Information Sheet on Ramsar Wetlands (RIS)

Categories approved by Recommendation 4.7, as amended by Resolution VIII.13 of the Conference of the Contracting Parties.

Note for compilers:
1. The RIS should be completed in accordance with the attached *Explanatory Notes and Guidelines for completing the Information Sheet on Ramsar Wetlands*. Compilers are strongly advised to read this guidance before filling in the RIS.

2. Once completed, the RIS (and accompanying map(s)) should be submitted to the Ramsar Bureau. Compilers are strongly urged to provide an electronic (MS Word) copy of the RIS and, where possible, digital copies of maps.

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1. Name and address of the compiler of this form:

FOR OFFICE USE ONLY.

DD MM YY

Designation date | Site Reference Number

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2. Date this sheet was completed/updated:

Originally completed: August 2004
Updated: February 2017

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3. Country:

South Africa

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4. Name of the Ramsar site:

Makuleke Wetlands

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5. Map of site included:
Refer to Annex III of the *Explanatory Note and Guidelines*, for detailed guidance on provision of suitable maps.

a) hard copy (required for inclusion of site in the Ramsar List): *yes* □ -or- *no* □

b) digital (electronic) format (optional): yes □ -or- *no* □

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6. Geographical coordinates (latitude/longitude):

S 31^0 06' E 22^0 34' S 31^0 31' E 22^0 42'
S 31^0 05' E 22^0 36' S 31^0 22' E 22^0 43'

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7. General location:
Include in which part of the country and which large administrative region(s), and the location of the nearest large town.

The area is situated in the northeastern corner of South Africa, in the Limpopo Province. The wetland is bordered by Zimbabwe to the north and Mozambique to the east. The site is mostly located within the borders of the Kruger National Park, with only a small section of the Limpopo floodplain located in the Makuleke's portion of the Makuleke Property Area outside the Park's western border (Banyini Pan). The nearest town is Thohoyandou, approximately 64 km to the southwest.

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8. Elevation: (average and/or max. & min.)

9. Area: (in hectares)

Ramsar site area: 7756 .98 ha. This comprises the following:
i. area of the pans in the Kruger National Park - 346.19 ha

(ii) Makuleke – floodplains of the Limpopo and Luvuvhu Rivers - 7409.98 ha

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10. Overview:
Provide a short paragraph giving a summary description of the principal ecological characteristics and importance of the wetland.

This wetland, which is also referred to as a floodplain vlei, comprises a number of landscape features that include riverine forest, riparian floodplain forest, floodplain grassland, river channels and pans. The riverine forest is mostly confined to the banks of the Limpopo and Luvuvhu Rivers, and consists of large, broad canopied trees over 20m in height. This is a very important habitat for a large variety of organisms that are dependant on this riparian zone in this dry landscape. Riparian floodplain woodlands comprising ana trees and fever trees occur on waterlogged clays. In addition, floodplain grasslands communities occur on both the Limpopo and Luvuvhu floodplains (Venter, 1990). Thirty-one seasonally flooded pans are found in the floodplain. They provide important breeding and feeding habitats for a variety of

animals and birds. The pans of the Limpopo River floodplain hold water well into the dry season, thereby creating important refuge areas for wildlife during the drier winter months. They also provide an important waterbird habitat during both summer and winter months in wet years and serve as a stopover for many migratory waterbirds. The Limpopo River is typically characterised by having a prominent levee on both banks. The floodplain forms depressions in places (pans), which are intermittently filled during flooding of the Limpopo River. Examples of these pans include Makwadzi and Manxeba, which are characterised by prominent floodplain vegetation, particularly emergent aquatic macrophytes. Mapimbi pan on the other hand appears to receive seepage water from Limpopo River and it is speculated that its hydrology may be related to fluctuations in the water table. The subsurface connection appears to be most evident when the river is full. It appears to receive surface water earlier during floods than the other floodplain pans, which fill predominantly from overtopping of the levee. The northern bank of the Luvuvhu River, on the other hand, shows no evidence of a prominent levee. As a result, Mabvubvanye pan, which occurs in this area, is shallower, has a more accessible connection to the river, and is flooded more regularly than those on the Limpopo floodplain. Another floodplain pan is Hapi, which occurs south of the Luvuvhu River in a depression running parallel to the river. During high flows (floods), the Luvuvhu River overflows its banks at the old Bobomene research station and campsite, where flow is obstructed by the low water approach to the Luvuvhu Bridge.
All of the above-mentioned pans, but especially Hapi, Makwadzi, Mapimbi and Mabvubvanye have substantial catchment areas and drainage lines of their own and may also fill completely as a result of runoff from these areas during normal rainfall years.

The Banyini pan is the largest covering an area of 162 hectares with an 8 km perimeter in the newly declared area incorporated into the Makuleke area.

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11. Ramsar Criteria:
Circle or underline each Criterion applied to the designation of the Ramsar site. See Annex II of the *Explanatory Notes and Guidelines* for the Criteria and guidelines for their application (adopted by Resolution VII.11).

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12. Justification for the application of each Criterion listed in 11. above:
Provide justification for each Criterion in turn, clearly identifying to which Criterion the justification applies (see Annex II for guidance on acceptable forms of justification).

Criteria for representative or unique wetlands

Criterion 1: **A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.**

- Motivation: The wetland is an excellent example of a floodplain type characteristic of the northern part of South Africa and the eastern part of Mozambique. Although the flow in the Luvuvhu and Limpopo rivers has

been reduced by human needs (24% in the Luvuvhu River) the floodplains are relatively unaffected by other human influences.

General criteria based on plants and animals

- Criterion 2: **A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.**

  - Motivation: Relevant to the Ramsar site or parts of the site only: Many rare mammals, reptiles, amphibians and birds that occur here are at some stage associated or dependent on the wetland. The rare samango monkey, four toed elephant-shrew and African civet occur in the riparian areas along the Luvuvhu and Limpopo Rivers.

    High densities of Nyala occur here as well as the last remaining herd of Hippopotamus east of Beit Bridge on the Limpopo River in South Africa are found at Makwadzi pan. The area have a few scarce nesting records for waterbirds in South Africa, such as the black, yellowbilled, marabou and openbilled storks, and three banded courser are from this site. Other rare bird species such as pygmy goose, white crowned plover, and nesting white backed vultures occur here, while the highest densities of Pel's Fishing owl in South Africa are found in the Luvuvhu River valley. The Böhm's and mottled spinetails, which are rare in South Africa, occur along the lower reaches of the Ramsar site. Three rare fish species occur in the Luvuvhu River. The Nile crocodile and African python, which are both regarded as vulnerable also occur here. This area also represent the south-western limits of the range of distribution of the Golden Spiny Reed Frog *Afrixalus brachycnemis brachycemis* (Boulenger), and the Dune Squeaker *Artholeptis stenodactylus* Pféffer, and in most instances, are the only records of their presence within the borders of Limpopo Province.

- Criterion 3: **A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.**

  - Motivation: The wetland system supports a high diversity of species, some of which have their centres of distribution in the area. Others have only been recorded from this area and

it is therefore possible that they are confined to this area.

- Criterion 7: **A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.**

    - Motivation: The wetland acts an important refuge for breeding stocks of fish which recolonise the floodplain by migrating upstream during flooding events. Stocks for the river are protected within the reserve. The reserve also provides an important stopover and breeding and feeding site for migrating waterbirds along the north/south migration route in the eastern part of southern Africa.

    - Motivation: The Ramsar wetland site has exceptional ecological features that are unique for South Africa as a country. A number of species occur here and nowhere else in the country. Bats like Rüppels bat, Swinny's horseshoe bat, the Madagascar large free-tailed bat and Commerson's leaf-nosed bat are only known in the country from specimens collected in the areas adjacent to, and constituting, the Ramsar site.

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13. Biogeography (required when Criteria 1 and/or 3 and /or certain applications of Criterion 2 are applied to the designation):
Name the relevant biogeographic region that includes the Ramsar site, and identify the biogeographic regionalisation system that has been applied.

a) biogeographic region: Limpopo plain

b) biogeographic regionalisation scheme (include reference citation): Preliminary Level I River Ecoregion Classification System for South Africa.

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14. Physical features of the site:
Describe, as appropriate, the geology, geomorphology; origins - natural or artificial; hydrology; soil type; water quality; water depth, water permanence; fluctuations in water level; tidal variations; downstream area; general climate, etc.

Geology and geomorphology

The northern sector of the Kruger National Park is known as the Punda Maria-Pafuri-Wambiya area. It is approximately 1830 km^2 in extent and is bordered to the north by the Limpopo River. It lies between 70 and 130 km north of the tropic of Capricorn. No other area of equivalent biogeographic importance in the South Africa lies wholly within the tropics. The high biodiversity of the Punda Maria-Pafuri-Wambiya area can be attributed to its geographic location and diversity of landscape features (Tinley, 1978).

Nine geological features with contrasting rock types are responsible for the intrinsic heterogeneity of this junction area (Venter, 1990). The main rock types occurring in the area are quartzite, sandstone, mudstone, shale and basic lavas (Waterberg, Stormberg and Karoo sedimentary rocks and lavas). The marls, ferricrete, calcrete and unconsolidated sand and boulder beds towards the east were formed along the inland edge of the sediments which make up the Mozambique Plain. To the north, at the confluence of the Luvuvhu and Limpopo Rivers, extensive areas of floodplain alluvium occur. The area is characterised by flat to slightly undulating and concave land. The area along the Limpopo River is characterised by a well-developed levee and adjacent floodplains. Small, rounded, basaltic koppies sporadically protrude through the alluvium, and some of them (e.g. Timhisi) are capped by well-rounded, quartzitic boulders and cobblestones.

After cutting spectacular gorges through the cave sandstones of the Luvuvhu and Lanner Gorges (Venter, 1991), the Luvuvhu River exits abruptly from the Lanner gorge and flows onto a broad alluvial deposit which stretches north-east all the way to its confluence with the Limpopo River (Heritage, 1994). The confluence is about 190 m above sea level.

The Luvuvhu River differs from the other rivers draining the northeastern escarpment of South Africa because of the succession of rock types over which it flows (Tinley, 1978). This geological succession comprises quartzite and sandstone of the Soutpansberg Group on the western side, followed by sedimentary rocks of the Karoo sequence in the central area of the river (Madzaringwe vicinity) and basalt on the eastern side. The valley of the Luvuvhu River is usually steep and narrow where the river has incised into the resistant quartzite and sandstones as opposed to the relatively shallow and wide valley where the softer rocks like shale and basalt cross. As the river exits Lanner Gorge, much of the sediment load of the Luvuvhu River is deposited, forming the floodplain alluvium that underlies most of the Luvuvhu section of the Ramsar site. Here the altitude seldom varies by more than 50 metres (Venter, 1990).

Bordering on the Limpopo River and to the west of the Kruger National Park lies the Makuleke Property. The main rock types occurring in this area are gneisses, schist calc-silicate rocks, marble and metaquartzite of the Limpopo Metamorphic Complex. In the Mabiligwe area, undifferentiated volcanic rocks of the Karoo Super Group predominate. Less frequent occurrences (for example, around the Makuleke area) of red and pink conglomerates and sandstones of the Malvernia Formation are evident in the outcrops. Conglomerates, sandstones, shales and tuff of the Soutpansberg Group and Mabiligwe Formation also occur in this region. A major fault occurs in the area, namely the Bosbokspruit fault, which is suspected to have displaced the Limpopo River northwards over the last 180 million years. Between 140 and 180 million years ago, numerous kimberlite pipes intruded into this catchment area.

The topography is mostly undulating and incised by annual streams running northwards into the Limpopo River. The altitude varies from just below 240 m above mean sea level at Banyini pan to 531,9 m at the beacon on top of the highest hill in the Makuleke Property. The Bosbokspruit fault has caused a noticeable change in the topography, which drops about 3 m from north to south across the fault.

Origins

The floodplains and pans of the Limpopo and Luvuvhu Rivers have developed as natural features in the ancient river courses (Tinley, 1978).

Hydrology

The Luvuvhu and Limpopo Rivers and their tributaries drain the Pafuri area in the Kruger National Park. As a result of resistance to weathering by the underlying geology, as well the erosive actions of the Luvuvhu River and its tributaries, the area is characterised and somewhat contrasted by high relief and steep gorges. Downstream of Lanner Gorge, the Luvuvhu River opens up to form a wide floodplain with several major ephemeral pans (Tinley, 1978). The Luvuvhu River with its deep hippo pools used to be perennial but recently agricultural, forestry and mining development upstream of the Kruger National Park caused the river to stop flowing regularly during the winter months. However, increasingly the Nandoni dam at Thohoyandou is being used to augment interim environmental flow requirements toward the KNP, which should alleviate this problem.

The Limpopo River is a seasonal river, characterised by a wide, sandy riverbed with several large pans on its floodplain. During summer months, when there is flow in the river, it can be a kilometre or so wide and spill over its banks to fill large pans on the floodplain.

The mean annual runoff (MAR) from the catchment of the Luvuvhu River (including the Mutale River tributary) for the undeveloped (virgin) condition is estimated to be 584 million m^3/a, although under present catchment conditions this is 446 million m^3/a (Bailey & Pitman, 2015). Runoff is unevenly distributed varying from 3% of mean annual precipitation (MAP) in the drier area of the catchment to 38% of MAP in the wetter areas along the Soutpansberg mountain range to the west. Some 38% of the total runoff is produced from 9% of the catchment. Both the Limpopo and Luvuvhu Rivers show high seasonal flow variation and upstream water abstraction occurs to various degrees. The trend is is for abstraction demands to increase within the catchment but also through inter-basin transfers to larger municipal areas outside of the catchment.

The floodplain pans and underlying aquifer play an important role in providing ground and seepage water downstream, thereby maintaining the extensive riparian forests that are so prominent in the area. The Pafuri floodplain pans fill or are fed during three main events. The majority of pans have large enough individual catchment areas to fill during heavy local rain showers or high floods. It is also likely that there is groundwater seepage into pans closest to the rivers (especially pans on the Limpopo River) when the is a high water table gradient from the Limpopo river (Van der Waal, 1996).

The types of floods in the Luvuvhu River

Two types of floods have been identified in the Luvuvhu River (Bruwer, 1987). The first of these are high floods that overtop the banks of the river after it exits Lanner

Gorge into the Pafuri floodplain area. Others are smaller floods of the lower floodplain when the river overtops its banks at the Luvuvhu/Limpopo confluence as a result of backflooding of the Limpopo River during flood. This can happen even though the Luvuvhu River is not in flood.

The first type, or high floods, inundates the floodplains on either side of the Luvuvhu River, including the pans on the northern bank. The high floods also play an important role in the natural functioning of the whole floodplain system, especially with regard to maintaining the ecological integrity and functioning of the pan system. On the southern bank of the Luvuvhu River, this type of flood follows the Hapi/Fever tree floodplain system, a very important factor in the reduction of accumulated Anthrax spores in this system (De Vos, et al. 1996). This type of flood is associated with high rainfall cycles and therefore occurs roughly every 8-10 years. It also scours the main channel, especially when it does not coincide with a Limpopo flood.

The second type, backflooding by the Limpopo River of the pans between the Limpopo and Luvuvhu Rivers, occurs more frequently, on average every two to three years. For inundation of these pans from water flowing over the embankments of the river, the Luvuvhu needs to have high flows(but not necessary in flood), but a pre-requisite is a simultaneous high flow of the Limpopo. Silt is deposited and pans such as Gwalala, Mabvubvanye, Nyala, Nwambi, Hulukulu, Makwadzi, Shipokonyolo, Banyini and Dakamila pans, are filled. This pan veld is a unique characteristic of this landscape (Gertenbach, 1983).

Soil type and chemistry

The Pafuri land type in the KNP consists of the alluvial lowlands that flank the lower Luvuvhu River and the Limpopo River. The area is characterised by flat to slightly undulating and concave land. The area along the Limpopo River is characterised by a well-developed levee and adjacent floodplains. The floodplains of both the Luvuvhu and Limpopo rivers incorporate several large seasonal pans. Large areas of the land type are occasionally temporarily inundated by floodwater from either the Luvuvhu or the Limpopo rivers (or both), but pans are more often than not replenished by runoff water, after heavy rains in their immediate catchment areas. Small, rounded, basaltic koppies sporadically protrude through the alluvium, and some of them (e.g. Timhisi) are capped by well-rounded, quartzitic boulders and cobblestones.

Due to the geological differences between the catchment areas of the Luvuvhu and the Limpopo rivers (Sibasa basalt and granitoid rocks respectively), there is also a marked difference in the alluvial deposits that flank these two rivers (Tinley, 1978). The soils of the area, which flank the Luvuvhu River, consist mainly of very deep, red, occasionally calcareous, neocutanic clay of the Oakleaf[1] form (frequently also with a high percentage of silt). The outer fringes of the Luvuvhu river floodplain are usually characterised by deep to moderately deep, red and brown, paraduplex, calcareous clay (Valsrivier[2] form). On the other hand, the soils, which are associated with the levee of the Limpopo River, consist mainly of very deep brown, neocutanic

[1] World Reference Base Soil Group (Acrisols, Lixisols, Arenosols, Cambisols)
[2] World Reference Base Soil Group (Luvisols, Lixisols)

and stratified, loam or fine sand (Oakleaf). The soils of the Limpopo floodplains are dominated by very deep, brown, calcareous and sodic, neocutanic and paraduplex clay (Oakleaf and Valsrivier forms) (Venter, 1990).

i. Alluvial soils

In the Makuleke area, just outside the Park's western border, alluvial soils occur adjacent to Banyini pan. Most of these soils were cultivated in the past. Surprisingly they are not calcareous, even though they occur in low-lying positions in the landscape. The pH is alkaline and they have a high phosphate and potassium content. They belong to the Dundee[3] Form, Mtamvuna family. The dryland cropping potential of these soils is high due to their inherent fertility, good permeability, relatively high water table and their ease of tillage. This potential, however, is limited by low rainfall in the valley. The irrigation potential is good. The fine sand fraction and its relatively high silt fraction make these soils moderately erodible due to runoff and wind erosion when tilled. Deep red soils occur mainly in the flatter area in the Makuleke area. Large specimens of white syringa (*Kirkia accuminata*) are often associated with these soils. The nutrient status is high in the topsoil. They belong mainly to the Hutton[4] Form, Lillieburn family, although a portion to the west is shallower and has calcareous subsoil that probably puts it into the Coega[5] Form, Nabies family. The dryland cropping potential of these soils is high, again due to their inherently good topsoil fertility, good permeability and ease of tillage. However, the low rainfall and high evaporation as well as the low cation exchange capacity (C.E.C.) in the subsoil make the realisation of this potential unrealistic. The irrigation potential is good to excellent due to their depth and subsoil texture. Rapid permeability could be a limiting factor.

ii. Gravels and rocky soils

Gravels and rocky soils are also common in this area, with the gravel consisting mainly of rounded, pebble- and cobble-sized, particles from many different geological origins, although quartz seems to dominate the mineral type. Soil occurs between the gravel particles in sufficient quantity to allow good plant growth. The chemistry shows that these soils are very fertile with generally high phosphate, potassium, calcium and magnesium levels. Most of the hills in the area have minimum soil cover with exposed rock being prominent. What little soil there is occurs in cracks and fissures between the rocks. These soils have no cropping or irrigation potential mainly because they are untillable. They are all suited only to the production of herbage for wildlife and domestic stock.

Water quality

Due to the seasonal hydrology of the sandy Limpopo River, it is well recognised that large amounts of sediment are transported during the bigger flooding events. The water column at this time is therefore expected to be high in suspended solids. After the floods have receded, some nutrient enrichment may be expected due to

[3] World Reference Base Soil Group (Fluvisols)
[4] World Reference Base Soil Group (Ferrasols, Acrisols, Lixisols, Arenosols, Cambisols)
[5] World Reference Base Soil Group (Calcisols)

agricultural practices upstream. Mining and industrial activities are largely absent from the majority of the catchment, which tends to indicate that the quality of the water that reaches the Ramsar site is reasonably good. The water quality of the Luvuvhu River too can be considered good (DWAF, 1995), probably even better than that in the Limpopo River (Table 1).

Table 1. Summary of water quality data in the Limpopo & Luvuvhu Rivers.

		Ca	Cl		EC	F	K	Mg	Na	NH4	NO3	pH	PO4	Si	SO4
Luvuvhu (@ Mhinga) A91 90399 1988-2016	**Min**	3.200	3.500	38.000	7.000	0.050	0.150	2.000	3.900	0.020	0.020	5.600	0.003	2.310	2.000
	0.25	7.700	7.400	88.000	11.750	0.110	0.870	4.950	6.650	0.020	0.020	7.535	0.013	4.000	2.000
	Mean	9.260	9.151	105.380	14.492	0.163	1.910	5.918	8.396	0.044	0.164	7.801	0.050	5.897	5.744
	0.75	10.600	11.200	120.000	16.450	0.190	2.425	7.100	9.700	0.050	0.279	8.090	0.030	7.520	8.100
	0.9	11.460	12.980	137.800	18.960	0.250	3.418	7.900	10.900	0.082	0.473	8.242	0.048	8.248	10.060
	Max	14.900	22.100	219.000	32.700	0.500	5.240	10.700	28.100	0.781	0.943	8.500	2.534	9.540	16.600
	N*	126	126	126	126	126	126	126	126	126	126	126	126	126	126
Mutale (@ Mutale Bend) A92 85326 2003-2016	**Min**	1.682	3.837	30.981	6.840	0.025	0.058	1.715	3.000	0.015	0.005	7.017	0.005	3.181	0.375
	0.25	5.571	11.897	74.156	10.948	0.050	0.521	3.664	8.021	0.025	0.025	7.631	0.006	3.930	1.500
	Mean	8.611	19.364	114.281	17.110	0.131	1.124	5.759	13.387	0.053	0.069	7.807	0.022	4.644	3.402
	0.75	10.691	23.748	135.673	20.850	0.160	1.623	7.571	16.122	0.067	0.058	7.974	0.019	5.089	4.459
	0.9	13.238	31.117	173.277	25.770	0.266	2.166	9.452	21.948	0.094	0.158	8.141	0.032	6.052	7.164
	Max	25.154	55.104	321.495	46.100	0.419	2.520	16.457	43.533	0.541	0.394	8.389	0.452	7.620	10.889
	N*	82	82	62	82	67	78	82	76	81	81	82	81	81	82
Limpopo (@ Hlukhulu) A91 189421 1988-2016	**Min**	20.800	11.985	161.909	12.000	0.150	2.100	6.000	13.170	0.025	0.005	7.140	0.005	3.085	2.500
	0.25	28.007	41.191	290.253	42.850	0.272	4.111	13.303	34.488	0.025	0.025	8.086	0.018	5.856	20.371
	Mean	32.636	58.726	347.039	51.823	0.320	4.888	16.383	45.243	0.065	0.158	8.176	0.051	6.914	32.766
	0.75	37.075	69.076	396.250	61.250	0.355	5.758	19.475	51.644	0.096	0.124	8.348	0.048	7.874	42.254
	0.9	41.419	89.928	440.577	65.340	0.458	6.499	22.383	63.400	0.113	0.487	8.458	0.092	10.076	47.237
	Max	50.995	127.378	577.246	85.700	0.622	8.102	29.651	110.808	0.340	1.581	8.709	0.398	11.855	102.983
	N*	42	43	27	43	32	42	43	41	42	37	43	42	42	41

* Number of samples

The water quality (Van der Waal, 1996) of the pans may be quite different to that of the rivers at times, particularly during the dry and hot summer months. Conductivity may range between 88 and 1249 mS/m in the pans, while the pH may range between 6.7 and 10.6. Water temperature in the pans is also variable, ranging from 13.5 to 33.3^{o} C, with a winter average of 17^{o} C and a summer average of 30^{o} C. Dissolved oxygen is normally less than 5 mg/l, according to Moore et al 1991. 6 mg/l-dissolved oxygen is the guideline value and 4 mg/l would be a critical value for key species such as invertebrates.

Depth, fluctuations and permanence

The Limpopo and the Luvuvhu Rivers show high seasonal variability in flow. Both the rivers have to rise a few metres to overspill their banks (the Luvuvhu, for example, needs to rise more than 7 m at the bridge in the Kruger National Park). The pans (Van der Waal, 1996) are generally shallow and can be alternatively dry or filled for more than one consecutive year. It is suggested that the pans could become dry once in three years in normal situations. Maximum depths (at overflow level either into the river or to the next pan) of some of the pans are recorded in Table 2. It is essential for the pans to be connected with the rivers in a flooding event in order to ensure recolonisation and exchange of fish and certain invertebrate species with the rivers.

Table 2. Maximum depths of a few of the pans in the system.

Name of pan	Depth cm	Name of pan	Depth cm
Mabvubvanye	215	Manxeba	180
Hapi	320	Gila	170
Makwadzi	255	Mapimbi	310
Nyavadi	160	Shipokonyolo	60

The water table

The water table occurs just below the ground surface of both the Limpopo and Luvuvhu River floodplains. Measurements from boreholes (game rangers diaries) situated in the Limpopo floodplain indicate that the water table fluctuates quite considerably, depending on flooding and rainfall in the area. Depths tend to range from 2.4 to 6.86 metres below the ground surface. During extensive droughts, the water table has been known to drop as much as 4 metres in places. A similar scenario is expected on the floodplain of the Luvuvhu River.

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15. Physical features of the catchment area:
Describe the surface area, general geology and geomorphological features, general soil types, general land use, and climate (including climate type).

Catchment area

The Limpopo River catchment is large, approximately 109 604 km^2 in extent (Smit, D.W.J. DEAT, 1996), and has a mean annual run-off (MAR) of 2 290 million m^3 (Pullen, 1994).

The relevant information so far gathered as given in Table 3 gives a preliminary overview of the water balance in the Limpopo River through estimated MAR (virgin and present) of the tributaries and their catchment sizes.

Table 3. Example Limpopo tributaries: catchment sizes: naturalised and denaturalised MAR's.

Tributary	Catchment area (km²)	Naturalised MAR (10^6 m²)	Denaturalised MAR (10^6 m²) for 2016	Source
Marico	13208	109	72	Baily & Pitman, 2016
Crocodile	29572	526	456	Baily & Pitman, 2016
Mokolo	7616	241	156	Baily & Pitman, 2016
Mogalakwena	20248	236	114	Baily & Pitman, 2016
Luvuvhu	4826	584	446	Baily & Pitman, 2016
Shashe Zimbabwe	18991		462(*)	ME & WRD.
Lower Shashe	4160		154 }435	BNWMPS. 1990
Tuli Zimbabwe	7910		281	ME & WRD.
Umzingwani	15695	?	350(*)	ME & WRD. Zimbabwe
Bubi	8140	?	53(*)	ME & WRD. Zimbabwe
Mwenezi Zimbabwe (Nuanetzi)	14759	?	256(*)	ME & WRD.

(*) From the Zimbabwe National Master Plan for Rural Water Supply and Sanitation (1986)

The Luvuvhu River is a tributary of the Limpopo River and covers 5956 km^2 (Smit, D.W.J. DEAT, 1996). It rises on the southern slopes of the Soutpansberg mountain range (Pullen, 1994). The Mutale and Mutshindudi rivers are two important tributaries of the Luvuvhu. The MAR of this river is approximately 584 million m^3, (Bailey & Pitman, 2016).

Downstream area

The Gaza Province in Mozambique lies downstream of the site. A large area of this region becomes a Transfrontier Conservation Area (TFCA). This TFCA covers 20 700 km^2 of protected area in Gaza and Inhabane Provinces and already has two gazetted national parks: Bahine National Park (7 000 km^2) and Zinave National Park (3 700 km^2). Traditionally, animals have migrated through this area to the Limpopo River. Due to the close proximity to conservation areas in South Africa and Zimbabwe (Gonarezhou National Park), the potential for natural and artificial stocking is high.

Climate

The Luvuvhu/Limpopo region falls in the Tropical Premontane Arid Thorn Woodland climatic region according to the classification system of Holdridge et al. (1971) as reported by Schulze & McGee (1978). Climatic conditions vary from hot and humid during the summer months to mild and dry during winter months. The mean annual rainfall in the Kruger National Park decreases from south to north and from west to east. The rainfall in the Limpopo/Luvuvhu floodplains area is the lowest in the Kruger National Park and the mean for the last 69 years was 424 mm per annum with a low of only 98 mm during the 1982/83 season. Research has shown that the lower the mean annual rainfall, the more unpredictable and variable the annual rainfall (Gertenbach, 1980). The low and unpredictable rainfall renders this area unsuitable for livestock or crop farming and the only sustainable long-term use of this area is ecotourism.

On a transect from the Soutpansberg eastwards across the Pafuri area of the Limpopo Valley to the coast, the rainfall curve follows the relief and influence of the land-sea junction closely, with highest rainfall occurring at both ends (Tinley, 1978). The highest mean annual rainfall occurs in the Soutpansberg Mountains to the west (Sibasa, 1 963 mm) and at the coast (Massinga 1 172 mm) in the east. The lowest rainfall on this east-west transect is in the Limpopo Valley at Pafuri (362 mm). The rain falls mostly between November and March, with February being the wettest month. The combined rainfall for May to August makes up only 4% of the annual total (Tyson, 1978). On average, there are only 42 days in the year with rain.

Table 4. The average monthly rainfall at Tshipise.

Month	**Rainfall (mm)**	**Rain days**
January	49.4	3.6
February	61.2	4.2
March	35.9	2.4
April	25.0	1,6
May	9.2	0.8
June	1.5	0.2
July	0.4	0.1
August	2.3	0.2

September	10.7	0.8
October	34.2	2.6
November	50.5	3.7
December	53.8	4.0
Total	334.1	24.3

The average daily maximum temperature (Tinley, 1978) in January (hottest month) is 33.5º C and in June and July (the coldest months) it is 24.9 ºC. The highest temperatures that have been recorded for summer and winter respectively are 43.5 ºC and 32.4 ºC. The mean daily minimum in January is 21.3 ºC and 15.9 ºC in June and July but extremes of 13 ºC and -3.8 ºC have been recorded. The strongest winds blow during September and October, mainly from the east, which, together with winds from the northeast, constitute the prevailing wind directions. Evaporation is very high with an annual average of 2 682 mm which exceeds the rainfall by some 2 348 mm per year. On average, hail and fog only occur once a year, while snow has never been recorded.

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16. Hydrological values:

Describe the functions and values of the wetland in groundwater recharge, flood control, sediment trapping, shoreline stabilization, etc.

The floodplain plays an important role in attenuating floods, thereby reducing flood damage in the downstream areas of Mozambique. The floodplain and its associated pans also play an important role in recharging the groundwater levels and maintaining of the riparian and floodplain vegetation (Rogers, 1995). Sediment retention also takes place during normal years. The effects of cyclone driven flooding in the catchment during 2012-13 demonstrated the dynamic geormorphological characteristics of the riparian zone, with new denudation and deposition sites created within the macro-channel. The floodplain and pans support both breeding and feeding populations of many terrestrial and aquatic animals. The pans also form an important refuge area for water dependent fauna. The physical resistance to flow of the landscape and its associated vegetation reduces flow velocities in the rivers, thus spreading flow laterally and increasing water retention times in any one area. The resulting reduced flows and the binding action of riparian plant roots in the soil also markedly reduces the erosion of riverbeds and banks. Riparian wetlands also act as natural filters of diffuse nutrient and pollution transfers between the terrestrial system and river via both surface run-off and subsurface flow. Similarly, the changes in flow characteristics caused by the riparian vegetation results in increased deposition of both organic and inorganic suspended materials within the wetland.

While many aquatic, aerial and terrestrial species utilise riparian wetlands during crucial parts of their life cycles, many other species are confined solely to these systems. Riparian wetlands therefore form centres of a very high biodiversity within the landscape (Naiman, Decamps & Pollock 1993). These types of wetlands also regulate nutrient movement from adjacent terrestrial systems (e g agricultural run-off), organic matter inputs (e g litter fall). The river corridor as a whole acts as an important migratory route for many species and forms an important biophysical link

along the length of the catchment. The state of the riparian zone is a major determinant of the ability of the river corridor to provide this function.

17. Wetland Types

a) presence:
Circle or underline the applicable codes for the wetland types of the Ramsar "Classification System for Wetland Type" present in the Ramsar site. Descriptions of each wetland type code are provided in Annex I of the *Explanatory Notes & Guidelines*.

Marine/coastal: A • B • C • D • E • F • G • H • I • J • K • Zk(a)

Inland: L • M • N • O • P • Q • R • Sp • Ss • Tp Ts • U • Va • Vt • W • Xf • Xp • Y • Zg • Zk(b)

Human-made: 1 • 2 • 3 • 4 • 5 • 6 • 7 • 8 • 9 • Zk(c)

b) dominance:
List the wetland types identified in a) above in order of their dominance (by area) in the Ramsar site, starting with the wetland type with the largest area.
M; P; R; Xf; N

The Makuleke Wetlands consist of approximately 31 pans whose hydro-gemorphology associated with the Limpopo-Luvuvhu flodplains is quite variable, giving rise to suite of wetlands with diverse characteristics. Nesbitt (2014) attempted to derive a localised classification system for these pans based on their abiotic characteristics, as depicted in Figure 1.

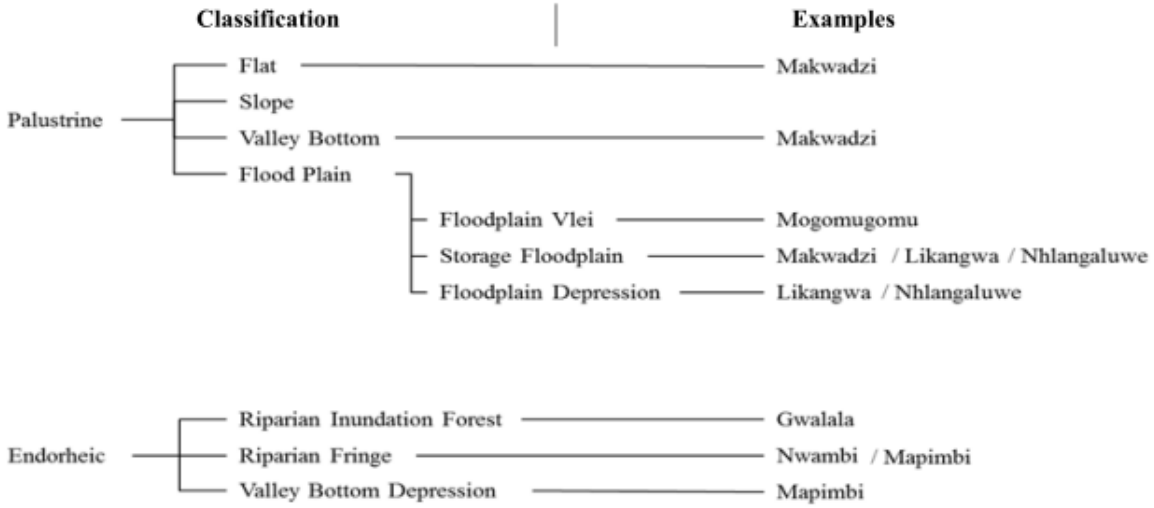

Figure 1. Proposed localised classification of the wetlands within the Makuleke Ramsar site. (after Nesbitt, 2014)

18. General ecological features:
Provide further description, as appropriate, of the main habitats, vegetation types, plant and animal communities present in the Ramsar site.

The location of the wetland system together with the diverse landscape features in the vicinity, form the foundation for the high biodiversity, which is characteristic of the

Limpopo/Luvuvhu floodplain and pan system. The diversity of landscape are depicted by the area the wetland system occurs in (Tinley, 1978):

- the continental old land and the young coastal plain meet;
- the mountains of the Soutpansberg and the Great Escarpment end;
- the north-south Lebombo Mountain range, which separates the Transvaal-Zululand Lowveld from the Mozambique coastal plain, ends;
- the north-south valley trough links the Transvaal and Zululand Lowveld; and
- the east-west valley trough of the Limpopo links the east coast with the continental interior (Kalahari-Mozambique).

This in turn is coupled with a high landscape and substrate diversity. In addition, the diverse topography provides a multiplicity of aspects open to or sheltered from aridity or moisture bearing winds. The presence of these landscapes and the contrasting moisture properties exhibited by the variety of substrates because of highly seasonal and erratic rainfall has resulted in a heterogeneous mosaic of plant communities in the vicinity of the Ramsar site. The major plant communities in the vicinity of the wetland and which are not found elsewhere in South Africa include (Tinley, 1978):

i. Lebombo ironwood forests;
ii. high mopane woodlands;
iii. boabab "forests"; and
iv. extensive areas of big timber riverine woodland.

In addition to number iv. above, there are a number of other more common wetland communities which constitute the Ramsar site. These include the following:

v. riverine forest or thickets;
vi. scrub-thicket on calcareous and brackish clays;
vii. clayveld;
viii. floodplain woodland;
ix. dambo grassland;
x. floodplain grassland; and
xi. herbaceous aquatic communities.

The diversity of landscape features is matched by a great variety of soils and relief aspects which support exceptional vegetation diversity.

The Punda Maria-Pafuri-Wambiya area not only contains the most spectacular scenery in the Kruger National Park, but also has the richest variety of fauna and flora (Tinley, 1978). A large number of plant and animal species occur here nowhere else in South Africa. By far the most important of the unique features of this northern sector of the country, is the high biotic diversity formed by the overlapping elements of many biogeographic centres.

Van Rooyen (1978) and Gertenbach (1983) described the vegetation of this area in detail, and only the major patterns are summarised here. The areas which occur immediately on either side of the Luvuvhu river, as well as the levee of the Limpopo river, are dominated by a tall and dense *Faidherbia albida / Ficus sycomorus /*

Xanthocercis zambesiaca riverine forest. *A. xanthophloea* is often dominant on the edges of pan and in concave areas. The outer part of the Luvuvhu floodplain is dominated by *Sporobolus consimilis* grassland.

The Makuleke section of the Ramsar site outside of the Kruger National Park (to the west) is also a unique landscape with an accompanying wilderness character. The riverine vegetation of this area includes two of the four most endangered plant communities in the Limpopo River system. The pans in this area, the Banyini Pan, together with the floodplain of the Limpopo River, make this area an important component of the Ramsar site. This area is also an historic migratory route for elephants and buffalo from Zimbabwe to the Transvaal Lowveld.

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19. Noteworthy flora:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 12. Justification for the application of the Criteria) indicating, e.g., which species/communities are unique, rare, endangered or biogeographically important, etc. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS*.

The vegetation of the area between the Luvuvhu and Limpopo rivers is characterised by a moderately dense to dense mopane/tall common corkwood or bush savannah (Van Rooyen 1978), with large boabab trees often conspicuous. Lowveld cluster-leaf and Lebombo Euphorbia are locally dominant on very shallow, calcareous soils and rock outcrops. The areas which occur immediately on either side of the Luvuvhu and Limpopo Rivers are dominated by riverine forest, tall and dense ana tree / common cluster fig / nyala tree stands. Tall fever trees are often dominant on the edges of pans. More than 256 plant taxa have been recorded in the Luvuvhu/Limpopo region (Zambatis, et al. 1996), nine of which are listed as threatened in the Red Data List (R.D.L.) of plants. Parts of this area, including the floodplain pans, have been poorly collected. Additional taxa can therefore be expected to be found here.

The diversity of landscape is matched by a great variety of soils and relief aspects which support an exceptionally high vegetation diversity - from floodplain grassland through many types of savannas and thickets to forest. Of the communities described by Van Rooyen (1978) and Bredenkamp (1993), the following are associated with the floodplain and riparian areas:

Acacia nigrescens-Sclerocarya birrea Savanna communities of dry sandy flood plains.

1. *Combretum hereroense-Acacia nigrescens* dense tree savanna
2. *Markhamia acuminata-Kirkia acumunata* open tree savanna
3. *Terminalia prunioides-Adansonia digitata* open tree savanna

Acacia tortilis-Acacia albida Flood Plains Savanna and Riparian Forest Communities

4. *Hyphaene coriacea-Acacia tortilis* floodplain Savanna
4.1 *Peuchel-loeschia leubnitziae-Acacia tortilis* pans and brackish plains savanna
5. *Acacia xanthophloea-Azima tetracantha* floodplain forest
6. *Faidherbia albida-Ficus sycomorus* riparian forest
7. *Setaria sagittifolia-Croton megalobotrys* riparian forest

Phragmites mauritianus-Breonadia salicina Reed Communities and Riparian Forest Communities
8. *Schotia brachypetala-Acacia robusta* Dry Riparian Forest
9. *Afzelia quanzensis-Combretum microphyllum* Riparian Forest
10. *Garcinia livingstonei-Phragmites mauritianus* Riparian Forest
11. *Pluchea dioscorides-Breonadia salicina* River bed community
12. *Phragmites mauritianus-Nuxia oppositifolia* River bed community

The *Colophospermum mopane / Acacia tortilus / Urochloa mossambicensis* savanna occurs on the basalt foot slopes adjacent to the river and pans in many places. It often forms the ecotone between the drier upslopes and the wetter bottom lands (Van Rooyen, 1978; Gertenbach, 1983). Other dominant woody species associated with this community include *Maerue parvifolia, Grewia bicolor, Azima tetracantha, Acacia senegal* var. *rostrata, Salvadora angustifolia, Hyphaene natalensis, Commiphora glandilosa, Thilachium africanum, Ximenia americana, Gardenia resiniflua, Maytenus heterophylla, Dalbergia melanoxylon, Acacia nigrescens, Gardenia spatulifolia, Zanthoxylum humilis, Boscia albitrunca* and *Adansonia digitata*. Almost homogeneous stands of baobabs *Adansonia digitata* occur in certain localities. The herb and grass layer includes a large variety of species such as the grasses *Tragus berteronianus, Aristida congesta* subsp. *barbicollis, Chloris virgata, Sporobolus smutsii, Enneapogon cenchroides* and *Dactyloctenium aegypteum*. Forbs include *Alternanthera pungens, Trianthema triquetra, Cyathula crispa, Corbichonia decumbens, Pupalia lappacea, Hibiscus micrantthus, H. engleri, Indigofera rhytidocarpa, Boerhaavia diffusa, Ecbolium revolutum, Gisekia africana* and *Ipomoea obscura*.

Table 5. List of plant species that have only been collected from the area between the Luvuvhu and Limpopo Rivers as well as a list of the current red data taxa occurring in this region (Zambatis, 1996).

Common plant species	**Common plant species**
Adiantum capillus-veneris	*Commiphora merkeri*
Urochloa brichopus	*C. tenuipetiolata*
Echinochloa crus-galli	*Polygala schinziana*
Panicum heterostachyum	*P. wilmsii*
Panicum repens	*Phyllanthus burchelli*
Stipagrostis uniplumis var. neesii	*Maytenus putterlickoides*
Aristida stipitata subsp. spicata	*Allophyllus alnifolius*
Eragrostis crassinervis	*Corchorus kirkii*
Cyperus articulatus	*Grewia inaequilatera*
C. imbricatus	*G. retinervis*
C. pygmaeus	*G. rogersii*
Commelina petersii	*Abutilon englerianum*

Aloe littoralis	*Dombeya kirkii*
Dipcadi glaucum	*Ochna arborea var. arborea*
Sansevieria aethiopica	*Combretum collinum subsp. taborense*
Xerophyta equisetoides var. pauciramosa	*Stomatostemma monteroae*
Ficus craterostoma	*Stapelia gettelfii*
Ficus natalensis	*Stapelia kwebensis*
Tapinanthus ceciliae	*Huernia kirkii*
Helixanthera garciana	*Turbina schirensis*
Cyathula orthacantha	*Stenodiopsis humilis*
Gisekia africana	*Dyschoriste depressa*
Potulaca collina	*Barleria crossandriformis*
Ranunculus multifidus	*B. lugardii*
Crotalaria distans subsp. mediocris	*B. matopensis*
Ptycholobium contortum	*Canthium setiflorum subsp. setiflorum*
Tephrosia virgata	*Senecio inaequidens*
T. zoutpansbergensis	
Current Red Data plant taxa	**Current Red Data plant taxa**
Barleria matopensis	*Loudetia filifolia*
Boscia angustifolia var. corymbosa	*Rhynchosia vendae*
Combretum collinum subsp. toborensis	*Tetrapogon tenellus*
Euphorbia rowlandii	*Stadmannia oppositifolia subsp. rhodesica*
Heteropogon melanocarpus	

During an investigation of the conservation status of the riparian vegetation of the Luvuvhu River east of Makhado to the confluence with the Limpopo, assessment scores were given to different areas according to certain criteria such as removal of riparian vegetation, presence of weirs or impoundments, abundance of invasive plant species within the riparian zone, etc. The conservation status of the riparian vegetation starts out relatively high outside Makhado, but then scores drop off dramatically on entry into the former Gazankulu and remain so until the Kruger National Park boundary (DWAF, 1994). This clearly reflects a situation of high vegetation removal, and utilisation associated with bank erosion outside the Park. This is typical of the subsistence farming practices that are common in the catchment. On entry into the Kruger National Park, the situation and condition

scores improved dramatically to attain nearly pristine status (Kemper, 1994), considering the damage done to the riparian zone due to the 1992-1993 drought and the simultaneous utilisation of the river upstream (Zambatis, et al. 1995).

The riverine vegetation along the Limpopo River in the Makuleke area is dominated by splendid acacia, umbrella thorn, fever tree, sycamore fig, apple leaf and in places in the pans, ilala palms. The grasses include, among others, buffalo grass and bushveld signal grass. The bottomlands and lower slopes are dominated by knob thorn, leadwood and gummy gardenia and when calcareous, magic guarri trees and bushveld signal grass. The palaeogravels and shallow, rocky areas on the hilltops surrounding the Ramsar site are dominated by mopane, red bushwillow and knob thorn trees. Grasses include nine-awned grass and spreading three-awn. The deep soils of the uplands are dominated by big and widely spaced trees that include mopane, white syringa, marula and shepherd's tree. The grasses include *Aristida congesta, Urochloa mossambicensis*, and *Digitaria* species. While boabab trees, are prominent everywhere except in the pans, they do not dominate any of the vegetation associations. There are 16 Red Data species of plants in the Makuleke area, one of which is a endangered cycad (*Encephalartos hirsutus*). Sisal plants (*Agave sisalana*, originally from Mexico) are exotic to the area and were used in the past to create a security fence along the border between the Makuleke Property and Zimbabwe. The remains of the fence are still very evident in the Makuleke area.

Attached at link is complete list of flora know recorded within the Makuleke region and Figure 1 gives the botanical regions of the Makuleke Contractual Park

Makuleke plants1_Guin.xlsx

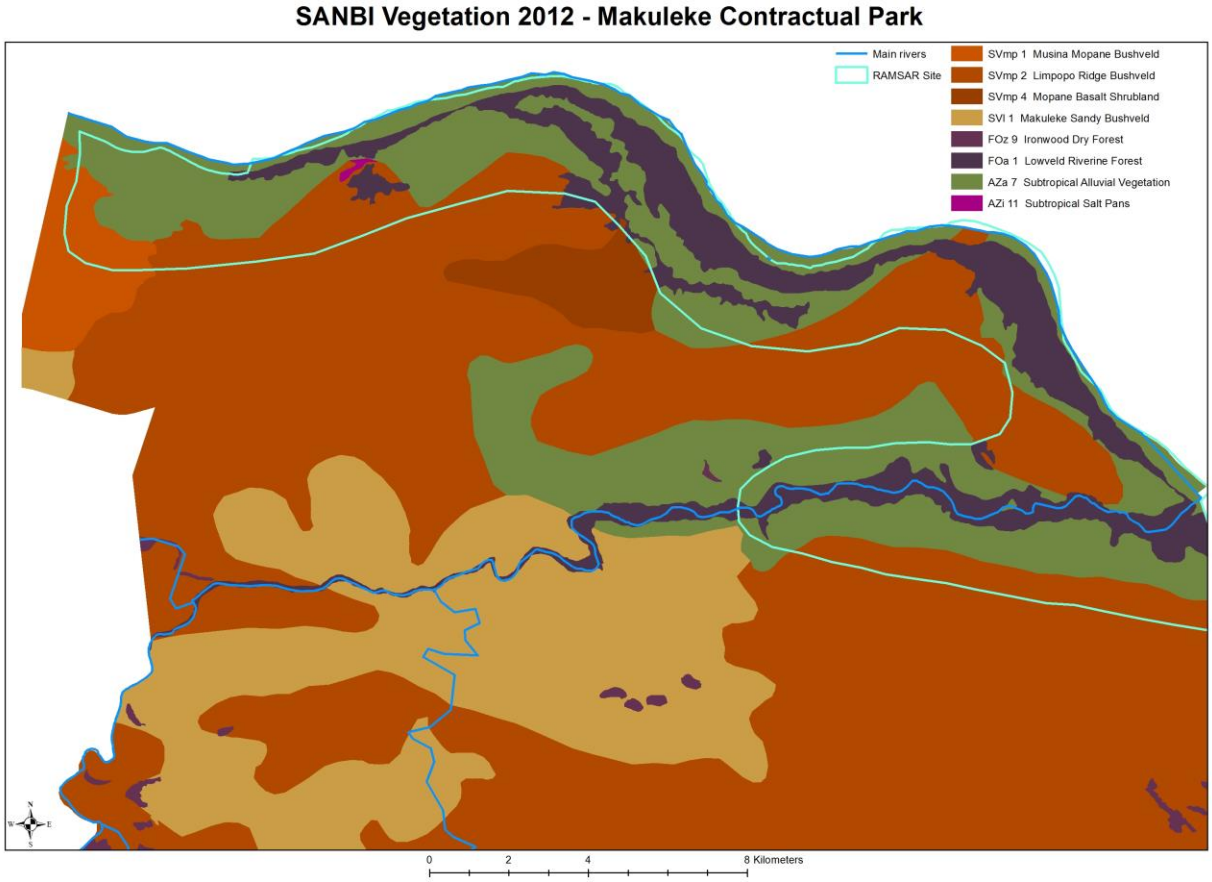

Figure 1. Botanical regions of the Makuleke Contractual Park (South African National Botanical Institute, 2012)

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20. Noteworthy fauna:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 12. Justification for the application of the Criteria) indicating, e.g., which species/communities are unique, rare, endangered or biogeographically important, etc., including count data. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

The Ramsar site area contains a considerable portion of the biodiversity of the lowveld in South Africa. A large number of species occur here and nowhere else in South Africa. The diversity of landscape is matched by a great variety of soils which support an exceptional vegetation diversity and an unusually high number of habitats and wildlife.

Larger mammals

Although the area between the Luvuvhu and Limpopo Rivers in the KNP section of the Ramsar wetland is not renowned for the big concentrations of large herbivores typical of the basalt plains further south, it does contain the highest density of nyala in the Transvaal. In the Transvaal the rare samango monkey has only been found in isolated forest patches in the Soutpansberg and Ohrigstad sector, and the riparian vegetation of the Luvuvhu and Limpopo rivers (Smithers, 1986). The last remaining herd of hippopotamus east of Beit Bridge on the Limpopo River occurs at Makwadzi Pan. Due to the 1992/93 drought, the hippo numbers in the Luvuvhu and Limpopo rivers in the Ramsar wetland, decreased from more than a hundred to only about 10

animals (Viljoen, 1995). However at the last census of 2016 there we 90 individual hippo recorded in the Luvuvhu alone. The area forms an important migration route for large animals such as elephant and antelope, linking the Kruger National Park with areas in Zimbabwe and Mozambique.

Apart from the mammals conserved in the KNP, the Makuleke area supports numerous large mammals. Nyala and waterbuck are commonly associated with the riverine areas and floodplains respectively. Warthog are common, as are vervet monkeys. Two herds of buffalo totalling about 70 animals, and elephants appear to be resident in the area, both of which utilise the floodplain and riparian habitats extensively. Although not a riparian species, the endangered wild dog has also been recorded in the area. The African civet, aardwolf, brown hyena, serval, leopard and Sharpe's grysbok, although not wetland species, also occur in the area. The aquatic ecotones and drainage lines are probably extensively traversed by these species and it is envisaged that the riverine areas are utilised by them at some stages. The hippopotamus, which is also regarded as rare, is still found in the few more permanent pools along the Limpopo River in the Makuleke Property.

In total 27 mammal species have been recorded directly utilising the pan systems within the Makuleke Ramsar wetlands (Antrobus, 2014). Large mammals of ecological significance (Smithers, 1986) depending on the existence of the Ramsar wetland include the following:

1. Samango monkey - In the Transvaal these animals these monkeys have only been found in isolated forest patches and the riparian vegetation of the Luvuvhu and Limpopo Rivers. Red data status - rare;
2. Bushpig - The highest concentration of these animals in the KNP (and thus protected) is found in the riparian vegetation of the Pafuri region;
3. Hippopotamus - In the northern region and along the Limpopo River, this is the last remaining herd east of Beit Bridge. There are 22 animals in Makwadzi pan and 8 in the Luvuvhu River (1996 hippo census). Red data status - rare;
4. Nyala - The highest density of Nyala in the Transvaal occurs in the Ramsar wetland riparian zone;

Mammals of ecological significance (Smithers, 1986) occurring in the area between the Luvuvhu and Limpopo Rivers, but not totally dependant on the wetland area, include the following:

1. Aardwolf - rare;
2. Brown hyaena - rare;
3. Serval - rare;
4. Leopard - rare;
5. African wild dog - endangered;

Small mammals

Numerous species of bats and small rodents are known to occur only in Ramsar wetland area between the Luvuvhu and Limpopo Rivers and nowhere else in South Africa (Pienaar, 1987). The colony of several thousand Egyptian fruit bats roosting in a cave in Lanner Gorge is one of only about seven such colonies known in South

Africa. Other bats like the Rüppels bat, Swinny's horseshoe bat, the Madagascar large free-tailed bat and Commerson's leaf-nosed bat are only known in South Africa from specimens collected at Pafuri. These species probably also use the riparian areas to forage.

Small mammals of ecological significance (Smithers, 1986) depending on the existence of the Ramsar wetland include the following:

1. Suni - vulnerable;
2. Four toed elephant-shrew - rare; restricted to the riparian forests of the Limpopo and Luvuvhu rivers and extreme northeast parts of KwaZulu-Natal.
3. African civet - prefer areas with riverine underbush, thickets and reed beds where trees and shrubs provide wild fruits. Red data status - rare;
4. Lesser grey-brown musk shrew - This shrew has a only been found on the banks of the Sabie River in the southern area of the Park, from the Mashicindzudzi area south of Pafuri, and from the banks of the Luvuvhu River;
5. Egyptian fruit bat - This bat has only been recorded along the Luvuvhu and Limpopo rivers in the Ramsar wetland area, they utilize the caves at Lanner Gorge. These bats are also rare in the rest of the old Transvaal. The riverine forests are important foraging areas for the bats;
6. Commerson's leaf-nosed bat - The only area where these bats have been encountered in South Africa is from the riverine forests of the Pafuri area. Red data status - indeterminate;
7. Rufous hairy bat - This extremely rare species in South Africa has only been collected from Skukuza and in the Pafuri area along the Luvuvhu river, this bat appears to prefer forests. Red data status - indeterminate;
8. Rüppell's bat - Within the borders of South Africa the only area where these bats have been encountered is in association with the riverine forests of Pafuri. Red data status - indeterminate;
9. Butterfly bat - In South Africa these bats have only been recorded from the Soutpansberg and from Pafuri where it is associated with riverine forest. Red data status - indeterminate;
10 Long-tailed Serotine bat - In the former Transvaal this uncommon bat has only been collected from the riverine area at Pafuri;
11. Damara woolly bat - In the Park this bat has only been collected from the Pafuri riverine forest. These bats appear to be confined to well watered areas and riparian forests. Red data status - indeterminate;
12. Lesser woolly bat - This bat has only been collected from the Pafuri area in the Park. In the former Transvaal they have only been collected from the Soutpansberg along the Njelele River and in the riparian vegetation at Pafuri;
13. Woodland mouse - These mice have a limited distribution in the Transvaal and have only been collected from the riverine forest area of the Limpopo and Luvuvhu areas;

Small mammals of ecological significance (Smithers, 1986) occurring in the area between the Luvuvhu and Limpopo Rivers, but not totally dependant on the wetland area, include the following:

1. African wild cat - vulnerable

2. Ant bear - vulnerable
3. Pangolin - vulnerable
4. South African hedgehog - rare
5. Wahlberg's epauletted fruit bat - Occurs along the Limpopo River. They appear to be dependent on evergreen forest;
6. Swinny's horseshoe bat - The only known records of these bats in the former Transvaal come from the Pafuri region. These bats have a limited distribution throughout the Subregion of Southern Africa. At night they frequent well wooded area in search of prey. Red data status - indeterminate;
7. Ansorge's free-tailed bat - In South Africa this bat is only known from two localities in the Park, namely Pafuri and Nwanetsi, and from Mkuzi Game reserve in Natal. These bats require rock clefts and caves for shelter. Red data status - indeterminate;
8. Madagascar large free-tailed bat - The only records of these bats in South Africa is from the Pafuri area. They appear to be dependent on a rocky terrain for their roosts. Red data status - indeterminate;
9. Yellow golden mole - Rare.
10. Honey badger - vulnerable

Birds

From an avifaunal point of view, Pafuri is strategically situated for many species. From a sub-regional perspective, the ecology of the area has been influenced by a mesic temperate regime from the south and west, an arid climatic regime from the northwest and a more tropical, humid influences from the north (Hurford, 1993). This has given rise to a wide diversity of bird species in the Pafuri area which is situated in the centre of this region. Some of the birds, which occur in the area, are tropical species that reach the southern limit of their ranges here hence, marginally occur within the boundaries of South Africa. Others are generally rare and considered threatened and their conservation is of importance not just within the Kruger National Park (K.N.P.) but, also abroad.

The large diversity of habitats, which occur in the area between the Luvuvhu and Limpopo Rivers, supports a diversity of species. The riparian forest with its abundance of fruit-bearing trees, the floodplain pans, and the dense riparian/riverine bush provide food, shelter and nesting sites for the highest number of bird species found in the Kruger National Park (Newman, 1987). Over 450 bird species have been identified in the Pafuri area and 34 are restricted to this northern area (Sinclair, et al. 1992). The highest densities in South Africa of the scarce, nocturnal and regionally Endangered Pel's Fishing Owl (*Scotopelia peli*), occur along the Luvuvhu River. The rare African Pygmy Goose {*Nettapus auritus*; listed as regionally Vulnerable (see Table 6 (c) footnote for reference)} also occurs here. Sparse, but localised populations of Böhm's and Mottled Spinetail (*Neafrapus boehmi* and *Telacanthura ussheri* respectively), which are rare in South Africa, occur along the lower reaches of the Ramsar site where Baobab trees (*Adansonia digitata*) occur. The Basra Reed-Warbler (*Acrocephalus griseldis*), which is a very rare non-breeding Palaearctic vagrant that feeds along the tall weedy growth in riparian forests. The Sedge Warbler (*Acrocephalus schoenobaenus*), also a Palaearctic migrant, occurs here alongside the former but, in more riverine habitats. Some other resident species not encountered at lower latitudes are Grey-headed Parrot (*Poicephalus*

fuscicollis), Meve's Starling (*Lamprotornis mevesii*; Figure 2) and Three-banded Courser (*Rhinoptilus cinctus*). Due to the above, the Luvuvhu/Limpopo region is widely acknowledged amongst bird watchers as one of the top bird-watching areas in the country.

For the Makhuleke Ramsar site the following six pentads from SABAP2[6] covering the area mostly above and inside K.N.P. was used to compile a recent list of rare, uncommon and threatened species occurring in the area. Eight hundred and ninety-nine (899) "cards"/lists were submitted among these pentads since 2007. The pentads' identity codes are: 2220_3105, 2220_3110, 2220_3115, 2225_3105, 2225_3110 and 2225_3115 (Figure 1 shows a map of these pentads covering the site).

Table 6 (c) shows a list of rare/uncommon wetland/water-dependent bird species however, more common but, threatened species are found within these six pentads covering the Ramsar site. Some of these species make use of the surrounding terrestrial savanna landscape. For example, four of the five vulture species are found at very low reporting rates around the Makhuleke Ramsar site but, most make use of large trees for nesting sites. The commonest of the five species: White-backed Vulture (*Gyps africanus*), the less common Hooded Vulture (*Necrosyrtes monachus*) and exquisite White-headed Vulture (*Aegypius occipitalis*) are all listed Critically Endangered, regionally and globally! The Lappet-faced' (*Torgos tracheliotes*) and non-resident Cape Vulture (*Gyps coprotheres*; a cliff-nesting species) are considered Endangered regionally and globally (See Table 5 (c) footnote for bibliographic reference). These serious conservation statuses may lead to extinction in coming decades due to poisoning, the traditional medicine trade, removal of large savanna trees, reduction in scavenging opportunities and the presence of high-voltage electricity pylons and -wires that cause collisions and electrocutions, respectively. Apart from the Yellow-billed Stork (*Mycteria ibis*) in Table 5 (c), the more common Saddle-billed Stork (*Ephippiorhynchus senegalensis*) and uncommon Black Stork (*Ciconia nigra*) are heavily dependent on water bodies for their main food source of fish. Hence, the quality of water especially those of the Luvuvhu/Limpopo River systems are of critical importance in maintaining these threatened species' populations in South Africa. The regionally Endangered Martial Eagle (*Polemaetus bellicosus*) is reported ~12% of the time. Poisoning results in mortalities together with power line collisions. The Bateleur (*Terathopius ecaudatus*) is another common bird of prey that declined in recent years to Endangered status regionally and Near-threatened status globally.

[6] The South African Bird Atlas Project 2 (SABAP2; www.sabap2.adu.org.za) is a citizen science project in existence since 2007 and is one of the world's largest bird record databases of its kind available to the public. Recently, it has been amended to include bird species records from other African countries also but currently, provides valuable insights into South African bird spatiotemporal distributions. Registered SABAP2 members record bird species on lists named "cards" and submit these to the University of Cape Town's Animal Demography Unit. The resolution of the data is five minute by five minute latitude/longitude cells and each cell or block is between eight and 10 Km in width and height. Species receive reporting rate percentages where smaller values equate to scarcer species. Thus, every time a card is submitted for the specific pentad, its species reporting rates are updated depending on whether they were reported or not.

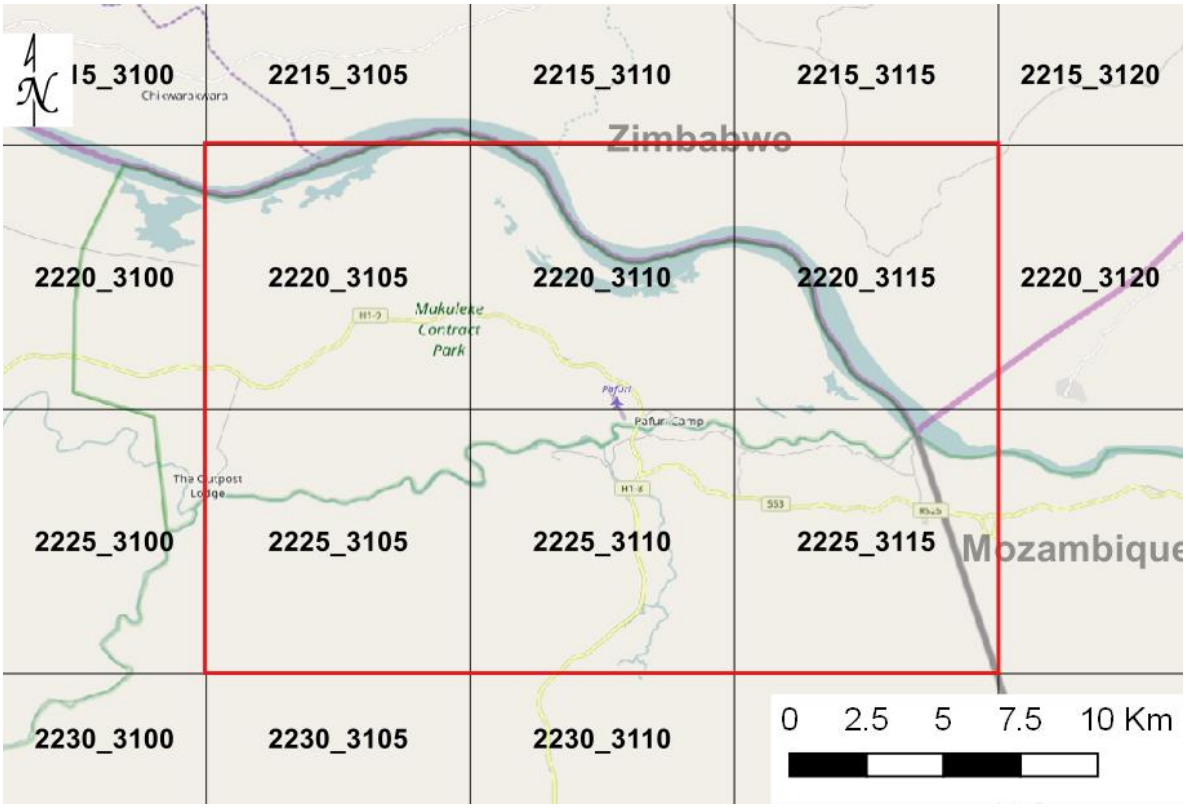

Figure 1: Pentads covering the Makhuleke Ramsar site that were used in the distribution map and reporting rate averaging. Eight hundred and ninety-nine (899) species lists were submitted since 2007 for these pentads (www.sabap2.adu.org.za; Accessed: 22 March 2017).

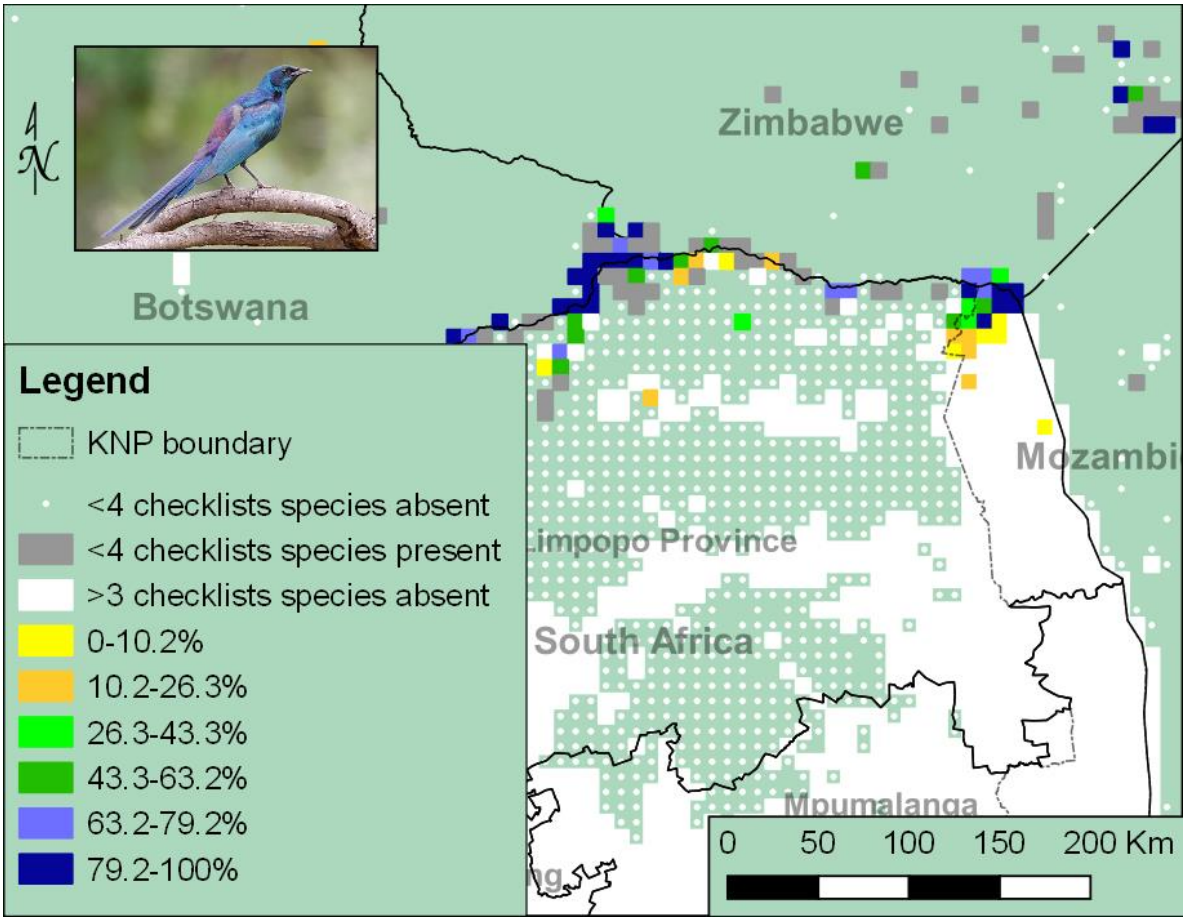

Figure 2: Distribution map of the Meve's Starling *Lamprotornis mevesii*, the most common bird species encountered in and around the Makhuleke Ramsar site. Pentads with <4 "cards"/lists provide inaccurate species reporting rates. Data was obtained from the South African Bird Atlas Project 2 (www.sabap2.adu.org.za; Accessed: 22 March 2017). Photo credit: Warwick Tarboton.

Table 6 (a): List of uncommon wetland/water-dependent birds found in the Makhuleke Ramsar site (Maclean, 1993; Newman, 1987; Sinclair, et al. 1992; Tarboton, et al. 1987).

Latin name	**Common name**	**Status in south africa (s.a.) - SA Red Data Book (Siegfried et al. 1976) and SA Red Data Book (Brooke, 1984).**
Pelecanus onocronatus	Great White Pelican	Rare.
Pelecanus rufescens	Pink-backed Pelican	Rare and threatened.
Ciconia nigra	Black Stork	Breed on cliffs of Pafuri region, very few nests in S.A. Intermediate - vulnerable.
Mycteria ibis	Yellow-billed Stork	Rare
Anastomus lameliigerus	African Openbill	One of two breeding colonies in S.A. and the largest breeding colony. Rare and threatened.
Ciconia episcopus	Woolly-necked Stork	Rare.
Ephippiorhynchus senegalensis	Saddle-billed Stork	Rare.
Leptoptilos crumeniferus	Marabou Stork	Rare and one of two breeding sites in S.A.
Botaurus stellaris	Eurasian Bittern	Vulnerable
Nattapus auritus	African Pygmy-Goose	Mostly in the pans of floodplains of the Limpopo and Luvuvhu Rivers. Rare.
Vanellus albiceps	White-crowned Lapwing	Highest density in S.A. on the Luvuvhu River. Rare.
Charadrius marginatus	White-fronted Plover	Rare, but common on the Limpopo River. Peripheral. Rare and vulnerable.
Gyps africanus	White-backed Vulture	High densities in the K.N.P. on the Limpopo and Luvuvhu Rivers - breeding in riparian zone. Rare and threatened.
Motacilla clara	Mountain Wagtail	Only common along Mutale and Luvuvhu Rivers in the K.N.P.

Table 6 (b): List of uncommon birds found in the terrestrial habitats surrounding the Makhuleke Ramsar site (Maclean, 1993; Newman, 1987; Sinclair, et al. 1992; Tarboton, et al. 1987). :

Latin name	**Common name**	**Status in south africa (s.a.) - SA Red Data Book (Siegfried et al. 1976) and SA Red Data Book (Brooke, 1984).**
Rhinoptilus cinctus	Three-banded Courser	Only sightings in SA and the only breeding site in SA..
Stephanoaetus coronatus	African Crowned Eagle	Uncommon in K.N.P., but localised at Pafuri
Falco peregrinus	Peregrine Falcon	Scarce or rare visitor that breeds in the Luvuvhu gorge just upstream of the Ramsar site. Rare breeding resident race.
Polihierax semitorquatus	Pygmy Falcon	Common to scarce. Vulnerable
Aplopelia larvata	Cinnamon Dove	Rare in K.N.P., but localised at Pafuri.
Scotopelia peli	Pel's Fishing Owl	Uncommon resident in S.A. - highest densities on the Luvuvhu River. Rare and vulnerable.
Neafrapus boehmi	Böhm's Spinetail	Uncommon. Resident at Pafuri. Nests inside hollow baobabs. Rare and local.
Telacanthura ussheri	Mottled Spinetail	Uncommon, only resident at Pafuri. Rare.
Merops hirundineus	Swallow-tailed Bee-eater	Rare in the K.N.P. and only recorded along the Limpopo River
Coracias spatulata	Racket-tailed Roller	Uncommon in S.A. - resident at Pafuri
Coracina caesia	Grey Cuckooshrike	Uncommon resident in S.A. Resident in small numbers on the Luvuvhu River
Oriolus auratus	African Golden Oriole	Uncommon visitor to SA. Restricted to the north of the K.N.P.
Erythropygia leucophrys	Bearded Scrub-Robin	Resident in riverine forests of the northern K.N.P.
Acrocephalus schoenobaenus	Sedge Warbler	Uncommon in the K.N.P. where it has only been recorded from the north
Malaenornis mariquensis	Marico Flycatcher	Uncommon in the K.N.P. where it has only been recorded from the north
Platysteira peltata	Black-throated Wattle-eye	Uncommon localised resident to S.A. Only seen in Pafuri. Peripheral.
Laniarius aethiopicus	Tropical Boubou	Occurs only in the north of the K.N.P. Rare
Laniarius atrococcineus	Crimson-breasted Shrike	Rare in K.N.P. with sightings only in the north
Telophorus nigrifrons	Black-fronted Bush-Shrike	Rare and vulnerable
Telophorus olivaceus	Olive Bush-Shrike	Rare in K.N.P. where it has only been recorded from the north
Lamprotornis mevesii	Meve's Starling	Uncommon resident in S.A. Only resident in the Limpopo/Luvuvhu River valley. Peripheral
Nectarinia venusta	Yellow-bellied Sunbird	Uncommon in S.A. Peripheral and rare.
Zosterops senegalensis	Yellow White-eye	Uncommon in S.A. where it has only been recorded from the Limpopo/Luvuvhu region

Latin name	Common name	Status in south africa (s.a.) - SA Red Data Book (Siegfried et al. 1976) and SA Red Data Book (Brooke, 1984).
Acrocephalus griseldis	Basra Reed-Warbler	Third sighting in S.A. along the Luvuvhu River

Table 6 (c): Rare wetland/water-dependent bird species (reporting rates <10%) obtained from the SABAP2 database (Accessed: 22 March 2017). The table is arranged in order of descending reporting rate, i.e. rarest species at the bottom of the list. Hockey et al. (2005) can be consulted for Latin names and southern African bird species accounts.

	Common name	Mean SABAP2 reporting rate (%)	Regional conservation status*	Global conservation status*
1	Jacana, African	9.9	LC	LC
2	Heron, Goliath	9.8	LC	LC
3	Swallow, Wire-tailed	9.1	LC	LC
4	Thick-knee, Water	8.1	LC	LC
5	Kingfisher, Giant	8.0	LC	LC
6	Egret, Little	7.6	LC	LC
7	Stork, Woolly-necked	7.4	LC	LC
8	Plover, White-fronted	7.3	LC	LC
9	Duck, Comb	7.2	LC	LC
10	Stork, Yellow-billed	6.5	EN	LC
11	Martin, Brown-throated	6.5	LC	LC
12	Goose, Spur-winged	6.5	LC	LC
13	Spoonbill, African	6.0	LC	LC
14	Duck, White-faced	5.8	LC	LC
15	Waxbill, Common	5.2	LC	LC
16	Cisticola, Rufous-winged	5.1	LC	LC
17	Cormorant, Reed	4.8	LC	LC
18	Kingfisher, Malachite	4.4	LC	LC
19	Stork, Black	4.4	VU	LC
20	Crake, Black	4.2	LC	LC
21	Lapwing, White-crowned	4.1	LC	LC
22	Heron, Squacco	4.0	LC	LC
23	Darter, African	3.9	LC	LC
24	Sandpiper, Marsh	3.9	LC	LC
25	Grebe, Little	3.6	LC	LC
26	Waxbill, Orange-breasted	3.6	LC	LC
27	Plover, Kittlitz's	3.3	LC	LC
28	Painted-Snipe, Greater	3.3	NT	LC
29	Stilt, Black-winged	3.3	LC	LC
30	Teal, Red-billed	3.3	LC	LC
31	Egret, Yellow-billed	3.0	LC	LC
32	Stint, Little	2.9	LC	LC
33	Night-Heron, Black-crowned	2.9	LC	LC
34	Bittern, Dwarf	2.8	LC	LC
35	Heron, Grey	2.7	LC	LC
36	Ibis, Glossy	2.7	LC	LC
37	Tern, Whiskered	2.6	LC	LC
38	Openbill, African	2.6	LC	LC

	Common name	Mean SABAP2 reporting rate (%)	Regional conservation status*	Global conservation status*
39	Pygmy-Goose, African	2.6	VU	LC
40	Ruff	2.4	LC	LC
41	Fishing-owl, Pel's	2.4	LC	EN
42	Reed-warbler, Great	2.3	LC	LC
43	Bittern, Little	2.2	LC	LC
44	Teal, Cape	2.2	LC	LC
45	Tern, White-winged	2.2	LC	LC
46	Finfoot, African	2.0	VU	LC
47	Rush-warbler, Little	1.9	LC	LC
48	Cormorant, White-breasted	1.8	LC	LC
49	Heron, Purple	1.8	LC	LC
50	Pelican, Great White	1.8	VU	LC
51	Swallow, White-throated	1.6	LC	LC
52	Swallow, Pearl-breasted	1.6	LC	LC
53	Lapwing, African Wattled	1.6	LC	LC
54	Swamp-Warbler, Lesser	1.6	LC	LC
55	Moorhen, Lesser	1.5	LC	LC
56	Heron, Black	1.4	LC	LC
57	Duck, White-backed	1.3	LC	LC
58	Gallinule, Allen's	1.3	LC	LC
59	Rail, African	1.3	LC	LC
60	Reed-Warbler, African	1.3	LC	LC
61	Duck, African Black	1.2	LC	LC
62	Duck, Fulvous	1.1	LC	LC
63	Plover, Chestnut-banded	1.1	NT	NT
64	Skimmer, African	1.1	LC	LC
65	Kingfisher, Half-collared	1.0	NT	LC
66	Sandpiper, Green	1.0	LC	LC
67	Gull, Grey-headed	1.0	LC	LC
68	Harrier, Pallid	1.0	NT	NT
69	Snipe, African	0.9	LC	LC
70	Plover, Common Ringed	0.8	LC	LC
71	Night-Heron, White-backed	0.7	VU	LC
72	Crake, Corn	0.6	LC	LC
73	Harrier, Montagu's	0.6	LC	LC
74	Pochard, Southern	0.6	LC	LC
75	Flamingo, Greater	0.5	NT	LC
76	Osprey	0.5	LC	LC
77	Crake, Striped	0.4	LC	LC
78	Crake, African	0.4	LC	LC
79	Duck, Yellow-billed	0.3	LC	LC

* - Taylor, M.R., Peacock, F. and Wanless, R.W. (eds.) 2015. *The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland*. BirdLife South Africa, Johannesburg; LC – Least Concern, NT – Near-threatened, VU – Vulnerable, EN – Endangered.

Reptiles

The Pafuri area is unrivalled in most parts of southern Africa in terms of its abundance and diversity of reptiles (Jacobsen, et al. 1994; Jacobsen, et al. 1989; Pienaar, et al. 1983). Of the 108 recorded species in the Kruger National Park, no fewer than 90 have been collected in some or other part of the Pafuri area. Several species are more or less restricted in their respective distributional ranges within the Park to this area, and two species i.e. Lang's round-snouted *amphisbaenian* and the golden blind skink have their centres of distribution here.

The Limpopo-Luvuvhu area is where the only specimens of the Pafuri flat gecko, the Transvaal flat gecko, Stevenson's/Khami dwarf gecko, the Limpopo dwarf burrowing skink and Kalahari wedge-snouted amphisbaenian have been collected (Jacobsen, et al. 1994). Recently, several specimens of the Horned adder were found on Mabyeni hill which lies adjacent to the Ramsar site. This provides evidence of a zoogeographic link between this area and the more arid western regions of southern Africa. A list of reptiles which are found in the area adjacent to the rivers and floodplains is provided in appendix 2.

Reptiles occurring in the floodplains and the Luvuvhu and Limpopo Rivers include the following:

1. Peter's Flat Skink - In the Transvaal these skinks have a limited distribution. In the Park, the species has been recorded at the confluence of the Luvuvhu and Limpopo Rivers, the eastern boundary between the Mathlakuza pan and Saselandonga gorge and the eastern boundary north of Nwanetsi. The status of this species is only regarded as secure in the former Transvaal because it occurs in the Park;
2. Slender Wedge-snouted Amphisbaenian - The distribution of this Amphisbaenian is along the Limpopo River (Branch, 1988). In the Park they have only recorded from the far northern sections where there is a substrate of deep sand (Pienaar et al, 1983).
3. Common African Python - Vulnerable
4. Nile crocodile - Vulnerable

Table 7. Crocodile counts in the Luvuvhu and Limpopo rivers in the Kruger National Park (Viljoen, 1991; Viljoen, 1993; Viljoen, 1995, Greaver & Ferreira, 2016).

Size class	**Year**												
	84	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**2016 ***
Very big	*	11	17	35	2	4	9	12	*	5	2	5	13
Big	81	72	80	68	47	25	73	77	44	94	90	76	193
Medium	13	11	15	10	75	98	21	16	52	73	86	75	68

	2	8	4	3			0	0					
Small	91	79	82	31	64	54	89	64	39	66	42	49	28
Unclassified	135	126	159	329	46	154	41	31	63	9	62	13	1
Total	439	406	492	566	234	335	422	344	198	247	282	218	303

* Not differentiated

Amphibians

Of the 33 amphibian species indigenous to the Ramsar Site, 28 are tropical forms (Passmore, et al. 1995). This area represents the only recorded localities in the KNP for the Vlei Frog and the Ornate Frog. The Vlei Frog is also known to occur in northern Kwazulu-Natal. This area also represent the south-western limits of the range of distribution of the Golden Spiny Reed Frog, and the Dune Squeaker and in most instances, are the only records of their presence within the borders of the Transvaal (Pienaar, et al 1976).

The Dune Squeaker is an inhabitant of Northern Zululand, Mozambique and Zimbabwe. It was not known to occur in the former Transvaal until very recently when it was discovered in the riverine forest of the Luvuvhu River near Bobomene Drift in the Pafuri area of the Kruger National Park. This frog has a limited distribution in South Africa and only occurs in the coastal dune forest at Cape Vidal and in the far northern areas of the Park where it has been collected from Shipudza spring and from Bobomene.

Fish

A total of 38 fish species have been recorded in the Luvuvhu and Limpopo Rivers in the Ramsar wetland area. The eastern part of the Luvuvhu River in the area is also the transitional zone between the foothill bio-region and the tropical bio-region, resulting in some cool water species such as the mountain catfish, and shortspine rock catlet entering the warm Lowveld region (Pienaar, 1978). In 1950 a Zambezi shark was also collected at the Luvuvhu/Limpopo confluence. These sharks are common in the coastal waters off Mozambique and northern Kwazulu-Natal. With the Luvuvhu River having changed from an perennial to a seasonal river by activities outside the Park, the habitats of fish species such as the rock catlets and the mountain catfish which need flowing water to survive, are being threatened (Pienaar, 1978; Skelton, 1987).

Recorded fish species preferring different habitats of the Luvuvhu:

Backwaters/deep pools: *Barbus annectens, Barbus radiates, Oreochromis mossambicus, Pseudocrenilabrus philander, Serranochromis meridianus, Tilapia rendalli, Petrocephalus catostoma, Hydrocynus vittatus, Barbus afrohamiltoni, Labeo congoro, Labeo rose, Labeo ruddi, Schilbe intermedius, Clarias gariepinus, Synodontis zambezensis, Tilapia sparrmanii,*

Glossobius giuris, Anguilla marmorata. Anguilla bengalensis labiate

Marginal/Riparian Fringe: *Micralestes acutidens, Barbus unitaeniatus, Barbus viviparous, Barbus trimaculatus, Marcusenius macrolepidotus, Brycinus imberi, Barbus toppini, Chiloglanis swierstrai*

Runs: *Barbus trimaculatus, Micralestes acutidens, Barbus eutaenia, Mesobola brevianalis, Schilbe intermedius, Chiloglanis swierstrai*

Riffles/Rapids: *Opseradium perinque; Barbus marequensis; Labeo molybdinus; Labeo cylindricus; Chiloglanis anoterus; Chiloglanis paratus; Chiloglanis pretoriae; Barbus argenteus; Anguilla mossambica*

Table 8. Fish species rare to the Lowveld area, found in the Ramsar site.

Name	**Status**
Amphilius uranoscopus Stargazer mountain catfish	Rare in the Ramsar area: only in the western section of the Luvuvhu River; constitutes the eastern-most limit of the distribution of this species.
Aplocheilichthys johnstonii Johnston's topminnow	Rare in the Ramsar area; has only been recorded from the Luvuvhu River, in the Pafuri area.
Awaous aeneofuscus Freshwater gobi	Rare in the Ramsar area; Found in the Pafuri area of the Luvuvhu River.

Deterioration of the Lowveld rivers due to water abstraction, siltation and pollution, causes that the environmental conditions for sensitive fish species are becoming less suitable. The Luvuvhu River is still in a relative acceptable state, although it stopped flowing in recent years during the low rainfall periods in the winter. Fish, sensitive to changes in quality and quantity fluctuations, that can still be found in the Luvuvhu River, but become rare or absent in the other tributaries of the Limpopo River (including the Olifants and Letaba Rivers in the Kruger National Park), are listed in table 8 below.

Table 9. Fish, sensitive to changes in quality and quantity fluctuations that can still be found in the Luvuvhu River, but become rare or absent in the other Limpopo tributaries.

Scientific name	**Common name**
Anguilla marmorata	Madagascar mottled eel
Anguilla mossambica	Longfin eel
Chiloglanis pretoriae	Limpopo or Dwarf rock catlet
Chiloglanis swierstrai	Lowveld of Bearded catlet
Hydrocinus vittatus	Tigerfish

Labeo congoro	Purple labeo
Marcusenius macrolepidotus	Bulldog
Micralestes acutidens	Silver robber
Petrocephalus catostoma	Churchill
Tilapia rendalli	Southern redbreast tilapia
Barbus afrohamiltoni	Hamiton's Barb
Total number of species in the Ramsar wetland section of the Luvuvhu and Limpopo Rivers is 38.	

It must also be noted that the hybridisation of the native Mozambique Tilapia (*Oreochromis mossambicus)* is known to have occurred with exotic Nile Tilapia (*O. niloticus*) in the Limpopo system as a whole and this is expected to have impacted the native population in the Luvuvhu.

Invertebrates

A total of 28 taxa representing 18 genera have been recorded exclusively in the Luvuvhu River (Moore & Chutter, 1988). Limited sampling has been done in the pans along the Limpopo floodplain and many more species are bound to still be discovered in this area. Most of the species occurring in the Pafuri/Limpopo area, would most probably also occur in the Makuleke Property section of the Ramsar site.

Dyamond (2017) determined that the macro-invertebrate diversity across the Makuleke pans is a diverse assemblage characteristic of Southern African waters and that these systems are dominated by species tolerant (low sensitivity) to significant changes in environmental variables such as water quality. Furthermore, these surveys concluded that the pan macro-invertebrate ecology indicates low impacts of upstream anthropogenic influence and retain a viable ecology. In total 113 macro-invertebrate taxa of 51 families and 12 orders were identified with the dominant taxa including; *baetidae, belostomatidae, ceratopogonidae, chironomidae, corixidae, hirudinae, hydrophilidae, libellulidae, lumbriculidae, noteridae, notonectidae* and *planorbidae*. The diversity decreases from wet to dry seasons.

Zooplankton

Dyamond (2017) identified 14 different taxa of zooplankton within the pans, these being from 8 families and 4 orders. As with the macro-invertebrates, the diversity of zooplankton decreases from wet to dry seasons.

Diatoms

Kock (2016) determined that approximnately 70 species of diatom exist across the wetland network, with each pan hosting between 12-20 species. Dominant species include: *Aulacoseira granulata, Gomphonema parvulum, Navicula sp.* and *Nitzschia sp.*

21. Social and cultural values:

e.g., fisheries production, forestry, religious importance, archaeological sites, social relations with the wetland, etc. Distinguish between historical/archaeological/religious significance and current socio-economic values.

In 1969 some 3000 people belonging to the Makuleke clan were removed from a 25 000 hectares of land between the Luvuvhu and Limpopo Rivers so that the boundaries of the Kruger National Park could be expanded to the Limpopo. The Makuleke livelihoods and cultural systems on the land between the rivers were adapted to the abundance of natural wealth that surrounded them. The soil on the river was fertile, nourished by nutrients carried in the waters of the Luvuvhu when it flooded. People could eat figs, maroela and jackal berries that grow wild in the bush.

People used xirongos – cylindrical baskets from reeds – to trap fish. Other fishing methods included using traps that were set in the water in a way that allowed fish to enter but not escape. Spears carved with a barded hook on the end were also used. In summer when the rivers were full, people used locally-made nets. Different species of fish provided a vital source of protein especially in the months of food scarcity – the agricultural off-season - when cultivated crops and wild fruits were scarce.

Hunting was an important element in their subsistence methods. The Makuleke operated with traps, snares, bows and arrows, and occasionally with rifles. Ivory and the skins of civet cats were sold, but meat, as the main source of protein was the main product of the hunt. Hunting also had socially important role as the distribution of venison cemented kinship links and solidarity. Chiefs were also recognised through gifts of lion and leopard skins.

The villagers made a wine called Vuchemas from the Malala palms that grow in few other parts of the country that had a high nutritional value.

After the removal, the Makuleke were resettled in the southwest of the Punda Maria entrance of the Kruger National Park in the area called Ntlhaveni. The conditions at Ntlhaveni did not have the rich mix of natural resources that existed on the floodplains of the rivers. The Makuleke community associate their removal with a sharp decline of livelihoods.

Ntlhaveni falls within Malamulele region of the Limpopo Province. According to the Development Bank of Southern Africa's 1998 Development profile, the Limpopo Province is amongst the poorest provinces in the country. The Malamulele region in turn is amongst the poorest in the province. The following are some of its characteristics:

- Unemployment is around 60% and out-migration is very high. The average increase in unemployment since 1980 is more than 20%.
- Pensions, remittances, occasional selling of agricultural surpluses and infringement informal activity are the main sources of income.
- More than one in four people live more than 5 kilometres from medical facility
- Infant mortality is 57 per 1000 births. The countries average is 41.8 per 1000. In 1994, 35.6% of the children between four and five years were stunted due to poor nutrition.
- Residents rely primarily on communal taps and only 7% of the dwellings have

water-borne sewerage.
- Electricity and communal telephones have recently been installed – including cell phone masts. However, there is still extensive reliance on fuelwood for cooking and heating.

The area is well known for its archaeological sites and extensive excavation are still being undertaken in the area. More than 30 archaeological sites of continuous human settlement dating back to the first century AD have been identified. The area is very historically significant to the Makuleke Community. It has several sites illustrating their traditional ways of living, such as hunting, fishing and ploughing. The Makuleke Royal family graveyard is valuable for the Makuleke community. Every year on the 24th of September they visit the site to perform "the ancestral calling and thanks giving" ceremony. There is an old store at the Crook's Corner built by a Portuguese, Fernandez, from Mozambique. The Crook's Corner was used for trade to people from Mozambique, Zimbabwe and South Africa. Closer to it there is a grave for the famous hunter, Vekenya, well known for hunting in all three countries sides, South Africa Zimbabwe and Mozambique. All pans still have good memories to the Makuleke elders. Some of pans named after the people living close to them.

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22. Land tenure/ownership:
(a) within the Ramsar site:

The majority of the Ramsar site falls within the boundary of the Kruger National Park and therefore falls under the jurisdiction of the Joint Management Board. The Ramsar site is a tribal land that belongs to Makuleke Communal Property Association. The Government of South Africa established a Communal Property Association in 1996 to enable tribal authorities to own piece of land. The Makuleke Tribal Authority got their land, which used to be in the Kruger National Park. The title deed was obtained in 1999 through the Constitutional Court. Presently the Joint Management Board, comprising members of Makuleke Communal Property Association and South African National Parks, is managing the land as a contractual park. The Makuleke Communal Property Association has full rights and the Joint Management Board is responsible for conservation and management of the area.

The portion of the Ramsar site outside of the Kruger National Park is state land. Since 1968, the land use and access has been restricted for military purposes. As such, the South African National Defence Force (SANDF.) manages the area.

(b) in the surrounding area:

No information

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23. Current land (including water) use:
(a) within the Ramsar site:

a. Ramsar site

The major portion of the Ramsar site is conserved within the borders of the Kruger

National Park. It is thus managed by the Joint Management Board for nature conservation. The Luvuvhu/Limpopo region represents one of the major biodiversity "hotspots" in South Africa (Tinley, 1978), with many species of a wide range of animal groups occurring only in this very small area of the country. Given the arid nature of the region, the low potential for agricultural yield and animal husbandry, together with the fact that anthrax is endemic in the area, the most suited land-uses are nature conservation and ecotourism. Ecotourism currently represents the only viable option for sustainable, long-term use of this area, with a good potential for generating revenue without impacting on the unique biodiversity present here (Venter, et al. 1994).

There has been no agricultural production in the Madimbo area since the SANDF. took over in 1968. However, there used to be subsistence cropping in the alluvial soils along the Limpopo and in a few lands on the flat, red-soils of the area. Cattle were also grazed in the area at that time. Towards the end of 1995, cattle were allowed to graze in the Corridor because there was no grazing left outside the area. The carrying capacity of the veld (grass and trees) is said to be about 18 ha per large stock unit on average, but this can drop to 30 ha per large stock unit during a drought. There is no resident population in the Corridor except for the military and their personnel who are not stationed there permanently.

(b) in the surroundings/catchment:

b. Surroundings and catchment:

The Limpopo River basin is extremely large and at this stage it is not possible to quantify the different land uses. It is reasonable to estimate that commercial and subsistence agriculture, together with cattle and game farming probably constitute the major land uses along this river. A few small towns do occur along the river and it's tributaries. The area that bounds the southern border of the Makuleke Property is sparsely populated and is mainly used for grazing. The Chickwarakwara irrigation project is situated in Zimbabwe, opposite Mabiligwe, north of the Limpopo River. The rest of the area in Zimbabwe is tribal land and is utilised by the local population for small-scale agriculture and stock farming, as well as a concession area for trophy hunting. The predominant current land uses in the Luvuvhu River basin are natural veld (51%) and national parks / nature reserves (30%). Cultivated lands comprise 13% (including irrigated lands which occupy 3% of the catchment). Afforestation comprises 4% of the catchment. Urban development comprises 3% of the basin area. The land use therefore ranges from commercial farms and forestry estates in the higher lying southwestern parts of the basin, to predominantly subsistence agriculture and grazing lands in the central basin. The lower lying northeastern part of the catchment is dominated by protected game reserve areas. A trend towards more intensive land uses (urban, irrigation and afforestation) can be expected outside the Kruger National Park.

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24. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land (including water) use and development projects:

(a) within the Ramsar site:

a. Ramsar site

The low flows, which have and still continue to be experienced in the lower Luvuvhu River in the Kruger National Park, have resulted from water abstractions upstream. At the time of registering the Makuleke Ramsar Wetlands the Luvuvhu river flow modifications had the effect of changing a perennial river to one with a seasonal flow (Venter, et al. 1994). This has led to undesirable changes in the natural environment of this river system. Along the downstream reaches of the river, such as in the Kruger National Park and adjacent to some irrigation schemes outside of the Park. Up to that pointthere were years with noticeable periods of low river flows and the death of river bank vegetation. In recent years, the water table in the Luvuvhu floodplain has lowered beyond the reach of roots of well-established fig trees. The result was that large stands of old fig tree forests died. In addition, the bedrock-"pockets" where Syzygium and Breonadia trees were abundant, also dried out and many of these trees also died (Deacon, pers. comm.). It is unclear to what extent the low flows were attributable to development in the upper reaches of the river and to what extent due to climate changes and the effects of the previous major droughts of 1991-92. What is clear however, is that the reduced flows simply exacerbated the effects of the drought.. There is already full use of the river base flows by upstream users during low rainfall periods. The consequences of a reduction in flow in the Luvuvhu River has caused:

- extended periods of no flows in the river;
- receding ground-water levels;
- extensive stretches of river bed (channel) and pools or refugia to dry up; and
- the accretion of sediment.

In addition, there is an increase in total dissolved solids (TDS) along the lowest reaches of the Luvuvhu River which is probably due to an increased proportional contribution from the drier sub-catchments as well as the geology of the lower basin. Whilst the river was reported to run clear in winter in the past, nowadays it is turbid throughout the year.

Realising the importance of the Luvuvhu River, its floodplain, pans and associated riparian corridor, as a unique ecological entity, and its value for the ecotourism sector, the Department of Water Affairs and Forestry launched an instream flow requirement study to determine the ecological needs of the river and associated floodplain system (DWAF, 1990). This was updated by Louw & O'Keeffe (1998) as a first order attempt to derive an environmental water requirement for river system operations. The latter are now thede facto rules used to release flows from the Nandoni Dam n the Luvuvhu River. These rules have shown success in ensuring that the Luvuvhu river flowed throughout the severe drought of 2015-16, and therefore significantly better than in previous droughts where it stopped flowing.. Importantly however, these are still interim EWR rules, and the Luvuvhu as of 2017 lacks any formal catchment protection in terms of a Management Class and Comprehensive Ecological Reserve (EWR) Determination study. The KNP continues to push for this at every opportunity especially as it relates to successful management of the Ramsar site. There also remains a continuing concern with dam operationson the effect of a dam on the sediment movement onto and through the floodplain system (trapping of sediment and the dampening effect of the dam on

floods).

Exotic aquatic plants such as Pistia and Azolla also pose a threat to the ecological integrity of the system.

A large threat to the integrity of the Ramsar site as well the adjacent ecotones and terrestrial area is mining. A recent permit to prospect for diamonds in the Mashakatini Nature Reserve was approved by the Department of Mineral and Energy Affairs and should diamonds be found, this area will face the threat of full-scale mining. Rehabilitation in this low rainfall area is extremely difficult and some argue that it is not possible. Mining is therefore a very large threat that will have long-term detrimental consequences for conservation in the area. Two coal-mines now exist upstream of the Ramsar site, on the Mutale tributary, whilst these are now in mine-closure mode continuous vigilance of these upstream activities is required.

While there is no population growth within the Makuleke Property, the population of the local people living outside of it is growing which is threatening the sustainable use of the natural resources in the area.

Redistribution of state-owned land for other purposes besides conservation and sustainable ecotourism also poses a threat.

Land claim by Makuleke community living southwest of Punda Maria entrance gate to Kruger National Park, in an area called Ntlhaveni, resulted in the restitution of land but not on main land use of the Ramsar site. The Makuleke community decided to retain the conservation status of the area when it was returned to them, with the aim of practising ecotourism. At present there are formal or accepted plans for development projects as listed below:

1. Building of three lodges to accommodate 200 beds.
2. Building of museum and interpretation centre
3. Building of tented camp for tour guides training
4. Hunting Safaris

All these projects will promote the sustainable utilization of natural resources.

(b) in the surrounding area:

b. Catchment area

A number of water supply schemes currently exist in the Luvuvhu River catchment which together with the Mutale tributary equates to 5652 km^2. These include the Nandoni Dam and the Xikundu weir together with the smaller Albasini, Vondo, Phiphidi and Tshakhuma dams which together with the purified water infrastrtucture are known as the Luvuvhu River Government Water Scheme (DWA, 2010). This schemes is now operated in most part by the Water Board Lepelle Northern Water, and the Nandoni scheme is presently being installed to supply greater Giyani in the neighbouring Letaba catchment. It is expected that annual water demands will increases from 2010 levels of 126 and 8 million m^3 in the Luvuvhu and Mutale

systems respectively to 204 and 12 million m^3 respectively by 2040 (DWA, 2014). Whilst runoff reduction of 11 and 80 million m^3 for invasive alien plants and streamflow reduction activities (agro-forestry), respectively, will continue at these present levels. This in the context that the natural Mean Annual Runoff for the Luvuvhu system is 584 million m^3 whilst present hydrological conditions in the catchment allow an MAR of 446 584 million m^3 (Bailey & Pitman, 2016).

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25. Conservation measures taken:

List national category and legal status of protected areas, including boundary relationships with the Ramsar site; management practices; whether an officially approved management plan exists and whether it is being implemented.

In accordance with the National Environment Management Protected Areas Act Act (Act 57 of 2003) the primary objectives include: the management of the Kruger National Park is to maintain a national system of protected areas om South Africa as part of a strategy to manage and conserve its biodiversity; provide for co-operative governance in the declaration and management of protected areas; promote sustainable utilisation of protected areas for the benefit of people, in a manner that would preserve the ecological character of the area; and promote participation of local communities in the management of protected areas where appropriate.
Since the majority of the Ramsar area falls within the Makuleke Contractual Park, they are the management authority for the region. A Conservation Development Framework was drafted in 2011 (Environmental Resources Management, Ltd, 2011) with future management recommendations for the entire contractual park, including the Ramsar sites themselves. This specifies a Special Management Zone for the Ramsar sites within the Makuleke Contractual Park. The role out of this management plan including a bio-monitoring protocol is presently underway.

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26. Conservation measures but not yet implemented:

e.g. management plan in preparation; official proposal as a legally protected area, etc.

The National Parks Board has an imaginative proposal to recreate the Limpopo Valley as a wildlife area and develop its potential as a major ecotourism destination, linking the protected areas of four countries in a trans-frontier park (Dongola Park). There have already been discussions with Mozambique about Transfrontier Conservation Areas (TFCA). The World Bank has made funds available for the implementation phase of the TFCA. As yet, there is still no clarity on further conservation measures in the Makuleke Property to the west.

27. Current scientific research and facilities:
e.g., details of current research projects, including biodiversity monitoring; existence of a field research station, etc.

There are two concessions (of 3 in total) who operate within the Makuleke Contractual Park who collect different levels of ecological data in the region with field research stations, these are EcoTraining and Return Africa. Furthermore, below is a list of recent projects co-ordinated through South African National Parks, Scientific Services.

Senior Researcher	Co-workers	Year Complete	Title	Objectives
Malherbe W	Smit N, Ferreira M, van Vuren JHJ, van der Merwe P	2017	The investigation of selected Ramsar wetlands biodiversity status and tourism value in support of the Ramsar convention information requirements: Makuleke Wetlands Case Study	*Determine what scientific information is available in terms o biodiversity of the Makuleke Wetlands.*
Lalley JS	Grab S, Mambo J, Viljoen M, Hardwick D, Antrobus RG, Knight C, Martin G, Zhogby B	2013	Makuleke Wetlands Ramsar Site: Biophysical Profiling of the Pan Network	*To establish a profile for all of these pans, which will help to requirements laid out by the Ramsar Convention on Wetlan proclamations and monitoring.*
Henley S & M	Douglas-Hamilton I, Roche C	2012	Transboundary elephant movements within the northern Kruger NP: A contribution to the Great Limpopo Transfrontier Park design	*To develop insights into the seasonal distribution patterns of around the Makuleke Concession and to determine to what elephant movement patterns between the far northern regio Gonarezhou NP and neighbouring areas can be explained by quality, safety benefits and accessibility.*

De Beer C	Kotze A, Jansen R, Dalton DL, Pietersen DW	2012	Molecular insights into the genetic variation of Cape Pangolin (Smutsia temminckii) populations in southern Africa	*To determine the genetic diversity, population structure and relationships of different populations of Cape Pangolin Smut southern Africa using microsatellite markers and full mitocho (mtDNA) sequencing.*
Pride RS	Lalley JS	2012	The implications of conservation land uses on the behavioural responses of five mammals within the Great Limpopo Transfrontier Park, Southern Africa	*To investigate the response behaviour of five mammals to th conservation land uses in the resource management zones o Transfrontier Park (GLTP).*
Antrobus RG	Pride RS, Lalley JS & Grab S	2012	The Influence of pan characteristics on their seasonal usage by mammals within the Makuleke Ramsar Wetland System	*This will help in maintaining the area's international status*
Maluleke GL	Robins S, Van der Waal K	2011	Rethinking protected area co-management in the Makuleke region, South Africa	*To examine the equality of the co-management agreement (SANParks and the Makuleke community*
Kearney TC	Seamark ECJ, Markotter W, Weyer J	2011	Inventory of bat species occurring at Pafuri (Makuleke Contractual Park), with a comparison of morphological and molecular identifications, and screening of voucher specimens for viruses	*To update the Chiroptera species records in the Pafuri area (Contractual Park) through active fieldwork, with the collectio specimens, tissues, and echolocation calls.*
Kearney TC	Seamark ECJ, Markotter W & Weyer J	2010	Inventory of bat species occuring at Pafuri (Makuleke Contractual Park) with a comparison of morphological and molecular identifications, and screening of voucher specimens for viruses	*To update the Chiroptera species recors in the Pafuri area th fieldwork with the collection of voucher specimens, tissues a calls.*
Manyaka M	Fraser	2006	The role of environmental education in promoting sustainable management of natural resources	*To determine the role that EE plays in promoting the sustain of natural resources using the agreement between the Maku and the Kruger National Park (KNP) as a case study.*

Turner RL	2003	Research on Makuleke region of the Kruger National Park	*The role of the state on communal management of protecte Africa.*

28. Current conservation education:
e.g. visitors' centre, observation hides and nature trails, information booklets, facilities for school visits, etc.

None

29. Current recreation and tourism:
State if the wetland is used for recreation/tourism; indicate type(s) and their frequency/intensity.

Day visitors game drives and picnic site

30. Jurisdiction:
Include territorial, e.g. state/region, and functional/sectoral, e.g. Dept of Agriculture/Dept. of Environment, etc.

Makuleke Communal Property Association
PO Box 305
SASELAMANI
0928

31. Management authority:
Provide the name and address of the local office(s) of the agency(ies) or organisation(s) directly responsible for managing the wetland. Wherever possible provide also the title and/or name of the person or persons in this office with responsibility for the wetland.

Joint Management Board
C/o: Punda Maria Camp
Kruger National Park
Private Bag X402
Skukuza
1350

32. Bibliographical references:
scientific/technical references only. If biogeographic regionalisation scheme applied (see 13 above), list full reference citation for the scheme.

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