overview of the Olifants catchment in Mozambique

2.2.1 River characteristics: water quality and quantity

Water quality

Studies have shown that there is a slight deterioration in the water quality of the Limpopo River after the confluence with the Olifants River in terms of nitrate, sulphate and Total Dissolved Salts (TDS) concentrations (LBPTC, 2010; LIMCOM 2013). More specifically, the Total Dissolved Salts (TDS) concentrations in the upper portion of the Limpopo River in Mozambique are at 220 mg/l but below the confluence with the Olifants River the TDS increases to 326 mg/l (LBPTC, 2010).

Although there is limited data available on the water quality of the Olifants River in the Mozambique, elevated sulphate concentrations and salinity have been recorded in the river downstream of Massingir Dam (LIMCOM, 2013). These elevated sulphate concentrations and salinity are residual effect of the intensive land use activities in the South African side of the Olifants Cathment.

In the Lower portion of the Limpopo River in Mozambique, Chilundo et al. (2008) found elevated salinity concentrations at the end of the dry season when there are low flows. Furthermore, frequent saltwater intrusion close to the Limpopo River mouth causes important salinity issues, resulting in limited potential for land use development in the area (Mineral Resources Centre at University of Zimbabwe, 2009). In addition, Chilundo et al. (2008) found elevated metal concentrations, exceeding in some cases the Mozambican standards, which are probably due to the upstream mining activities in the Olifants Catchment. However in general, the metal concentrations reduced in a downstream direction, possibly caused by sedimentation and adsorption onto sediment particles.

Finally, Mozambique has a number of sampling points in the lower Limpopo River (LIMCOM, 2013):

- E372 at the Barrage near Chokwe
- E36 at Chibuto/Sicacate
- E-38 at Xai-Xai

Water quantity

The Limpopo River is characterised by considerable inter and intra-annual variation in natural flows, with very low flows during the dry season (UN-HABITAT/UNEP, 2007). Figure 15 shows the large variation in flows in the Limpopo River within the Chokwe area due to the seasonal pattern in rainfall, and consequently river runoff (LBPTC, 2010). From Figure 15, it is clear that the average monthly flow is at its lowest between August to October. Furthermore, it has been estimated that only 10% of the measured flow at Chokwe is generated within the Mozambican portion of the Limpopo Basin (UN-HABITAT/UNEP, 2007). Although the flow variations of the major tributary, the Olifants River, are smaller than for the Limpopo River, they are still significant and the Massingir dam plays an important role to regulate flows for intensive water use (UN-HABITAT/UNEP, 2007).

In addition to the large inter and intra-annual variation in natural flows, the large water abstraction in the upstream countries poses another important problem. Dams built in Zimbabwe, Botswana and South Africa for water storage purposes has a detrimental impact on downstream river flows in Mozambique, especially during dry periods when water requirements are most important (FAO, 2004). The large water abstractions have caused the Limpopo River to change from being a perennial river to completely drying out for some months each year over large stretches of its middle and lower portions (FAO 2004, LBPTC, 2010). Moreover, the Limpopo River has stopped flowing for periods up to 36 months in the past years (UN-HABITAT/UNEP, 2007). In contrast, greater floods occur when peak flows in the Limpopo and Olifants Rivers coincide downstream of their confluence, as it was the case for the 2000 floods (CGIAR, 2003).

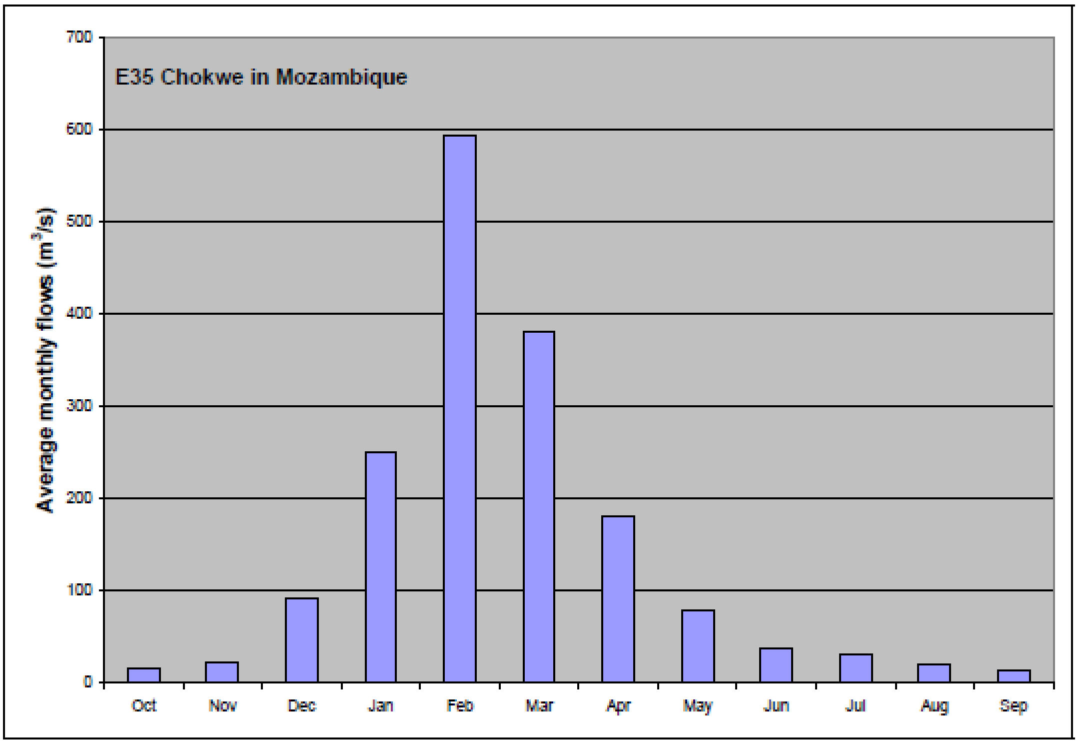


Figure 15: Distribution of average monthly river flows in the Limpopo River within the Chokwe area (LBPTC, 2010).

2.2.2 Groundwater

The aquifers of the Limpopo Basin of Mozambique are generally characterized by poor water quality and limited productive capacity, resulting in limited groundwater potential for human exploitation (ING et al., 2003; FAO, 2004). Figure 16 is a map of the predominant zones considered for characterizing the groundwater potential in the Olifants Catchment in Mozambique, based on the hydrogeological zones identified by the Mozambican National Directorate of Water (ING et al., 2003).

Of these zones, only the coast dune's aquifer can be sustainably used for small and medium-scale abstractions (FAO, 2004). Moreover, these aquifer contain good quality water which is rapidly recharged due to their porous sandy soils. However, the presence of salt-water lakes and lagoons near some of the coastal dunes can limit their productivity (ING et al., 2003).

The aquifer in the alluvial soil valleys contain high levels of salinity and sodicity (FAO, 2004; Mineral Resources Centre at University of Zimbabwe, 2009; ING et al., 2003). In some areas, this is caused by the presence of saline and sodic lacustrian and estuarine deposits under the alluvium (Mineral Resources Centre at University of Zimbabwe, 2009). However, the aquifers near the river provide opportunities for groundwater exploitation as it is replenished directly from surface water and is of sufficient quality for irrigation purposes (ING et al., 2003). Furthermore, the areas at the junction of the alluvial valley with the coastal dunes are particularly productive, as water from the base of the hills is used for small-scale irrigation (FAO, 2004; ING et al., 2003). Lastly, deep aquifers exist at the confluence of the rivers, at about 80m in Mabalane and 200m in Xai-Xai. At present, the water supply for the cities of Chokwe and Xai-Xai in Mozambique are supplied via groundwater (ING et al., 2003).

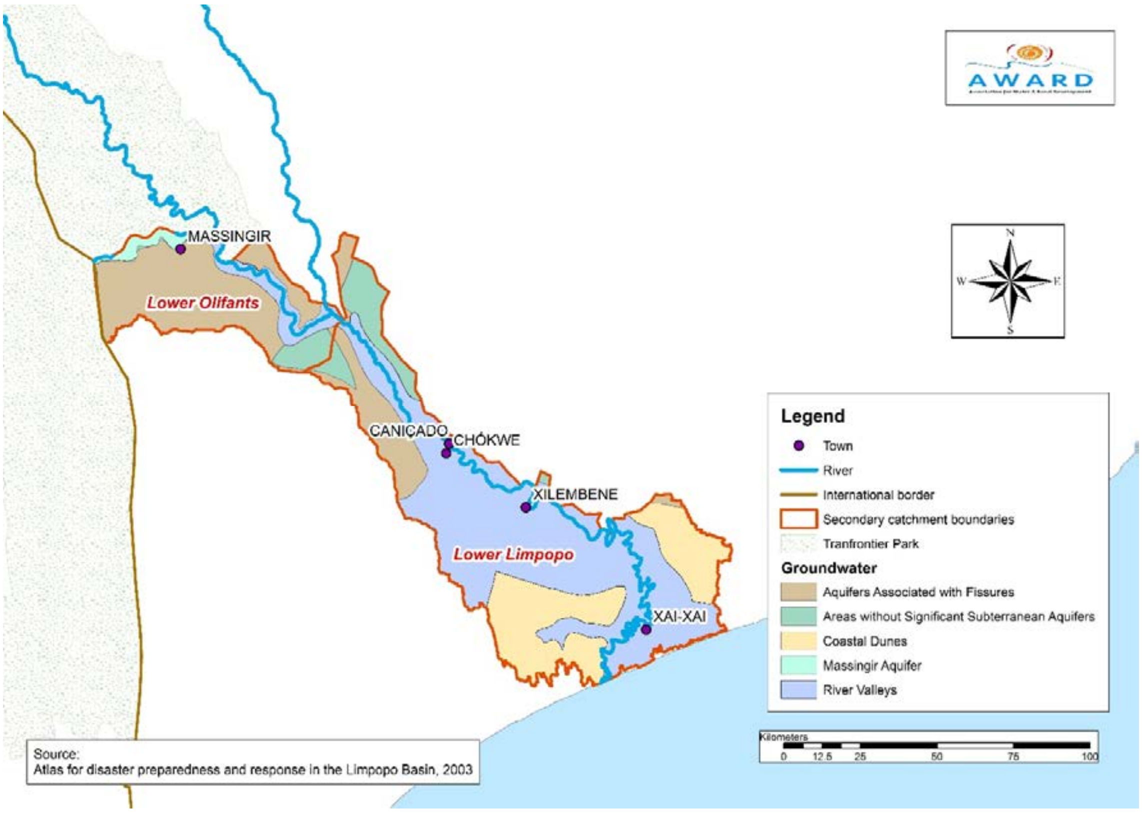


Figure 16: Predominant zones considered for characterizing the groundwater potential in the Olifants Catchment in Mozambique (ING et al. 2003).

3 Demographic & social overview

3.1 Demographic and social overview of the Olifants Catchment in South Africa

3.1.1 Demographic information: population distribution and density

In 2000, the total population in the Olifants catchment in South Africa was approximately 2.8 million (DWAF, 2004). Based on the analysis of Census data for 2011, the population in the Olifants catchment was estimated to have grown to about 3.4 million, representing a population of about 7% of the total national population.

The Olifants catchment has a predominantly rural character with 66 % out of the total population residing in rural areas, primarily in the Elands (703 932) and Middle Olifants (691 986) sub-catchments (Figure 17). More specifically, the former homelands of Lebowa, Bophuthatswana, Kwa-Ndebele and Gazankulu, which constitute 26% of the area in the basin, are the most densely populated. The population density in these former homeland areas vary mainly from 40 – 100 people/km2 to 100 – 500 people/km2 (Figure 18). Moreover, the population density in a few wards within these former homelands even reaches up to: 500 - 1000 people/km2 and 1000 - 5000 people/km2 (Figure 18). This situation is rather unique to South Africa as typically rural areas are defined as having a low population density and small settlements. However these areas in the former homelands are classified as “rural areas” although they have very high population densities which is the consequence of South Africa’s historical apartheid displacement policies.

The Upper Olifants contains the largest urban population (561 942) concentrated in the two main urban centres of Witbank (Emalahleni) and Middleburg (Figure 17). The wards with the highest population density within those two urban centres is around 5 000 - 12 300 people/km2 (Figure 18).

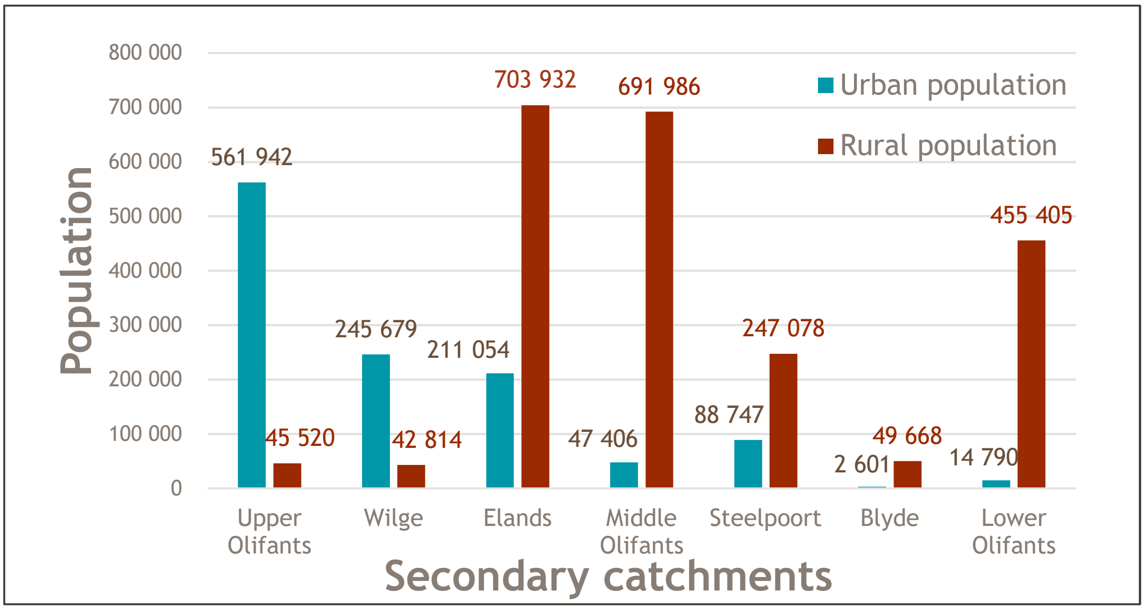


Figure 17: Urban and rural population in each secondary catchment in the Olifants catchment in South Africa.

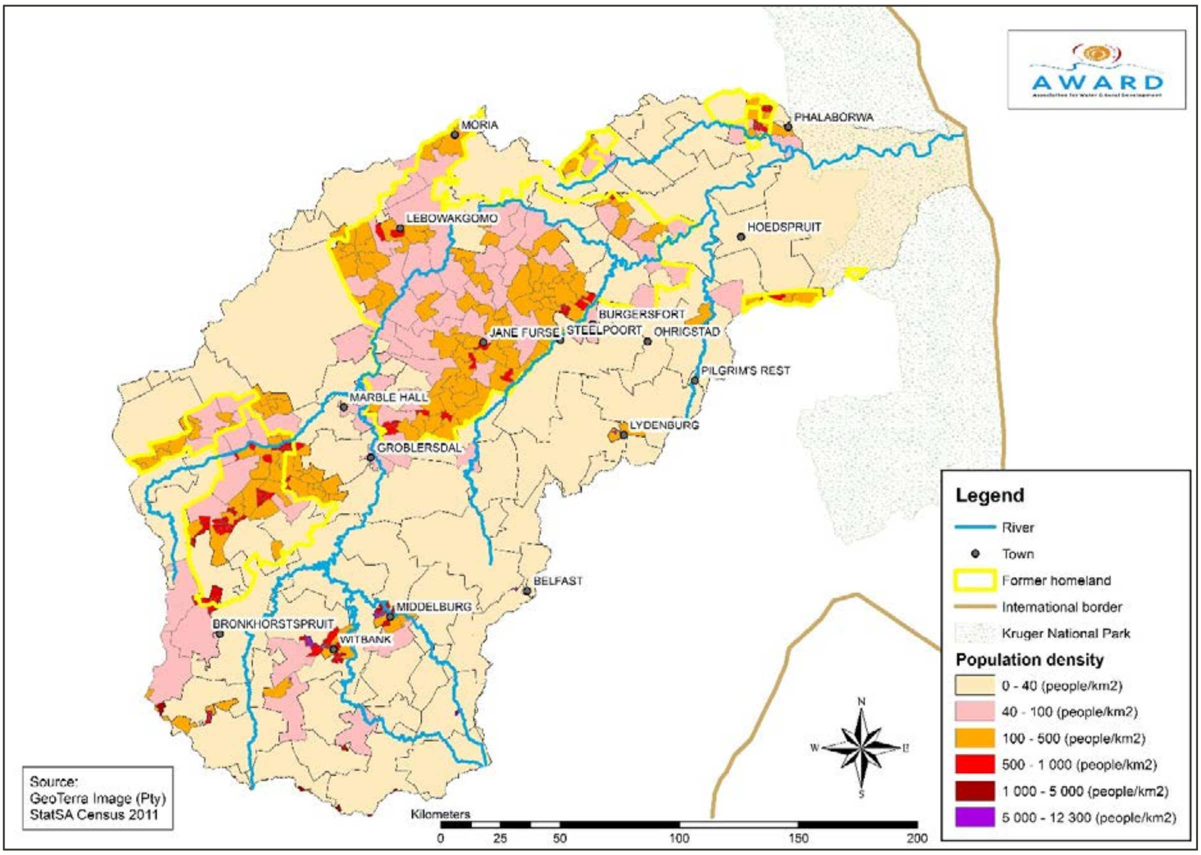


Figure 18: Population density in the Olifants catchment in South Africa (based on the analysis of Census data 2011 at ward level).

The population pyramid below shows the distribution of the population in the Olifants catchment by age and gender based on Census data 2011 (Figure 19). An important feature that stands out is that the population in the catchment is generally young as about 50 % of the people in the area fall under the age of 24. More specifically, the Greater Sekhukhune district has the largest percentage of people within this age category, with more than 60 % of the district's total population below the age of 24 (DEA, 2009).

The population pyramid below also shows that the sex ratio is relatively equal within the Olifants catchment (Figure 19). However, the sex ratio does get slightly skewed from the age of 30 and more as there is gradually more women than men. This lower ratio of men to women in older age groups is caused by the lower life expectancy of men, which is similar to most countries around the world.

The overall population pyramid of the Olifants catchment is relatively typical of developing countries as it contains a wide base indicating a high proportion of children, a rapid rate of population growth and a low proportion of older people. This type of pyramid is generally referred to as an expansive pyramid and it indicates a population in which there is a high birth rate, a high death rate and a short life expectancy. However, the population pyramid of the Olifants catchment does differ slightly from the typical expansive pyramid as there is a noticeable decrease in the percentage of population in the age groups of 5-9 and 10-14 for both male and female (Figure 19). Furthermore, the population pyramids from Census data 2011 for both Limpopo and Mpumalanga provinces also contain a similar decrease in the percentage of population for the exact same age groups (Census, 2011a, 2011b). The cause for this noticeable decline in the number of children between the ages 0-9 and 10-14 may be from the impacts of HIV/AIDS. Further research needs to be done to understand in more detail the reasons for this pattern amongst the population pyramids.

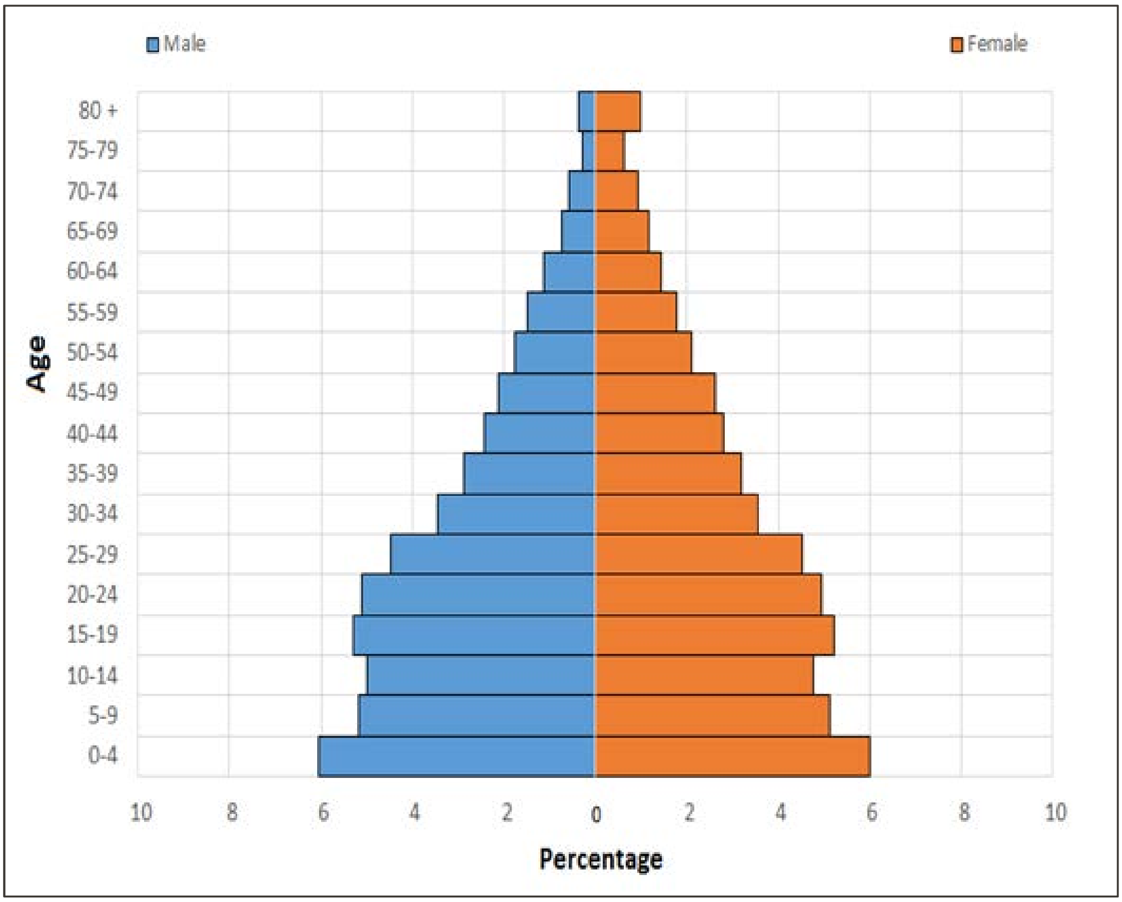


Figure 19: Population pyramid of the Olifants catchment in South Africa (based on the analysis of Census data 2011).

3.1.2 Education

The functional literacy rate in the Olifants catchment is estimated at approximately 60 % (DWA, 2011d). Moreover from analysing Census data 2011, it has been estimated that about 10% of the total population in the Olifants catchment has no schooling meanwhile 19% has Grade 12 and only 3% have tertiary education (Table 2).

TABLE 8: POPULATION IN THE OLIFANTS CATCHMENT WITH NO SCHOOLING, HAVING ACHIEVED GRADE 12 AND TERTIARY EDUCATION (BASED ON THE ANALYSIS OF CENSUS DATA 2011).

SECONDARY OLIFANTS	NO SCHOOLING	GRADE 12	TERTIARY EDUCATION	TOTAL POPULATION
POPULATION	354 376	631 891	107 125	3 408 621
PERCENTAGE	**10 %**	**19 %**	**3 %**	

3.1.3 Health

HIV/AIDS is a major health problem in the Olifants catchment as well as the rest of South Africa. There are no numbers available about the HIV prevalence specifically within the Olifants catchment area. However based the National Antenatal Sentinel HIV and Syphilis Prevalence Survey 2011, there has been an increase in estimated HIV prevalence in the Mpumalanga province of 2.0 % from 2009 to 36.7 % in 2011 whereas in the Limpopo province there has been a steady increase from 2009 to 22.1 % in 2011.The districts within the provinces are clearly heterogeneous with respect to the epidemic. For example in the Greater Sekhukhune district which falls entirely within the Olifants catchment, HIV prevalence is estimated around 18.9% (National Department of Health, 2011).

Several research projects have been carried out in the Sekhukhunelands in order to understand how HIV/AIDS influences the livelihood, socio-economic aspects and household structure in the area such as The Greater Sekhukhune-CAPABILITY outreach project (Gregersen et al., 2013) and the Social Interventions for HIV/AIDS Intervention with Micro-finance for AIDS and Gender Equity (IMAGE) Project (Hargreaves et al., 2002).

3.1.4 Household profile: household size, gender and age of head of household

All information concerning the average household size, gender and age of head of household in the Olifants catchment in South Africa was estimated by analysing Census data 2011. The household size within the 7 different secondary catchments in the Olifants catchment were found to vary between 2.9 and 3.6 (Table 9). Moreover, the overall average household size for the entire Olifants catchment is of 3.2 which is just slightly lower to the average size of 3.8 in both the Limpopo and Mpumalanga provinces (Table 9).

Figure 20 shows the number of households in the 7 different secondary catchments of varying size from 1 person household size to a household size of 10 people or more. In each secondary catchment, the majority of households contained a household size of 1 person (Figure 20). Further research needs to be carried out in order to verify and/or understand these unexpected findings.

TABLE 2. AVERAGE HOUSEHOLD SIZE FOR EACH SECONDARY CATCHMENT IN THE OLIFANTS CATCHMENT IN SOUTH AFRICA AND FOR THE LIMPOPO AND MPUMALANGA PROVINCES (BASED ON THE ANALYSIS OF CENSUS DATA 2011).

Secondary catchment	Upper olifants	Wilge	Elands	Middle olifants	Steelpoort	Blyde	Lower olifants	Total olifants	Limpopo province	Mpumalanga province
Average household size	3.0	2.4	3.5	3.4	3.6	3.2	2.9	3.2	3.8	3.8

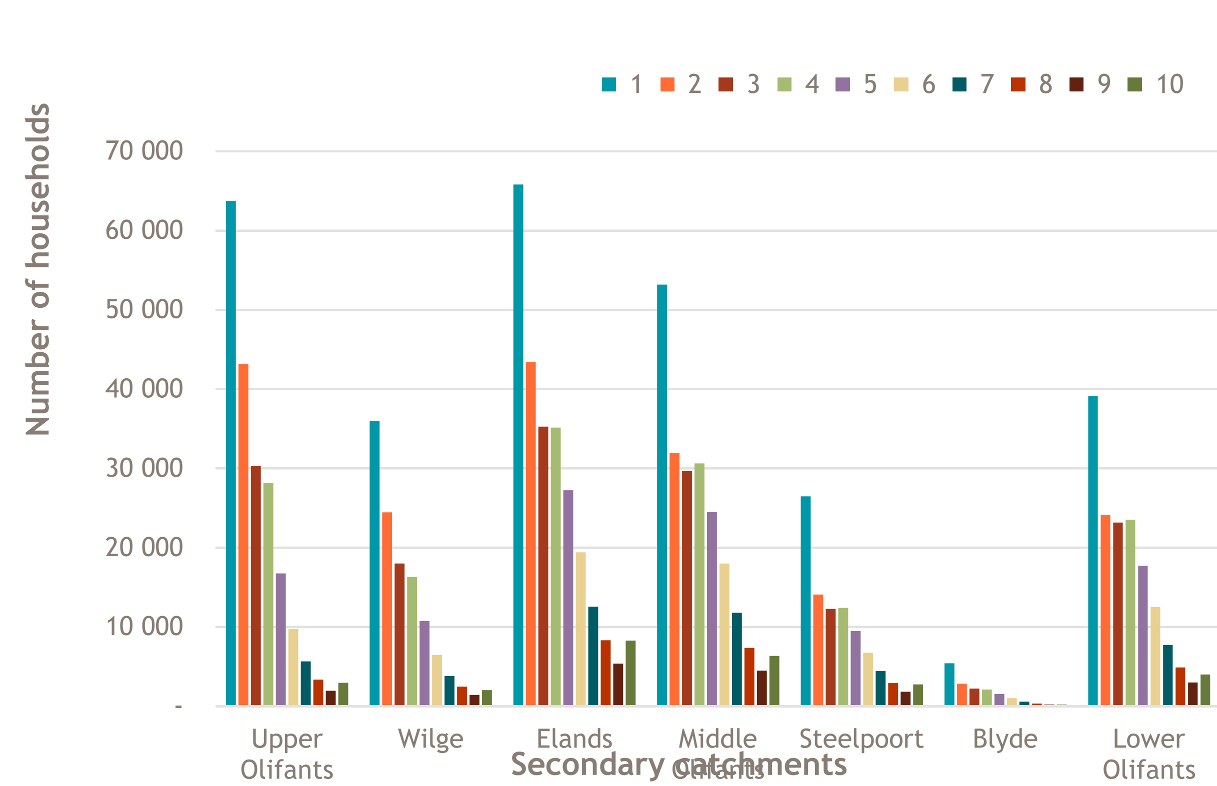


Figure 20: Household size (1 to 10 and more people) in each secondary catchment in the Olifants catchment in South Africa (based on the analysis Census data 2011).

In the Olifants catchment, it was estimated that about 58 % of households are headed by men whereas 42 % are female headed households. In each secondary catchment (except for the Middle Olifants) there is a greater number of male headed households than female headed households (Figure 21). The number of male headed household in comparison to female headed household is especially high in the Upper Olifants catchment (73% male headed households) and followed by the Wilge catchment (68% male headed households). On the other hand, in the Middle Olifants (which contains most of the Lebowa former homeland area) 54% of households are female headed.

Female-headed households are generally reported as having low socio-economic status and therefore are considered more vulnerable (Chant, 2007; Posel, 2001). In general, the primary reasons for female headed households are related to male labour migration and non-marriage (Posel, 2001). South Africa's apartheid policies, which facilitated the movement of black men to the urban areas in order to provide a ready and low-cost labour pool, resulted in a disproportionate number of female-headed households in rural areas (Schreiner and Naidoo, 2001). Although female-headed households in this context is largely due to South Africa's history of apartheid, it is also increasingly being connected to ''contemporary macro-economic conditions'' (Goebel et al., 2010) and the impact of HIV/AIDS on household structure (Gilbert et al., 2010).

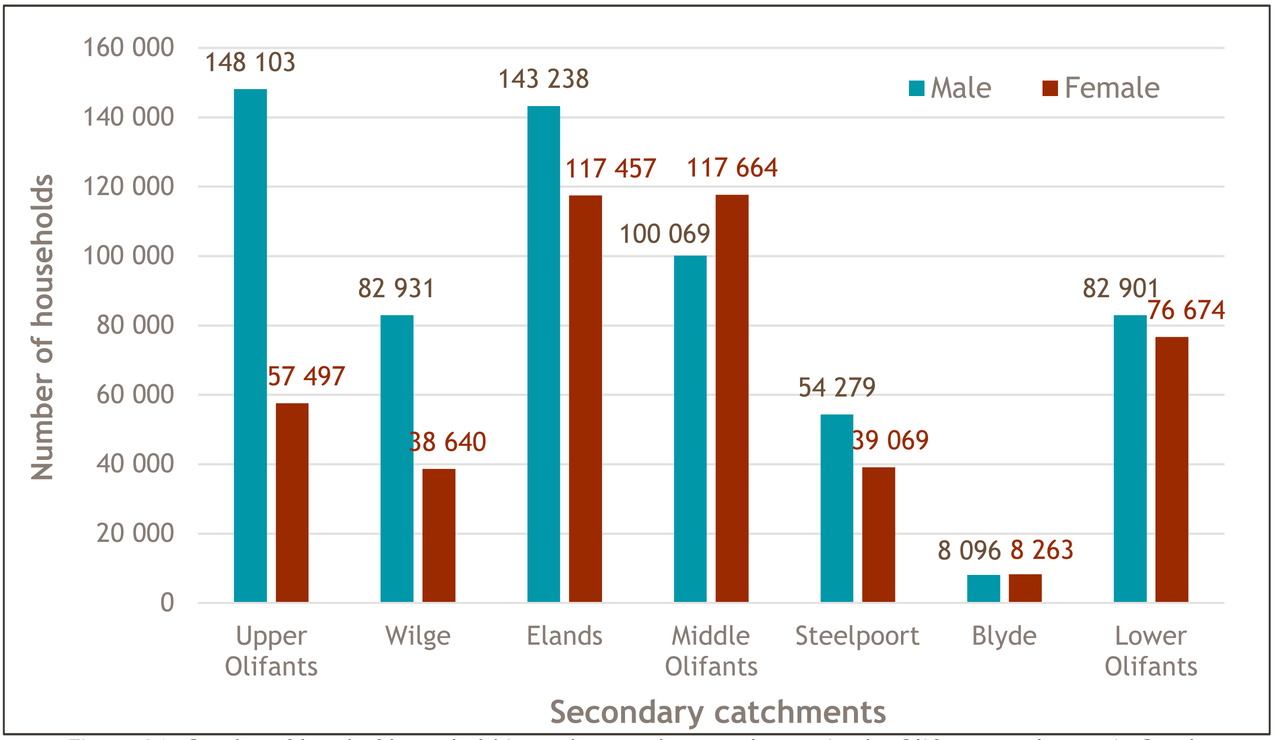


Figure 21: Gender of head of household in each secondary catchment in the Olifants catchment in South Africa (based on the analysis of Census data 2011).

In the Olifants catchment, most households are headed by adults ranging between the ages of 20 to 60 (Table 10). On the other hand, about 2 % heads of households are between the ages of 10 to 19 meanwhile about 10 % of heads of households are 70 years old and more (Table 10). More specifically, households headed by elderly people aged 70 or more is particularly high in the Middle Olifants (which contains most of the Lebowa former homeland area), representing about 16 % of households (Figure 22).

In South Africa, several studies have found that family structures have been altered by HIV/AIDS as there is a high number of orphan children that become head of households. However, most orphaned children are incorporated into the extended family, especially into their grandparents' households. Therefore, the main reason for the high percentage of head of households of age 70 or more in the Olifants catchment, especially in the Middle Olifants sub-catchment, is likely to be due to the impacts of HIV/AIDS in the area.

TABLE 10: AGE OF HEAD OF HOUSEHOLDS IN EACH SECONDARY CATCHMENT IN THE OLIFANTS CATCHMENT IN SOUTH AFRICA (BASED ON THE ANALYSIS OF CENSUS DATA 2011).

Secondary catchment	**Age of head of household**							
	10 to 19	**20 to 29**	**30 to 39**	**40 to 49**	**50 to 59**	**60 to 69**	**70 to 79**	**80 +**
Upper Olifants	1950	40891	53766	47004	36738	16326	6529	2386
Wilge	1273	21812	31964	29186	21171	10213	4374	1533
Elands	5134	34193	49742	55778	48922	35491	19994	11397
Middle Olifants	5322	24401	35223	44776	40247	32582	22575	12489
Steelpoort	1533	15425	22644	21090	14854	9588	5344	2851
Blyde	405	2417	3097	3234	2770	2192	1516	716
Lower Olifants	4434	23970	35378	35001	26460	17397	10953	5907
TOTAL	**20051**	**163109**	**231814**	**236069**	**191162**	**123789**	**71285**	**37279**
Distribution	**2 %**	**15 %**	**22 %**	**22 %**	**18 %**	**12 %**	**7 %**	**3 %**

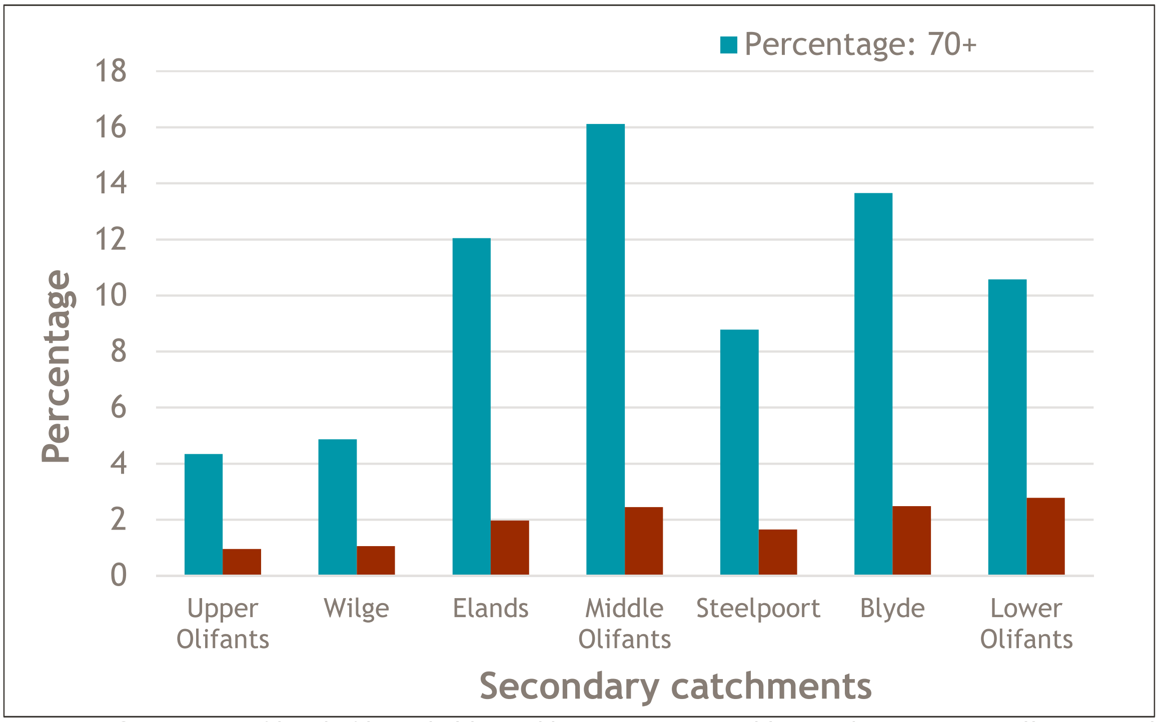


Figure 22: Percentage of head of households aged between 10-19 (in blue) and 70 or more (yellow) in each secondary catchment in the Olifants catchment in South Afrcia (based on the analysis of Census data 2011).

3.2 Demographic and social overview of the Olifants Catchment in Mozambique

3.2.1 Demographic information: population distribution and density

The total population in the Olifants catchment in Mozambique was estimated by using the Census data of 2007 available at district level and adding to it a growth rate of 2.5 % per year based on the projections claimed by the National Institute of Statistics. According to these calculations, the total population in the Olifants catchment in Mozambique is estimated to be close 700 000 in 2013. Moreover, the Census 1997 classified about 80% of the population in the Limpopo Basin as rural. The major urban centre in the Olifants catchment in Mozambique is Xai-Xai city with a population of 116 343 in 2007.

In the Olifants catchment, the population density decreases as you move further inland from the coast and away from the Chokwé area (Figure 23). More specifically based on Census data 2007, Xai-Xai city contains the highest population density of about 1018 persons/km^2 whereas Massingir district contains a low population density of about 6 person/km^2.

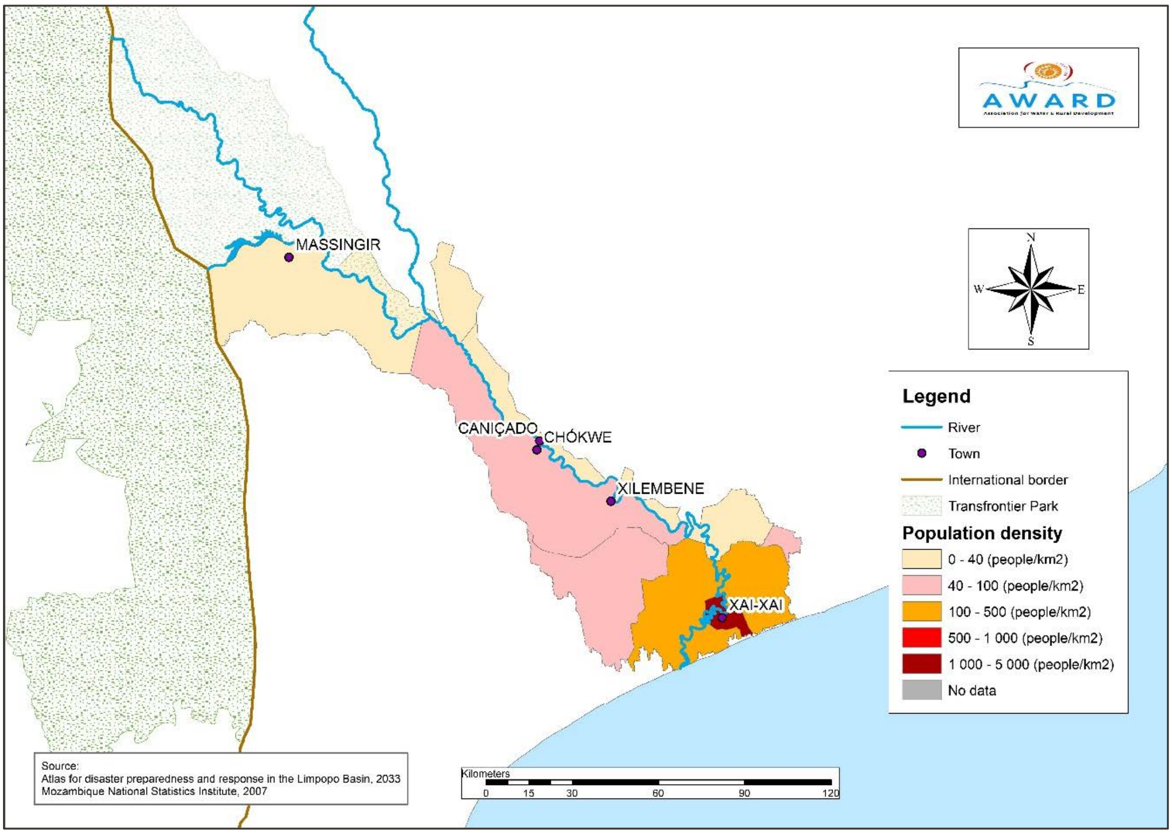


Figure 23: Population density in the Olifants catchment in Mozambique (based on the analysis of Census data 2007 at district level).

The population pyramid below shows the population distribution by age and gender in the Limpopo Basin in Mozambique according to Census data 1997. The population in the basin is particularly young as just under half of the population (43.7%) is younger than 15 years (ING et al., 2003). A striking feature of this population pyramid is the important imbalance between the number of men and women in the area. There is overall a low number of males in comparison to females in the area, especially in the 20-24 age group where the ratio female to male is 2:1. The Limpopo basin has historically been an area from which much of Mozambique's migrant labour is drawn therefore the cause for this imbalance is most likely due to the large migrations of men for work in Maputo and South Africa (ING et al., 2003).

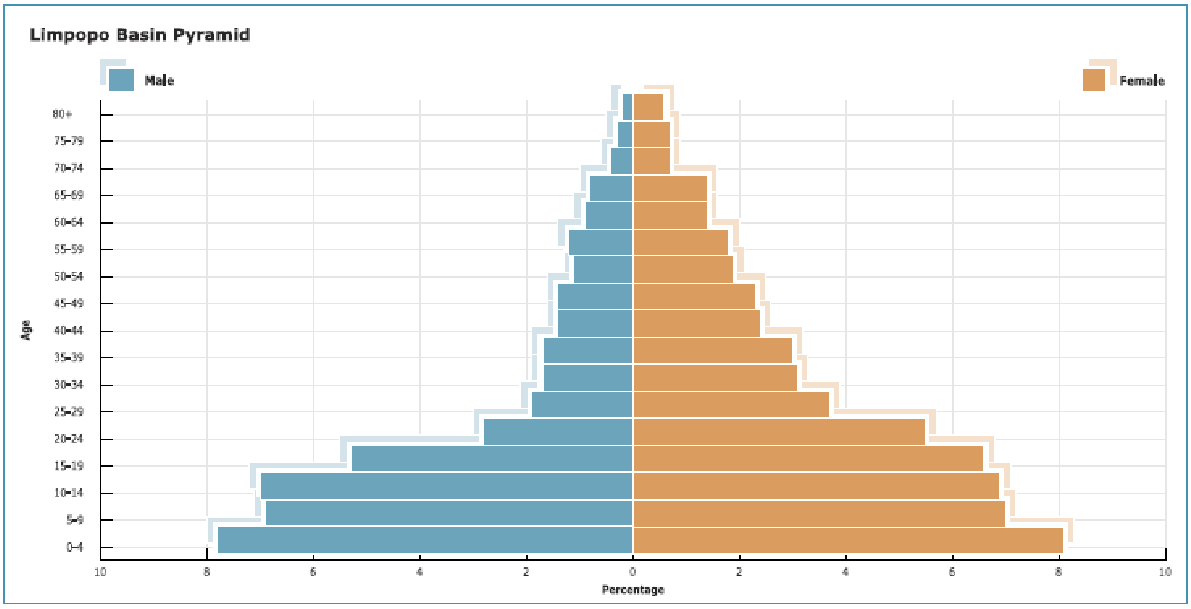


Figure 24:Population pyramid of the Limpopo Basin in Mozambique based on Census data 1997 (ING et al., 2003).

3.2.2 Education

The literacy rate in the Gaza province, within which falls the Olifants catchment, has improved considerably between the two censuses of 1997 and 2007. In 1997, 52.7 % of adults in Gaza could not read or write but this figure has fallen to 38.5 % by 2007. However there is an important difference in illiteracy rate between men and women as only 23.5 % men are illiterate versus about 48.8 % of women (Table 11). Furthermore, 25.5 % of children aged between 6 and 17 within the Gaza province are not at school.

TABLE 11: ILLITERACY RATE AMONGST ADULTS IN GAZA PROVINCE IN 1997 AND 2007 (BASED ON CENSUS DATA 2007).

Gaza province	Illiteracy rate			
	Adults in 1997	**Adults in 2007**	**Men in 2007**	**Women in 2007**
Percentage	52.7 %	38.5 %	23.5 %	48.8 %

3.2.3 Health

Malaria has for a long time been the most important public health problem in the Limpopo basin in Mozambique. The average annual malaria incidence rates are the highest in the southern part of the Basin. Moreover, Xai-Xai City is the most affected area by malaria in the basin which could be due to the fact that it is one of the lowest lying areas within the basin. In addition, the 2000 floods led to extremely high increase in malaria in Xai-Xai city.

HIV/AIDS is increasingly becoming a major health issue in the Gaza province. The results from Census 2007 showed that about 40.7 % of deaths in the province were HIV/AIDS related whereas 18.8 % of deaths were caused by malaria. In consequence, HIV/AIDS has overtaken malaria as the main killer in Gaza province.

4 Socio-economic overview

4.1 Socio-economic overview of the Olifants Catchment in South Africa

This section will specifically look at the Census 2011 and other quantitative data to analyse and try and create an understanding of the current economic scenario in which the ORC finds itself.

4.1.1 Employment Status

The Statistics South Africa Census 2011 categorized employment status in five categories. As can be seen in Figure 25, the “Not economically active” and “Not Applicable” categories has been combined. “Not economically active” is stated in the Census 2011 Metadata Report (2012) as “unemployed people of a working age not seeking employment” and “Not applicable” as “If age is less than 15 or greater than 65 years.”

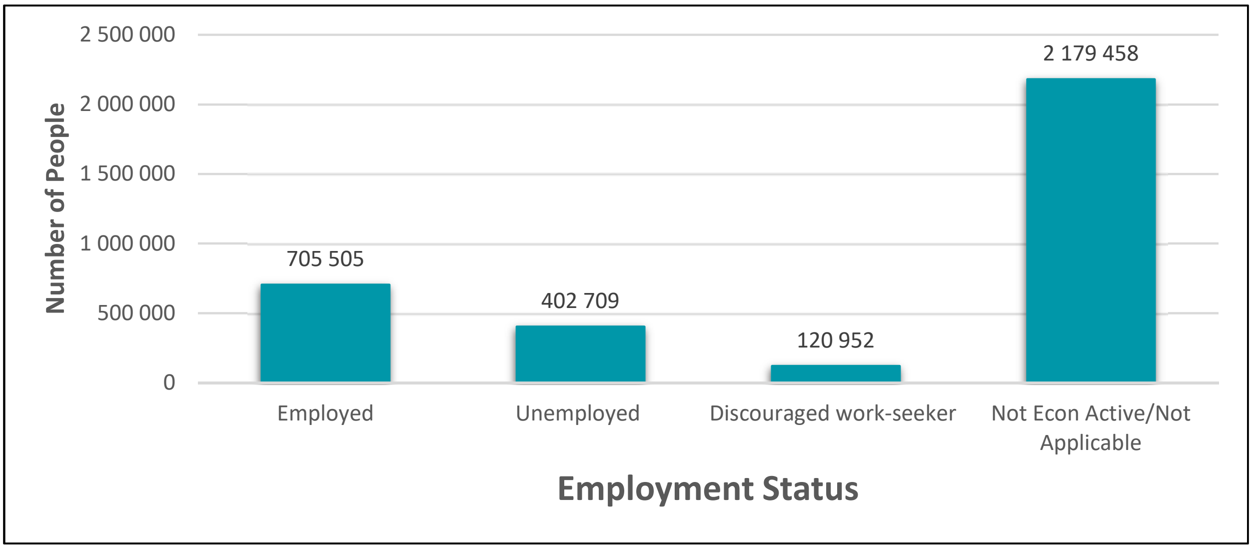


Figure 25: Employment Status within the ORC (Source: Census 2011).

As can be seen a major issue in the ORC is the fact that the amount of employed (707 505), which is basically the income providers for the area, is vastly outweighed by the other categories not bringing in any income (2 703119), except through miscellaneous income sources such as grants. This creates a Dependency Ratio of 01 : 3.8. Thus showing that for every employed person in the ORC there are 3.8 others not bringing in any formal income.

When looking at unemployment, there are two types. Basic Unemployment Rate, (unemployed/labour force)*100, and the Expanded Unemployment Rate, which includes discouraged work-seekers under the unemployed category (Census 2011 Metadata Report, 2012).

South Africa in 2011 had a basic unemployment rate of ±25%, in comparison to the ORC had a 32.8% rate according to Census 2011 data. The expanded unemployment rate in South Africa was ±36% during 2011. The ORC area has a remarkably higher rate at ±42.6% (Census 2011).

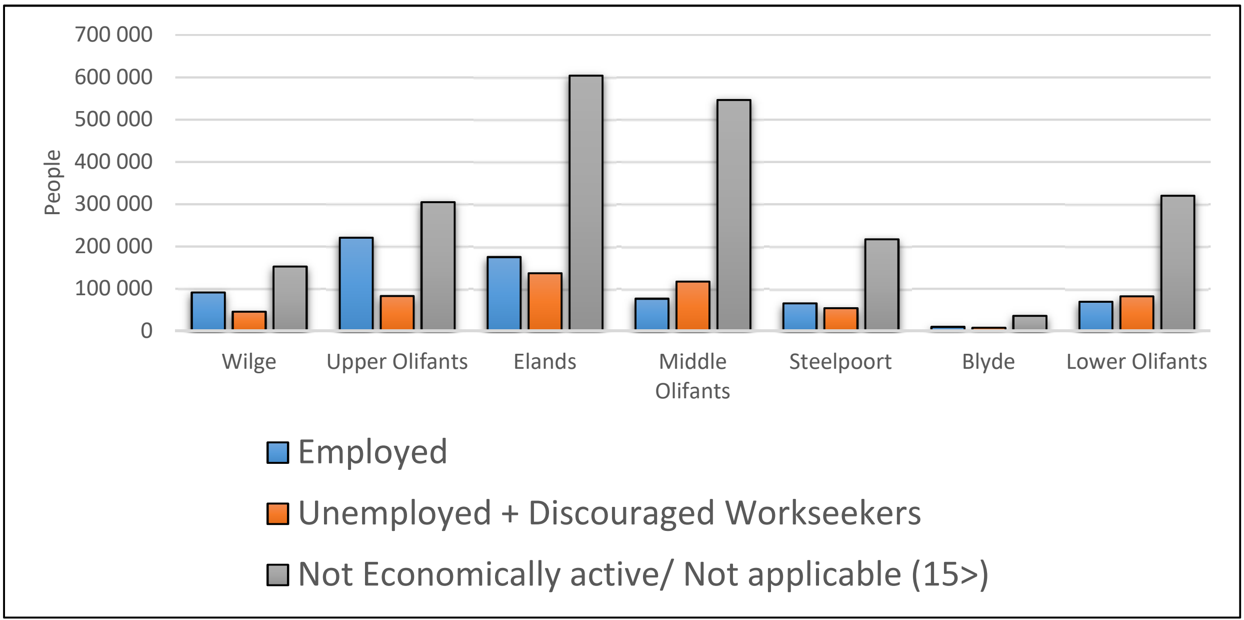


Figure 26: Employment Status per Secondary Catchment. (Source: Census 2011)

Looking at Figure 26 above which shows employment status per secondary catchment it is clear that the largest contributors to this high unemployment level is the Middle Olifants; Lower Olifants and Elands- secondary catchments. These areas suffer this fate due to underdevelopment of the areas, with especially the Middle Olifants (former homelands area) being struck by high unemployment and a staggering dependency ratio of 01 : 8.7. The areas doing the best in terms of avoiding high unemployment levels and dependency ratios are those in the most developed areas of the ORC. These are the Wilge and Upper Olifants, the energy production hub of South Africa, and a major mining area (DEA, 2009).

4.1.2 Employment per sector

By the time of this study StatsSA did not yet make available the detailed "Type of Sector Employed In" data at ward level, the level at which this analysis was done. The information made available only divided the sectors into basic forms, as shown in Figure 27. Please note that "Private Household" refers to people working as domestic workers, either as employee or as houseparent/keeper (Census 2011 Metadata Report, 2012).

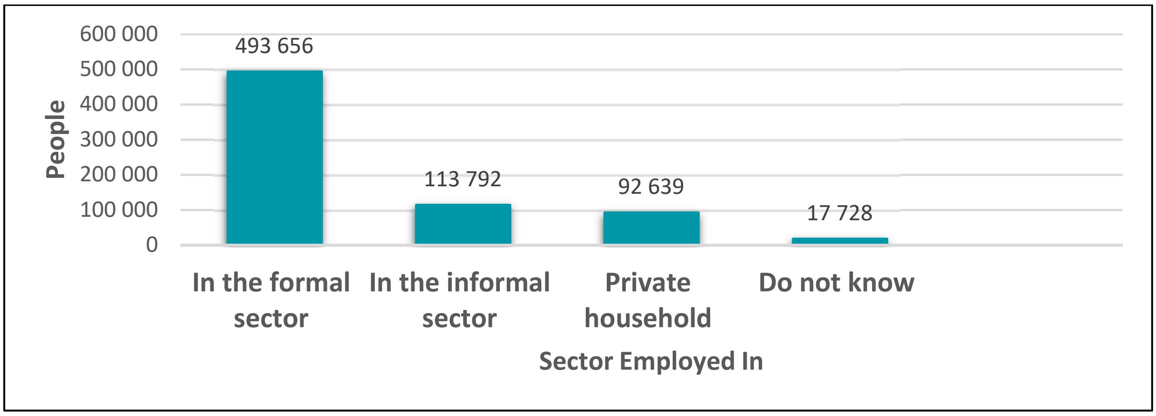
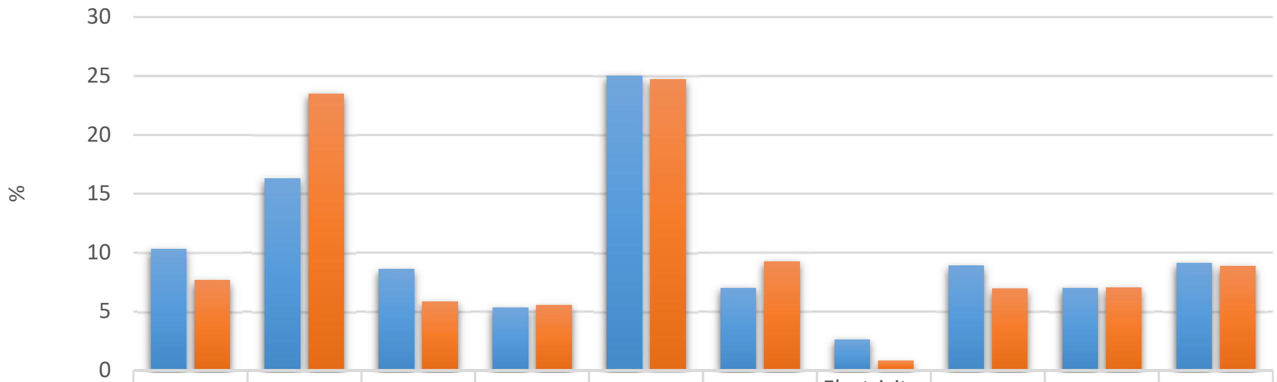


Figure 27: Employment per Sector for entire Catchment. (Source: Census 2011)

It is clear that the formal sector is by far the dominant one, with “Private Household” coming in as a large number, especially compared to other countries where this type of employment is a lot more limited.

Because of the data from the Census 2011 being limited, a look was taken at the Socio Economic Review and Outlook Reports (SERO) of both Limpopo (42% land area of ORC) and Mpumalanga (45%) for 2012. This information is not fully representable of the ORC, but is the best source of information on the general division of employment by sector in the area. Please not that in Figure 28 community services represents government employment (Census 2011 Metadata Report, 2012). The more developed an area in general the less it is dependent on primary sectors such as mining and agriculture. Looking at Figure 28 this seems to be the case, but it is important to note that a lot of the services provided, like for example the finance and transport sector is dependent on the primary sectors, for instance mining and agriculture in the ORC area.



	Priv HH	Community services	Finance	Transport	Trade	Constrution	Electricity, gas and water	Manufacturng	Mining	Agriculture
Limpopo	10	16	9	5	25	7	3	9	7	9
MP	8	23	6	6	25	9	1	7	7	9

Limpopo MP

Figure 1. Employment by Sector for MPL and Lim for 2012 (Q1)
(Source: Limpopo 2012 Sero Report & Mpumalanga 2012 Sero Report.)

Table 12 shows the employment by sector for the ORC. It is from the DWA Classification report of 2011, but the data is taken from the Statistics South Africa 2001 Census. Added to this is a basic growth estimation based on the sectorial growth in employment gathered from the Mpumalanga SERO report of 2012 between the dates 2001-2012. As can be seen on the right the colours show the average growth per annum, with green representing low growth (±2% p.a), orange shows medium (±3,5% p.a) and blue high growth (±6% p.a). Please note that this is simply an estimation made on the data of growth per employment sector for Mpumalanga. It provides a general overview, as no way of accurately calculating the size and growth per employment sector was available at the time this report was written.

TABLE 12: EMPLOYMENT BY SECTOR FOR ORC IN 200, COMBINED WITH THE GROWTH OF MPUMALANGA'S EMPLOYMENT BY SECTOR FROM 2001-2012

Employment 2001	Total	% of total (2001)
Agriculture; hunting, forestry and fishing	25 959	9
Mining and quarrying	33 858	11
Manufacturing	30 415	10
Electricity; gas and water supply	7 668	3
Construction	20 309	7
Wholesale and retail trade; repairs, hotels and restaurants	40 693	13
Transport, storage and communication	11 752	4
Financial intermediation; insurance; real estate and business services	16 711	6
Community; social and personal services	57 393	19
Private households	35 212	12
Undetermined	21 924	7
Total	**301 920**	

Ave % growth p.a. (2001-2012)	
Low	±2.0
Medium	±3.5
High	±6.0

(Source: DWA, 2011. & Mpumalanga Sero Report 2012)

4.1.3 Household Income

To create an understanding of how household income has transformed from the 2001 to 2011 census, a comparison was drawn between the percentages of people in each income category. The 2001 data used comes from a 2011 DWA report, therefor it has been adjusted with inflation as used from an inflation calculator. The calculations were made using an average annual inflation increase of 6.3% per annum, adding up to a total value decrease of 83.5% per Rand from 2001 to 2011. From Figure 29, it is clear that with inflation calculated in not a lot of change has occurred in the area. The most notable change has been the 8% decrease in the Very Poor Category, combined with an increase in the next income category (Poor). The government aims of decreasing poverty through several processes, for instance the Comprehensive Rural Development Plan (CRDP), acts only as a slow driver, not creating the immediate impact desired. The Wealthy category increased over the ten years by 2% of the overall households, which even though still a small percentage, shows inequalities in growth of household incomes.

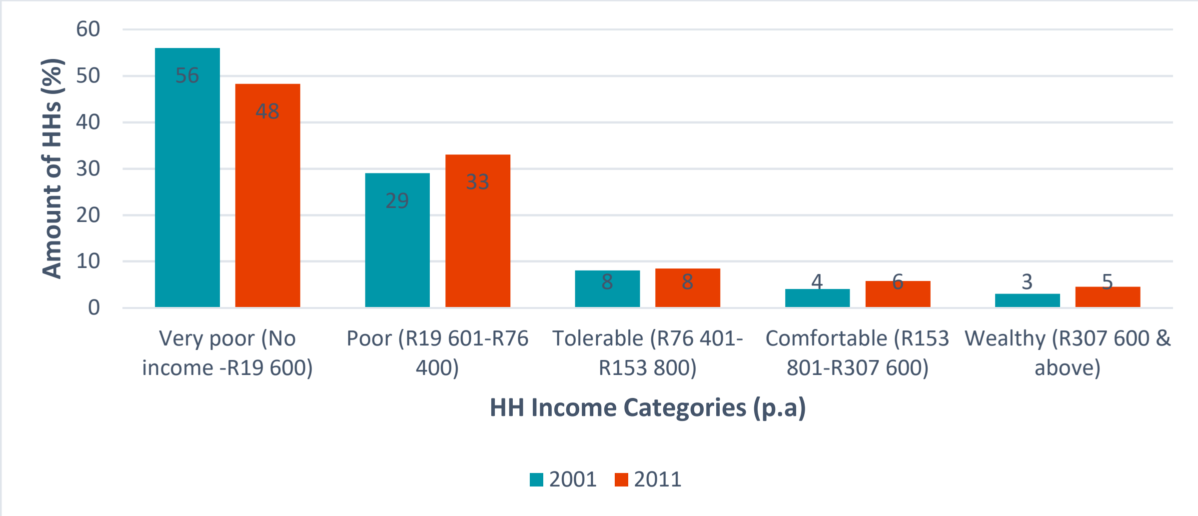


Figure 29: Comparison of income spread per household p.a. (Inflation included)
(Source: DWA, 2011 & Census 2011)

The stats from 2011, when analysed further shows that in terms of the internationally accepted poverty line of $1.25 per person per day, amassing to roughly R4562.5 p annum (R10*$1.25*365), taken at a steady R/$ exchange rate of around R10, means that 14% of the households in the ORC lived below the poverty line in 2011. (Poverty Profile of South Africa 2008/2009).

When looking at the income differences within the ORC, done at secondary catchment level, it becomes apparent that major differences exists. Figure 30 shows the difference between the wealthiest and poorest secondary catchments. The different income categories and the percentage of people (out of all the people in that secondary catchment) making up that category is shown. The wealthiest is the Upper Olifants whilst the poorest is the Middle Olifants. The large mining sector and industries around the Upper Olifants, produce a very high Wealthy household income class, as is clearly visible when looking at the graph below, with the other income categories being uniform. The Middle Olifants has a highly spread income system, but notably 81% of households have an income of ≤R76 800 p.a. It is also important to note that whilst being the poorest, it is also the most populous of the secondary catchments.

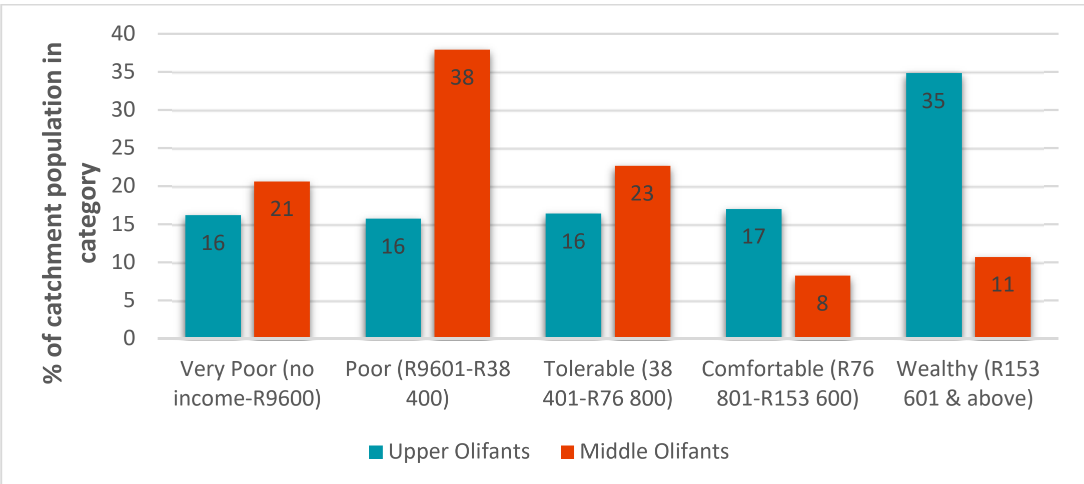


Figure 2. Income differences between Upper- & Middle- Olifants sub catchments (wealthiest & poorest)
(Source: Census 2011)

4.1.4 Grants

Grants were analysed because of its role as source of income for so many people. It is the safety net in place to make sure the most vulnerable groups of society do not succumb to absolute poverty.

For analysis of the grants system data from the StatsSA community survey of 2007 was used, as it was the most recent information available. Figure 31 is a pie chart showing that around 26% of the people in the ORC received grants in in 2007. This is in line with national statistics of South Africa for the same year, with 25.5% of people receiving grants on national (Source: Van der Berg, et al. 2010. Efficiency and equity effects of social grants in South Africa).

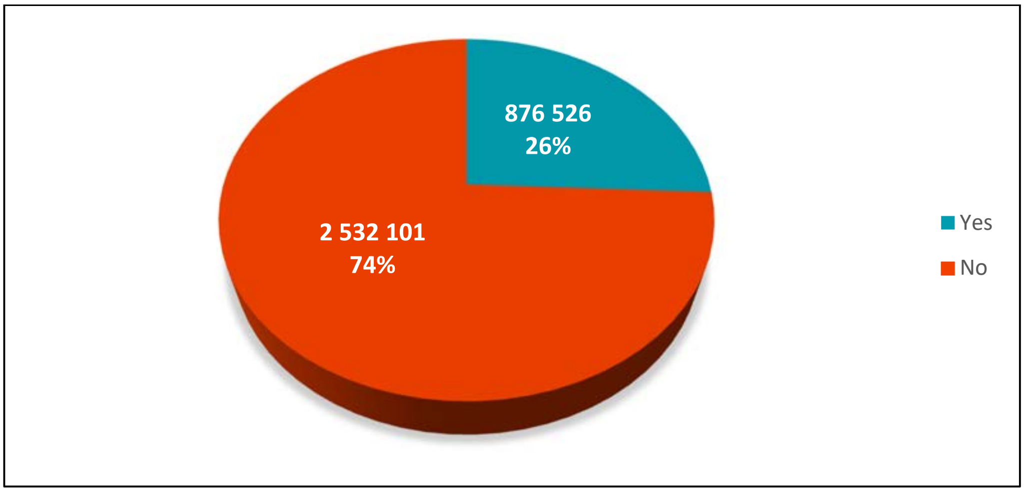


Figure 31: Olifants Catchment: Amount of population receiving grants vs not receiving grants (Source: StatsSA, Community Survey, 2007)

South Africa has a very prominent grants system, with about 12.4 million people receiving grants in 2008, a figure unmatched by any other developing country. Social assistance spending in South Africa, which amounted to 3.5 percent of the GDP in 2006, is even high when compared to the Western European welfare states of the 1980s. In 2006 the South African government's spending exceeded the GDPs of some 88 countries, including 3 other African states (Source: Van der Berg, et al. 2010. Efficiency and equity effects of social grants in South Africa).

The make-up of the grant types handed out in the ORC in 2007 can be viewed in Figure 32. It is clear that the dominant grant type handed out is for child support. According to the South African Social Security Agency (2013) the amount redeemable per child stands at R300, if all the guidelines for a valid claim (amongst others being an individual income of less than R34 800 per year for the caretaker) is met. The other most prominent grant claim in the ORC is old age pension, amounting to 21% of the total claims. Looking at the statistics, it is clear that the social grants support system is predominantly utilised by/for people of an economically inactive age.

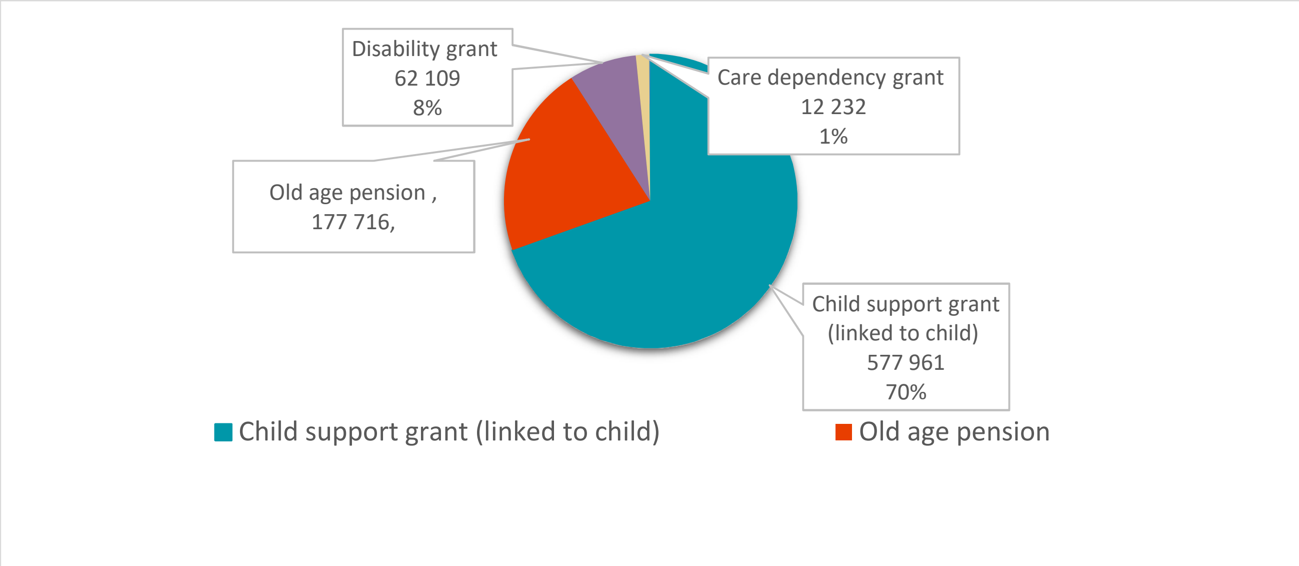


Figure 32: Olifants Catchment: Different Social Grants weighted according to make-up of total amount of grants handed out (Source: StatsSA, Community Survey, 2007)

Looking at the SERO Report of Mpumalanga for 2013, an interesting trend emerge showing that according to SASSA child support grants made up 67% of the provinces total grants hand outs in 2005, whilst in 2013 that figure increased to 75%. This whilst old age pension grants made up 21% in 2005, but decreased to making up only 16% of the same provinces' grant hand outs in 2013. These two jumps shows a prominent trend starting to develop, which might need further discussion.

To analyse trends over time further there was looked at information on provincial scale. Figure 33 illustrates the percentage share of the full amount of the South African government's expenditure on social grants. It shows the percentage per province of the total expenditure for 2005 and 2013 to help one understand the trends involved. The provinces of interest is Mpumalanga and Limpopo, and with the prior (MPL) over the time period 2005-2013 an increase in the weight of grants is seen, whilst in the latter (LP) a decrease is observed. The reasons for these decreases and increases is unknown, but a possibility is that during the time period the borders of these provinces shifted, with the Bushbuckridge area no longer being part of Limpopo, but rather falling within the boundaries of Mpumalanga.

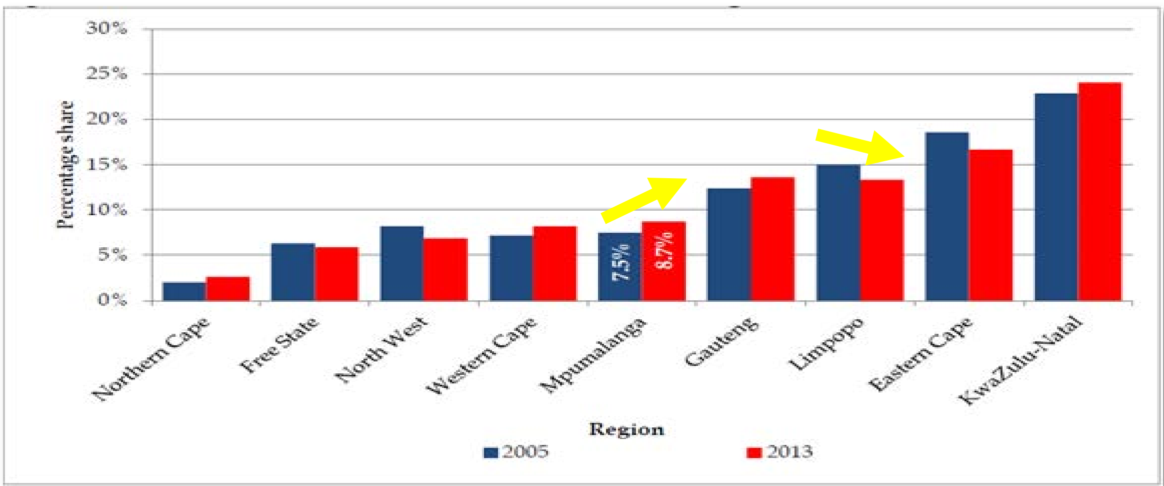


Figure 33: Percentage of grants (as total of SA) handed out per province, tracking the changes from 2005-2013 (Source: Mpumalanga Sero Report, 2013)

5 Economic overview

5.1 Economic overview of the Olifants Catchment in South Africa

5.1.1 Background

The Olifants river catchment (ORC) lies within 3 provinces, Limpopo, Mpumalanga and a small portion in Gauteng. Limpopo is one of the poorer, less developed of South Africa's provinces whilst Mpumalanga performs close to the South African standard for wealth, development and poverty. The ORC area within these three provinces, is a very diverse area. It contains some wealthy areas and also some of the poorest areas in South Africa. In general the level of development in the ORC follows the level of mineral resource availability.

The ORC annually contributes about 5% to the South African GDP. Below is a pie chart of the main contributors. Weighing this up against SA's GDP contributors for 2013 [Q1] (as can be seen in the Table 13), it is clear that for instance mining is a dominant factor in the ORC economy. One should also take note that the other two biggest contributors to the ORC's GDP make up, namely manufacturing and electricity generation are almost fully dependant on mining. Coal is the primary providers of fuel for these sectors, with the steel manufacturing industries and coal power stations around the Emalahleni area being dependant on it for cheap energy. Therefor it is clear that mining and particularly coal, is the backbone of the ORC economy.

TABLE 13: COMPARISON OF SA GDP PER SECTOR TO ORC

GDP CONTRIBUTION DIFFERENCES (%)	SA	ORC
MINING	5	22.1
MANUFACTURING	15	18.2
ELECTRICITY GENERATION	2	15.9
GOVERNMENT	14	15.6

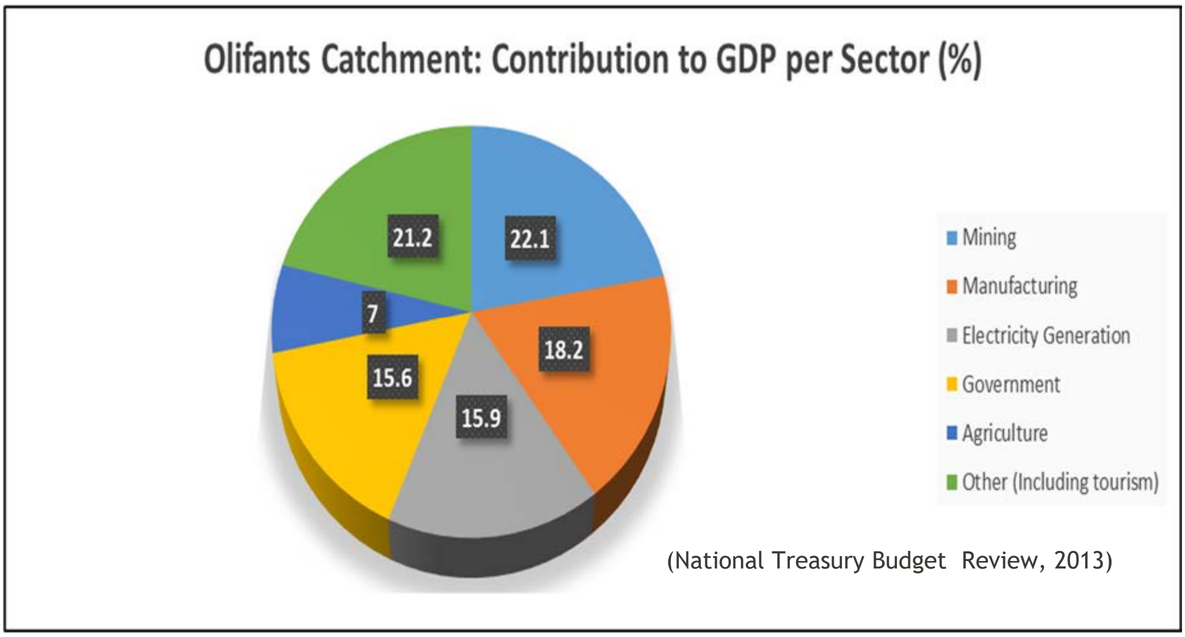


Figure 34: GDP contribution per sector in the ORC (%)(DWAF, 2004)

Defining the trade balance of the ORC was not possible due to lack of information, therefor looking at the Limpopo Treasury's SERO report of 2012, was seen as the best alternative. It is interesting to note that Limpopo has a huge positive trade balance. It is to be expected that the area has a lot of exports due to the mineral wealth of the area, as well as some commercial farming producing export market produce. The fact that this trade balance is disproportionate (with much more exports than imports) however leads to a belief that the money received from all the exports does not stay in the basin/Limpopo area, but gets moved elsewhere. Thus the wealth of the area is not spread amongst its inhabitants, otherwise imports would have been higher, as the area is definitely not able to internally produce all the products/services demanded by the area (Imports show purchasing power, thus the amount of money in the area).

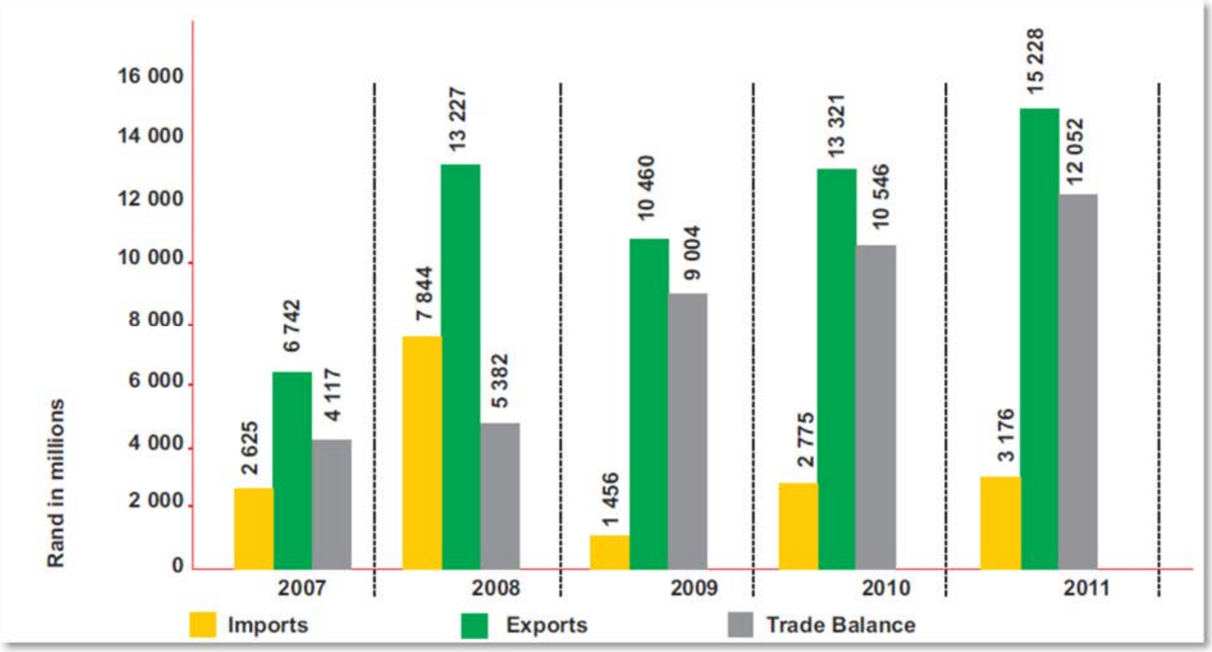


Figure 35:Imports/Exports for Limpopo Province for 2007-2011 (Limpopo SERO report, 2012)

5.1.2 Economic Scenario by Secondary Catchment

Upper Olifants (B1)

This secondary catchment is most developed of the ORC. This is primarily due to the extensive mining occurring in the area. Coal mining plays the biggest role, as it runs the local economy as primary energy source for the electricity energy production and steel industries of the area; as well as being exported via Richards Bay. The mining and industries are however likely to decline over time, with small declines already visible. Currently however this area remains the energy production hub of South Africa, with coal fuelling 6 large coal energy thermal plants providing an estimated 34% of ESKOM's total installed electricity production capacity (Jeffrey, 2005) & (DWA, 2009).

Within the catchment, there are five major coal companies (BHP Billiton, Anglo Coal, Exstrata, Exxaro and Optimum Coal) that produce the bulk of coal, with approximately 143,9 million tons of coal produced in 2010 (57% of total coal produced in SA that year) (DWA, 2011).

Other than mining and its associated industries acting as the primary drivers of this area, the most prominent economic development in the area is agriculture. This is mostly rain-fed/dry-land agriculture with some limited irrigation agriculture mostly from boreholes, with also some cattle grazing in the Hendrina area. As the mining sector slowly declines over the long term, agriculture is seen as one of the viable alternatives to keep the economy of this area going. Another possible driver of alternative economic growth is the Maputo Development Corridor (MDC) connecting Johannesburg to Maputo. This corridor runs through the heart of this catchment and provides a lot of potential for further development (DWA, 2009).

Wilge (B2)

The Wilge catchment is very similar to the Upper Olifants. The area however is less mined, as well as not having as big towns and industrial areas as the Upper Olifants. The predominant mining type still remains coal, that amongst others support one of the world's biggest coal run thermal power stations, Kendal, on the border between the Wilge and Upper Olifants. There is also in the area the proposed Kusile coal power station with an estimated 4800 MegaWatts, being built. Other economic activities include agriculture. The area produces high yields due to the favourable soil types, climate and rainfall of the area. Maize is the dominant dry-land agriculture types, with boreholes mostly providing for some irrigated agriculture to the west of the catchment. The WIlge also contains the MDC, which can economically be exploited (DWA, 2011).

Elands (B3)

The Elands catchment area is quite rural, mostly due to the Springbokvlakte area to the north of the catchment, a sparsely populated area that does not contain any primary resources, with minimal mining in the area, as well as agriculture being limited to rain fed crops such as maize and sunflower in a drought prone area. The main economic activities in the area is irrigated agriculture (IWMI, 2008). There is an extensive irrigation scheme in the Groblersdal, Marble Hall area, which is the largest in the ORC. The irrigation scheme is mostly focus on high value crops, such as citrus and table grapes for export. Combined with this, the area also has some food processing plants. To the north east of Marble Hall there is also a small area where marble and limestone is mined (DWA, 2011).

Steelpoort (B4)

The Steelpoort catchment area has high potential for nature-based tourism. The scenic natural beauty of the area, the low human population and its relatively undeveloped state acts as a great lure for tourists visiting this area. Along with that the close proximity of this area to the large urban centres of Johannebsurg and Pretoria provide a big supply of tourists. This creates a highly favourable and marketable scenario for tourism in the area. The best example of this is the town of Dullstroom, with several tourist activities such as trout fishing and numerous restaurants, this town has fully built its economy around tourism (DWAF 2005). There is limited agriculture in the area with some dry land agriculture and cattle farming occurring in the area.

Mining is largely underdeveloped in the area, with some scattered mines across the area. To the north east of the catchment lies the Dilokong Corridor, sweeping up from north of Lydenburg, past Steelpoort and Burgersford, extending further into the Middle Olifants catchment. This area will in future, if the value of platinum (the principal mineral found in this corridor) increases and water licenses are made available, become highly developed. Currently the area is already growing faster than its infrastructure is developed, providing valuable job opportunities for the impoverished people of the area (DWA, 2011).

Middle Olifants (B5)

The single most important historical driver influencing this area is the fact that it was a homeland during the Apartheid regime. This forced massive numbers of people into the area, without introducing the concurrent development needed. This creates a scenario today that sees the catchment as the poorest, and also most populous area in the ORC.

The area also is not richly endowed with a lot of resources. The area is very rural with subsistence, rain fed agriculture being dominant in the area. This has however caused the land to become quite degraded decreasing productivity over time. The area has some tourism potential, with the main attraction being the Sekhukhuneland Centre of Endemism and several cultural heritage sites around the area. These areas are under threat though due to the Dilokong platinum corridor extending up from Steelpoort into the south east of the catchment. This brings with it mining and industry, that although demoting a more sustainable and environmentally friendly source of income, namely tourism, would promote a more aggressive economic growth route that will help decrease large levels of unemployment and poverty a lot faster than tourism promotion could. This catchment will thus likely see even more large development in the Dilokong corridor area in the near future if favourable markets allow for mining investments. (DWA, 2011) & (CSIR, 2003).

Blyde (B6)

The Blyde catchment is quite diverse in its economic exploits. It is not dominated by any certain type of economic activity, rather having a smaller scaled wide array of activities happening. The area is seen as a tourism hotspot, with the Blyde River Canyon and escarpment area, as well as the area extending into the Lowveld, acting as ecotourism attraction whilst the Pilgrim's Rest area acts as a cultural/heritage tourism area. Mining in the area is limited, but still annually employs about a couple of hundred, individuals in the catchment (DWAF 2005). Agriculture, is marginally the biggest driver of this area's economy. There is some subsistence farming, as well as two irrigation schemes providing water for commercial farmers in the area. The one scheme is based around the Ohrigstad River, producing mostly maize, and also some tobacco and fruits. A larger scheme lies downstream, in the Lowveld close to where the Blyde meets up with the Olifants. This highly commercial farming based area focusses on producing export crop, especially fruit such as papaya and mango. The final leg in the Blyde economy is the large commercial forestry industry found around its southern region, all around the escarpment. This is by far the biggest forestry area in the whole of the ORC, estimated to cover an area of about 220km^2 (IWMI, 2008).

Lower Olifants (B7)

The Lower Olifants has an economy dominated by tourism. The KNP, with its adjacent wildlife reserves (Timbavati, Klaserie, Balule, Umbaba and others covering almost 250 000ha) covers the most of the eastern and southern sections of the catchment (DWAF 2005).The southern part of this catchment is thus highly focussed on tourism, whilst to the north near Phalaborwa there is also extensive mining, mostly of copper, occurring. Mining in this area is however declining, and there should be focussed on promoting other economic drivers like tourism. To the east of Phalaborwa, around the Ga-Selati dam occurs some commercial irrigated agriculture, helping to diversify the economy. Combined with this, there also some food processing industry in the area. The mining and farming around the Ga-Selati however puts severe pressure on the river (IWMI, 2008).

5.2 Economic overview of the Olifants Catchment in Mozambique

The analysis of Mozambique will occur on a national level first, just as an overview of the macro economic scenarios shaping the current economy of Mozambique. Thereafter there will be looked at the largest districts present in the ORC in Mozambique, because spatially that is the only way to bind the area.

5.2.1 Background

Mozambique is a country crippled by its past. It is a third world country with very limited development due to events like the civil war that was ongoing in the country from 1977 to 1992, a fifteen year struggle between the FRELIMO, the reigning government, and the RENAMO faction. This civil war hampered development and increased foreign dept. In the war the need to protect certain areas was met with landmines. Destruction of infrastructure was also rife as these factions tried to cripple each other. All these factors led to most importantly, huge amounts of damage to the people through injuries and deaths because of mines, limiting the workforce and increasing independence of households on bread winners. It also caused the destruction of infrastructure limiting economic progression through limiting investment and exports whilst increasing imports. (Phiri, 2012) & (Igrera, 2010).

The takeover of Chissano from Machel in 1986 (both FRELIMO) who passed away in an aeroplane crash meant a move away from a Marxist to a capitalist system. In 1990 a new constitution was also enacted, as well as the war ending in 1992, with the first democratic election in 1994. This combination of factors, with specific emphasise on the 1992 constitution promoting open free-market economics, meant foreign investment was not only finally made possible, but also attractive for the outside world (IMF Country Focus, 2006).

The development of Mozambique is thus steadily happening, with one of the fastest growing economies in Africa, since 1992. It is estimated that GDP growth since 1992 lies steady at over 7.5%. This is due to the untapped natural resource bases that are finally starting to get exploited. Some of these resources include: 36 million hectares of fertile land (of which by 2012 90% was still uncultivated); 2,470 km long coastline offering opportunities for fisheries and tourism; and mineral- (mostly heavy mineral sands) and coal- resources in the north of the country, as well as offshore gas. (Mozambique UNDAF 2012-2015) & (Dept of Foreign Affairs, Trade and Development Canada; 2013)

Mozambique however remains a very poor country, with the above mentioned growth often being inequitable. An example thereof is the fact that according to the 2010 Human Development Report Mozambique ranked 165th out of 169 countries (Mozambique UNDAF 2012-2015).

Government currently plays its part in the promotion of a more equal society, combined with economic development via its Poverty Reduction Action Plan. It was launched in 2011 and will run to an end this year.

Statistics on how successful this initiative is, are yet to be quantified, but its main aim was stated as being the following:

> *"...To reduce the incidence of poverty from 54.7 percent in 2009 to 42 percent in 2014, with a deliberate decision that government action must first of all promote "pro-poor" growth. In the Mozambique context, this "broad-based" growth can be achieved through investment in agriculture of the kind that will boost the productivity of the family sector and diversify the economy, supporting micro, small and medium- sized enterprises, and fostering human and social development. Such economic growth will simultaneously reduce food insecurity and chronic child malnutrition, while strengthening defence mechanisms against endemic diseases such as HIV/AIDS, tuberculosis and malaria."*
>
> (PARP 2011-2014)

The other most prominent hamper on growth in Mozambique is that it is prone to natural disasters. The Atlas report states that, "Mozambique has suffered from 53 natural disasters in the past 45 years, an average of 1.17 disasters per year." The best example of this is the 2000 floods that displaced more than 500 000 people, as well as causing damages estimated at U$600 million (Atlas report).

The ORC area however do have limited natural resources. The predominant resources in the ORC area in Mozambique is arable land combined with a decent supply of water, promoting agriculture as main economic driver. At the coast, as well as the most western part of the Mozambique ORC has a lot of tourism potential. The west because of the GLTFA and the east because of a scenic coastline (Atlas report).

It is important to note that in general as a rule of thumb Mozambique as a country shows a tendency to be get more developed from West to East as well as from North to South, with the Maputo area being the economic hub of the country. There has however recently been some possibilities of large scale mining taking off to the north, which might change this over time.

5.2.2 Economic Scenario by District

Massingir

- Poverty Rate: ±65%
- Unemployment: ±26%
- Economic Dependency Rate: 01:1.2 (Quantified as for every 10 children or elders there are 12 people of working age)

Massingir is a Posto (District) in the west. It, is as most of Mozambique, is highly underdeveloped. It is also the least populous of the districts discussed. This is mostly due to the limited agricultural ability of the area, caused by irregular rainfall and limited arable land. The economy however is still mainly run on subsistence farming. This primary way of survival for locals is supplemented by hunting and some limited fishing exploits on the Massingir dam, with industry and markets being absent but for some craft and wood (primary fuel source) sales. In terms of commercial farming the area would be most suited to some limited forestry and large-scale livestock farming if diseases could be eliminated. This area also have some eco-tourism potential due to the GLTFCA and Massingir dam in the area (Profile of Massingir District, Republic of Mozambique, 2005). Tourism is also seen as one of the biggest potentials for this area by government, with the national government website emphasising the Masingir area as one of 18 priority areas for tourism investment (Government of Mozambique website, 2006).

Chokwe

- Poverty Rate: ±60%
- Economic Dependency Rate: 01:1.3

To the East of Massingir lies Chokwe, where the Olifants and Limpopo come together creating large, highly fertile alluvial plains. To this end an extensive irrigation network called the Chokwe Irrigation Scheme was developed, that contains nearly 40% of the total irrigated land in Mozambique. This area has great economic potential due to the irrigation scheme, it is however currently struggling due to extensive damages caused by the 2000 floods combined with limited upkeep laying the scheme to ruins. The scheme covers 33,000 hectares, but only 7,000 were under cultivation, mostly by rice producers, back in 2010. The area has recently been quoted as a focus area for repairs by government, as well as its potential being noticed by large scale commercial farmers (Government of Mozambique website, 2006). This means that in the near future this area will most likely see exponential development, with especially sugar cane being seen as a low input/high output product fit for this area by large corporations. The effect of this downstream may however be detrimental as overconsumption of water resources may be an issue with limited water quota and monitoring systems.

Chokwe is home to the second biggest urban area in the Mozambique ORC, also named Chokwe. It had a population estimated at 63,695 during the National Census of 2007, with a population density of 1200 people/km^2. The Chokwe area is primarily driven by informal agriculture in terms of the economy, with limited excess being sold to adjacent markets such as BIlene and Xai Xai. The urban area also contains some industrial infrastructure serving the agricultural based economy with for instance a tomato processing and canning plant, as well as a cotton processing factory. There is also present some commercial farmers in the area producing amongst other cane sugar, cashew nuts and tobacco area (Profile of Chokwe District, Republic of Mozambique, 2005).

The area is economically buoyed by some NGOs in the area providing farming initiation schemes and the International Bank of Mozambique running a credit system in promotion of farming activities. The small surplus produced by the informal farmers, combined with limited transport, storage capacity and access to markets, however creates an unconducive business environment (Hearn & Piesse, 2010).

Bilene

- Poverty Rate: ±60%
- Unemployment rate: ±22%
- Economic Dependency Rate: 01:1.3

The Bilene district lies in between Chokwe (to the west) and Xai Xai (to the East). Similarly to the other districts the predominant economic activity is agriculture. This area however also suffered immensely from the 2000 floods, destroying the vast majority of agricultural standings in the area and affecting about a quarter of the population. The subsistence farming communities have recovered though and plant mostly cassava, maize, beans, rice and vegetables. There is also some commercial farming in the area, mostly focussing on sugar cane and cashew nuts (Profile of Bilene District, Republic of Mozambique, 2005).

The area also benefits from its proximity to Xai Xai, thus having access to markets, for wood, reed and coal sales acting as commercial alternative to agriculture. This however tends to exaggerate issues of deforestation in the district. There is also some industry in the area with small-scale mining of clay pits and a heavy sands project in Chibuto, one of Bilene's postos; as well as some food processing units in the vicinity, the most prominent one being a cashew nut factory able to process about 3000 tons of nuts a year (Profile of Bilene District, Republic of Mozambique, 2005).

Xai Xai

- Economic Dependency Rate: 01:1.3

Xai Xai is the most developed and populous area in the Mozambique side of the ORC with a population density of 110.6 inhabitants per km^2. It contains Cidade de Xai Xai, the biggest urban area in the Mozambique ORC urban area with a population of 127 366 people according to the National Census of 2007. It is part of a well-developed and connected network with good infrastructure, telecommunications and a prominent road system running through it, with the main transport artery of the country (the EN1) running from Maputo in the south to the north of the country. This allows for better access to markets, thus abating one of the biggest problems for economic development in the Mozambique ORC. This access to markets are clear with the primary economic activity of agriculture being by far the smallest out of all the districts looked at. Land conflicts tend to be rife in the area due to the high population density, combined with agriculture still being the main source of survival for most in the Xai Xai area. The biggest other primary economic activity is trade. There is in terms of industry, some food processing plants in the area, as well as fishing being a replacement for agriculture, with less arable land available. Cidade de Xai Xai is also a services hotspot, with governmental offices as well several companies' district offices (Profile of Xai Xai District, Republic of Mozambique, 2005). The Xai Xai district is also a hotspot for social and community upliftment programmes with various NGOs and government programmes active in this area (PARP 2011-2014). Tourism is also quite prominent in the area, with a picturesque 80km coastline. It is also seen as one of the biggest potentials for this area, with the national government website emphasising the Xai Xai coastal area as one of 18 priority areas for tourism investment in Mozambique (Government of Mozambique website, 2006).

5.2.3 Conclusion

As was shown in the above assessment by district, it is clear that the Mozambique ORC section is highly dependent on its primary economic activity, agriculture, predominantly practiced at subsistence farming level. This creates an area quite vulnerable to frequent occurring natural disasters such as floods and drought. It is clear that that government does not have the funds available to create a resistant form of infrastructure development, with for example the Chokwe Irrigation System, mostly still lying in ruins, about 14 years after the destructive 2000 floods. It is clear however that the people, although very vulnerable due to their dependency on the environment, have become quite resilient to these effects through their subsistence farming systems which can recover quite quickly.

In conclusion it must be stated that an in the study and in depth understanding of the functioning of the Mozambique economy was done in a limited way due to lack of information firstly, and secondly the language barrier existing, especially when looking at statistics and governmental reports as most of these are done in Portuguese.

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7 Appendices

7.1 Appendix 1: Geological terms

Schist is a group of medium-grade metamorphic rocks, chiefly notable for the preponderance of lamellar minerals such as micas, chlorite, talc, hornblende, graphite, and others. By definition, schist contains more than 50% platy and elongated minerals, often finely interleaved with quartz and feldspar. Schist is often garnetiferous.

Phyllites are types of type of foliated metamorphic rocks primarily composed of quartz, sericite mica, and chlorite; the rock represents a gradiation in the degree of metamorphism between slate and mica schist. Minute crystals of graphite, sericite, or chlorite impart a silky, sometimes golden sheen to the surfaces of cleavage (or schistosity). Phylite is formed from the continued metamorphism of slate.

Ironstone is a fine-grained, heavy and compact sedimentary rock. Its main components are the carbonate or oxide of iron, clay and/or sand. It can be thought of as a concretionary form of siderite. Ironstone also contains clay, and sometimes calcite and quartz.

Conglomerate rocks are sedimentary rocks. They are made up of large sediments like sand and pebbles. The sediment is so large that pressure alone cannot hold the rock together; it is also cemented together with dissolved minerals.

Limestone is a sedimentary rock composed largely of the mineral calcite (calcium carbonate: $CaCO3$). The deposition of limestone strata is often a by-product and indicator of biological activity in the geologic record. Calcium (along with nitrogen, phosphorus, and potassium) is a key mineral to plant nutrition: soils overlying limestone bedrock tend to be pre-fertilized with calcium.

Amphibolite is a grouping of metamorphic rocks composed mainly of amphibole (as hornblende) and plagioclase feldspars, with little or no quartz. It is typically dark-colored and heavy, with a weakly foliated or schistose (flaky) structure. The small flakes of black and white in the rock often give it a salt-and-pepper appearance.

Lava is molten rock expelled by a volcano during an eruption. When first expelled from a volcanic vent, it is a liquid at temperatures from 700 °C to 1,200 °C (1,300 °F to 2,200 °F). Although lava is quite viscous, with about 100,000 times the viscosity of water, it can flow great distances before cooling and solidifying, because of its thixotropic and shear thinning properties.

Quartzite is a hard metamorphic rock which was originally sandstone. Sandstone is converted into quartzite through heating and pressure usually related to tectonic compression within orogenic belts. Pure quartzite is usually white to grey, though quartzites often occur in various shades of pink and red due to varying amounts of iron oxide ($Fe2O3$). Other colors are commonly due to impurities of minor amounts of other minerals.

Shale is a fine-grained sedimentary rock whose original constituents were clay minerals or muds. It is characterized by thin laminae breaking with an irregular curving fracture, often splintery and usually parallel to the often-indistinguishable bedding plane. This property is called fissility and where it is not present the rocks are called mudstones or siltstones. Shale is the most common sedimentary rock.

Plateau is an area of highland, usually consisting of relatively flat terrain

7.2 Appendix 2: Description of geological rocks

Sedimentary rock is formed from grains and fragments of weathered rock that are deposited layer upon layer. This deposition usually happens in large bodies of water. The layers exert increasing pressure until the fragments of rock are compressed and cemented together to form solid rock. Organic and chemical deposits may occur in sedimentary rock.

Igneous rock is formed when molten rock or magma reaches the earth's surface, erupting as lava from volcanoes. When lava cools down, it solidifies to form lava flows. Alternatively, magma may cool down and solidify before it has reached the surface. This forms igneous intrusions surrounded by pre-existing rocks. Igneous intrusions are only exposed if erosion strips off the overlying rocks.

Metamorphic rocks are formed deep below the earth's surface, when existing rocks are altered and take on new characteristics. Thermal metamorphism occurs when heat given off by igneous intrusions alters the surrounding rock. Regional metamorphism is when structural deformation occurs, for example during the formation of mountains. The last type of metamorphism, dislocation metamorphism, affects rocks lying adjacent to fault planes.

The Association for Water and Rural Development

AWARD is a non-profit organisation specialising in participatory, research-based project implementation. Their work addresses issues of sustainability, inequity and poverty by building natural-resource management competence and supporting sustainable livelihoods. One of their current projects, supported by USAID, focuses on the Olifants River and the way in which people living in South Africa and Mozambique depend on the Olifants and its contributing waterways. It aims to improve water security and resource management in support of the healthy ecosystems to sustain livelihoods and resilient economic development in the catchment.

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USAID: RESILIM-O focuses on the Olifants River Basin and the way in which people living in South Africa and Mozambique depend on the Olifants and its contributing waterways. It aims to improve water security and resource management in support of the healthy ecosystems that support livelihoods and resilient economic development in the catchment. The 5-year programme, involving the South African and Mozambican portions of the Olifants catchment, is being implemented by the Association for Water and Rural Development (AWARD) and is funded by USAID Southern Africa.

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