



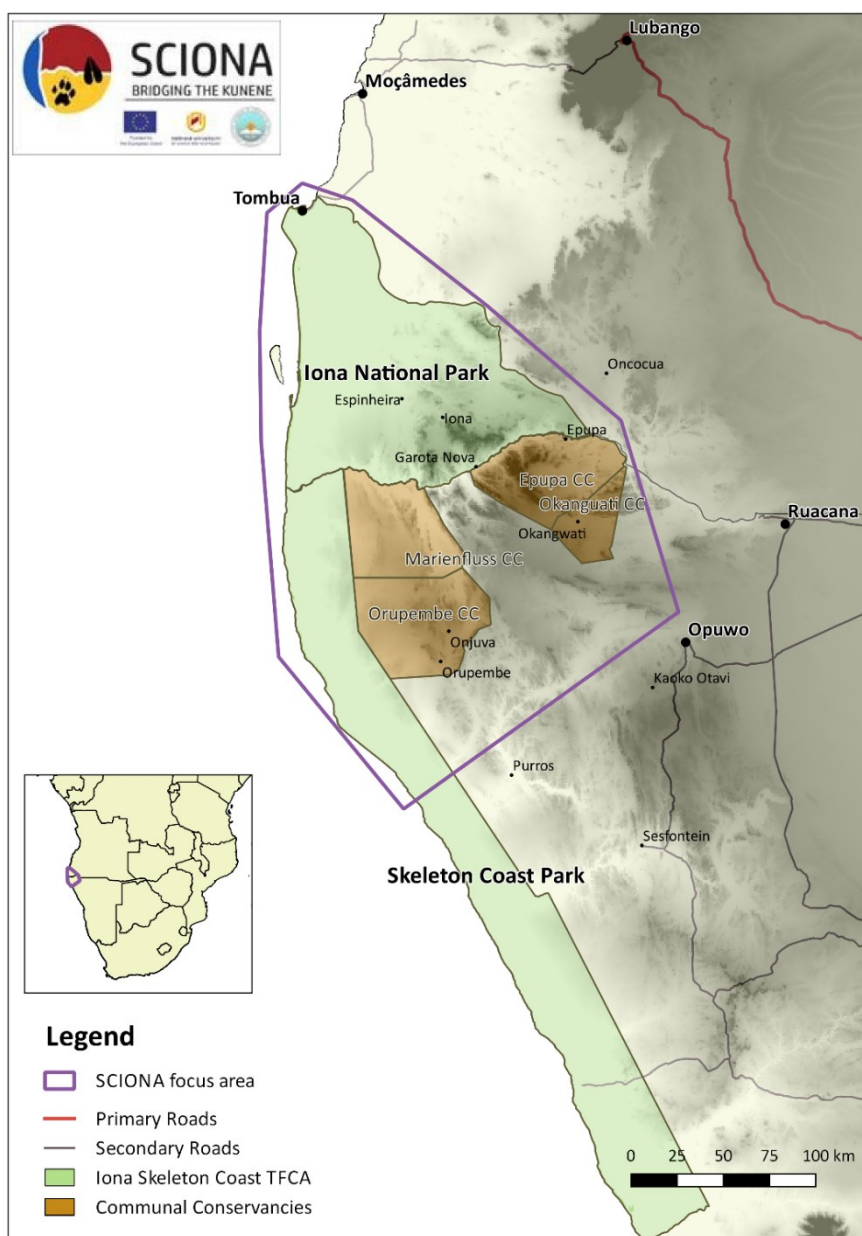
SCIONA
BRIDGING THE KUNENE



Funded by
the European Union



NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY



Assessment of status quo in the SCIONA study area Desktop study: Ecosystem management

Editor: Vera De Cauwer

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Introduction

SCIONA or “Co-designing conservation technologies for Iona - Skeleton Coast Transfrontier Conservation Area (Angola - Namibia)” is a project funded by the European Union (EuropeAid/156423/DD/ACT/Multi) that started in February 2018 and will last three years. The lead institute is the Namibian University of Science and Technology (NUST) and the main implementing partner the Instituto Superior de Ciências de Educação da Huíla (ISCED); the Higher Institute of Education Sciences of Huíla, Angola. The SCIONA project aims to strengthen cross-border ecosystem management and wildlife protection in the Iona – Skeleton Coast Transfrontier Conservation Area (TFCA) through co-designing and implementing conservation monitoring technology with the park authorities and surrounding communities. More information on the project is available at sciona.nust.na.

The Iona – Skeleton Coast Transfrontier Conservation Area (TFCA) is the newest TFCA in southern Africa, officially established in May 2018. For effective management of the TFCA, accurate, up-to-date information and a deeper understanding of the situation within the parks and the neighbouring conservancies is necessary. The SCIONA project therefore started with a thorough analysis of critical management information available for the TFCA and for four adjacent conservancies in northern Namibia. The assessment will consist of two components:

1. A community-based assessment that provides insight in the communities’ current livelihood and natural resource governance.
2. A desktop study that collects and evaluates ecosystem information required for natural resources management. This includes the data needed for the establishment of a SCIONA GIS database.

The information collected will allow the definition of ecosystem indicators and the development of an integrative sustainable ecosystem plan for the TFCA and adjacent areas.

This document summarises the information collected for the desktop study. Next to an overview of baseline ecosystem information for the study area, it focuses on critical conservation issues in the study area as defined by the SCIONA team, including the human-wildlife conflict, poaching, inadequate grazing management, mining, illegal fishing, and climate change. Key indicator species are proposed in the last chapter. The desktop study will be continuously updated throughout the project. This version will be submitted to the donor in April 2019.

I would like to thank everyone who contributed to this report; names of authors are added to the sections where they provided input.

Dr Vera De Cauwer
Editor
SCIONA Principal Investigator
NUST

1. The SCIONA study area: Iona-Skeleton Coast TFCA and adjacent areas

Contributions: Vera De Cauwer, Meed Mbizo, Marina Coetzee, Wessel Swanepoel

The Transfrontier Conservation Area (TFCA) concept aims to create transboundary megaparks from networks of conservation areas (Van Aarde & Jackson, 2007) to support conservation of natural resources and socio-economic development. The Iona - Skeleton Coast TFCA was established when the Memorandum of Agreement was signed on 3 May 2018 between the governments of Namibia and Angola. It is one of the larger transboundary conservation areas in southern Africa (34,043 km²) and contains the Skeleton Coast Park (SCNP) in Namibia and Iona National Park (INP) in Angola (Figure 1).

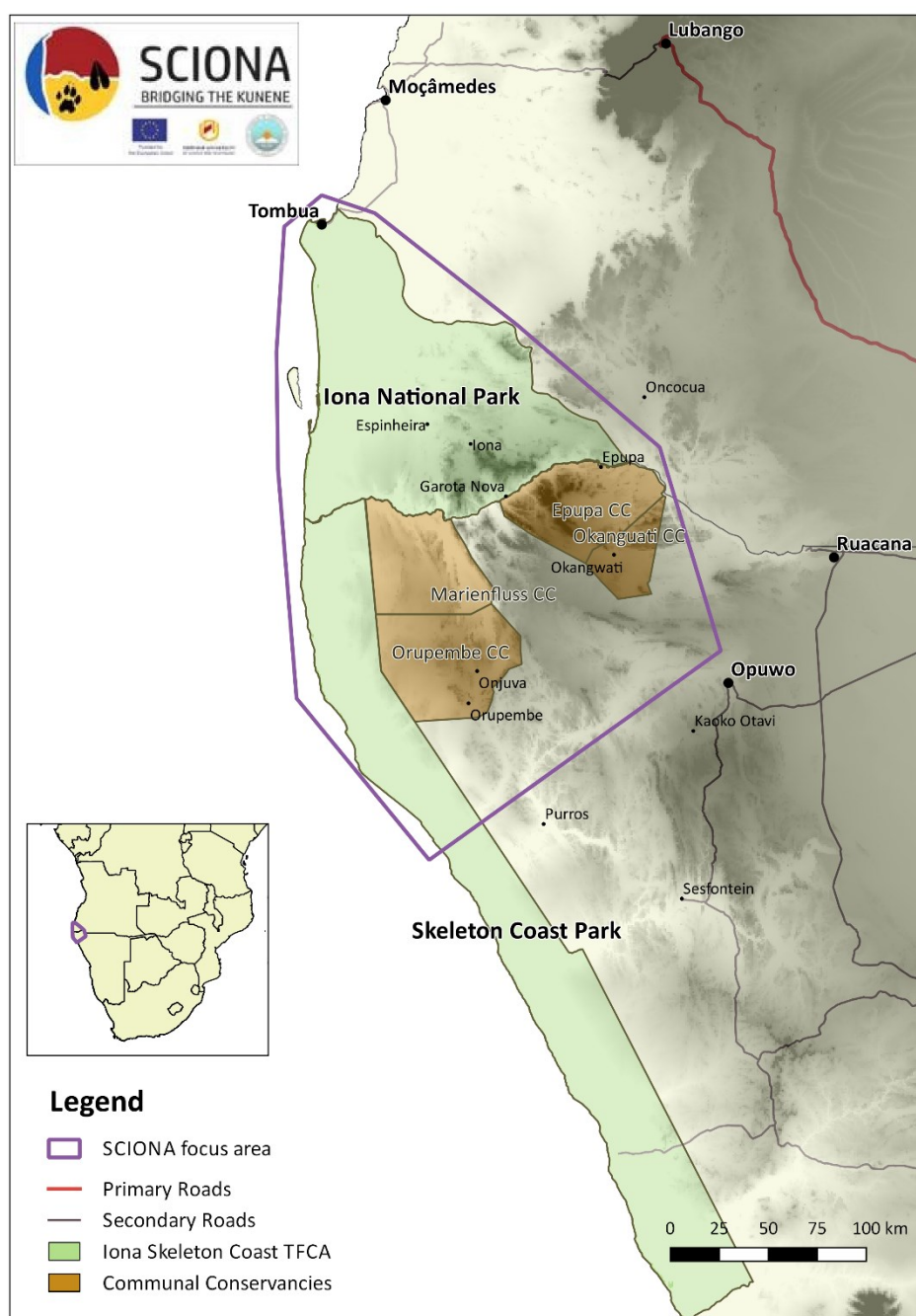


Figure 1: SCIONA study area (Mapping: V. De Cauwer)

The SCIONA study area includes the Iona – Skeleton Coast TFCA and four Namibian communal conservancies situated northeast of SCNP: Marienfluss, Orupembe, Okanguati, and Epupa. The SCIONA project focuses only on the northern part of the TFCA, up till the Khumib River and covers an area of 34,201 km² (Figure 1). This desktop study focuses on the SCIONA study area although several sections include information on the south of SCNP. SCNP stretches about 500 km along the Atlantic Coast of Namibia, from the Ugab River in the south to the Kunene River in the north and covers 16,820 km². When travelling from the Atlantic Coast inland, the park covers the first 26 to 46 km. Iona national park covers an area of about 15,150 km² (UNEP-WCMC & IUCN, 2019).

The TFCA is among the last wildernesses; it is situated within two of the most intact ecosystems of the planet: the Miombo – Mopane woodland ecosystem and the Kalahari – Namib Desert ecosystem. The Miombo – Mopane ecosystem is also among the five ecosystems with the highest biodiversity at global level (Mittermeier *et al.*, 2003). Compared to other TFCA's in the region, the area has little viable agricultural land, lacks industrial development, is difficult to access due to its remoteness and rugged terrain, and has a low population density. Only the Angolan part of the TFCA is inhabited and those communities compete for grazing with the wildlife. While the Angolan communities have not seen any benefit from tourism attracted to the TFCA, the Namibian communities are organised in conservancies that allow them to benefit from tourism activities within their conservancies. They indirectly benefit from the TFCA when the TFCA's wildlife ventures into the conservancies.

The TFCA mainly relies on basic institutional structures that are insufficient and result in poor ecosystem management and inadequate wildlife law enforcement. This is reflected by marine overfishing, poaching, habitat destruction caused by overgrazing, illegal mining, animal out-migration and local species extinction, threatening the sustainable future of the transboundary park. Poaching, overgrazing and animal out-migration are also observed in the conservancies adjacent to SCNP, where additionally, organised commercial rhino poaching takes place. The establishment of the TFCA can counteract these trends as many protected areas in the tropics have shown to be successful in protection of species and ecosystems (Bruner *et al.*, 2001). It initiated cross-border management, when the treaty was signed in May 2018,

Marienfluss conservancy

The Marienfluss conservancy covers a large area of 3,034 km² but encompasses a small population of around 340 people, most of whom speak Otjihimba. This conservancy was gazetted in January 2001. The conservancy is located in the desert with less than 100 mm average annual rainfall. Because of its arid environment, the Marienfluss has always been marginal for settlement, but has supported small groups of semi-nomadic Himba people for generations. The Marienfluss lies in the furthest reaches of an area formerly known as Kaokoveld. Wedged between the mountain ranges of the escarpment in the east and the Skeleton Coast Park in the west, the conservancy stretches north to the Kunene River, the border with Angola. To the south and east more conservancies cover most of the Kunene Region in a vast conservation landscape that also links to Etosha National Park with the coastal national parks.

The landscape is made up of rugged hills that cover the eastern area, while grasslands dominate the broad, central Marienfluss and Hartmann's Valleys. Extensive dunes cover the western section. Marienfluss falls under Desert and Nama-Karoo biomes and vegetation types of northern desert and north-western escarpment and Inselbergs. Some of the features that stand out are the Kunene River, Marienfluss Valley, dune fields, Hartmann's Valley, and Baynes Mountains. Springbok, gemsbok, and ostrich are common in Marienfluss. Other mammals include giraffe, mountain zebra, kudu, jackal, klipspringer, duiker, steenbok, and the diminutive dik-dik. Cheetah, leopard, spotted and brown hyaena do not reside permanently in Marienfluss but are shared with other neighbouring areas.

Marienfluss conservancy is involved in the following enterprises: joint-venture tourism agreements with Camp Syncro, Marienfluss Lodge, Kunene Camp and Serra Cafema; Okarohombo Campsite (community campsite); trophy hunting; own-use hunting; *Commiphora* and resin harvesting.

Orupembe conservancy

The Orupembe conservancy covers an area of 3,565 km² and has an estimated population of 240 people. The conservancy was gazetted in July 2003. It is also an arid area with less than 100 mm average annual rainfall. Largely semi-desert and sparse savannah. The landscape is a combination of hills, plains and wooded river valleys. The conservancy falls in the Desert Nama-Karoo and Savanna biomes with vegetation type of northern desert, north-western escarpment and inselbergs and western highlands. Major wildlife resources include Leopard, cheetah, steenbok, kudu, ostrich, giraffe, gemsbok, mountain zebra, springbok and klipspringer. Enterprises in the conservancy includes Joint-venture tourism agreement with House on the Hill; Orupembe Campsite (community campsite); crafts; trophy hunting; premium hunting; own-use hunting and *Commiphora* resin harvesting.

Okanguati conservancy

Okanguati conservancy covers an area of 1,159 km² and has an estimated population of 2,223 people. The conservancy was gazetted in May 2012. Wildlife resources include gemsbok, jackal, klipspringer, kudu, mountain zebra, ostrich, springbok, and steenbok. Elephants have been absent from this area since 1990 (W. Swanepoel, personal communication).

Epupa conservancy

The Epupa Conservancy covers an area of 2,912 km² and has an estimated population of 3,518 people. The conservancy was gazetted in October 2012 and generate most of its income from tourism and conservation hunting. Key wildlife species found in Epupa include gemsbok, jackal, klipspringer, kudu, mountain zebra, ostrich, springbok, and steenbok.

2. Physical characteristics of the SCIONA study area

2.1 Topography

Contributions: Vera De Cauwer, Nicky Knox, Wessel Swanepoel

The TFCA covers the northern parts of the Namib Desert, the mountainous area named Escarpment where elevation rises drastically, as well as the transition zone in between, the pro-Namib. The eastern parts have terrain that is more level. Elevation within the study area rises from sea level at the coast up to about 2000 m in the east. Main mountain chains include the Hartmann and the Otjihipa mountains (Figure 2). The Otjihipa Mountains are one of the highest mountain ranges along the Escarpment of Namibia with a northwestern peak at 1836 m elevation and a northeastern peak at 1973 m, rising almost 1600 m above the Kunene River and floor of the Marienfluss Valley (Swanepoel, 2008). The Chamalindi Mountains (Serra/Monte Techamalinde) are a dissected outlier of the Ovashimba Plateau, an intensely broken mountain belt through which the Kunene River and its dry water courses ('*dambas*') flow (Beernaert, 1997).

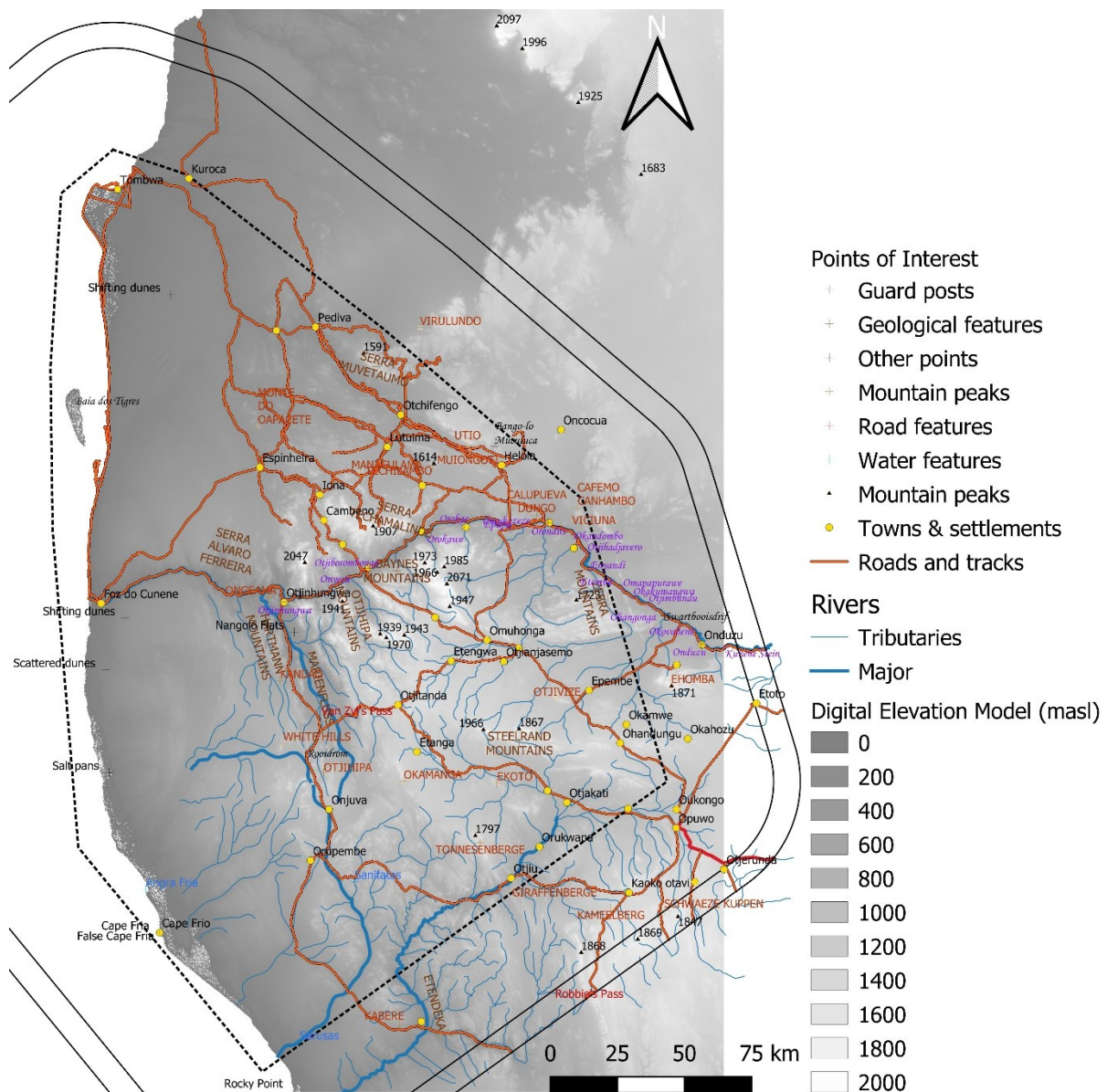


Figure 2: Topography within the SCIONA study area. Mean altitude is extracted from the Shuttle Radar Topography Mission (SRTM) (NASA JPL, 2013) (Mapping: N. Knox).

2.2 Geomorphology

Contributions: Marina Coetzee, Vera De Cauwer

The northern Namib has a large amount of geomorphic complexity from the coast inland with as major terrestrial landscapes (Beernaert, 1997; Robertson *et al.*, 2012; Ministry of Environment and Tourism, 2013; De Cauwer & Becker, 2018) (Figure 3):

1. Gravel plains with associated drainage lines and rare inselbergs;
2. Sand dunes and sandy plains: large, shifting sand dunes and smaller fields of vegetated dune hummocks (figure 3);
3. Rocky basaltic areas;
4. Valleys of ephemeral rivers.

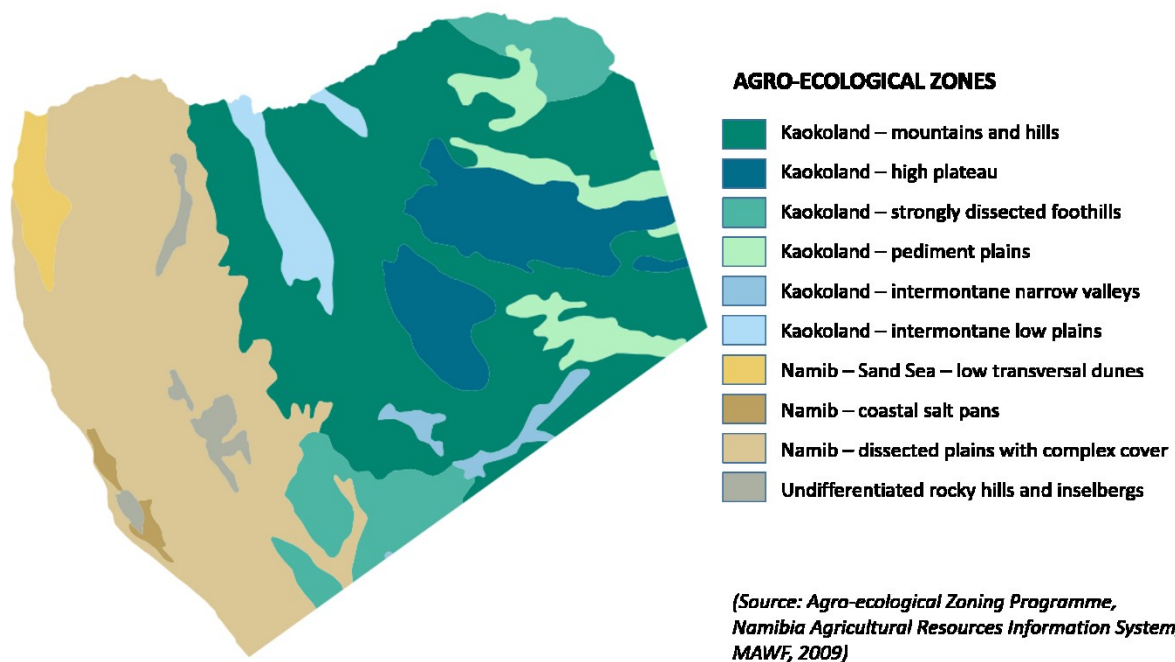


Figure 3: Agro-ecological zones in the Namibian part of the SCIONA study area reflecting geomorphology of the terrain (Mapping: M. Coetzee)

The coastline is characterised by sand-, gravel- and pebble beaches, exposed bedrock headlands, northerly-extended sand spits and raised beach terraces. This strip shows the influence of Pleistocene and earlier sea level changes: six marine transgressions have been identified along the southern Namibian coast. The data on the intertidal coastal habitat types is available in GIS format and was collected by V. De Cauwer for the BCLME programme.

The coastal plain's elevation varies from sea level to about 600 m, and the width between 30 and 50 km, with a very gentle slope of 1–2°. The northern part consists of roughly bevelled bedrock in which

mechanical weathering is controlled by the geological structure and rock type. It is partly exposed and partly covered by dunes, sand sheets, sand streaks, river terrace deposits, thin soils and gravels.

Large expanses of the coastal platform consist of broad, almost flat (i.e. low relief) and almost level (i.e. low slope) gravel plains with shallow washes and drainage lines, low ridges of resistant rock and some inselbergs. Heavy mineral particles are abundant, with garnet adding a pinkish to dark reddish hue and ilmenite and magnetite adding black hues. A layer of fine, dark basaltic grains and pebbles often covers the lighter soil. Biological crusts of lichens, cyanobacteria (and to a lesser extent algae and mosses) entrap mineral grains and stabilise the surface of gravel plains in the fog belt. The coastal gravel plains are visually striking, especially the areas around Sarusas and Cape Fria, but fragile systems. When damaged, for example by off-road driving, the bio-protection is lost and recovery is extremely slow. Further inland, gravel plains transform into annual grasslands that support plains game when it rains.

The Great Escarpment lies to the east of the Namib Platform and separates it from a mountainous hinterland at $\pm 900 - 1,300$ m height (Partridge and Maud, 2000) (Figure 3). The Great Escarpment is a result of continental uplift and denudation following the break-up of Gondwana and opening of the South Atlantic during the early Cretaceous. Weathering-resistant rocks of the Escarpment form outliers jutting into the coastal plain that had, in some places, been eroded to inselbergs.

Pediments extend from mountain footslopes towards the coastal plain. These are gently-sloping erosional landforms consisting of bedrock with a relatively thin covering of alluvial and/or colluvial material.

More information on the geomorphology in SCNP is available and can be obtained from SCIONA on request.

Inselbergs and dykes

Inselbergs (isolated mountains) and rocky hills are important habitats within the arid environment, as they support larger numbers and more diverse biota than the surrounding plains. They intercept fog and may receive more orographic rainfall. Some SNCP inselbergs are horizontally-layered remnants – in the form of mesas and buttes – of Etendeka basalts, while intrusive granites appear as jointed koppies and exfoliated domes (Robertson et al., 2012; Anonymous, 1999). Differences in rock hardness allow formation of hollows and cracks where colluvial and alluvial material collect. Runoff from rock surfaces provide more mesic conditions in these sandy/gravelly pockets, providing favourable conditions for plant growth. Rock crevices, hollows and ledges provide shelter for reptiles, insects and birds. Inselberg biota is strongly influenced by hill/mountain size, lithology and distance from the coast (in terms of fog and temperature conditions). The footslopes of inselbergs typically have slightly deeper and finer-grained soil with somewhat higher water-holding capacity than the surrounding plains, and support more species-rich plant communities and more biomass.

Agate Mountain is a prominent, almost circular hill of 1.5 km diameter near Cape Fria. It is a carbonatite, composed of igneous rocks with >50% calcium, magnesium and iron carbonate minerals. The 'agate' is actually aragonite, a type of calcium carbonate formed in cavities as magma cools down (Swart & Marais, 2009). Its formation and characteristics are described in great detail by Miller (2000).

In the SCNP, **dykes** – usually of dolerite or marble and often covered by desert varnish – form long, low, dark ridges where weathering and erosion have removed softer host rocks. Dykes are sheet-like near-vertical intrusions of igneous rock that cuts across older host rocks. They form when magma is

forced into fissures in the host rock. They provide different growth conditions than the surrounding plains, containing more lichens and succulents.

Mega-yardangs and Ventifacts

The area south of the Kunene Dune Field consists of basement rock of the Swakop Group (570-900 Ma) that had been sculpted by corrosive (abrasive) wind erosion into narrow more-or-less parallel linear ridges, typically 8-10km long and 300-350m apart, known as **mega-yardangs**. These are oriented SSE-NNW, in line with the dominant wind direction. Wind records from Möwe Bay indicate that in 62.5% of the time, winds blow from 157.5°S – 212.5°S. Pre-existing jointing of the basement rock provides a structural framework which is enhanced by the sand-blasting effect of the wind. (Goudie & Viles, 2015; Goudie, 2007).

Ventifacts (wind-faceted stones; ‘windkanter’) are individual stones, usually from hard, fine-grained rocks, that had been pitted, grooved, etched or polished by wind-driven sand. ‘Dreikanter’ are pyramidal ventifact with three facets on the surface, while the buried side is rounded or irregular.

Sand dunes

Next to sandy plains and isolated dunes, the SCIONA study area has two extensive dune fields: the Kunene (or Northern Namib) Erg, and the Curoca-Bahia dos Tigres Erg. The dune fields are dominated by transverse dunes, with barchans around the edges and surrounded by sandy plains. Both the Kunene and Curoca-Bahia dos Tigres Ergs have some linear dunes towards the northeast. The dune sand is predominantly from the Orange River, to a lesser extent from rivers draining the Damara Orogen in central Namibia (especially the Swakop River) and some from the Etendeka lavas. Strong swell-driven longshore currents have been carrying sediments north along the Namibian and southern Angolan coasts for millions of years, in the longest cell of littoral sand transport recorded on Earth (Garzanti *et al.*, 2014, 2018; Lancaster, 2014).

The **Kunene** (or Northern Namib) **Dune Field** (*erg*), covering about 1,600 km², stretches from ±17.86°S, north of the Engo River, to the Kunene River at ±17.16°S, where the river abruptly stops the northward migration of dunes. The erg is underlain by igneous and metamorphic rocks from the Swakop Group (570-900Ma). The largest areas of dunes within the study area is the **Curoca-Bahia dos Tigres Erg** south of Tombua, in Angola, and just north of the Kunene River in Namibia, where it widens to approximately 55 km in an east-west direction. It encompasses an area of ±4,000 km² and terminates at the deeply incised Curoca River Valley.

Kunene River Mouth

The Kunene River Mouth (KRM), also known as the Kunene Deltaic Complex, covers an area of ± 4,130 m². The river spreads out into braided channels between sand bars (some vegetated), with a periodically flooded lagoon and mudflats inland of a 2.5 km long linear berm (sand bar, spit, littoral bar) on the southern bank and shorter one on the northern bank, that partially block access to the Atlantic Ocean (Greenwood, 1999; Paterson, 2007). A study by Simmons *et al.* (1993) found that the lagoon was 2.36 km long and 1.60 km wide and flooded to a depth of up to 70 cm by backed-up river water at high tide. At low tide, only 10-50 % (when river flow was low and high, respectively) of the lagoon was under water, exposing sand and mudflats. The lagoon water is up to 10°C warmer than the sea (Simmons *et al.*, 1993). The tidal range is around 1.4 m and tidal influence is discernible up to

4 km upstream (NACOMA, 2009). The KRM lacks estuarine benthic fauna, marine and estuarine plankton, and marine fish species (Carter & Bickerton 1996; Morant & Carter 1996; BCLME 2007), which indicates that it acts as a river mouth rather than an estuary, according to the classification of Whitfield (2001). The system is fluvially dominated, with very little evidence of intrusion of seawater at low-flow periods (Carter 1996, BCLME2007), as long as a permanent minimum flow of $\pm 20 \text{ m}^3 \cdot \text{s}^{-1}$ is maintained (NAMANG 1997). Simmons et al. (1993) found that the salinity of water just inside the mouth during peak flow (April) was about 10 times as much as 4 km upstream, but still predominantly fresh. Low flow resulted in a fourfold increase in salinity at that same place, but still only a 10^{th} of that of seawater.

The permanent Kunene River flushes out the sand and interrupts the northward migration of dunes. Sediment deposited within the mouth is of aeolian origin, from dunes encroaching from the south along the lower stretches of the river, as well as sand blown inland from beaches south of the river mouth. The mouth is never completely closed (Robertson et al., 2012). Simmons et al. (1993) found that the opening varied between 30 and 80 m at low and high flows respectively and mention that the opening was more than a kilometre wide in 1975. They also discovered a 275 m northward and 150 m westward migration of the southern sand bar between 1975 and 1992. This points to the highly dynamic nature of sediment deposition and river mouth morphology. The mouth supports dense riparian vegetation.

Fairy circles

The enigmatic fairy circles are widespread in the dry grasslands on sandy soils of the study area. Fairy circles are circular patches of about 5 m to 8 m large that are denuded of vegetation and surrounded by a band of more densely packed tussocks within a shorter, more sparse grassland matrix (Becker & Getzin, 2000). They occur in those parts of the Namib Desert with mean annual rainfall between 50 and 100 mm, from the border with South Africa (Picker *et al.*, 2012) up to the south of Angola. In the study area, they can be found amongst others in the west of Iona National Park, in the Marienfluss Valley, and the Hartman's Valley, with increasing density from west to east (Becker & Getzin, 2000). The largest cohesive area in Namibia with fairy circles is the Hartman's Valley extending to the area south of it, and covering about 80 km by 25 km (Becker & Getzin, 2000). The circles are not permanent and have a life span from about 25 to 75 years, increasing with size of the circle (Tschinkel, 2012).

Next to the classic fairy circles, "inverse" fairy circles and vegetation stripe patterns were observed near the Skeleton Coast National Park (De Cauwer & Becker, 2018).

2.3 Climate

Contributions: Nichola Knox, Marina Coetzee

Historical

Within the SCIONA region there is a paucity of long-term climate data available. As a result of this, to gain an understanding of the long term trends within the region we have analysed the long term bioclimatic records derived from the WorldClim vs2 dataset (Fick & Hijmans, 2017). This dataset through regional spline interpolations provides 19 bioclimatic variables based on global data collected from between 9000-60000 weather stations (variable dependent) for the temporal range of 1970-2000 (*ibid.*). Two trends seem to be evident when analysing these long-term trends within the study area. The first is an increase in rainfall, excluding fog, from West to East with average annual rainfall ranging from near 0 mm in the West to 450 mm in the NE (Fig 4b). Most of this rain appears to fall

within a single wet quarter (Fig 4a). Within this long-term rainfall regime there appears to be an increase in rainfall associated with the topography around the Hartmann mountain range.

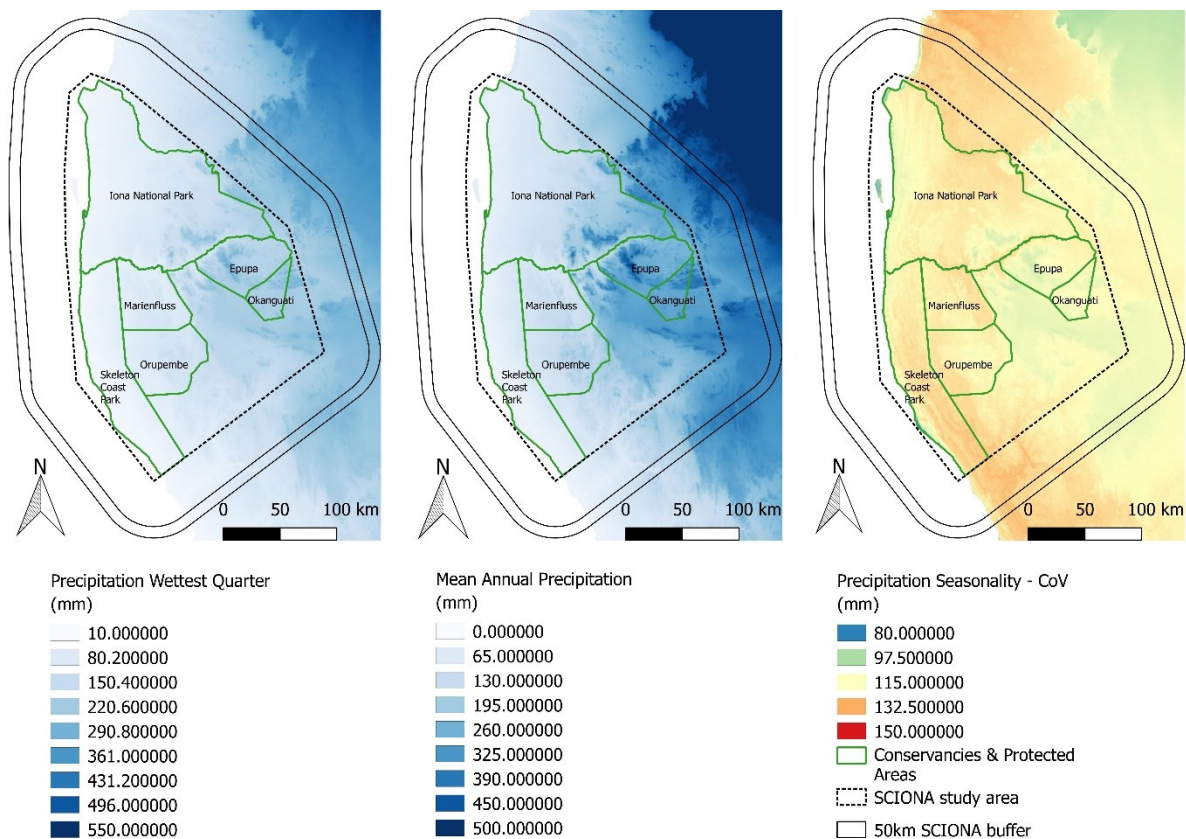


Figure 4: Rainfall climatic variables a) Precipitation during the wettest quarter, b) Average annual precipitation, c) Precipitation seasonality (coefficient of variation) derived from the Worldclim vs2 dataset (Fick & Hijmans, 2017) (Mapping: N. Knox)

The second climatic trend appears when analysing the temperature variables (Fig 5 & 6). For the temperature variables the E-W trend is less defined, but there is an increase in the minimum and average temperature from South to North (Fig 5a & b), and a less clear similar trend with the maximum temperature (Fig 5c). The diurnal and annual temperature ranges (Fig 5a & b) show the impact of the coastal climate with small changes (8 & 10°C respectively) along the coastline along the entire study area, and inland temperature changes of ca. 16°C diurnally and ca. 20°C annually. Similar to the trends observed with the rainfall, the area around the Hartmann mountain range appears to differ to the trend of the entire study area, with cooler temperatures and less difference between the minimum and maximum temperatures (Fig 5 & 6).

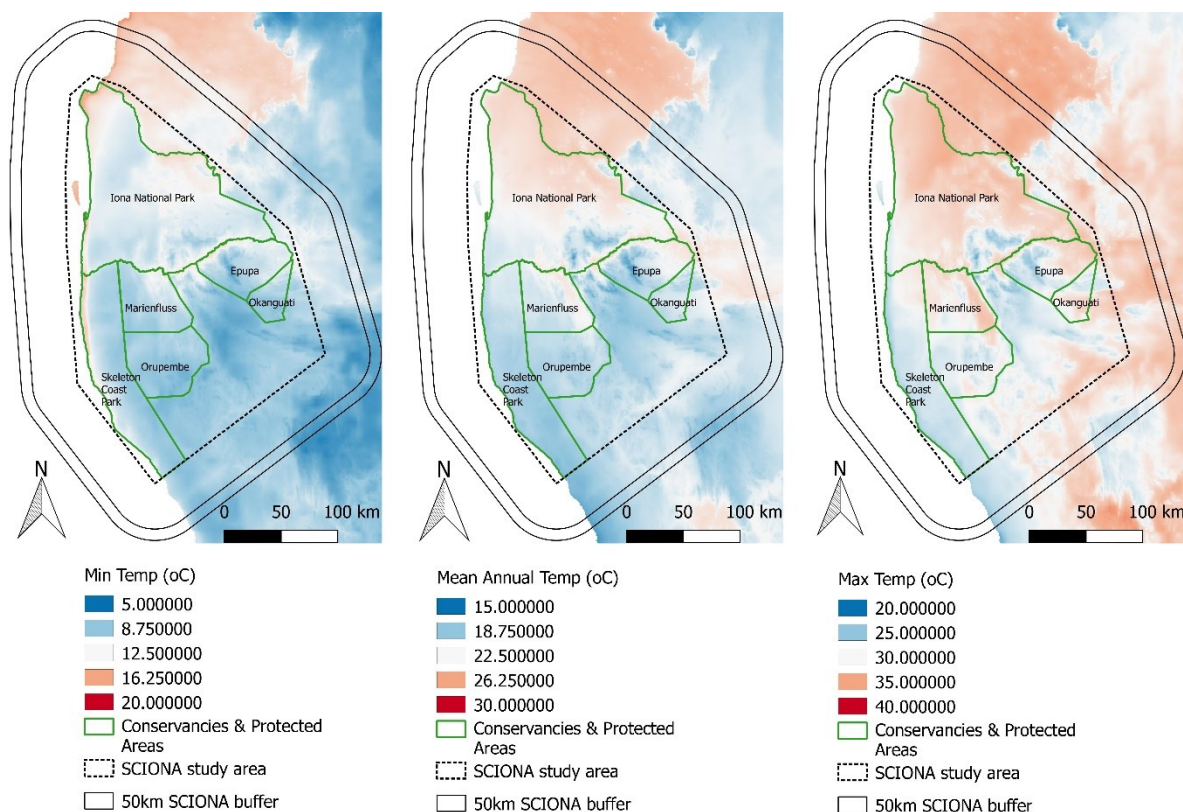


Figure 5: Temperature climatic variables a) Minimum temperature, b) Mean annual temperature, c) Maximum temperature derived from the Worldclim vs2 dataset (Fick & Hijmans, 2017) (Mapping: N. Knox)

So-called ‘Benguela Niño’ events – when the South Atlantic is warmer than normal and the Inter-Tropical Convergence Zone progresses further south – bring higher than normal rainfalls to the Kaoko highlands which result in high-magnitude flash floods that last several days (Jacobson *et al.*, 1995; Krapf *et al.*, 2003; Stollhofen *et al.*, 2014), for example in 1982 and 1995.

Present

Since 2015 under the SASSCAL WeatherNet program, four weather stations were instrumented within the core study area, and a further three fall within the 50km buffer area (Fig 7). Within the study area the Espinheira station has been operational since 2015, the Iona Coastal and Marienflusstal have both been decommissioned in 2017, thus currently in the core study area there are two operational stations (Espinheira and Okangwati) (Table 1). Analysis of the monthly recordings (derived from the daily observations) for the seven WeatherNet stations within the study area, shows a seasonal trend in the minimum temperature, but no clear seasonal trends in either the average or maximum temperature. The minimum temperatures falls within the months May-August. For all stations there is a dry season from May-September, the rainy season appears to be bi-modal, with a small peak in December and the main rains in February/March.

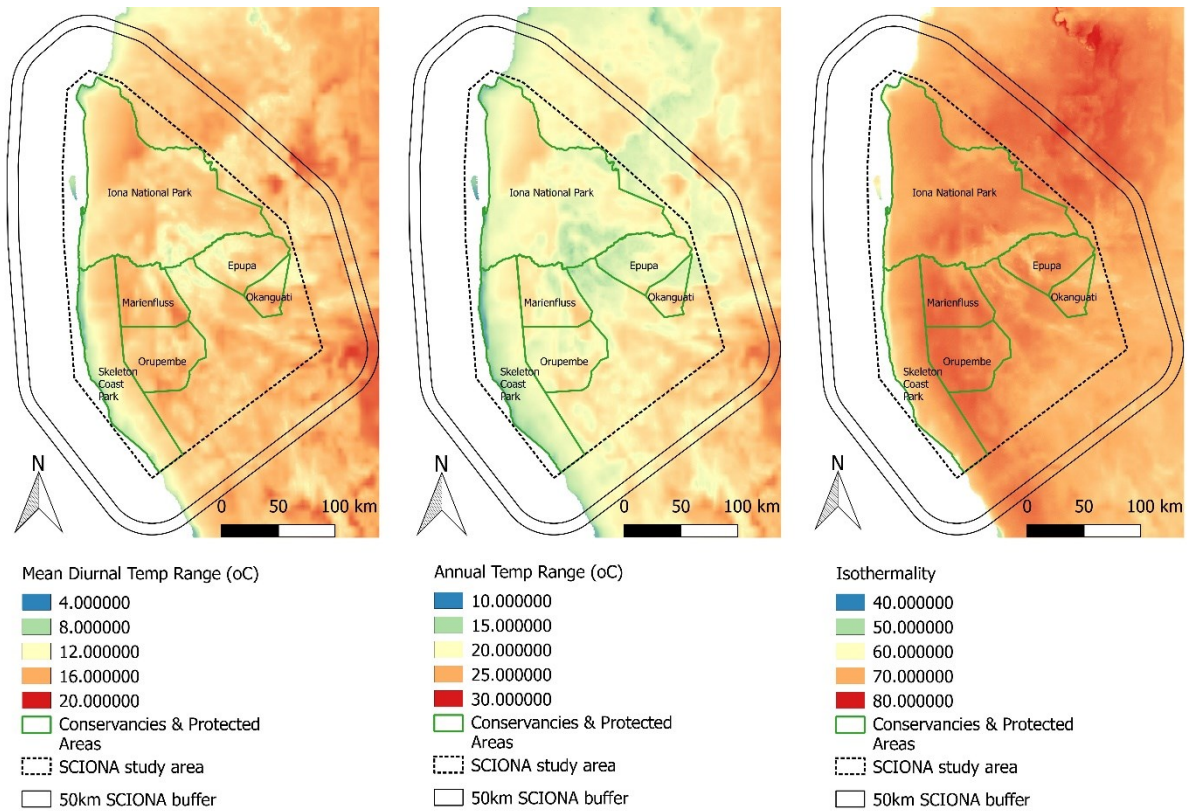


Figure 6: Temperature climatic variables a) Mean diurnal temperature range, b) Annual temperature range, c) Isothermality derived from the Worldclim vs2 dataset (Fick & Hijmans, 2017) (Mapping: N. Knox)

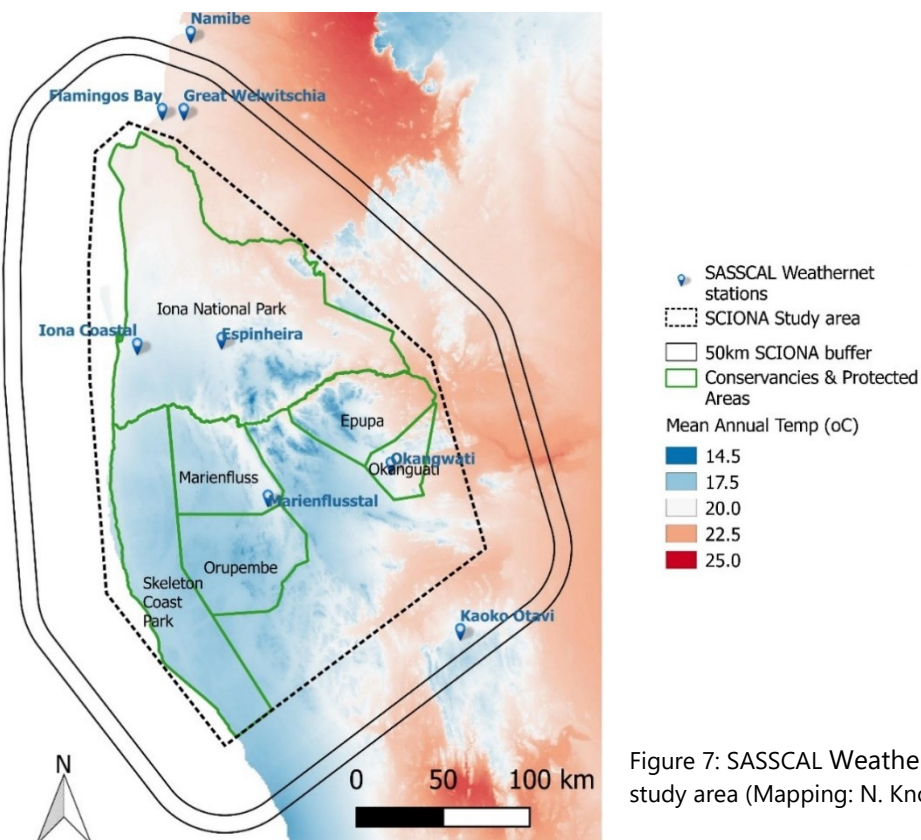


Figure 7: SASSCAL Weathernet stations within the study area (Mapping: N. Knox)

Table 1: SASSCAL Weathernet stations for the SCIONA study area, including the date of implementation and an end date if they have been decommissioned. The number of observations refers to the number of days of recorded data used to derive the current climatic conditions presented in this section.

Station	Start Date (end if applicable)	# obs (days)
Espinheira ^b	2015-10-20	1126
Flamingos Bay ^b	2017-10-13	398
Great Welwitschia ^b	2015-10-26	1120
Iona Coastal ^c	2017-01-15 (2017-02-04)	21
Kaoko Otavi ^a	2016-04-17	901
Marienflusstal	2015-06-30 (2017-05-07)	678
Okangwati ^a	2016-04-15	903

^aData range until 4 Oct 2018; ^bData range until 18 Nov 2018; ^cRemoved from analysis because of two few data records

2.4 Marine environment

Contributions: Marina Coetzee

The TFCA borders the Atlantic Ocean. The cold waters form part of the Benguela Current Large Marine Ecosystem that stretches from Cape Agulhas in South Africa in the south (35°S) to about Moçâmedes (former Namíbe) in Angola in the north (15°S), where it subducts under the warmer, tropical Angola Current at the seasonally shifting Angola-Benguela Front. The Benguela Current forms the eastern leg of the anti-clockwise South Atlantic Gyre. It flows north along the Namibian coast at a speed of 10 – 30 cm, with a counter bottom-current flowing southward near the edge of the continental shelf. Upwelling, with a strong cell off Cape Fria, underpins the high productivity of the Benguela ecosystem. Strong upwelling events result in plumes of cold water extending up to 30-50 nautical miles offshore towards the northwest (Shannon 1985). During late summer and autumn, when southerly winds are weaker, the Benguela upwelling system also weakens and warmer water from the tropical, more saline Angola Current intrudes further south (Sakko, 1998).

The continental shelf is between 100-140 km wide, narrowing to only 30 km off the Kunene River Mouth. The Walvis Ridge separates the Angola Basin from the Cape basin and presents an obstruction to deep ocean circulation. The Walvis Ridge is a submarine mountain chain of extinct volcanoes from off Cape Fria to the mid-Atlantic Ridge in the direction of Tristan da Cunha and Gough Island, with a length of more than 2,500 km and height of more than 4,000 m above the abyssal plain (Robertson et al., 2012).

Since the epeirogenic uplift of the continental margin after separation from South America, **sea levels** have fluctuated widely between +200 m (above current sea level) around 70Ma and -400 m about 30Ma. Sea level was ± 120 m lower and the coastline 10-50 km further west 18,000 years ago during the last glacial maximum, when much water was locked up in polar ice caps. Some 5,500 years ago, sea level was 1.5 m higher than now (Robertson et al., 2012; Sieser & Dingle, 1981). During the current era ('Anthropocene'), sea levels on the Namibian coast have risen, on average, about 1.87 mm per year since 1959 (Mather, Garland & Stretch, 2009; Brundrit, 1995). Though coastal erosion happens in

places and is likely to be exacerbated by sea level rise due to climate change, many parts of the Namibian coastline are aggregating. The tidal range is ± 1.4 m.

The Skeleton Coast coastline has no deep, sheltered inlets; just some small bays north of (rocky) headlands. Several elongated coastal salt pans are found parallel to and just inland of the coastline. Coastal geomorphology is greatly affected by a pair of strong wind-driven wave swell-regimes, one originating in the Atlantic Storm Belt (the 'Roaring Forties') in the Southern Ocean and the other generated by the South Atlantic Anticyclone. They produce a persistent, northward longshore current along the inner continental shelf that forms a powerful littoral transport system, stretching from Cape Town to the Gulf of Guinea (Robertson, et al., 2012; Garzanti et al., 2014). Wave fronts meet the shore obliquely. Wherever they encounter a rocky headland, waves are refracted and lose some of their energy and thus their ability to keep sediment in suspension and motion (Garzanti et al., 2014). Sand is deposited as northward-pointing sand spits, and in J-bays behind headlands.

The fresh water plume from the Kunene River mixes with seawater and creates estuarine conditions in the coastal waters just north of the river mouth (BCLME, 2007). Satellite imagery reveals a 100 km² plume of warm, nutrient-rich river water extending NNW into the Atlantic Ocean in March (Simmons et al., 1993). The northward-flowing longshore current ensures that fresh river water has no noticeable influence on the marine environment south of the mouth.

2.5 Freshwater resources

Contributions: Marina Coetzee, Vera De Cauwer

Rivers

The two countries and parks are separated by the only perennial river in the study area: the Kunene River or Rio Cunene, whose valley forms an oasis in the arid ecosystem. The river is approximately 1,050 km long, with a catchment of 106,500 km², of which $\pm 92,400$ km² lies in Angola and 14,216 km² in Namibia (Paterson, 2007; Midgely 1966; Morant, 1996; Greenwood, 1999; BCLME, 2007; Strohbach, 2008). The river is impounded in six places upstream of Ruacana. On average, about 5.5 km³ water flows down the Kunene annually (Robertson et al., 2012) at a maximum discharge rate of about 1,000m³.s⁻¹ and transporting around 9 million tons of sediment (Garzanti et al., 2017).

Namibia has a hydropower scheme in the Kunene River near Ruacana and has considered the installation of another hydropower scheme at Epupa, further downstream. The hydropower scheme would require the flooding of a large part of the Kunene valley. Impact assessments were performed and the Epupa site was compared with a site near the Baynes Mountains (Corbett, 1999). The dam was never established.

All other rivers within the study area are ephemeral rivers. The largest within Iona National Park is the Curoca, forming the northern border. Within the SCNP part of the study area, there are from south to north the Khumib, Sechomib, Nadas, Munutum, and Engo (Ondusengo) Rivers. The catchment sizes of the northern ephemeral rivers are as follows: Engo (Ondusengo) $\pm 1,010$ km², Munutum ± 672 km², Nadas ± 670 km² and Sechomib $\pm 1,534$ km² (Strohbach, 2008). The Sechomib, Nadas and Munutum widen into small alluvial fans where their valleys leave the hills (Miller, 2008, p. 25-36, 25-37, 25-38).

The Khumib River has the strongest and most regular flow of rivers north of the Hoarusib and occasionally reaches the sea. It has several springs. The catchment area is $\pm 2,308$ km² and river length is ± 80 km (Jacobson, Jacobson & Seely, 1995; Strohbach, 2008). The Khumib is an example of an

anastomosing river, with channels repeatedly branching and rejoining around permanent, vegetated alluvial islands (Swart & Marais, 2009). Anastomosing rivers typically have very low gradients and thus low energy, so they carry only the finest sediments. The Khumib interrupts the northward march of those barchans that manage to cross the mouth of the Hoarusib. The dune field reforms further north of the Khumib, starting out as separate barchan dunes, consolidating into transverse and eventually linear dunes. The Khumib River's paleo-delta is similar to that of the Uniab. It has bedded gravels and a coastal cliff, up to 30m high, that decreases in height to the south and north and is broken by the current river channel (Miller, 2008, p. 25-44).

The rivers originate in the highlands beyond the escarpment, are westward-flowing and do not always reach the sea. The 'Benguela Niño' events bring higher than normal rainfalls to the Kaoko highlands which result in high-magnitude flash floods that last several days (Jacobson et al., 1995; Krapf et al., 2003; Stollhofen et al., 2014), for example in 1982 and 1995. These floods, usually during February to April, do not only bring water, but also sediments and nutrients to the lower reaches of the ephemeral rivers. Where ephemeral rivers are barred by dunes, most flows terminate in flat interdune playas or active fan systems, forming short-lived wetlands. Only exceptional floods in the rivers with the larger catchments can break through the dunes, such as the Hunkab, a river south of the study area, in 1995 (Ward and Swart, 1997). The ephemeral rivers are of vital importance for supporting biodiversity in the hyper-arid environment. Riparian vegetation and relatively shallow groundwater in alluvial aquifers – which occasionally surface as springs – provide 'linear oases' to both resident and migrating wildlife, from where they undertake grazing forays. Biodiversity is higher along the river courses than in the surrounding desert.

Springs

There are several ephemeral springs within the study area; the Okau, Sarusas, Oasis, Auses, Gantias, Soutvlei, and Hoaswater springs (Ministry of Environment and Tourism, 2013). Okau is a spring on the Munutum River, near Cape Fria (Figure 8). Springs found in the normally dry streambeds of ephemeral rivers play a disproportionately large role as oases in the surrounding hyper-arid landscape. They occur where impermeable underlying geological formations such as dykes refract groundwater upwards (Watson & Lemon, 1985). The upwelling waters can be either fresh or brackish.



Figure 8: Okau spring in Skeleton Coast National Park (Photos: Vera De Cauwer (L) and Nicky Knox (R))

In the communal areas east of Skeleton Coast Park, there are hot springs west of Okangwati (Schneider, 2004), as well as springs at Ombivango, Omutati, Okapaizirwa, Omuatjivingo, Otjihaa, Omuatjinguma, Orupembe, Sanitatas, Otjijanjasemo, Omayuru, Ondova, Okangwati, Ogams (Sanitatas area), Okakuyu (Ehama area), Oryeheke (Epupa area) and Etanga (Christelis & Struckmeier, 2011). In Iona National Park, there are hot springs in Pediva, east of Salondjamba. Dispersed through Iona are springs, wells and water pumps, although only some have a permanent water flow.

Pans

Streamflow is irregular, intermittent, ephemeral and often endorheic – ending in inland depressions, *playas* (pans) and *salinas* (salt pans). **Inland pans** are located at the ends of active or paleo rivers and washes, or where water temporarily ponds after sporadic, localised rainfall, or where groundwater is very shallow. Capillary rise of groundwater brings dissolved solids to the surface, where evaporation concentrates them in halite deposits. Many westward-flowing ephemeral rivers are blocked by dune fields, so flood waters pause and spread out in short-lived, shallow wetlands. Unless floods are energetic and voluminous enough to breach the dunes, water infiltrates and evaporates to leave dried lake beds known as terminal pans or *playas*. Evaporation concentrates any salts that were dissolved in the water. The order of crystallisation is CaCO_3 and MgCO_3 that precipitate as calcite, aragonite or dolomite, followed by gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) and eventually halite (NaCl) and other highly soluble salts. When the temporary lake pond dries up, the mud at the bottom shrinks and cracks, and precipitated salts form a crust on top of the playa floor and in cracks in the soil surface. A *playa* with high salt content is known as a salt pan or *salina* (Figure 9). The Engo (Ondusengo) River ends in a playa east of the dunes. Its floods seldom have the required volume and energy to breach the dunes.

Coastal salt pans (*salinas*) are flat, with brown surfaces and are often elongated inland of and parallel to the shore. Coastal salt pan formation starts when sand spits grow northwards from headlands across bays to eventually form lagoons (Eckardt & Drake, 2011). The lagoons silt up from material washed and blown in, forming layers of fine sand, medium sand and clayey sand. Pans also form when beach ridges build up between low-lying coastal areas and the ocean. As most pan surfaces are close to sea level, seepage of seawater through the sand bars and inundation during spring tides and storms replenish the brine. Some pans show the effect of tides.



Figure 9 - Saltpan with puffy Solonchak (photo: Alex Derr)

Salts precipitate when they are sufficiently concentrated by evaporation. Salt precipitation proceeds from the surface downward, so a hard salt crust may cover concentrated brine and sulphurous, dark mud. Salt pans are relatively low in biodiversity, though some provide breeding sites for Damara terns. They contribute to the SCNP's 'sense of place' and have visual appeal. Some pans (e.g. at Cape Fria) are thought to hide old shipwrecks. Vehicle tracks can persist for years on pans. The soils of salt pans are mostly Solonchaks (high soluble salt content) (Figure 9), though some pans, or parts of them, may be dominated by high exchangeable sodium content and be classified as Solonetz.

GIS data

The GIS data available for fresh water resources are not very accurate, especially with regard to river locations (Atlas of Namibia, accuracy lower than 1 km), while data on springs is not complete. Larger pans are available in GIS format but smaller ones are missing.

2.6 Geology

Geological history

Contributions: Marina Coetzee

Source: (Miller, 2008)

The oldest northwest Namibian rocks (Epupa, Huab, Kunene Metamorphic Complexes) formed in mobile belts (long, narrow, tectonically active areas) between the ancient Angolan and Kaapvaal Cratons (large rafts of relatively stable, thicker crust, rooted deep in the upper mantle). Cycles of rifting and assembly welded the mobile belts onto the cratons, accreting into the larger Congo and Kalahari Cratons. The original metavolcanic rocks underwent several phases of metamorphism during the Vaalian (<2,100 Ma) and Mokolian (1,759-900 Ma) ages, with the Meso-proterozoic Kibaran Orogeny (1,400-1,100 Ma) culminating in the assembly of the supercontinent **Rodinia** (1,780-850 Ma; Upper Paleo-proterozoic to Meso-proterozoic). A 400 million-year period of relative tectonic quiescence allowed extensive erosion of these mountains.

The evolution of the Neo-proterozoic **Damara Supergroup** got underway around 850 Ma, when Rodinia started breaking up through formation of two intra-continental rifts into which great thicknesses of sediments and some volcanic were deposited. Rifting proceeded to spreading (starting 750 Ma). The northern rift deepened, with deposits of (possibly) up to 17,000 m thick sedimentary and volcanic rocks, but continental crust did not rupture. The crust under the southern rift broke, with formation of the narrow (Red Sea-like) Khomas Ocean between the Congo and Kalahari Cratons, complete with oceanic crust, a mid-oceanic ridge and accumulations of turbidites. In the west, the Adamastor Ocean opened, separating the Rio de la Plata Craton from the Congo Craton. During rifting and spreading, the Otavi, Swakop, Witvlei and Zerrissene Groups were deposited. Two Snowball Earth events took place during the rifting and spreading: the Sturtian-equivalent (750 Ma, when initial rifting evolved into spreading) and Marinoan-equivalent (635 Ma) episodes, resulting in the Chuos and Ghaub Formations respectively. Sequences of tillites, cap carbonates and banded iron formations are seen as evidence of these extreme, equator-ward global glaciation events.

The Kaoko Belt formed a passive margin on the eastern side of the newly-formed Adamastor Ocean. Around 650 Ma, on the west of the Adamastor Ocean, subduction, metamorphism and emplacement of granite formed the precursor of what would become the Coastal Terrane of the Western Kaoko Zone. Erosion of the cratons supplied sediments that accumulated in the oceans, possibly up to 10 km thick in the Khomas Ocean.

The spreading stopped (about 600 Ma) and reversed. West of the Adamastor Ocean, the São Francisco and Rio de la Plata plates amalgamated (630-620 Ma). The Adamastor and Khomas Oceans closed, followed by continental collision between the Rio de la Plata and Congo Cratons along the northwestern Kaoko Belt (595-550 Ma) and between the Congo and Kalahari Cratons along the central-Namibian Damara Belt (542 Ma). The Kalahari Craton subducted under the Congo Craton (until 480 Ma), which, in turn, subducted under the Rio de la Plata Craton. The Coastal Terrane (Kaoko accretionary prism) were added onto the rest of the Kaoko Zone.

The continental convergence folded, heated and pushed up sediments from the ocean floor between the two cratons, building the alpine-type Damara Mountain Belt. A foreland basin developed to its south, forming a warm, shallow shelf sea with carbonate reefs, into which erosion products of the high mountains accumulated as Nama Group sediments (starting 555 Ma). These dominate the present southern Namibian geology.

Magmatic bodies rose and intruded granites and pegmatites into the piled-up sediments of the Damara Belt (565-470 Ma). Erosional products from the Damara Mountains were deposited as the Mulden Group on the Otavi Group carbonates. Today, the coastal (Kaoko) and intracontinental (Damara) arms of the Damara Orogeny underlie much of northwest and central Namibia. The Damara Orogeny is part of the much larger Pan-African orogenic cycle of opening and closing of several large oceans and collisions of a number of cratons that culminated in the formation of the supercontinent **Gondwana**.

Extensive planation of the Gondwana surface took place before onset of the next development phase, represented by the **Karoo Supergroup**, which started with the Permo-Carboniferous glaciogenic Dwyka Group (320-270 Ma). As tectonic plates moved, Gondwana straddled the South Pole and vast ice sheets (analogous to the present Greenland and Antarctic ice sheets) covered much of southern Africa for about 50 million years. The ice sheets ground down high mountain ranges, glaciers carved out deep valleys (e.g. the Kunene, Engo, parts of Hoarusib) and left glacial sediments (tillites). As Gondwana drifted northwards again, ice sheets and glaciers melted and deposited glacial, lacustrine and fluvial sediments in deep freshwater lakes, along rivers and deltas, in marine and coastal areas (270-200 Ma; Permo-Triassic). An aborted rifting phase cut deep ENE-WSW basins across central Namibia.

Further warming of the climate triggered extreme aridity and formation of an immense inner continental desert with vast sand seas. These were eventually petrified into aeolian sandstones of the Etjo Group (200-180 Ma; Upper Triassic to Lower Jurassic). During the period 300-135 Ma, the Damara Mountain belt was weathered and eroded to a few remnants of smaller mountain chains and granite inselbergs, the land surface underwent peneplanation and glacial, fluvial and aeolian sediments were deposited in basins. The large inland Karoo basin of southern Africa accumulated more than 10,000 m of sediments and lavas.

Gondwana started **breaking apart** around 180 Ma (Lower Jurassic), with extensive volcanism over southern Africa. Around 135 Ma, deep-seated Proterozoic crustal weaknesses – that were reactivated during the Pan-African (Damara) metamorphism and again with initiation of the break-up of Gondwana – allowed violent fracturing of the crust and injection of pressurised magma into subsurface fractures. These formed NE-SW trending Giant Dyke Swarms which were exposed once softer country rock had been eroded away, for example the Henties Bay-Outjo Dyke Swarm.

Around 132 Ma (Lower Cretaceous), the rise of the Tristan mantle plume – a local heat source in the upper mantle (>100 km deep) – and tectonic stresses caused crustal thinning. Deep crustal faults split open in kilometres-long fissures, from which an estimated 6,340 km³ hot, fluid continental basalts erupted for 1-2 million years. Concurrently, quartz latites erupted from central shield volcanoes in hot, fluid pyroclastic flows travelling up to 650 km from the vents and covering up to 170,000 km². The

Saras quartz latite may have had a volume of up to 11,000 km³. Horizontal layers ('traps') of volcanic flows accumulated at least 2,000 m thick, to form the Paraná-Etendeka Large Igneous Province, which today covers about 78,000 km² in the Etendeka volcanic Plateau of Namibia and more than 1.5 million km² in the Paraná lava field of Uruguay, southern Brazil, eastern Paraguay and northern Argentina.

The Damaraland intrusive igneous complexes (plutons) formed more or less at the same time (137-125 Ma; Lower Cretaceous), with their magma crystallizing slowly several kilometres below the surface. These 32 ring complexes and diatremes (volcanic pipes) extend northeast from across central Namibia and include the Brandberg, Erongo, Spitzkoppe, Cape Cross, Doros, and Messum complexes. They are not associated with a mountain-building event, but with tensional stresses caused by the break-up of Gondwana and the Tristan hotspot.

The Gondwana separation proceeded from south to north over the period 139-128 Ma, the Atlantic Ocean intruded between South America and Africa, and the western coastline of Namibia was formed. The break-up caused isostatic up-warp of the Great Escarpment around the edge of the southern Africa, forming the Kalahari Basin in the interior of the subcontinent. Erosion proceeded throughout the Cretaceous and Paleogene and into the Miocene Epoch of the Neogene Period and wore the landscape down to the African Erosion Surface, which is higher in the interior than at the coast due to the difference in base levels. The peneplanation removed great thicknesses of Karoo age rock and, in places, planed down to Precambrian basement complexes. The erosional debris were deposited on the coastal plain and offshore on the continental shelf.

The **Kalahari** and **Namib Groups** were deposited from 70 Ma. Isostatic uplift of southern Africa (70-60 Ma; Miocene) of up to one kilometre ended the African erosion phase and initiated the Post African I and II erosional phases. The Namib Group includes marine, fluvial and aeolian deposits. Much of these are derived from Orange River and other river delta sediments, deposited on the continental shelf, transported north by longshore drift, displaced onshore by wave action and transported inland by wind.

Arid conditions started around 43 Ma (Eocene epoch) and peaked by 15 Ma (Miocene epoch) with the development of the Antarctic Ice Sheet. Dune fields covered much of the coastal plain and is preserved as the Tsondab Sandstones. More humid conditions followed up to about 10 Ma, during which gravels were deposited and river terraces formed.

The onset of the Benguela Current and its upwelling system, and the return of aridity (5 Ma; Pliocene epoch) initiated formation of the present Namib Desert, as well as widespread calcretisation. Ice ages in the Quaternary (< 2.58 Ma) lowered sea levels and thus base levels for erosion. This caused intensification of erosion, further eastward retreat of the Escarpment and deeper incision of rivers into the coastal plain.

Parts of the Kunene, Erongo and Munutum river valleys are of **glacial origin**, dating from around 300-280Ma – the Permo-Carboniferous Dwyka glaciation, at the base of the Karoo Sequence. At that time, Namibia was in the interior of Gondwana, close to the South Pole. It is postulated that these glacial valleys were formed by outflow glaciers on the margins of a large ice-sheet, somewhat similar to the present-day Greenland Ice Sheet. The evidence of glacial origin is in the typical U-shapes of valleys, striations in valley walls and floors, remnants of glacial sediment deposits and presence of erratics (randomly dropped large rocks) (Schneider, 2004; Robertson et al., 2012; Jacobson, Jacobson & Seely, 1995).

Geological data

Contributions: Marina Coetzee, Vera De Cauwer

Namibia:

1. *Geological maps* (1:250,000); can be obtained from the Geological Survey of Namibia in both digital and printed format. In some areas the accuracy can be improved and satellite images can provide more accurate information.
2. The monumental 3-volume *Geology of Namibia* (2008), edited by R. McG. Miller and published by the Geological Survey of Namibia, contains several in-depth studies of the geology of parts of Kaokoland, Damaraland and the Skeleton Coast National Park.
3. The *Roadside Geology of Namibia* (Schneider, 2004) and *Fascination of geology – Namibia* (Grünert, 2013) are more accessible to lay persons.

Angola:

1. *Geology map* (1:1,000,000; 1980); created by Heitor de Carvalho in 1980 based on surveys performed in 1974. The legend and map however do not match the Namibian map well making interpretation in a Transfrontier area difficult.
2. *Geological map* (1:1,000,000; 1988); coordinated by A.G. de Araujo, O.V. Perevalov, R.A. Jukov.
3. *Hydrogeological map* (1:250,000; date unknown) was prepared by Sir M. MacDonald & Partners Limited, in association with Hidroprojecto Consultores de Hidraulica & Salubridade.

The Angolan government recently outsourced the creation of more detailed maps. A Spanish and a Portuguese consortium are working on the south of Angola.

Current geology and mines

Contributions: Vera De Cauwer, Marina Coetzee, Wessel Swanepoel, Gail Morland

Bowell et al. (2013) mention the following minerals as being common or widespread in the Kaokoveld: Anglesite, Barite, Bismutite, Calcite, Chalcocite, Chrysocolla, Cuprite, Dioptase, Dolomite, Galena, Goethite, Hematite, Malachite, Mottramite, Planchéite, Quartz, Shattuckite, Wulfenite

There are a few active mines in the study area. The rare orange mandarin garnet is mined intermittently in northern Marienfluss and the Hartmann mountains (Schneider, 2004). Amethyst is seasonally mined at Sarusas, in SCNP. Sodalite, a rare and ornamental stone, is mined east from Swartbooisdrift, just outside the study area. It is one of only two sodalite mines in the world (Schneider, 2004). A new mining license will be issued to Trustco who received an environmental clearance certificate for mining diamonds in an area south of the Kunene River, SCNP, from MET in July 2018. Diamond used to be mined at Möwe Bay, in SCNP and outside the SCIONA study area.

2.7 Soil

Contribution: Marina Coetzee

In the desert areas of Skeleton Coast and Iona National Parks, soils are generally poorly developed and thin, due to the aridity and paucity of biological agents (plants, animals, humans). These soils have neutral to alkaline pH, very high (>90%) base saturation, less than 2% organic matter, high amounts of sesquioxides and are often at least slightly saline. Large areas of the Namib are under sand plains and dunes (Arenosols). The Escarpment is dominated by shallow, stony soils (Leptosols), calcareous soils (Calcisols), and Regosols and Cambisols where eroded material accumulates in valleys.

Soil formation

In arid and hyper-arid environments, soil formation is controlled by exogenetic processes such as physical weathering and erosion that include sheet wash, mass-wasting and aeolian transport. The northern part of the Namib Desert is covered with aeolian deposits, originating from weathering of Cretaceous to Tertiary deposits, and to a lesser extent by alluvial deposits (Beernaert, 1997). Chemical weathering and translocation of clays is limited by the low availability of water, though fog does play a significant role in the Namib Desert. Evaporative concentration of salts is an important pedogenetic process. Soil physical properties exert significant local control over vegetation in terms of moisture availability.

Climate influences the kind and rate of soil forming processes, especially rainfall, seasonal and diurnal temperature fluctuations and wind action influence the rate of **weathering**. The high solar radiation received during the day – enhanced by the Namib Desert’s position in the tropics and virtual absence of clouds – heats the ground to very high temperatures. The ground colour determines its response to radiation: the albedo of desert soils is typical 24 (darker soil, absorbs more heat) to 28 (lighter soil). At night, the dry air allows desert to cool down dramatically through conduction and longwave radiation. Cold air collects in the lowest part of the landscape as a result of gravity flow. The large diurnal temperature variation places shear stress on rocks and minerals, thereby hastening physical weathering. Exfoliation (or ‘onion-skin weathering’) – flaking off of outer layers – is caused by different rates of heating and cooling through the bulk of the rock. This is particularly noticeable in granites. In some places, thick sheets (≥ 20 cm) may spall off the granitic core of inselbergs. The process is hastened if water enters cracks, freezes and expands on very cold nights. Airborne salt (aerosols in sea breezes, fog) seeps into pores and cracks of rock.

Evaporation lets salts crystallise and expand, which exert pressure on the walls of the rock pores. If the pressure exceeds the tensile strength of the rock, granular physically (mechanical) weathering occurs – a process known as ‘haloclasty’ or salt weathering. The salt crystals physically pry mineral grains apart. Wind also plays a role in the process, by promoting evaporative salt crystal growth. Once cavities form, a reduction in air pressure within the cavities results in increased wind speed and enhanced evaporation – a positive feedback. Goudie and Viles (2014) suggest that salt weathering may be implicated in the process of ‘haloplanation’ - creating the large, relatively flat coastal plains of the Namib. Small hollows are called ‘alveoli’, closely clustered alveoli are referred to as ‘honeycombs’, while larger cavities with rounded entrances and smooth concave walls are known as ‘tafoni’. These weathering forms are most frequently found in granular rock such as sandstone, granite and sandy limestone.

Soil types

The soil types observed or likely to occur in the SCNP, Kaokoveld and Iona National Park are as follows:

- Arenosols (AR)
- Leptosols (LP)
- Calcisols (CL)
- Gypsisols (GY)
- Solonchaks (SC)
- Fluvisols (FL)
- Cambisols (CM)
- Regosols (RG).

Figure 10 shows the distribution of the soils in the Nambian part of the study area. In Iona Park Fluvisols can be found along the Curoca River, large areas of Arenosols under dunes and sand plains of the coastal strip, Solonchaks north of the Curoca and Leptosols comprising all of eastern Iona (Figure 11).

Arenosols are deep sandy soils in recently deposited sands such as dunes, beaches, sandy plains and valleys such as the Marienfluss, and in residual sands formed by in situ weathering of silica-rich sediments or rocks such as sandstone, granite and quartzite (IUSS Working Group WRB, 2015). The SCNP's beach and dune sands are composed of up to 70-80 % quartz (Garzanti *et al.*, 2014). These soils are mostly unconsolidated, with very little horizon development due to scarcity of water and wind-driven mobility. Their coarse textures result in high permeability and low water and nutrient storage capacity. Fine to medium-grained sands are extremely sensitive to wind erosion.

The parts of the study area that are mountainous, have shallow bedrock (e.g. the basaltic or granitic plains of the SCNP), have highly dissected topography or are eroding fast, are covered by *Leptosols*. These are very shallow soils over continuous rock, or soils that are extremely stony.

The coastal salt pans, as well as terminal playas of rivers, have *Solonchaks*, which are saline soils. They are seasonally or permanently waterlogged. The high salt content inhibits plant growth, though halophytic plants such as *Salicornia*, *Tamarix* and *Salsola* can tolerate moderate salinity. Some parts of coastal salt pans may contain *Solonetz*, which are soils high in sodium, though not necessarily in other salts.

Gypsisols are widespread along the Namib coast, though their presence has not been confirmed in Iona. They are found in highly stable, long exposed surface gravels and sands, up to 50 km from the coast, but mainly concentrated in the first 5-10 km from the coast. As their formation is linked to deposition of atmospheric sulphates of marine biogenic origin, the best-developed Gypsisols are downwind of the largest upwelling cells. Gravel plains with Gypsisols are vulnerable to damage by vehicles. The weight of vehicles causes collapse of the puffy structure, which leaves highly visible vehicle tracks on the desert floor.

Calcisols cover large parts of the study area, where secondary carbonates accumulate in base-rich (calcareous) parent material. They are typically pale brown, with calcrete found in outcrops or at shallow depth. They occur further inland than Gypsisols.

Riverbeds, river valleys, alluvial fans, deltas and tidal marches have *Fluvisols*. They are inundated periodically and show stratification in texture, colour, organic matter content and the nature of coarse fragments, caused by each new flood.

Cambisols are poorly developed soils found in alluvial, colluvial and aeolian material. They show

incipient signs of horizon development.

Regosols are even less developed than Cambisols, with no horizon development. They are found in young sediments, eroding and accreting landscapes, such as footslopes of mountains. They are highly erodible and prone to desiccation.

Durisols – shallow to moderately deep, moderately to well-drained soils that contain cemented silica – may occur on old, stable land surfaces, on level to gently sloping alluvial plains and pediments. Their presence has not been confirmed in the study area yet.

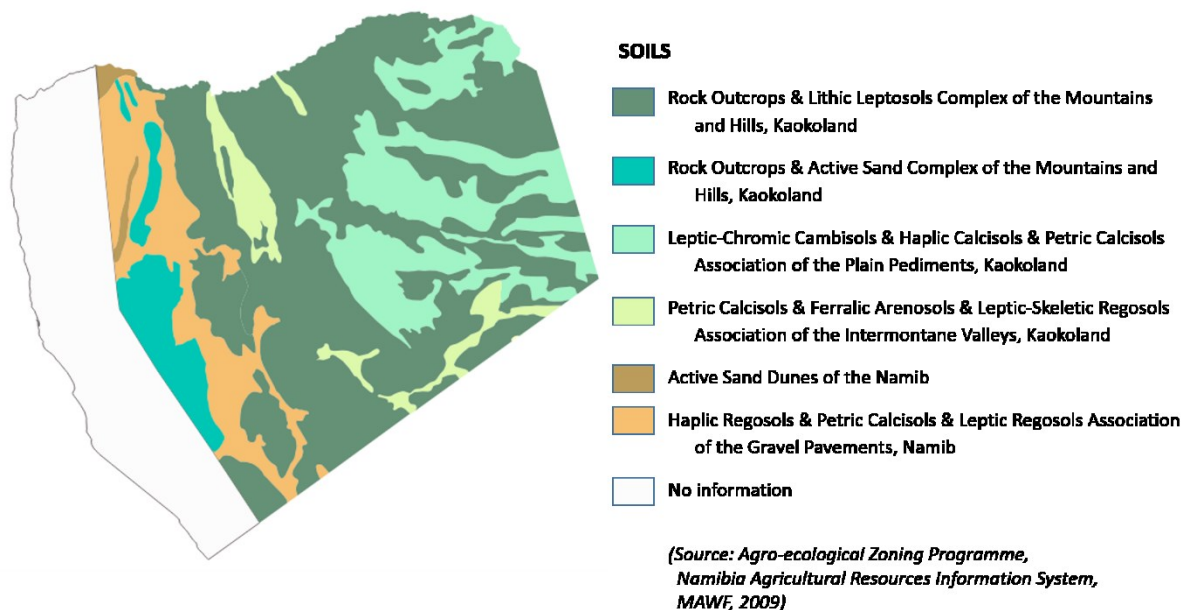


Figure 10 - National Soil Map of Namibia with scale 1:1,000,000 (phase 1) (MAWF, 2009) (Mapping: M. Coetzee)

The surface of arid soils in the study area are often associated with specific soil properties. Soils with Yermic properties often have a vesicular ('foamy') structure in the upper centimetres. They are usually associated with unvegetated, structurally unstable, silty loam soils with a surface crust or desert pavement. Gravel or stone fragments can be embedded in the upper soil layer forming a polygonal network of desiccation cracks, that may be filled with in-blown material and that extends into the underlying layers. Desert varnish, ventifacts, soluble mineral accumulations, layers with weak to moderate platy structure, thin aeolian sand or loess may occur on the surface above the vesicular layer (Ellis, 1988, 1990; Lambrechts & MacVicar, 2004). Aridic soil properties refer to a number of characteristics of surface horizons, such as low soil organic carbon, evidence of aeolian activity, high base saturation and relatively dark and strong colour, especially when moist. Aeolian activity is demonstrated by rounded to subangular sand particles with a matt surface, ventifacts (wind-shaped rocks), aeroturbation (e.g. cross-bedding) or other signs of wind erosion or deposition.

Soil minerals

Heavy minerals such as ilmenite, rutile, monazite, zircon, magnetite and staurolite, derived from granites, basalts, metamorphic rocks and pegmatites of the Karoo and Damara Sequences in the hinterland, are present in beach and dune sands of the Skeleton Coast. Sand and heavy minerals are moved onshore by strong, sustained wave action. Further sorting by size and density takes place, mainly on the upper part of the eulittoral zone (Van Gosen *et al.*, 2014). Strong winds remobilise the

fine sands and heavy minerals to form dunes landwards of beaches. Selective removal of larger low-density grains by wind leaves behind smaller, denser grains resulting in progressive heavy-mineral enrichment of beach and dune sands (Komar, 2007). Namibian coastal sands contain, on average, 7 % heavy-minerals within the storm-beach section 1.5-3 m above sea level, though higher concentrations are found in placer deposits (Hugo, 1968). Garnet concentration of 0.8 ± 0.3 %, and opaque Fe–Ti–Cr oxides concentrations of 0.93 ± 0.02 % are reported in the dune sands of SCNP (Garzanti *et al.*, 2018). In the Moçamedes Desert, garnet is the most abundant and locally dominant heavy mineral. In a few places, garnet and a combination of iron-titanium- chromium oxides respectively constitute up to 17% and 20% of dune sands, and 50% and 60% of beach sands. At some placer deposits, the combined heavy mineral contents constitute 95 - 99 % of dark deep red to black beach placer deposits (Garzanti *et al.*, 2018).

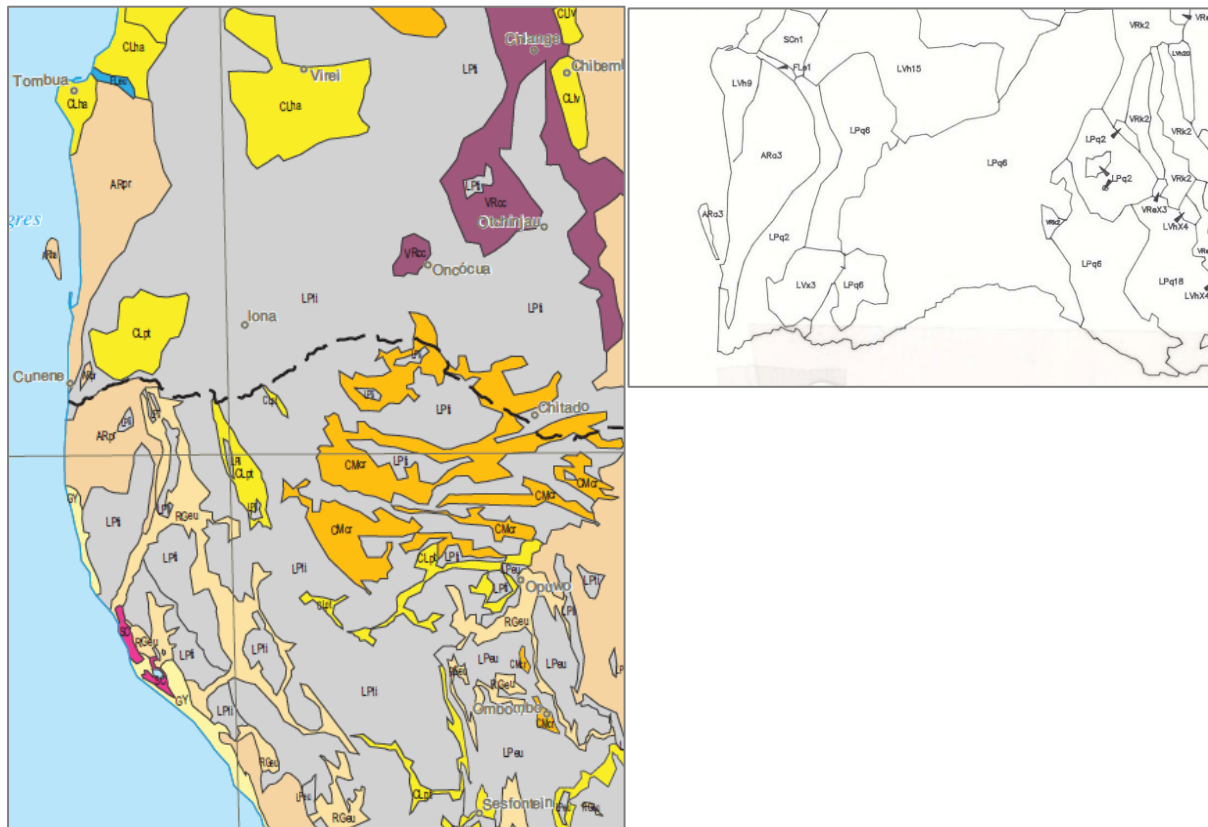
Soil data

Namibia:

The MAWF (2000) *Preliminary Soil Map of Namibia* has a scale of 1:1,000,000 (Figure 10). It does not, however, cover the Skeleton Coast National Park. This map is at present being updated by M. Coetzee under a Ministry of Land Reform project and the SCIONA project.

Angola:

1. *Soil and Terrain Map and Database of Angola* (1:2,500,000; 1997), prepared by Frank Beernaert for the FAO; uses the FAO Soil Map of the World classification and SOTER database format.
2. *SOTER Database for Southern Africa – SOTERSAF* (2003), compiled by ISRIC and FAO (AGLL). The Angolan part is based on the work by Beernaert; GIS, database
3. *Carta Generalizada dos Solos de Angola*, the 3rd approximation (1:1,000,000; 1965), prepared by J.V. Botelho da Costa, Ario Lobo Azevedo, R. Pinto Ricardo, E.P. Cardoso Franco & E.M. Silva da Camara; Centro de Estudos de Pedologia, Insituto de Investigação Científica Tropical, Lisbon.
4. *Carta Generalizada dos Solos de Angola*, the 4th approximation (1:1,000,000; 1997). Centro de Estudos de Pedologia, Insituto de Investigação Científica Tropical, Lisbon; using FAO's Revised Legend (1988) as soil classification system.
5. *Draft Soil Map* (1:3,000,000, 1991); prepared under the SADCC Food Security Programme (Figure 11).
6. *Erosion Hazard Map* (1:2,000,000; date unknown); published by the SADCC Soil and Water Conservation and Land Utilization Co-Ordination Unit
7. *Soil Atlas of Africa* (1:3,000,000; 2013), prepared by Jones et al. (2013), published by the European Commission, using the World Reference Base classification system (Figure 11).



3. Biodiversity in the SCIONA study area

3.1 Introduction

Contributions: Vera De Cauwer

The TFCA is considered to be among the last wildernesses on earth. It is situated within two of the most intact ecosystems of the planet: the Miombo – Mopane woodland ecosystem and the Kalahari – Namib Desert ecosystem. The Miombo – Mopane ecosystem is also among the five ecosystems with the highest biodiversity at global level (Mittermeier *et al.*, 2003). Conservation in such areas becomes of global importance considering the world's increasing species extinction (the complete loss of a species), extirpation (a localized extinction), and also what is recently being described as defaunation (loss of abundance) (Dirzo *et al.*, 2014; McCauley *et al.*, 2015; Young *et al.*, 2016). A study of nearly half of known vertebrate species (Ceballos *et al.*, 2017), indicates that 32% are decreasing in population size and range and refer to it as a biological annihilation.

The study area contains many endemic and unique species. We consider a taxon endemic if confined to the SCIONA study area (Figure 1). Most endemic species are found in the Kaokoveld, while some authors refer to the escarpment region as centre of endemism (Simmons *et al.*, 1998). The Kaokoveld is one of Namibia's two centres of diversity and endemism (Simmons *et al.*, 1998; UNEP-WCMC, 2013). The exact extent of this centre of endemism is not known (Craven & Vorster, 2006). It probably extends up to Benguela in Angola because of the presence of endemic birds and *Commiphora* species not too far south from Benguela and due to the narrow belt of aridness (Swanepoel, pers. observ.). Angola is considered as the country in southern Africa that is most need of Escarpment research and conservation (Clark *et al.*, 2011). Several factors contribute to the high species diversity in the study area, especially the transition from desert to semi-desert vegetation, the fog and lower temperatures in the desert, and the large variations in altitude (Craven & Vorster, 2006).

The mouth of the Kunene River, which forms the boundary between Namibia and Angola, is the second most species-rich coastal wetland of Namibia (Simmons *et al.*, 1993).

The topographic and rainfall gradient in the east-west direction allow to distinguish three major ecosystem units within the study area, described in slightly different ways by global and national classification systems (Table 2). The WWF ecoregions use the name Kaokoveld Desert for the northern Namib Desert, referring to the desert area only and not including the escarpment area. In Namibia and in most literature, the name Kaokoveld is used for the area and the endemic centre that includes the escarpment area.

Table 2 – Comparison of ecoregions and vegetation types of literature (Barbosa, 1970; White, 1983; Olson *et al.*, 2001; Burke *et al.*, 2002). Mean altitude is extracted from the Shuttle Radar Topography Mission (SRTM) (NASA JPL, 2013).

	Coastal area		Escarpment	Highland
Mean altitude (m)	337		774	1093
WWF Ecoregions	Kaokoveld Desert		Namibian Savanna woodlands	
White's Vegetation Map of Africa	Namib Desert		Bushy Karoo-Namib shrubland	Transition from mopane scrub woodland to Karoo-Namib
Vegetation types of Namibia	Northern Desert	North-western escarpment and inselbergs		Western Highlands
Vegetation map Barbosa	Desert with sand dunes	Desert Flats		Steppe with <i>Commiphora</i> and mopane

3.2 Microbial ecology

Contributions: Elise Nghalipo

The hyper-arid area south of the SCIONA study area has a limited diversity of higher plants and animals (Scola *et al.*, 2017), due to long periods of desiccation, strong winds, low nutrient status and high temperature fluxes (Pointing & Belnap, 2012). As a consequence of the limited macrofauna diversity in this extreme system, small poikilohydric life forms (hypoliths - photosynthetic cyanobacteria, fungi, bacteria and lichens) carry out biological activity that occurs belowground and on rock surfaces (Pointing & Belnap, 2012). These soil microbial communities flourish in the hyper-arid environment, are the dominant drivers of this ecosystem, and therefore play a particularly influential role in mediating key ecosystem processes, both on the soil surface and subsurface (Makhalanyane *et al.*, 2015). The open areas in the study area have abundant hypoliths - photosynthetic cyanobacteria that have colonized the underside of translucent stones (quartz rocks) throughout much of the region. Hypoliths are generally dominated by the cyanobacterial genus *Chroococcidiopsis* in most hyper-arid areas, but can also support substantial heterotrophic bacterial assemblages, particularly acidobacterial and proteobacterial populations (Pointing & Belnap, 2012). The taxonomic diversity of soil microbial communities, surprisingly, is higher than initially assumed, traversing a number of key taxa. In most hyper-arid areas, hypoliths are believed to account for a significant portion of local carbon inputs to the system (Don Cowan *et al.*, 2011).

3.3 Vegetation

Contributions: Vera De Cauwer, Marina Coetzee, Wessel Swanepoel

All three floristic regions of Namibia are represented in the study area: the Karoo-Namib in the west, the Zambezi region in the east, and in between the Kalahari-Highveld transition zone (White, 1983; Maggs *et al.*, 1998).

The ecoregion classification of WWF (Olson *et al.*, 2001) overlaps with the vegetation units of the African vegetation map (White, 1983) for the study area: the Kaokoveld ecoregion covers the Namib desert, and the Namibia Savanna Woodland ecoregion covers the bushy Karoo-Namib shrubland and the transition from Mopane scrub woodland to Karoo-Namib scrubland (Figure 12). The more detailed national vegetation maps match each other well at the country boundary, except for the distinction between the gravel desert flats and the escarpment (Figure 12). A uniform and detailed vegetation map for the transboundary area is currently missing, but is being compiled for the west (Jürgens, oral communication).

The Mopane woodlands cover the eastern parts of the study area (Figure 12). In Namibia, they form a small fraction of the total area of Mopane woodlands of about 77,000 km², where at least 60% of the Namibian population lives (Thomas, 2013). The Mopane woodlands are dominated by the species *Colophospermum mopane*, which structurally can occur either as a tree up to 20–25 m tall (Geldenhuys & Golding, 2008) or a shrub. The distribution range of Mopane woodland covers areas with an annual rainfall of 400 to 700 mm (Chirwa *et al.*, 2014). The distribution range of the species *C. mopane* is larger as it includes scrubland, and is mainly influenced by frost, minimum temperature, dry season length, and a preference for clay-rich soils (De Cauwer *et al.*, 2018). The Mopane tree has many economic uses. It provides good quality firewood, construction material, medicines, fodder for game and domestic animals, and young bark for ropes, and it is a food plant for Mopane worms (Madzibane & Potgieter, 1999; Mannheimer & Curtis, 2009).

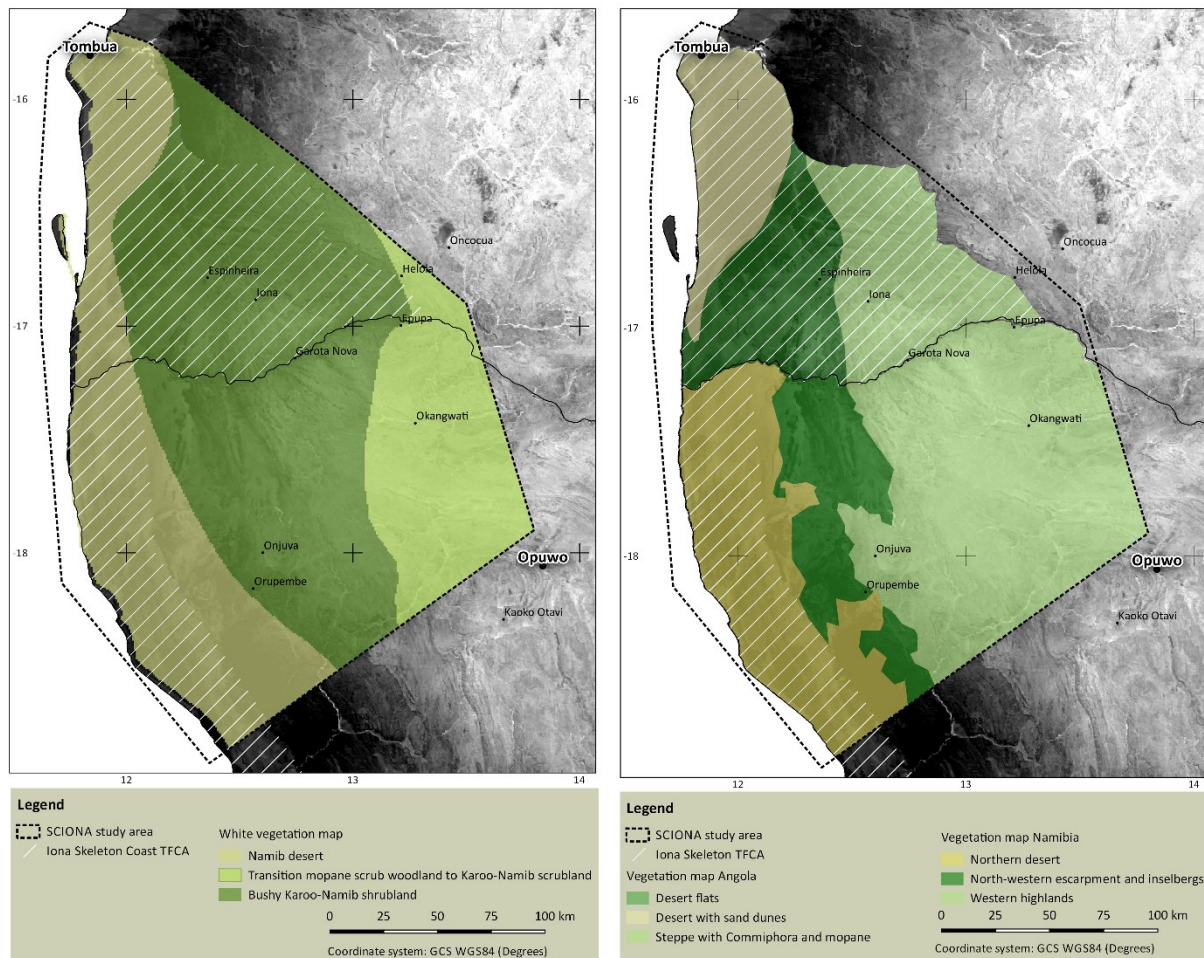


Figure 12: (a) Vegetation map of White (1983) (b) Vegetation maps of Namibia (Burke *et al.*, 2002) and of Angola (Barbosa, 1970). Both maps have a MODIS Enhanced Vegetation Index for the month of August averaged over 2000 – 2018 in the background (Mapping: V. De Cauwer).

Desert-adapted plants occur in the coastal sand desert zone of the Skeleton Coast. Discrete hummocks are generated by stabilisation of the mobile desert sand on the lee side of these plants, especially Inara (*Acanthosicyos horridus*), dollar bush (*Zygophyllum stapffii*) and *Salsola* spp. (Figure 13), but also other species. The plants grow upwards to escape the encroaching sand. In the fog zone, the exposed positions of these plants help with fog-harvesting. Plant material and windblown detritus accumulate, creating small ecosystems with characteristic desert wildlife such as insects and reptiles. The hummocks provide a discontinuous migration route along the entire coastline in a long, intermittent chain parallel to the coast, east of the littoral zone.

Euphorbia and *Commiphora* are among the most common genera in the Kaokoveld and are especially observed in the pro-Namib and on the escarpment. Next to the woody *Euphorbia* and *Commiphora* species listed in annex 1, several non-woody *Euphorbia* were observed during the SCIONA scoping trip in Kunene (De Cauwer & Becker, 2018): *Euphorbia gariepina*, *Euphorbia glanduligera*, *Euphorbia kaokoensis* (Figure 14), *Euphorbia mauritanica*, and *Euphorbia phylloclada*.



Figure 13: Hummocks with *Salsola* spp. in Skeleton Coast National Park (Photo: Alex Derr)



Figure 14: Left: *Euphorbia rimireptans*, a newly described species (Photo: Vera De Cauwer). Right: *Euphorbia kaokoensis*, a rare Kaokoveld endemic (Photo: Alma Möller)

Grasslands in the study area are dominated by *Stipagrostis uniplumis*, as well as *S. hirtigluma*, with *S. giessii* in areas with relatively better water supply (Becker & Getzin, 2000). Palatable grasses include the perennial *Schmidtia papporoides*, and the annual *Urochloa brachyura*. The grass layer in dense Mopane woodland is very sparse, possibly because of the dense shallow lateral root system of *C. mopane* (Verlinden & Dayot, 2005) but mainly due to severe overgrazing.

There are 185 shrub and tree species in the study area (Annex 1), of which 46% have been observed during the SCIONA fieldtrips in year 1. Riparian vegetation refers to both the riverine vegetation along the Kunene River as the non-perennial rivers such as the Hoarusib, Otjinjange, and the Khumib. Some

species have a (potential) socio-economic importance such as the !nara (*Acanthosicyos horridus*), marula (*Sclerocarya birrea*), the bird plum (*Berchemia discolor*), and the sour plum (*Ximena* spp.) for their fruits, and the Namibian myrrh (*Commiphora wildii*) for its perfumed resin. Mopane (*Colophospermum mopane*) is the most important species for firewood. Close to all species have medicinal uses.

Invasive alien plants are present along both perennial and non-perennial watercourses. During the SCIONA reconnaissance, we found wild tobacco (*Nicotiana glauca*) and the castor oil bush (*Ricinus communis*) along the Hoarusib River, and castor oil bush along the Kunene River.

Some of the Kaokoveld species show a disjunct distribution with one part in the study area that is separated from another arid area elsewhere in Africa (Maggs *et al.*, 1998). Taxa with such disjunct distribution area include *Moringa* and *Sesamothamnus*, which also occur in north-eastern (Jürgens, 1997) or southern Africa. They appear to result from a fragmentation of a once much larger arid vegetation belt (Jürgens, 1997).

Endemic plants of the SCIONA study area

The Kaokoveld is recognised as one of the global centres of plant diversity (Davis *et al.*, 1994; UNEP-WCMC, 2013) with high plant endemism. In Namibia's part of the Kaokoveld, the highest plant diversities are in the areas around the Baynes mountains, Sanitatis, and Orupembe (Craven & Vorster, 2006; Craven, 2009). Kaokoveld is the only region within Namibia that has endemic trees (Craven & Vorster, 2006). Annex 1 includes 20 endemic woody species of the SCIONA area, such as *Commiphora giessii* and the hairy shepherds-tree (*Boscia tomentosa*).

New species continue to be found in the Kaokoveld centre of endemism (Craven & Vorster, 2006). Examples of newly discovered species include *Ceraria kuneneana*, *Commiphora kuneana*, *Aloe kaokoensis*, *Euphorbia ohiva*, and *Maerua sebrabergensis* (Swanepoel, 2007, 2008, 2009, 2015; van Jaarsveld & Swanepoel, 2007). A new *Euphorbia* species was found during the SCIONA scoping trip in Kunene and described during a follow up trip in 2019 by Mr Swanepoel, Dr Becker, and Mrs Möller (Figure 14).

The data on the distribution of these new species is incomplete and their conservation status, habitat, or socio-economic importance has not been assessed. One of the reasons of the continuing species discovery in the region is the high interannual rainfall variability, with less species present but persisting through their seeds during periods of drought (Craven & Vorster, 2006).

At least 75 plant species are endemic to the northern Namib Desert. They are often taxonomically isolated, such as grasses of the genus *Kaokochloa*. Intense speciation is ongoing within certain taxa, such as *Petalidium* (Maggs *et al.*, 1998).

Other endemic plants include amongst others:

- Species from the genera *Antiphiona* and *Marcellipsis* (Craven & Vorster, 2006)
- At the coast: *Ectadium rotundifolium*, *Merremia multisecta*, *Hermannia gariepina*, grasses *Chloris flabellata* and *Sporobolus virginicus* (Craven & Vorster, 2006)

Near endemic plants

The Namib Desert has at least 275 endemic plant species (Maggs *et al.*, 1998). The famous *Welwitschia mirabilis* is often claimed to be an endemic of the Namib desert, although it actually occurs also east of it, especially near Khorixas in north-western Namibia (Mannheimer & Curtis, 2009). This iconic plant, attracting many tourists in the central Namib, is a gymnosperm. It is the only species within the

family of the Welwitschiaceae, and has been occurring in the area for more than 100 million years. There are several geographically separated populations of the species. There is significant genetic and morphological variation within and between the populations with little evidence of inbreeding (Jacobson & Lester, 2003; Jacobson *et al.*, 2014). Hence, it is assumed the species had a continuous distribution but became progressively isolated to relict populations through a drying climate and possibly physical disturbances such as browsing (Jürgens, 1997; Jacobson & Lester, 2003; Jacobson *et al.*, 2014). This is reinforced by the fact that few young plants are found in the hyper dry Namib Desert, while a normal demographic structure is found further inland. For example, there are millions of healthy *W. mirabilis* individuals in rainfall zones of 250 to 350 mm in southern Angola (Jürgens, 1997).

Annex 1 includes 23 woody species that are endemic to Namibia and Angola, and five of them are near-endemic to the SCIONA study area.

Information gaps

- The exact extent of the Kaokoveld centre of endemism and diversity is not known, although it can indirectly be derived from available data of endemic species.
- A uniform vegetation map for the study area that is detailed enough to guide biomass assessments, habitat studies, ecological assessments, and further botanic studies.
- Plant distribution data in floristic reference works are often based on inadequate collection, not uniformly gathered in Namibia and Angola (Maggs *et al.*, 1998).
- The threat status of many species has not been assessed (Red Data list).
- It is not known whether desertification and migration of arid taxa is ongoing (Jürgens, 1997).
- Grass and herbs list for study area.

3.4 Arthropods

Contributions: Gail Morland

Current globally described arthropod classifications stand at 1,242,040 (Zhang *et al.*, 2011), of which 1,020,007 are classified as insects. These are known species, the debate concerning the number of insects that are undescribed is a hot topic. The highest estimate is 30 million (Erwin, 1982). More conservative estimates stand at 12.5 million (Hammond, 1992), 5 to 15 million (Stork, 1993) and 5 million (Gaston, 2016) respectively, with many of these estimates being revised and queried by fellow scientists.

Insects: overview

Contributions: Gail Morland, Vera De Cauwer

Insects make up over 80% of the total biomass of land animals and are the most diverse and successful life forms on earth (Cranshaw & Redak, 2013). They are important components of terrestrial systems, contributing significantly to biodiversity and ecosystem structure and function (Picker *et al.*, 2002), and occur at all levels of the food web (Seymour & Dean, 1999). In the hyper-arid Namib Sand Sea south of the SCIONA study area, they have been attributed an important role as plant decomposers in a detritus-based ecosystem. Main detritivores are beetles and termites, but also fungi (Jacobson *et al.*, 2015).

Additionally, members of some insect groups live in the soil or use soil as a substrate for eggs and other inactive life stages (Higgins *et al.*, 2014), helping soil formation by moving and mixing huge amounts of soil as they tunnel (Cranshaw & Redak, 2013). The diversity, richness and composition of insects and their associated functions vary within and between ecosystems (Holm & Edney, 1973), and may shift under changing environmental factors, such as temperature, precipitation as well and vegetation structure. This is particularly true for sensitive ecosystems such as the hyper-arid deserts, where projected climatic conditions are predicted to cause hot and intense prolonged drought, which may affect vegetation composition and structure. This will eventually have an impact on insect diversity, richness and composition (Wharton, 1980).

The most abundant insect members of arid ecosystems are particularly groups of Orthopterans, Coleopterans, Neuropterans, Lepidopterans and Hymenopterans (Weaving, 2000).

Southern African insect diversity is poorly discussed in the literature with only specific references made to very discrete biomes or ecological niches. There are 80,000 species recorded in Southern Africa across 579 families found in 26 orders (Scholtz & Holm, 2008). Holm (2017) estimates that there are around 80,000 species from more than 660 family groups of insects found in Southern Africa.

Namibia currently has 6421 described insect species of which 24% are endemic to the country (Ministry of Environment and Tourism, 2014). The Namibian Biodiversity Database (NBD) indicates that there are 8064 insect species found in Namibia of which 121 are endemic (Irish).

Of the endemic insects found in Namibia the Mantophasmatidae are a newly describe family of insects including the species *Mantophasma zephyra* also known as the gladiators. The endemic beetles include the fog-basking beetle *Onymacris rugatipennis*, the flower beetle *Dischista cincta*, the jewel beetle *Julodis eggho*, the flightless orange dung beetle *Pachysoma denticolle*, the scarab beetle *Scapanoclypeus hardap*, the long-horned beetles *Ontachariesthes namibianus* and *Sthenias damrensis*, the tiger beetle *Lophyra namibica* and the tortoise beetle *Zophosis moralesi* (Zhang *et al.*, 2011).

Other Namibian insect endemics include two the butterfly species *Acraea hypoleuca* and *Iolais obscurus* a cricket *Comicus calcaris* and a grasshopper *Crypsicerus glabra*. The plant bug *Peritropis waclawi*, a mydas fly *Eremophaplomydas desertorum*, a wasp *Priscomasaris namibiensis* and an ant *Camponotus detritus* (Zhang *et al.*, 2011).

Insect studies in the Skeleton Coast National Park and surrounding Kaokoveld include:

- (Tjeder, 1966, 1967, 1987; Mansell, 1990, 1996, 2018) who studied Neuroptera with the aim of describing new species in the study area;
- (Deckert & Gollner-Scheiding, 2006) studied Heteroptera in the study area with the aim of determining the biodiversity of the group within Southern Africa;
- (Guadarrama-Cetina *et al.*, 2014) studied Tenebrionids from the Skeleton Coast to determine how their elitra is adapted for fog basking.
- The phylogeny of a rare species of Tenebrionidae found up near the Kunene was also analysed to clarify the genus *Onymacrus* (Lamb *et al.*, 2017).
- (Pitzalis *et al.*, 2016) studied the Meloidae beetle group to determine diversity within Namibia and the Kaokoveld area was included in their study.

Insect studies in the greater Namibian area include:

- Studies with regards to Tenebrionidae beetles conducted by; (Lighton, 1991); (Edney, 1971); (Ward & Seely, 1996); (Naidu & Hattingh, 1986); (Seely, 1973); (Bartholomew *et al.*, 1985);

(Nicolson, 1990) and (Koch, 1962). These were done in the Central Namib Desert area and were focused on the biology and physiology of certain Tenebrionid beetles. One study was also undertaken to determine the physiology of a scarab beetle this was done by (Duncan & Byrne, 2000).

- (Lighton, 1990) and (Curtis, 1985b, d, c,a, 1990) studied a specific ant found in the Namib Desert. Mantophasmidae was extensively studied in the Cape Cross area by (Adis *et al.*, 2002). Bradyporidae a family within the Orthoptera was studied by (Irish, 1992).
- Studies with regards to the biodiversity of a specific area include (Wharton, 1980); and (Holm & Edney, 1973) which also focused on areas in the Central Namib Desert. (Theron, 2010) focused on arboreal insects collected in the Omaruru river and (Martens *et al.*, 2003) focused on Odonata collected from all over Namibia with a strong focus on the Caprivi area. (Irish, 2009) focused on the insect diversity of the Fish River Basin as part of a biodiversity study of the area.

Major gaps on insect studies in the study area include:

The complete diversity and richness of insects in the SCIONA area is very poorly represented in the literature available. There are very specialised focused studies on specific groups of insects but the wholeistic view of the insect assemblages in the area is unknown.

Insects as valuable protein source: Mopane worms

Contributions: Gail Morland

Mopane worms (*Imbrasia belina*) are the larval stage of a type of moth (family Saturniidae) belonging to the insect order of the Lepidoptera. Lepidoptera fauna of Namibia account for 819 species, 445 genera and 50 families of which 121 species are endemic to the country (Barnard, 1998; Kopij, 2014). One Lepidoptera study took place in the Brandberg area of Namibia (Mey, 2004). Another study was done in the Hobatere area East of Etosha to determine Lepidoptera assemblage there (Braine, 2002). Finally Kopij (2014) did a study of the moths of the Koakoland (Mopane) Savanna.

In Namibia seven of the ten dominant ethnic groups feed on Mopane worm, making it a highly valuable source of protein to the Namibia population (Marais, 1996). Mopane worm abundance is dependent on annual rainfall and therefore overharvesting is a common problem facing the sustainability of this food source (Thomas, 2013). Harvesting of the worm in Namibia is not strictly regulated and is largely based on indigenous knowledge, beliefs and local institutional frameworks as a form of control (Thomas, 2013).

Insects as architects of fairy circles?

Contributions: Vera De Cauwer

Scientific debate on the origin of the fairy circles is ongoing and not concluded. One of the most often proposed theories is that the harvester termite *Hodotermes mossambicus*, widely distributed in southern Africa, creates the fairy circles in the Kaokoveld (Becker & Getzin, 2000). Another study points to the black pugnacious ant (*Anoplolepis steingroeveri*) (Picker *et al.*, 2012). Other theories include a yet unknown plant growth inhibiting factor (van Rooyen *et al.*, 2004) and self-organised spatial vegetation patterning arising from resource competition and facilitation (Cramer & Barger, 2013).

Other arthropods

Contributions: Mervyn Mansel, Marina Coetzee

The invertebrates class Arachnida consists of spiders, scorpions and sun spiders. Scorpions were encountered during the scoping trip outside the study area (Khowarib Schlucht camp), while spider species found in the study area included:

- **Order Araneae** (spiders)

Family Sicariidae (crab spiders, six-eyed sand spiders), *Sicarius* sp., possibly *S. testaceus*. In sand in caves and under rock overhangs. Highly venomous (Figure 15).

Family Sparassidae (white lady spider). *Leucorchestris arenicola*. Found in dune hummock, Skeleton Coast National Park (Figure 14).

- **Order Solifugae** (sun spiders)

Family Solipugidae (sun spiders, “son spinnekoppe, haar skeerders”). Ablution block at Opuwo camp site and elsewhere.



Figure 15: Crab spider (*Sicarius* sp.) (Photo: Alex Derr) and white lady spider (*Leucorchestris arenicola*) (Photo: Nicky Knox)

3.5 Amphibians

Contributions: Jill Heaton, Jon DeBoer, Francois Becker

Two species sightings of toads were made during the SCIONA scoping trip, and are likely (Figure 16):

- *Sclerophrys* sp. (typical toad) or *Amietophrynus maculatus* (flat-backed toad) at Camp Synchro;
- *Poyntonophrynus* sp. (pygmy toad) at Khowarib Schlucht Lodge.

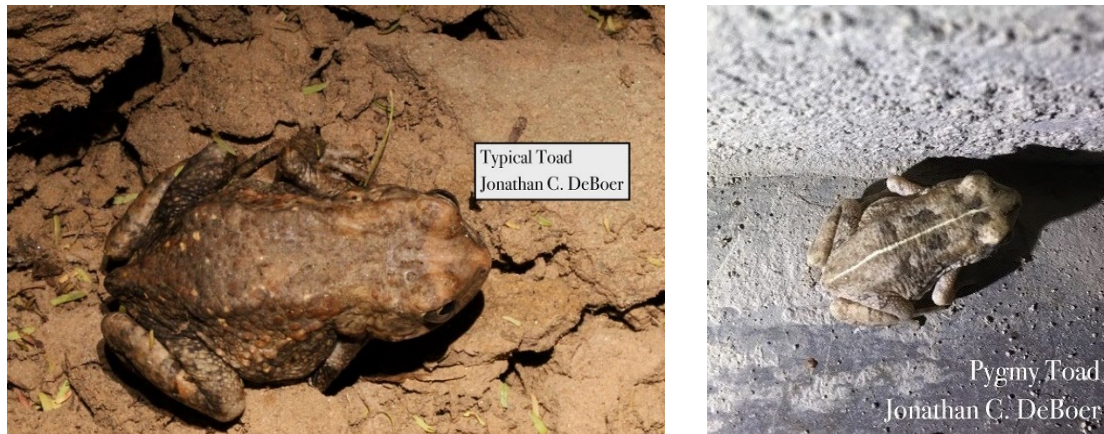


Figure 16 – Typical toad and pygmy toad (Photos: Jon DeBoer)

3.6 Reptiles

Contributions: Jill Heaton, Jon DeBoer, Manfred Finckh, Paulina Zigelski, Rasmus Revermann, Francois Theart, Ninda Baptista, Vera De Cauwer

Significant sightings made during the SCIONA scoping trip included:

- 5/25/18 – *Stigmochelys pardalis* (leopard tortoise) – CITES protected, just after Kamanjab
- 5/25/18 – *Gerrhosaurus nigrolineatus* (black-lined plated lizard) – just after Kamanjab – Found death on the road, whole body specimen collected (Figure 17)
- 5/28/18 – *Chamaeleo namaquensis* (Namaqua chameleon) – CITES protected – SCNP, right after Green Drum (Figure 17)
- 5/28/18 to 5/29/18 – *Gerrhosaurus skoogi* (desert plated lizard) – SCNP – multiple sightings on slip face of dunes.



Figure 17: Black-lined plated lizard (*Gerrhosaurus nigrolineatus*) and Namaqua chameleon (*Chamaeleo namaquensis*) (Photos: Jon DeBoer)

Other sightings made during the Namibian and Angolan scoping trips:

- *Agama aculeate* (ground agama) – Opuwo to Camp Marble

- *Agama anchietae* (Anchieta's agama) – Opuwo to Camp Marble, as well as at Espinheira Biodiversity Observatory
- *Agama planiceps* (Namib rock agama) – observed throughout entire Namibian scoping trip, except absent in SCNP, and also at the Salondjamba entrance of Iona national park
- *Chondrodactylus fitzsimonsi* (Fitzsimons thick-toed gecko) – possibly F1 hybrid with *C. pulitzerae* (Dr Aaron Bauer, pers. comm.) – on the way to Camp Marble
- *Chondrodactylus pulitzerae* (Pulitzer's thick-toed gecko) – found at Camp Synchro and in Espinheira Park Headquarters
- *Heliobolus lugubris* (bushveld lizard) – Opuwo to Camp Marble
- *Lygodactylus bernardi* (Bernard's dwarf day gecko) – small gecko found at Palmwag
- *Trachylepis acutilabris* (wedge-snouted skink) – on the way to Rooidrom, and at Espinheira Biodiversity Observatory
- *Trachylepis sulcata* (western rock skink) – on the way to Rooidrom
- *Naja nigricinctus* (western barred spitting cobra) – Camp Synchro
- *Pedioplanis breviceps* (short-headed sandveld lizard) – just out of SCNP
- *Pedioplanis gaerdesi* (Kaokoveld sand lizard) –going down big hill & group gathering Onjuva
- *Rhoptropus boultoni* (Boulton's day gecko) – Camp Synchro and on the Angolan side at the rocks near the Kunene rapids
- *Rhoptropus afer* (Namib day gecko) – throughout SCNP
- *Rhoptropus biporosus* (Kaokoveld Namib Day Gecko) - at Espinheira Biodiversity Observatory
- *Crocodylus niloticus* (Nile crocodile): Kunene River, at Camp Synchro, and at the Angolan side from the community camp at Otjihungwa.

3.7 Birds

Contributions: Rolf Becker, Wessel Swanepoel

A birdlist of the Kaokoveld and Skeleton Coast National Park is added in annex 2 and contains 397 species. The two most significant sightings during the SCIONA scoping trip were made in the Marienfluss Valley: Abdim's stork (*Ciconia abdimii*) and white stork (*Ciconia ciconia*).

3.8 Freshwater invertebrates

Freshwater fish and freshwater invertebrates occur in the Kunene River, the springs and the ephemeral pools.

3.9 Terrestrial mammals

Contributions: Morgan Hauptfleisch

Historical mammal distribution and population trends

Knowledge of the historical distribution of wildlife in any area of Namibia requires reliance on anecdotal writings and accounts of early explorers. It is not until 1934 (Shortridge, 1934) that a formal account is provided.

In an account of wildlife trends in Angola, Huntley (2017) describes the intermontaine parts of Iona national park as a seasonal haven for large herds of springbok (*Antidorcas marsupialis*), oryx (*Oryx gazelle*) and the near-endemic Hartmann's mountain zebra (*Equus zebra hartmannae*) until the 1970's. This was mirrored on the Namibian side of the Kunene (Owen-Smith, 2011). The herds sustained large predators such as leopard (*Panthera pardus*), cheetah (*Acionyx jubatus*), brown and spotted hyaena (*Parayhaena brunnea* and *Crocuta crocuta*) and occasionally lion (*Panthera leo*). South-western black rhino (*Diceros bicornis occidentalis*), Angolan giraffe (*Giraffa giraffe angolensis*) and elephant (*Loxodonta Africana*) were also present, although in small numbers. In the 1930s there was reported to be approximately 200 giraffe in the far northern Kaokoveld (Shortridge, 1934) while elephant were frequently seen along the entire extent of the Kunene River.

Wildlife in both Namibia and Angola saw significant declines from the late 1960's to the 1970's in Namibia and until the early 2000's in Angola (Huntley, 1974; Brown, 2006; Owen-Smith, 2011; Huntley, 2017). Seen as unused resources, European colonial hunters and traders decimated large mammal populations through much of the eighteenth and nineteenth century until some conservation efforts in the twentieth century reduced the plunder to an extent (Murombedzi, 2003). These efforts restricted the use of wildlife, but mostly merely led to an increase in illegal hunting by local populations. It was not until the 1970s when wildlife populations started to see significant recovery when residents were allowed sustainable limited use of wildlife (Owen-Smith, 2011).

Potential flagship species

Black faced impala *Aepyceros melampus petersi*

The black faced impala is a good flagship species in the study area because it is easy to monitor, the area used to be its primary habitat, and the species is an indicator of riparian health.

Distribution

In 1934, Shortridge (1934) referred to the subspecies as Angolan impala and observed the Kunene River riparian to be the species' core distribution area where they were plentiful. By 1971 their population in the area of the Kunene was limited to areas around Epupa, Otjipembe and Swartbooisdrift. Currently small populations exist in the southern communal conservancies of the Kunene region, but none are known to presently occur in the TFCA (EIS, 2018) (Figure 18). Extended periods of drought, grazing pressure and overhunting have been thought to be the main cause of the local extinction of black-faced impala from the SCIONA core area in Namibia. Presently Etosha National Park has become the main sanctuary for the subspecies. This population grew steadily from a small group of around 60 at Otjovasandu to high numbers across all woody dominated areas of the park (Joubert, 1971). As the colloquial name Angolan impala of 1934 suggests, black-faced impalas were plentiful in the riparian woodland of the southern Angolan rivers but their current distribution is unknown.

Ecology

The impala is classified as a mixed feeder (Bothma & Toit, 2010), and the black-faced impala subspecies is no different. It was observed to graze and browse in equal volumes in times of good rainfall when grazing is readily available. In dry periods however, they rely heavily on browse in riparian woodland. Leaves of *Acacia* and *Combretum* species are preferred, and especially the leaves and pods of *Faidherbia albida*.



Spotted hyaena

The species is known to be an important keystone predator in southern Africa (Paine, 1969). Although Trinkel (2009) suggests that protected areas will provide the most important growth area for the species, there has been a noted increase in number, and extension of range, of spotted hyena in the eastern part of north-west Namibia (Figure 19).

Angolan giraffe *Giraffa giraffa angolensis* previously *Giraffa camelopardalis angolensis*

Distribution

Historically and naturally, Angolan giraffe occurred in the northern third of Namibia in most habitats including the SCIONA arid zone (Cunningham, 2014). Shortridge (1934) references sightings of giraffe across much of what was then known as Kaokoland, and an account in 1958 reports giraffe to be numerous and widespread across the Kaokoveld, except for the extreme western desert (Cunningham, 2014). Occurrence along the Kunene river seems to have always been restricted to the eastern parts (Shortridge, 1934). Angolan giraffe frequently moved across north-central Namibian where Ovambo hunters mostly killed them for meat and hides (Shortridge, 1934). It is therefore assumed that southern Angola had a healthy population. Giraffe historically occurred in the Mopane and Acacia savannas of southern Angola. An area immediately to the east of Iona National Park between the Curoca and Kunene rivers seems to have been then the heartland of the western giraffe population (Marais *et al.*, 2013).

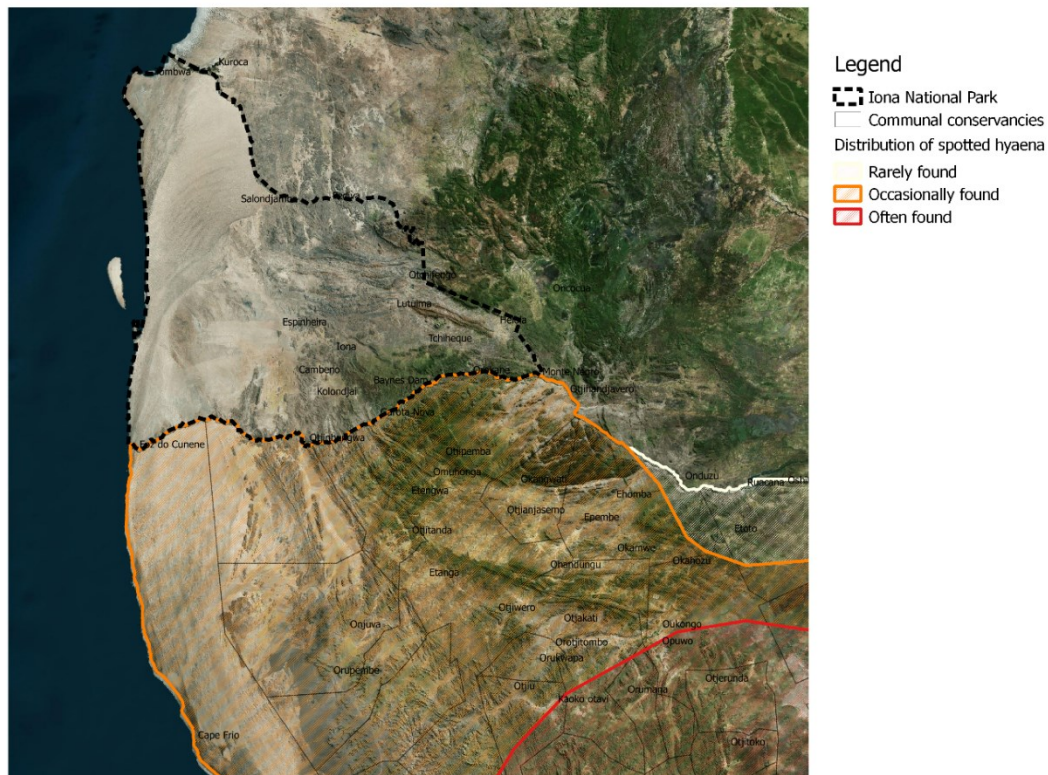


Figure 19: Spotted hyaena distribution and density in the SCIONA study area (Mapping: M. Hauptfleisch).

Presently giraffe are known to occur in Orupembe conservancy and the eastern parts of riverbeds in the Skeleton Coast park (Figure 20). The furthest north giraffe have been sighted in the SCIONA study area was on the Hartmann's valley, approximately 40 km south of the Serra Cafema Camp in Namibia. They are thought to be solely dependent on the riparian woodland of the ephemeral rivers of the area (Fennessey, 2004). The last overall estimate of giraffe numbers in the entire north-western part of Namibia's Kunene Region was 1105 individuals in 2004 (Fennessey, 2004). Annual counts of giraffe in the communal conservancies of the entire north west (including areas well to the south of the SCIONA study area) fluctuated between 59 and 256 individuals over the past 16 years, with a steadily increasing population trend until 2012 and stable thereafter.

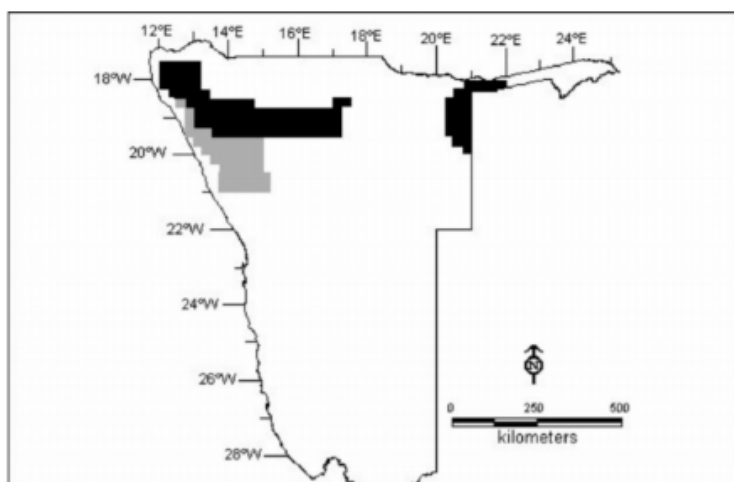


Figure 20: Distribution of giraffe in Namibia (From Fennessey, 2004).

Ecology and conservation concerns

Recent genetic research has separated what was until then one species of giraffe globally into four distinct species (Fennessy et al., 2016) of which SCIONA's giraffe together with the South African giraffe form the southern giraffe species (*G. giraffa*) (Figure 21). This increases the vulnerability of giraffe globally, as each species has a far smaller population and distribution than one species with its greater global distribution. Southern giraffe are however the only species of giraffe which is not under immediate conservation threat (Fennessy et al., 2016).

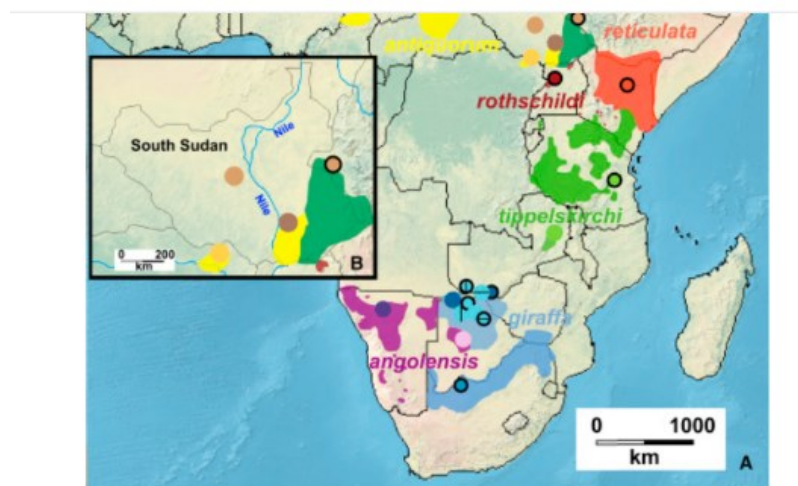


Figure 21: Distribution of giraffe species and subspecies in Africa (From Fennessy et al. 2016).

Fennessy *et al.* 2016 estimates that the overall Angolan giraffe population is approximately 13,000 individuals, occurring only in Namibia and Botswana. This is despite the type specimen for the subspecies being collected in southern Angola, less than 250km east of Iona National Park. This confirms that the subspecies is extinct in Angola. There were recent introductions of giraffe into privately owned game reserves in Angola, sadly the South African subspecies was introduced (Marais *et al.*, 2013).

A concern for the conservation of the subspecies is genetic pollution due to introduction of the more common and commercially available South African subspecies into the range, leading to hybridization. A reintroduction of Angolan giraffe into the SCIONA study area should be considered, but only after an assessment of habitat and security. Were communities in Angola to show tolerance of the species and an interest in conserving wildlife in general, as is currently the case in Namibia, a reintroduction is likely to be successful.

Studies of the ecology of giraffe in arid and hyper-arid areas are restricted to the west-flowing ephemeral rivers of Namibia's Kunene region (Fennessy *et al.*, 2003; Fennessy, 2004). In this area giraffe are totally water independent, and rely solely on riverine woodland vegetation.

Hartmann's mountain zebra *Equus zebra hartmannae*

With the type specimen of this species collected in 1898 within the SCIONA study area, it makes sense for this species to be a flagship for the transboundary park. Being an endemic to Namibia and southern Angola, it has a limited distribution (Figure 22) and is classified as vulnerable on the IUCN red list (The IUCN Red List of Threatened Species). It is also a species of economic importance as a preferred trophy

Legend

- Iona National Park
- Communal conservancies
- Distribution of Hartmann's zebra

A photograph of a savanna landscape. In the foreground, four zebras are standing on a dry, yellowish-brown field. The middle ground shows a vast, flat expanse of similar terrain. In the background, a range of large, rugged mountains with reddish-brown peaks rises against a clear sky. The lighting suggests a bright, sunny day.

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Cheetah *Acinonyx jubatus*

Attributing flagship status to the cheetah is relevant because it is a threatened species, it is an indicator of prey and competing predator population trends, it predares on livestock when natural prey is scarce and camera trap monitoring at waterholes and marking trees is possible for para-ecologists.

Distribution

The Pro-Namib has historically been an important habitat for cheetah (Coetsee, C.G, 1971), and the SCIONA area of Angola and Namibia contains a significant portion of this habitat type. Cheetahs are, with brown hyenas, the most regularly observed large predator in the SCIONA study area. Both Orupembe and Marienfluss conservancies report sightings annually (Figure 24). They are also reported to be seen, although rarely, in Iona (Purchase *et al.*, 2007). This is reported to be an indicator of recovering herds of the species' prey base in southern Angola (Morais *et al.*, 2018).

Ecology and conservation concerns

As an apex predator, cheetah numbers reflect the prey base populations. Cheetah are particularly fond of springbok and ostrich in arid areas (Skinner & Chimimba, 2005). They are also poor competitors and their numbers decline with increases in populations of lion, hyena and leopard. They are also known to be responsible for more livestock losses than most other predators in southern Africa (Skinner & Chimimba, 2005). An interesting cultural value is attached to cheetah among the Ovahimba (Chesselet *et al.*, 2004). Killing a cheetah and eating its heart is believed to enhance bravery and prevent cowardice.

Cheetah are globally listed as vulnerable on the IUCN red list, while a plethora of specialists have suggested the status should be upgraded to endangered (Durant *et al.*, 2017). This is as a result of declines across most of its range, and that the Namibian stronghold for the species is largely on unprotected farmland where conflict with livestock owners is rife. Increases in the cheetah population of SCIONA will therefore have globally significant value.

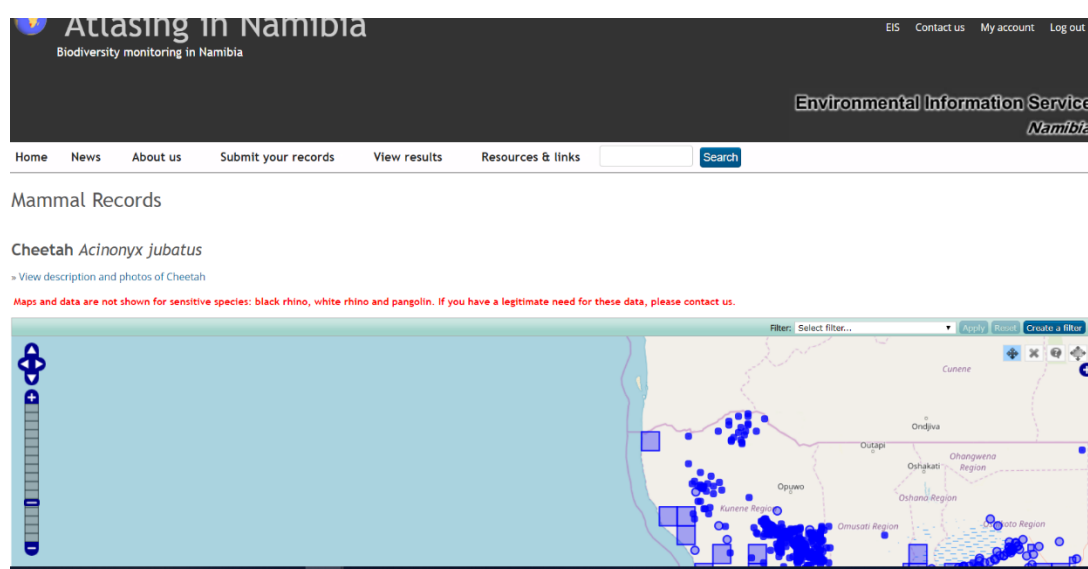


Figure 24: Reported sightings of cheetah in the Namibian SCIONA study area (from the Namibia Atlas project (EIS 2019).

Information gaps

- Distribution of black faced impala in Angola
- Assessment of habitat and security for re-introduction of Angolan giraffe in Iona National Park. Studies of the ecology of giraffe in arid and hyper-arid areas are restricted to the west-flowing ephemeral rivers of Namibia's Kunene region
- economic potential of the Hartmann's mountain zebra in the study region

3.10 Marine fauna

Contributions: Morgan Hauptfleisch, Marina Coetzee

The Kunene River Mouth lacks estuarine benthic fauna, marine and estuarine plankton, and marine fish species (Carter & Bickerton 1996; Morant & Carter 1996; BCLME 2007), which indicates that it acts as a river mouth rather than an estuary, according to the classification of Whitfield (2001).

Cape fur seal *Arctocephalus pusillus*

The Cape Fur seal is proposed as flagship species for the study area as it is a marine and terrestrial energy and nutrient link and an indicator of marine productivity, as well as sustainable commercial fisheries.

Distribution

The west coast of southern Africa is the most important habitat for this species. It provides the cold water and productive fish stocks of the Benguela current (Alava, 2017). The main colonies of the Namibian coastline are censused annually.

Using the recently produced high resolution images for Iona, a little over 15,000 seals were counted within Baia dos Tigres alone (Mendelsohn & Haraes, 2018).

Ecology

Cape fur seals prefer rocky outcrops or islets which remain dry at high tide (Skinner & Chimimba, 2005). Within the SCIONA study area, False Cape Fria holds the largest colony. The seals are in direct competition with commercial fisheries as both target the same species. Much has been written about the effect of increasing seal numbers on fisheries and vice versa (Shannon *et al.*, 2004)

Within the context of SCIONA Cape fur seals are an important nutrient and energy transfer link between the ocean and the land ecosystems. Feeding in the ocean, seal droppings fertilise the coastline, and predation by hyena, jackal and other predators spreads the nutrients inland to supplement terrestrial systems.

4. Human habitation with the SCIONA study area

Contribution: Vera De Cauwer

There is no human habitation within SCNP with exception of the park rangers. About 3,300 people live in the eastern and southern parts of Iona National Park belonging to different ethnic tribes, including the Himba. They have close relationships with the Himba on the other side of the Cunene River, in Namibia. The Namibian Himba live widespread in northern Cunene, and are organised in communal conservancies. The four target communities have a population of about 6,300 people with more than half of them living in the Epupa conservancy.

Although most local communities nowadays have a subsistence economy, they used to have a higher degree of economic diversification before 1920. This changed because of restrictions on the movement of livestock imposed by the South African and Portuguese regimes in the respective countries (Corbett, 1999).

Next to livestock farming, most Himba households engage in crop production during part of the year. They focus on the alluvial soil along the Cunene and produce maize, and various types of pumpkins and melons (Corbett, 1999).

5. Current management within the TFCA and adjacent areas

5.1 TFCA

Contribution: Vera De Cauwer

Namibia and Angola are currently embarking on the development of an integrated development plan catering for more tourism in the area.

The TFCA concept supports the management of wildlife populations at regional level and across international boundaries (Van Aarde & Jackson, 2007). According to Ms Naambo lipinge of MET, it is possible within a TFCA for the local community members to cross the country boundary (the Kunene/Cunene River) and travel to within 60 km from the border without any passport control.

Several community camps were recently constructed by the National Biodiversity Project for the Conservation of Iona National Park (2013 – 2018), a project of the Angolan Ministry of Environment that was co-financed by the EU, GEF, and UNDP (Figure 25). The new entrance gate in Iona was also funded by this project, however does not seem to be used by the park staff. The community camps have ablution blocks without water. There is no uniform policy in place with regard to camp fees or garbage. In Otjinhungwa, the campsite administrator – who is also the Chief's daughter – informed us to pay N\$ 10 (Kz 200) per person per night. The community asked to leave garbage bags behind so they could check for items to recycle. In Cambêno, we were asked to contribute a camping fee as we saw fit.



Figure 25: (a) Community camp at Otjinhungwa (Photo: V. De Cauwer) (b) Community camp at Cambêno (Photo: C. Muashekele)

5.2 Namibian Communal Conservancies

Contributions: Meed Mbidzo, Vera De Cauwer

Source: (NACSO, n.d.)

Communal conservancies in Namibia are involved in biodiversity monitoring. Biodiversity monitoring aims to provide trends of data on natural resources to ensure their healthy state (Seak *et al.*, 2012), which is often used by conservation managers for decision-making. More information on the current system of ecosystem monitoring is described in the Community Assessment Report.

Gaps in existing monitoring systems and tools

According to the event book system, conservancies are supposed to monitor rainfall, as well as the location where all the incidents took place, but these are not currently recorded by most conservancies. In some cases, not even the name of the village where the incidents took place is recorded. For all the activities involving wildlife species listed in the event book, only the name of the species is recorded. Age and sex of the species is not taken into account, which could be important information for decision making. Data on livestock movements could be very useful for managing predator-livestock conflict. However, there are no conservancies that monitor livestock movement in the country.

The communities also don't monitor vegetation or soils with this system, but the audit report allows for collecting information on vegetation change in the conservancies. Based on the event book system, conservancies are supposed to do seasonal grass assessment but no vegetation assessments have been conducted and reported in the event books. This is despite the fact that local communities have a good knowledge of indicator species for local land use units. A study of Verlinden and Davot (2005) used key informants in north-central Namibia to understand the local indigenous environmental knowledge (IEK). The key informants had a good environmental knowledge and were appointed by the headman of the villages. All key informants could identify woody species while the majority identified the main common grass and herb species. A minority of informants identified almost all grass and herb species. Other things that are supposed to be monitored by conservancies but are not monitored include; fishing effort (Gill nets, traps/siyande, tourism fishing) and tourist sightings or visits.

6. Critical conservation issues in the SCIONA study area

Contributions: Morgan Hauptfleisch

Although the attitudes of the governments of Angola and Namibia, as well as many communities, are now more positive towards conservation, they are by no means ideal. A major concern for SCIONA is the encroachment of communities with their livestock, into wildlife zones in search of grazing to replace consistently less productive rangelands elsewhere (Huntley, Brian, 2017). This is a complex issue, combining climate change, increasing human population, rangeland management and culture, which is why a major component of SCIONA deals with community wildlife interactions.

Major threats to wildlife which will be investigated as part of SCIONA are further described in this section and include human-wildlife conflict, poaching, inadequate livestock management, illegal fishing, and climate change.

6.1 Human-wildlife conflict

Contributions: Meed Mbidzo, Vera De Cauwer, Morgan Hauptfleisch

The term “human-wildlife conflict” (HWC) refers to any conflicts between people, their livestock and wildlife. However, it often is only used for those conflicts that negatively affect people and their livestock. The wildlife success stories in the south of the SCIONA study area, have increased wildlife populations but also increase incidents of human-wildlife conflict (Government of the Republic of Namibia, 2009), thereby counteracting improved attitudes of communities towards wildlife. Most HWC’s occur along the Kunene river, in the communal conservancies east of Skeleton Coast Park and in the east of Iona National Park.

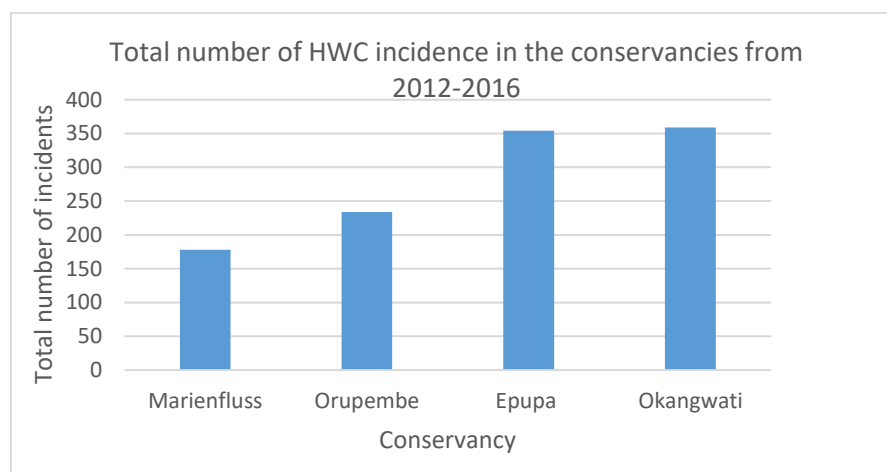


Figure 26: Total number of human-wildlife conflicts in the four Namibian conservancies over a period of five years (2012-2016).

The Okanguati and Epupa conservancies suffer the most when it comes to HWC incidents (Figure 26). This can discourage Okanguati conservancy because at the moment they are not making income from conservation of wildlife and the cost of living with wildlife is more than the benefits. Apart from HWC compensation from MET, the Okanguati conservancy cannot afford on to pay it members for any losses to predators. The predators that are causing conflict in these two conservancies are cheetah and leopard, which are species that are protected by the Nature Conservation Ordinance. This makes

it difficult to allow more of these species to be on the conservancy hunting quotas. The population sizes of these two species are not known in the area as the two conservancies (Okanguati and Epupa) never had a game count since they were gazetted in 2012. The predators that cause most conflict are big predators that can cause huge damage.

Marienfluss and Orupembe are well established and can manage to control the HWC incidents within their conservancies. Brown hyena is the species causing more conflict within these two conservancies.

Overall, HWC data at both national and conservancy level is not complete. Specifically, the spatial element of the conflict is missing from the existing HWC dataset. For instance, the data available assumes that HWC is the same across a conservancy. This makes it difficult to target support to the most affected households in a chosen conservancy. It further limits the scope of data analysis.

Orupembe conservancy

According to the Event book data from 1996-2016 and the compiled annual audit report (2012-2016) for conservancies, in Orupembe, brown hyena is the species that is the most involved in human wildlife conflict incident while cheetah is recorded as second most conflict causing species within the conservancy. Livestock attack is the most conflict between humans and predators. The highest attacks of livestock have occurred in the months of June, July, August, October, November in the years 2016-2013 while in 2012 the highest attack of livestock was in January.

Marienfluss conservancy

In Marienfluss conservancy, human wildlife conflict is mostly caused by Hyaena and Leopard according to the Event book data from 1996-2016 followed by Caracal. However, the communities view crocodile as the most conflicting species in the area possibly because crocodiles attacks humans. Livestock attacks are reported to occur mostly in the following months; April, May, June, September, November July, August in year 2012-2016. Apart from livestock attacks, two people were killed in 2013 in July while one person was attack in January 2015.

Epupa conservancy

In Epupa Conservancy the most conflict causing species are leopard, caracal and crocodile. Livestock attack occurs mostly in April, October, November and December, and in April 2014 there is a case recorded on crop damage within the conservancy area.

Okanguati conservancy

Cheetah and caracal are the most conflict causing species in the Okanguati conservancy. Livestock attack occurs mostly in February, October November and December.

Iona National Park

During the Angolan scoping trip, human-wildlife conflicts were reported for Otjinhungwa, mainly crocodiles attacking cattle and humans, but apparently also leopards that sometimes kill goats. In Cambêno, it was reported that brown hyena kills many goats and calves, while there are many zebra snakebites.

6.2 Poaching

Contributions: Morgan Hauptfleisch, Vera De Cauwer

Poaching with the study area occurs both for meat and for high cash income (e.g. rhino horn, pangolin, elephant tusk, bones of carnivores). Ambush sites of poachers are often near water supply points. The

eastern part of SCIONA is a known smuggling route for rhino horn and elephant tusks, since the 1970s (Huntley, Brian, 2017), but persists today (confidential source). This impacts not only on the wildlife of SCIONA, but on the region as a whole. The communal conservancy programme of Namibia is a model which SCIONA will follow to ensure community benefits from wildlife, reducing the risk of poaching (Owen-Smith, 2011; NACSO, 2015).

6.3 Inadequate livestock management

Contributions: Vera De Cauwer, Morgan Hauptfleisch

Communities mainly herd their livestock into TFCA areas zoned for wildlife during periods of drought, while wildlife mainly remains in the western parts of the study area where there is hardly no competition with livestock and little human disturbance. It is suspected that long-term rangeland productivity is decreasing because of overgrazing and climate change. This, has limited the ability of grazing wildlife herds, and the biodiversity which accompany them, to move back into certain areas.

Local communities do have several coping mechanisms during times of drought, for example by opening up restricted grazing areas or by relying on tree pods and fruits (Corbett, 1999).

6.4 Mining and prospecting

Contribution: Vera De Cauwer

The effect of mineral exploration within the study area is not known, but it is assumed that it has a minimal effect with exception for the fragile ecosystem on the gravel plains of SCNP. Mineral exploration takes place on the Namibian side of the study area, especially in the conservancy areas. Exploration in the northern SCNP focuses on the coastline and the area south of the Kunene River.

6.5 Illegal fishing

Contribution: Morgan Hauptfleisch

Extensive illegal fishing occurs within the Benguela upwelling system (Standing, 2008; Agnew *et al.*, 2009). This is having an effect not only on commercial fishing in Angola and Namibia, but also on the SCIONA marine-terrestrial energy flows.

6.6 Climate change

Contributions: Vera De Cauwer, Morgan Hauptfleisch

Climate change is placing pressure on species across southern Africa, and particularly for range restricted species. Namibia's western escarpment, which is significantly represented in the SCIONA study area, is highlighted as a habitat which will be negatively impacted by climate change (Turpie *et al.*, 2010).

Data is limited to assess the extent of the threat of climate change. For example, it is not known if desertification continues to take place and thus if the Namib Desert is expanding (Jürgens, 1997). Considering the evidence of *W. mirabilis* and *Aloe dichotoma*, it is expected that future research will bring to light evidence for a relatively recent expansion of the Namib Desert (Jürgens, 1997). Further study is also needed with regard to a potential range shift of the mopane woodlands. Informal reports and a study of Venter *et al.* (2018) indicate that the Mopane woodlands of northwestern Namibia are

thickening and expanding towards the east, while drought induced mortality of the mopane tree has been observed in South Africa (Macgregor & O'Connor, 2002).

7. Towards an integrated ecosystem management plan

Contributions: Vera De Cauwer, Morgan Hauptfleisch

The establishment of an integrated ecosystem management plan for the TFCA will have to address the existing threats within the area. Ecosystem threats may appear limited compared to the environmental degradation and species extinction faced in many parts of the world (Maggs *et al.*, 1998). However, the relatively untouched environment or wilderness should be considered a great opportunity for pre-emptive conservation initiatives, especially considering the low human population density (Baillie *et al.*, 2004) and the global species extinctions, extirpations, and range decreases (Dirzo *et al.*, 2014; Young *et al.*, 2016; Ceballos *et al.*, 2017).

Many protected areas in the tropics have shown to be effective in mitigating negative effects of hunting and grazing (Bruner *et al.*, 2001). Park effectiveness correlated positively with basic management activities, especially density of guards, degree of border demarcation, and the existence of direct compensation programmes to local communities. Park budget and local involvement of communities and park management were not significantly related to park effectiveness (Bruner *et al.*, 2001).

A key strategy to facilitate adaptation of wildlife to climate change is the development of open and interconnected landscapes. This facilitates movement of wildlife in response to increasing spatially and temporally unpredictable and erratic rainfall associated with climate change for the region (Turpie *et al.*, 2010). SCIONA's objective of supporting a large open landscape co-managed across boundaries and between parks and neighbours adds well to this adaptation strategy. Another key strategy recommended to manage climate change impacts is effective monitoring programmes for protected areas, another objective of the SCIONA project.

The best measure of conservation management success is the conservation of the ecosystem and its biodiversity in the TFCA. This can be evaluated through a systematic approach that includes prioritising and monitoring of indicators, often a set of indicator species. The keystone species concept introduced in 1969 (Paine, 1969) has been an important component of ecosystem management and nature conservation since. It can be defined as a species that provides a key trophic linkage, which ensures the sustainability of an ecosystem. Socio-economic important species will have to be included if managers also want to maintain or even improve the socio-economic value of the TFCA. Baseline information on these species is needed before sustainable extraction or ecotourism can be encouraged.

The arid to hyper-arid SCIONA area is likely to contain a number of keystone species. It is impractical to expect all keystone species to be monitored intensively, particularly if local communities are expected to monitor them. Key indicators are only relevant if enough monitoring data can be collected and analysed, hence they should be easy to monitor with the available resources (Timko & Innes, 2009).

7.1 Likely mammal flagship and indicator groups or species for TFCA management

Contributions Morgan Hauptfleisch

Small mammals (bats, rodents, shrews, elephant shrews, hedgehogs, moles) orders Chirpotera, Rodentia, Insectivora, Macroscelidea

Of Namibia's presently known 16 endemic mammal species 11 are small mammals (Barnard, 1998). They remain the most underexplored and poorly understood of all mammal taxa in Namibia. As recently as 2014, a new species of elephant shrew – the Etendeka round-eared sengi *Macroscelides micus* was discovered and described only 200 km south of the SCIONA study area.

Small mammals are vital for healthy ecosystem functioning as they provide services dispersal of seeds, seed predation, nutrient cycling through ground bioturbation, specialist and primary consumption, predation and as prey for animals on a higher trophic level (Avenant, 2000).

7.2 Likely plant flagship and indicator groups or species for TFCA management

Contribution: Vera De Cauwer

Potential candidates for plant key indicators can be selected because of their ecological and socio-economic value. Top candidates include:

jackal-berry	<i>Diospyros mespiliformis</i>
!nara	<i>Acanthosicyos horridus</i>
baobab	<i>Adansonia digitata</i>
mopane	<i>Colophospermum mopane</i>
leadwood	<i>Combretum imberbe</i>
umbrella-thorn	<i>Acacia tortilis</i>
Angola green thorn	<i>Balanites angolensis</i>
mouse-eared combretum	<i>Combretum hereroense</i>
blue-leaved corkwood	<i>Commiphora glaucescens</i>
slender corkwood	<i>Commiphora virgata</i>
blue-bush	<i>Diospyros lycioides</i>
Kaoko Rhigozum	<i>Rhigozum virgatum</i>
marula	<i>Sclerocarya birrea</i>
Silver cluster-leaf	<i>Terminalia sericea</i>
purple-stem corkwood	<i>Commiphora multijuga</i>
Horn-pod tree	<i>Diplorhynchus condylocarpon</i>
magic guarri	<i>Euclea divinorum</i>
Damara Euphorbia	<i>Euphorbia damarana</i>
Kaoko tree Euphorbia	<i>Euphorbia eduardoi</i>
ana	<i>Faidherbia albida</i>
phantom tree	<i>Moringa ovalifolia</i>
mustardbush	<i>Salvadora persica</i>

Species distribution should be assessed for the continent as many plant taxa have disjoint distribution areas within Africa. These disjoint distributions are most probably the remnants of a continuous belt of arid habitats providing warmer refuge areas where palaeotropical species survived during the last

glaciation (Jürgens, 1997). Hence, some species that occur in Kaokoveld, may not be present in the neighbouring *Baikiaea* woodlands of the Kalahari Desert, but can be found in the Miombo woodlands of Zambia and Zimbabwe.

The arid to semi-arid ecosystems of the area are characterised by several endemic and protected species that have adapted to the dry conditions (Simmons *et al.*, 1998). There is however not enough information for many species to determine their conservation status. Namibia has established Red Data lists to assess the conservation status of taxa. For example, the Red Data Book of Namibian Plants (Loots, 2005) assesses the status of only a third of Namibia's (1,272 out of 3,961) spermatophyte taxa against the IUCN 2001 Red List criteria. For 301 of the 1,272 taxa there was not enough data available to determine the conservation status (Loots, 2005). Red lists are a useful tool for both policy- and decision-makers and conservationists. They focus attention on the loss of biodiversity and the need to conserve the taxa included in the red lists (Loots, 2005).

7.3 Monitoring data needed for key indicator species

Contributions: Vera De Cauwer

Knowledge of the distribution of the key indicators and of the ecological niche requirements of key indicator species are required to develop suitable conservation strategies and implement natural resources management plans (Guisan & Zimmermann, 2000; Zimmermann *et al.*, 2009; Kgosiesele, 2010). For Kaokoveld, the actual distribution of many species is unknown due to the area's inaccessibility and vastness (Simmons *et al.*, 1998; Craven, 2002) and new species are still being discovered. Once the range extents of the species under study are known, they can be evaluated for their use as ecosystem indicators and possibly included in future TFCA monitoring.

The species distributions will also allow to determine the exact extent of the centre of endemism, something that is currently not known (Craven & Vorster, 2006). The centre's boundaries can be defined with a systematic approach that determines the area of congruence between endemic species distributions (Craven & Vorster, 2006).

Long term monitoring in the area is currently very limited (e.g. climate and vegetation observatories).

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Annex 1 – List of trees and shrubs in the SCIONA study area

Contributions: W. Swanepoel, V. De Cauwer, A. Fillipus, R. Revermann, F. Lages

Species	Namib Desert	Escarpment	Mopane Savanne	Riparian	SCIONA fieldtrips
<i>Acacia arenaria</i>			X		
<i>Acacia ataxacantha</i>			X	X	
<i>Acacia erioloba</i>				X	X
<i>Acacia erubescens</i>			X		
<i>Acacia fleckii</i>			X		
<i>Acacia hebeclada subsp. tristis</i>			X		
<i>Acacia kirkii</i>		X	X		X
<i>Acacia mellifera subsp. detinens</i>		X	X		X
<i>Acacia mellifera subsp. mellifera</i>		X	X		X
<i>Acacia montis-usti</i>		X			X
<i>Acacia nilotica</i>		X			X
<i>Acacia reficiens</i>		X			X
<i>Acacia robynsiana</i>		X	X		X
<i>Acacia senegal</i>		X	X		
<i>Acacia tortilis</i>		X	X		X
<i>Acanthosicyos horridus</i>	X				X
<i>Adansonia digitata</i>		X	X		X
<i>Adenia pechuelii</i>	X				X
<i>Adenium boehmianum</i>			X		X
<i>Adenolobus garipensis</i>		X		X	
<i>Adenolobus pechuelii</i>	X	X	X		
<i>Albizia anthelmintica</i>			X		
<i>Albizia brevifolia</i>		X	X		X
<i>Albizia tanganyicensis</i>		X	X		
<i>Allophyllus africanus</i>				X	
<i>Aloe littoralis</i>		X			X
<i>Balanites angolensis subsp. welwitschii</i>	X	X	X	X	X
<i>Berchemia discolor</i>			X	X	X
<i>Boscia albitrunca</i>			X		X
<i>Boscia foetida</i>		X	X		X
<i>Boscia microphylla</i>	X		X		X
<i>Boscia mossambicensis</i>		X	X		
<i>Boscia tomentosa</i>			X		X
<i>Bridelia tenuifolia</i>		X	X		
<i>Cadaba schroepelii</i>		X			X
<i>Caesalpinia rubra</i>		X			
<i>Cassia abbreviata</i>		X			
<i>Ceraria longipedunculata</i>		X			X
<i>Calicorema capitata</i>		X			X
<i>Catophractes alexandri</i>		X	X		X
<i>Ceraria carrissoana</i>		X	X		

Species	Namib Desert	Escarpment	Mopane Savanne	Riparian	SCIONA fieldtrips
<i>Ceraria kaokoensis</i>		x			
<i>Ceraria kuneneana</i>		x			
<i>Ceraria longipedunculata</i>		x	x		x
<i>Cissus nymphaeifolia</i>		x	x		
<i>Colophospermum mopane</i>		x	x	x	x
<i>Combretum apiculatum</i>		x	x		x
<i>Combretum hereroense</i>			x	x	
<i>Combretum imberbe</i>				x	x
<i>Combretum mossambicense</i>			x		
<i>Combretum oxystachyum</i>			x		
<i>Combretum wattii</i>			x	x	
<i>Commiphora africana</i>		x			x
<i>Commiphora anacardiifolia</i>		x			x
<i>Commiphora angolensis</i>			x		
<i>Commiphora crenato-serrata</i>		x			
<i>Commiphora dinteri</i>		x			
<i>Commiphora discolor</i>		x			
<i>Commiphora giessii</i>			x		x
<i>Commiphora glandulosa</i>		x	x		
<i>Commiphora glaucescens</i>			x		x
<i>Commiphora kuneneana</i>			x		x
<i>Commiphora mollis</i>		x			
<i>Commiphora multijuga</i>		x	x		x
<i>Commiphora oblanceolata</i>	x	x			x
<i>Commiphora otjhipana</i>		x			
<i>Commiphora pyracanthoides</i>		x	x		
<i>Commiphora steynii</i>		x	x		x
<i>Commiphora tenuipetiolata</i>		x			x
<i>Commiphora virgata</i>		x	x		x
<i>Commiphora wildii</i>	x	x			x
<i>Cordia sinensis</i>				x	x
<i>Croton gratissimus</i>			x		
<i>Croton menyharthii</i>		x		x	
<i>Cryptolepis decida</i>	x				
<i>Cyphostemma currorii</i>		x	x		
<i>Cyphostemma juttae</i>					
<i>Cyphostemma uter</i>		x	x		x
<i>Dichrostachys cinerea</i>			x		x
<i>Diospyros lycioides</i>			x		
<i>Diospyros mespiliformis</i>				x	
<i>Diplorhynchus condylocarpon</i>			x		
<i>Ectadium rotundifolium</i>	x				x
<i>Ehretia alba</i>		x	x		
<i>Ehretia namibiensis subsp. kaokoensis</i>				x	
<i>Elaeodendron transaalense</i>			x		
<i>Elephantorrhiza suffruticosa</i>			x		

Species	Namib Desert	Escarpment	Mopane Savanne	Riparian	SCIONA fieldtrips
<i>Entandophragma spicatum</i>		x	x		
<i>Erythrina decora</i>		x			
<i>Euclea divinorum</i>			x	x	
<i>Euclea pseudebenus</i>				x	x
<i>Euclea undulata</i>			x		x
<i>Euphorbia berotica</i>		x			?
<i>Euphorbia damarana</i>	x	x	x		x
<i>Euphorbia eduardoi</i>			x		x
<i>Euphorbia guerichiana</i>			x		x
<i>Euphorbia kaokoensis</i>		x	x		
<i>Euphorbia leistneri</i>				x	x
<i>Euphorbia ohiva</i>			x		x
<i>Euphorbia otjingandu</i>		x			
<i>Euphorbia subsalsa</i>				x	
<i>Euphorbia virosa</i>	x		x		x
<i>Faidherbia albida</i>				x	x
<i>Ficus burkei</i>				x	
<i>Ficus capreifolia</i>				x	x
<i>Ficus cordata</i>		x	x	x	
<i>Ficus glumosa</i>		x	x		
<i>Ficus sycomorus</i>				x	x
<i>Fluggea virosa</i>			x		
<i>Fockea multiflora</i>		x	x		
<i>Gossypium anomalum</i>		x	x	x	
<i>Grewia bicolor</i>			x		
<i>Grewia flava</i>			x		
<i>Grewia flavescens</i>			x		
<i>Grewia olukondae</i>			x		
<i>Grewia schinzii</i>			x		
<i>Grewia subspathulata</i>			x		
<i>Grewia tenax</i>			x	x	
<i>Grewia villosa</i>			x		
<i>Gymnosporia senegalensis</i>		x	x	x	
<i>Gyrocarpus americanus</i>		x			
<i>Hexalobus monopetalus</i>		x	x	x	
<i>Hymenodictyon floribundum</i>				x	
<i>Hyphaene petersiana</i>			x	x	x
<i>Kirkia acuminata</i>		x	x		x
<i>Laggera decurrens</i>			x		
<i>Lycium bosciifolium</i>		x			
<i>Maerua kaokoensis</i>		x		x	
<i>Maerua schinzii</i>		x	x		x
<i>Maerua parvifolia</i>		x			x
<i>Maerua sebrabergensis</i>			x		
<i>Mimosa pigra</i>				x	x
<i>Montinia caryophyllacea</i>		x	x		

Species	Namib Desert	Escarpment	Mopane Savanne	Riparian	SCIONA fieldtrips
<i>Moringa ovalifolia</i>			X		X
<i>Mundulea sericea</i>			X		
<i>Myrothamnus flabellifolius</i>		X			
<i>Mystroxylon aethiopicum</i>				X	
<i>Nicotiana glauca</i>				X	X
<i>Obetia carruthersiana</i>		X	X		
<i>Ormocarpum kirkii</i>		X		X	
<i>Ozoroa crassinervia</i>				X	
<i>Pachypodium lealii</i>			X		X
<i>Parkinsonia africana</i>			X		X
<i>Pavetta schumanniana</i>				X	
<i>Pavetta zeyheri</i>		X	X		
<i>Pechuel-Loeschea leubnitziae</i>	X	X			
<i>Peltophorum africanum</i>			X		X
<i>Phaeoptilum spinosum</i>	X	X			X
<i>Philenoptera nelsii</i>		X	X		X
<i>Phyllanthus reticulatus</i>				X	X
<i>Pseudolachnostylis maprouneifolia</i>			X		
<i>Ptaeroxylon obliquum</i>		X	X		
<i>Pterocarpus lucens</i>			X		
<i>Pterocarpus rotundifolius</i>		X			
<i>Rhigozum brevispinosum</i>		X	X		X
<i>Rhigozum virgatum</i>		X		X	
<i>Ricinus communis</i>				X	X
<i>Salix mucronata subsp. mucronata</i>				X	
<i>Salsola spp.</i>	X				X
<i>Salvadora persica</i>		X	X	X	X
<i>Sarcocaulon mossamedense</i>	X	X			
<i>Sclerocarya birrea</i>		X	X		X
<i>Searsia leptodictya</i>	X	X			
<i>Searsia quartiniana</i>				X	
<i>Searsia pyroides</i>		X			
<i>Sesamothamnus benguellensis</i>		X			X
<i>Sesamothamnus guerichii</i>		X	X		X
<i>Sesamothamnus leistneri</i>					
<i>Sesbania sesban</i>				X	
<i>Spirostachys africana</i>			X		
<i>Sterculia africana</i>		X	X		X
<i>Sterculia quinqueloba</i>		X	X		X
<i>Strophantus amboensis</i>		X			X
<i>Tamarix usneoides</i>				X	X
<i>Tarchonanthus camphoratus</i>		X	X		
<i>Terminalia prunioides</i>		X	X		X
<i>Terminalia sericea</i>			X		X
<i>Tinnea rhodesiana</i>		X	X		
<i>Trema orientalis</i>		X			

Species	Namib Desert	Escarp- ment	Mopane Savanne	Riparian	SCIONA fieldtrips
<i>Vangueria infausta</i>			x		
<i>Welwitschia mirabilis</i>	x	x	x		x
<i>Ximenia americana</i>			x		
<i>Ximenia caffra</i>			x		x
<i>Ziziphus mucronata</i>			x	x	
<i>Zygophyllum stapffii</i>	x				x
Total number of species	18	96	108	44	85

Annex 2 – Bird list of the Kaokoveld and Skeleton Coast National Park

Contributors: Rolf Becker, Wessel Swanepoel

	ORDER/FAMILY	ENGLISH NAME	AFRIKAANS NAME	GENUS	SPECIES
Order	STRUTHIONIFORMES				
Family	Struthionidae	Ostriches			
		Common Ostrich	Volstruis	Struthio	camelus
Order	ANSERIFORMES				
Family	Anatidae	Ducks, Geese and Swans			
		White-faced Whistling Duck		Dendrocygna	viduata
		White-backed Duck	Witrugeend	Thalassornis	leuconotus
		Spur-winged Goose	Wildemakou	Plectropterus	gambensis
		Egyptian Goose	Kolgans	Alopochen	aegyptiaca
		Hottentot Teal	Gevlekte Eend	Spatula	hottentota
		Cape Shoveler	Kaapse Slopeend	Spatula	smithii
		Cape Teal	Teeleend	Anas	capensis
		Red-billed Teal	Rooibekeend	Anas	erythrorhyncha
		Southern Pochard	Bruineend	Netta	erythrophthalma
		Maccoa Duck	Bloubekeend	Oxyura	maccoa
Order	GALLIFORMES				
Family	Numididae	Guineafowl			
		Helmeted Guineafowl	Gewone Tarentaal	Numida	meleagris
Family	Phasianidae	Pheasants, Fowl and Allies			
		Orange River Francolin	Kalaharipatrys	Scleroptila	gutturalis
		Hartlaub's Spurfowl	Klipfisant	Pternistis	hartlaubi
		Red-billed Spurfowl	Rooibekfisant	Pternistis	adpersus
		Red-necked Spurfowl	Rooikeelfisant	Pternistis	afer
		Swainson's Spurfowl	Bosveldfisant	Pternistis	swainsonii
		Common Quail	Afrikaanse Kwartel	Coturnix	coturnix
		Harlequin Quail	Bontkwartel	Coturnix	delegorguei
Order	SPHENISCIFORMES				
Family	Spheniscidae	Penguins			
		African Penguin	Brilpikkewyn	Spheniscus	demersus
Order	PROCELLARIIFORMES				

Fa mil y	Oceanitidae	Austral Storm Petrels			
		Wilson's Storm Petrel	Gewone Stormswael	Oceanites	oceanicus
Fa mil y	Diomededidae	Albatrosses			
		Wandering Albatross	Grootalbatros (-malmok)	Diomedea	exulans
		Black-browed Albatross	Swartruglbatros (-malmok)	Thalassarche	melanophris
		Shy Albatross	Bloubekalbatros (-malmok)	Thalassarche	cauta
		Atlantic Yellow-nosed Albatross		Thalassarche	chlororhynchus
Fa mil y	Hydrobatidae	Northern Storm Petrels			
		European Storm Petrel	Europese Stormswael	Hydrobates	pelagicus
		Leach's Storm Petrel	Swaelstertstormswael	Oceanodroma	leucorhoa
Fa mil y	Procellariidae	Petrels and Shearwaters			
		Southern Giant Petrel	Reusenellie	Macronectes	giganteus
		Northern Giant Petrel	Grootnellie	Macronectes	halli
		Pintado Petrel	Seeduifstormvoël	Daption	capense
		Broad-billed Prion	Breëbekwalvisvoël	Pachyptila	vittata
		Great-winged Petrel	Langvlerkstormvoël	Pterodroma	macroptera
		Atlantic Petrel	Atlantiese Stormvoël	Pterodroma	incerta
		Soft-plumaged Petrel	Donsveerstormvoël	Pterodroma	mollis
		White-chinned Petrel	Bassiaan	Procellaria	aequinoctialis
		Cory's Shearwater	Geelbekpylstormvoël	Calonectris	borealis
		Sooty Shearwater	Malbaartjie	Ardenna	grisea
		Great Shearwater	Grootpylstormvoël	Ardenna	gravis
		Manx Shearwater	Swartbekpylstormvoël	Puffinus	puffinus
Or de r	PODICIPEDIFORMES				
Fa mil y	Podicipedidae	Grebes			
		Little Grebe	Kleindobbertjie	Tachybaptus	ruficollis
		Black-necked Grebe	Swartnekdobbertjie	Podiceps	nigricollis
Or de r	PHOENICOPTERIFORMES				
Fa mil y	Phoenicopteridae	Flamingos			
		Greater Flamingo	Grootflamink	Phoenicopterus	roseus
		Lesser Flamingo	Kleinflamink	Phoeniconaias	minor

Order	CICONIIFORMES			
Family	Ciconiidae	Storks		
		African Openbill	Oopbekooievaar	Anastomus lamelligerus
		Black Stork	Grootswartooievaar	Ciconia nigra
		Abdim's Stork	Kleinswartooievaar	Ciconia abdimii
		White Stork	Witooievaar	Ciconia ciconia
Order	PELECANIFORMES			
Family	Ardeidae	Hérons and Bitterns		
		Little Bittern	Kleinrietreier (Woudapie)	Ixobrychus minutus
		Green-backed Heron	Groenrugreier	Butorides striata
		Squacco Heron	Ralreier	Ardeola ralloides
		Western Cattle Egret	Veereier (Bosluisvoël)	Bubulcus ibis
		Grey Heron	Bloureier	Ardea cinerea
		Black-headed Heron	Swartkopreier	Ardea melanocephala
		Goliath Heron	Reusereier	Ardea goliath
		Great Egret	Grootwitreier	Ardea alba
		Yellow-billed Egret	Geelbekwitreier	Ardea intermedia
		Black Heron	Swartreier	Egretta ardesiaca
		Little Egret	Kleinwitreier	Egretta garzetta
Family	Scopidae	Hamerkop		
		Hamerkop	Hamerkop	Scopus umbretta
Family	Pelecanidae	Pelicans		
		Great White Pelican	Witpelikaan	Pelecanus onocrotalus
Order	SULIFORMES			
Family	Sulidae	Gannets and Boobies		
		Cape Gannet	Witmalgas	Morus capensis
Family	Phalacrocoracidae	Cormorants and Shags		
		Reed Cormorant	Rietduiker	Microcarbo africanus
		Crowned Cormorant	Kuifkopduiker	Microcarbo coronatus
		White-breasted Cormorant		Phalacrocorax lucidus
		Cape Cormorant	Trekduiker	Phalacrocorax capensis
Family	Anhingidae	Anhingas and Darters		
		African Darter	Slanghalsvoël	Anhinga rufa

Order	ACCIPITRIFORMES			
Family	Sagittariidae	Secretarybird		
		Secretarybird	Sekretarisvoël	Sagittarius serpentarius
Family	Pandionidae	Ospreys		
		Western Osprey	Visvalk	Pandion haliaetus
Family	Accipitridae	Kites, Hawks and Eagles		
		Black-winged Kite	Blouvalk	Elanus caeruleus
		African Harrier-Hawk	Kaalwangvalk	Polyboroides typus
		Egyptian Vulture	Egiptiese Aasvoël	Neophron percnopterus
		White-backed Vulture	Witruugaasvoël	Gyps africanus
		White-headed Vulture	Witkopaasvoël	Trigonoceps occipitalis
		Lappet-faced Vulture	Swartaasvoël	Torgos tracheliotus
		Black-chested Snake Eagle		Circaetus pectoralis
		Brown Snake Eagle	Bruinslangarend	Circaetus cinereus
		Bateleur	Berghaan	Terathopius ecaudatus
		Martial Eagle	Breëkoparend	Polemaetus bellicosus
		Wahlberg's Eagle	Bruinarend	Hieraaetus wahlbergi
		Booted Eagle	Dwergarend	Hieraaetus pennatus
		Tawny Eagle	Roofarend	Aquila rapax
		Steppe Eagle	Steppe-arend	Aquila nipalensis
		Verreaux's Eagle	Witkruisarend	Aquila verreauxii
		African Hawk-Eagle	Grootjagarend	Aquila spilogaster
		Gabar Goshawk	Witkruissperwer (Kleinsingvalk)	Micronisus gabar
		Pale Chanting Goshawk	Bleeksingvalk	Melierax canorus
		Shikra	Gebande Sperwer	Accipiter badius
		Little Sparrowhawk	Kleinsperwer	Accipiter minullus
		African Marsh Harrier	Afrikaanse Vleivalk(Paddavreter)	Circus ranivorus
		Black Harrier	Witkruisvleivalk (-paddavreter)	Circus maurus
		Pallid Harrier	Witborsvleivalk (-paddavreter)	Circus macrourus
		Black Kite	Swartwou	Milvus migrans
		Yellow-billed Kite	Geelbekwou	Milvus aegyptius
		African Fish Eagle	Visarend	Haliaeetus vocifer
		Common Buzzard	Bruinjakkalsvoël	Buteo buteo
		Augur Buzzard	Witborsjakkalsvoël	Buteo augur
		Jackal Buzzard	Rooiborsjakkalsvoël	Buteo rufofuscus
Order	OTIDIFORMES			
Family	Otididae	Bustards		
		Kori Bustard	Gompou	Ardeotis kori
		Ludwig's Bustard	Ludwigpou	Neotis ludwigii
		Rüppell's Korhaan	Woestynkorhaan	Eupodotis rueppellii
		Red-crested Korhaan	Boskorhaan	Lophotis ruficrista

		Southern Black Korhaan Northern Black Korhaan	Swartvlerkkorhaan Witvlerkkorhaan	Afrotis Afrotis	afra afraoides
Order	GRUIFORMES				
Family	Rallidae	Rails, Crakes and Coots			
		African Crake	Afrikaanse Riethaan	Crex	egregia
		Black Crake	Swartriethaan	Amaurornis	flavirostra
		Spotted Crake	Gevlekte Riethaan	Porzana	porzana
		Allen's Gallinule	Kleinkoningriethaan	Porphyrio	alleni
		Purple Gallinule	Amerikaanse Koningriethaan	Porphyrio	martinica
		Common Moorhen	Grootwaterhoender	Gallinula	chloropus
		Red-knobbed Coot	Bleshoender	Fulica	cristata
Family	Gruidae	Cranes			
Order	CHARADRIIFORMES				
Family	Turnicidae	Buttonquail			
		Common Buttonquail	Bosveldkwarteltjie	Turnix	sylvaticus
Family	Burhinidae	Thick-knees			
		Water Thick-knee	Waterdikkop	Burhinus	vermiculatus
		Spotted Thick-knee	Gewone Dikkop	Burhinus	capensis
Family	Chionidae	Sheathbills			
Family	Haematopodidae	Oystercatchers			
		African Oystercatcher	Swarttobie	Haematopus	moquini
Family	Recurvirostridae	Stilts and Avocets			
		Black-winged Stilt	Rooipootelsie	Himantopus	himantopus
		Pied Avocet	Bontelsie	Recurvirostra	avosetta
Family	Charadriidae	Plovers			
		Blacksmith Lapwing	Bontkiewiet	Vanellus	armatus
		Crowned Lapwing	Kroonkiewiet	Vanellus	coronatus
		American Golden Plover	Amerikaanse Goue Strandkiewiet	Pluvialis	dominica
		Grey Plover	Grysstrandkiewiet	Pluvialis	squatarola
		Common Ringed Plover	Ringnekstrandkiewiet	Charadrius	hiaticula
		Kittlitz's Plover	Geelborsstrandkiewiet	Charadrius	pecuarius
		Three-banded Plover	Driebandstrandkiewiet	Charadrius	tricollaris
		White-fronted Plover	Vaalstrandkiewiet	Charadrius	marginatus

		Chestnut-banded Plover	Rooibandstrandkie wiet	Charadrius	pallidus
		Caspian Plover	Asiatiese Strandkiewiet	Charadrius	asiaticus
Fa mil y	Rostratulidae	Painted Snipes			
		Greater Painted Snipe	Goudsnip	Rostratula	benghalensis
Fa mil y	Jacanidae	Jacanas			
		African Jacana	Grootlangtoon	Actophilornis	africanus
Fa mil y	Scolopacidae	Sandpipers and Snipes			
		Whimbrel	Kleinwulp	Numenius	phaeopus
		Steppe Whimbrel	Steppewulp	Numenius	alboaxillaris
		Eurasian Curlew	Grootwulp	Numenius	arquata
		Bar-tailed Godwit	Bandstertgriet	Limosa	lapponica
		Ruddy Turnstone	Steenloper	Arenaria	interpres
		Red Knot	Knoet	Calidris	canutus
		Ruff	Kemphaan	Calidris	pugnax
		Broad-billed Sandpiper	Breëbekstrandloper	Calidris	falcinellus
		Curlew Sandpiper	Krombekstrandloper	Calidris	ferruginea
		Sanderling	Drietoonsrandloper	Calidris	alba
		Little Stint	Kleinstrandloper	Calidris	minuta
		White-rumped Sandpiper	Witrugstrandloper	Calidris	fuscicollis
		Terek Sandpiper	Terekruiter	Xenus	cinereus
		Red Phalarope	Grysfraingpoot	Phalaropus	fulicarius
		Common Sandpiper	Gewone Ruiter	Actitis	hypoleucos
		Green Sandpiper	Witgatruter	Tringa	ochropus
		Marsh Sandpiper	Moerasruiter	Tringa	stagnatilis
		Wood Sandpiper	Bosruiter	Tringa	glareola
		Common Greenshank	Groenpootruiter	Tringa	nebularia
Fa mil y	Glareolidae	Coursers and Pratincoles			
		Burchell's Courser	Bloukopdrawwertjie	Cursorius	rufus
		Temminck's Courser	Trekdrawwertjie	Cursorius	temminckii
		Double-banded Courser	Dubbelbanddrawwertjie	Rhinoptilus	africanus
		Bronze-winged Courser	Bronsvlerkdrawwertjie	Rhinoptilus	chalcopterus
Fa mil y	Laridae	Gulls, Terns and Skimmers			
		Sabine's Gull	Mikstertmeeu	Xema	sabini
		Grey-headed Gull	Gryskopmeeu	Chroicocephalus	cirrocephalus
		Kelp Gull	Swartrugmeeu	Larus	dominicanus
		Caspian Tern	Reusesterretjie	Hydroprogne	caspia
		Royal Tern	Koningsterretjie	Thalasseus	maximus
		Swift Tern	Geelbeksterretjie	Thalasseus	bergii
		Sandwich Tern	Grootsterretjie	Thalasseus	sandvicensis
		Damara Tern	Damarasterretjie	Sternula	balaenarum
		Common Tern	Gewone Sterretjie	Sterna	hirundo
		Arctic Tern	Arktiese Sterretjie	Sterna	paradisaea

		White-winged Tern Black Tern	Witvlerksterretjie Swartsterretjie	Chlidonias Chlidonias	leucopterus niger
Fa mil y	Stercorariidae	Skuas			
		Subantarctic Skua Pomarine Jaeger Parasitic Jaeger Long-tailed Jaeger	Bruinroofmeeu Knopstertroofmeeu Arktiese Roofmeeu Langstertroofmeeu	Stercorarius Stercorarius Stercorarius Stercorarius	antarcticus pomarinus parasiticus longicaudus
Or de r	PTEROCLIFORMES				
Fa mil y	Pteroclididae	Sandgrouse			
		Namaqua Sandgrouse Double-banded Sandgrouse Burchell's Sandgrouse	Kelkiewyn Gevlekte Sandpatrys	Pterocles Pterocles Pterocles	namaqua bicinctus burchelli
Or de r	COLUMBIFORMES				
Fa mil y	Columbidae	Pigeons and Doves			
		Speckled Pigeon African Mourning Dove Red-eyed Dove Cape Turtle Dove Laughing Dove Emerald-spotted Wood Dove Namaqua Dove African Green Pigeon	Kransduif Rooioogtortelduif Grootringduif Gewone Tortelduif Rooiborsduifie Namakwaduifie Papegaaiduif	Columba Streptopelia Streptopelia Streptopelia Spilopelia Turtur Oena Treron	guinea decipiens semitorquata capicola senegalensis chalcospilos capensis calvus
Or de r	MUSOPHAGIFORMES				
Fa mil y	Musophagidae	Turacos			
		Grey Go-away-bird	Kwêvoël	Corythaixoides	concolor
Or de r	CUCULIFORMES				
Fa mil y	Cuculidae	Cuckoos			
		Senegal Coucal White-browed Coucal Great Spotted Cuckoo Jacobin Cuckoo Diederik Cuckoo Klaas's Cuckoo Black Cuckoo African Cuckoo	Senegaleiloeerie Gestreepte Vleiloeerie Gevlekte Koekoek Bontnuwejaarsvoël Diederikkie Meitjie Swartkoekoek Afrikaanse Koekoek	Centropus Centropus Clamator Clamator Chrysococcyx Chrysococcyx Cuculus Cuculus	senegalensis superciliosus glandarius jacobinus caprius klaas clamosus gularis

Order	STRIGIFORMES			
Family	Tytonidae	Barn Owls		
		Western Barn Owl	Nonnetjie-uil	Tyto alba
Family	Strigidae	Owls		
		African Scops Owl	Skopsuil	Otus senegalensis
		Southern White-faced Owl		Ptilopsis granti
		Spotted Eagle-Owl	Gevlekte Ooruil	Bubo africanus
		Verreaux's Eagle-Owl	Reuse-ooruil	Bubo lacteus
		Pearl-spotted Owlet	Witkoluil	Glaucidium perlatum
		Marsh Owl	Vlei-uil	Asio capensis
Order	CAPRIMULGIFORMES			
Family	Caprimulgidae	Nightjars		
		Rufous-cheeked Nightjar	Rooiwangnaguil	Caprimulgus rufigena
		Freckled Nightjar	Donkernaguil	Caprimulgus tristigma
		Square-tailed Nightjar	Laeveldnaguil	Caprimulgus fossii
Order	APODIFORMES			
Family	Apodidae	Swifts		
		African Palm Swift	Palmwindswael	Cypsiurus parvus
		Alpine Swift	Witpenswindswael	Tachymarptis melba
		Common Swift	Europese Windswael	Apus apus
		Bradfield's Swift	Muiskleurwindswael	Apus bradfieldi
		Little Swift	Kleinwindswael	Apus affinis
		White-rumped Swift	Witkruiswindswael	Apus caffer
Order	COLIIFORMES			
Family	Coliidae	Mousebirds		
		White-backed Mousebird	Witkruismuisvoël	Colius colius
		Red-faced Mousebird	Rooiwangmuisvoël	Urocolius indicus
Order	CORACIIFORMES			
Family	Coraciidae	Rollers		
		Purple Roller	Groottroupant	Coracias naevius
		Lilac-breasted Roller	Gewone Troupant	Coracias caudatus

Fa mil y	Alcedinidae	Kingfishers			
		Grey-headed Kingfisher	Gryskopvisvanger	Halcyon	leucocephala
		Woodland Kingfisher	Bosveldvisvanger	Halcyon	senegalensis
		African Pygmy Kingfisher		Ispidina	picta
		Malachite Kingfisher	Kuifkopvisvanger	Corythornis	cristatus
		Giant Kingfisher	Reusevisvanger	Megaceryle	maxima
		Pied Kingfisher	Bontvisvanger	Ceryle	rudis
Fa mil y	Meropidae	Bee-eaters			
		Swallow-tailed Bee-eater	Swaelstertbyvreter	Merops	hirundineus
		Little Bee-eater	Kleinbyvreter	Merops	pusillus
		Olive Bee-eater	Olyfbyvreter	Merops	superciliosus
		European Bee-eater	Europese Byvreter	Merops	apiaster
Or de r	BUCEROTIFORMES				
Fa mil y	Upupidae	Hoopoes			
		African Hoopoe	Hoephoe	Upupa	africana
Fa mil y	Phoeniculidae	Wood-hoopoes			
		Green Wood-hoopoe	Rooibekkekelaar	Phoeniculus	purpureus
		Violet Wood-hoopoe	Perskakelaar	Phoeniculus	damarensis
		Common Scimitarbill	Swartbekkekelaar	Rhinopomastus	cyanomelas
Fa mil y	Bucerotidae	Hornbills			
		Damara Red-billed Hornbill		Tockus	damarensis
		Southern Red-billed Hornbill		Tockus	rufirostris
		Monteiro's Hornbill	Monteironeushoringvoël	Tockus	monteiri
		Southern Yellow-billed Hornbill		Tockus	leucomelas
		African Grey Hornbill	Grysneushoringvoël	Lophoceros	nasutus
Or de r	PICIFORMES				
Fa mil y	Lybiidae	African Barbets			
		Yellow-fronted Tinkerbird	Geelblestinker	Pogoniulus	chrysoconus
		Acacia Pied Barbet	Bonthoutkapper	Tricholaema	leucomelas
Fa mil y	Indicatoridae	Honeyguides			
		Lesser Honeyguide	Kleinheuningwyser	Indicator	minor
		Greater Honeyguide	Grootheuningwyser	Indicator	indicator
Fa mil y	Picidae	Woodpeckers			
		Bennett's Woodpecker	Bennettspeg	Campethera	bennettii
		Golden-tailed Woodpecker		Campethera	abingoni
		Bearded Woodpecker	Baardspeg	Chloropicus	namaquus

		Cardinal Woodpecker	Kardinaalspeg	Dendropicos	fuscescens
Order	FALCONIFORMES				
Family	Falconidae	Caracaras and Falcons			
		Pygmy Falcon	Dwergvalk	Polihierax	semitorquatus
		Rock Kestrel	Kransvalk	Falco	rupicolus
		Greater Kestrel	Grootrooivalk	Falco	rupicoloides
		Grey Kestrel	Donkergrysvalk	Falco	ardosiaceus
		Red-necked Falcon	Rooinekvalk	Falco	chicquera
		Red-footed Falcon	Westelike Rooipootvalk	Falco	vespertinus
		Eurasian Hobby	Europese Boomvalk	Falco	subbuteo
		Lanner Falcon	Edelvalk	Falco	biarmicus
		Peregrine Falcon	Swerfvalk	Falco	peregrinus
Order	PSITTACIFORMES				
Family	Psittacidae	Parrots			
		Rüppell's Parrot	Bloupenspapegaai	Poicephalus	rueppellii
		Rosy-faced Lovebird	Rooiwangparkiet	Agapornis	roseicollis
Order	PASSERIFORMES				
Family	Platysteiridae	Wattle-eyes and Batises			
		Pirit Batis	Piritbosbontrokkie	Batis	pririt
		White-tailed Shrike	Kortstertlaksman	Lanioturdus	torquatus
Family	Prionopidae	Helmetshrikes			
		White-crested Helmetshrike		Prionops	plumatus
		Retz's Helmetshrike	Swarthelmlaksman	Prionops	retzii
Family	Malaconotidae	Bushshrikes			
		Grey-headed Bushshrike	Spookvoël	Malaconotus	blanchoti
		Orange-breasted Bushshrike		Chlorophoneus	sulfureopectus
		Bokmakierie	Bokmakierie	Telophorus	zeylonus
		Brown-crowned Tchagra	Rooivlerktjagra	Tchagra	australis
		Black-crowned Tchagra	Swartkroontjagra	Tchagra	senegalus
		Black-backed Puffback	Sneeubal	Dryoscopus	cubla
		Swamp Boubou	Moeraswaterfiskaal	Laniarius	bicolor
		Crimson-breasted Shrike	Rooiborslaksman	Laniarius	atrococcineus
		Brubru	Bontroklaksman	Nilaus	afer
Family	Campephagidae	Cuckooshrikes			
		White-breasted Cuckooshrike		Coracina	pectoralis
		Black Cuckooshrike	Swartkatakoeroe	Campephaga	flava

Fa mil y	Laniidae	Shrikes			
		Magpie Shrike	Langstertlaksman	Urolestes	melanoleucus
		Southern White-crowned Shrike		Eurocephalus	anguitimens
		Lesser Grey Shrike	Gryslaksman	Lanius	minor
		Southern Fiscal	Fiskaallaksman	Lanius	collaris
Fa mil y	Oriolidae	Figbirds and Orioles			
		Eurasian Golden Oriole	Europese Wielewaal	Oriolus	oriolus
		African Golden Oriole	Afrikaanse Wielewaal	Oriolus	auratus
		Black-headed Oriole	Swartkopwielewaal	Oriolus	larvatus
Fa mil y	Dicruridae	Drongos			
		Square-tailed Drongo	Kleinbyvanger	Dicrurus	ludwigii
		Fork-tailed Drongo	Mikstertbyvanger	Dicrurus	adsimilis
Fa mil y	Monarchidae	Monarchs			
		African Paradise Flycatcher		Terpsiphone	viridis
Fa mil y	Corvidae	Crows and Jays			
		Cape Crow	Swartkraai	Corvus	capensis
		Pied Crow	Witborskraai	Corvus	albus
Fa mil y	Paridae	Tits and Chickadees			
		Carp's Tit	Ovamboswartmees	Melaniparus	carpi
		Ashy Tit	Akasiagrysmees	Melaniparus	cinerascens
Fa mil y	Remizidae	Penduline Tits			
		Cape Penduline Tit	Kaapse Kapokvoël	Anthoscopus	minutus
Fa mil y	Alaudidae	Larks			
		Spike-heeled Lark	Vlaktelewerik	Chersomanes	albofasciata
		Gray's Lark	Namiblewerik	Ammomanopsis	grayi
		Benguela Long-billed Lark		Certhilauda	benguensis
		Dusky Lark	Donkerlewerik	Pinarocorys	nigricans
		Chestnut-backed Sparrow-Lark		Eremopterix	leucotis
		Grey-backed Sparrow-Lark		Eremopterix	verticalis
		Sabota Lark	Sabotalewerik	Calendulauda	sabota
		Fawn-colored Lark	Vaalbruinlewerik	Calendulauda	africanoides
		Eastern Clapper Lark	Hoëveldklappertjie	Mirafra	fasciolata
		Cape Clapper Lark	Kaapse Klappertjie	Mirafra	apiata
		Rufous-naped Lark	Rooineklewerik	Mirafra	africana
		Monotonous Lark	Bosveldlewerik	Mirafra	passerina
		Stark's Lark	Woestynlewerik	Spizocorys	starki
		Red-capped Lark	Rooikoplewerik	Calandrella	cinerea
Fa mil y	Pycnonotidae	Bulbuls			

		African Red-eyed Bulbul	Rooioogtiptol	Pycnonotus	nigricans
		Yellow-bellied Greenbul	Geelborswillie	Chlorocichla	flaviventris
Fa mil y	Hirundinidae	Swallows and Martins			
		Brown-throated Martin	Afrikaanse Oewerswael	Riparia	paludicola
		Sand Martin	Europese Oewerswael	Riparia	riparia
		Barn Swallow	Europese Swael	Hirundo	rustica
		White-throated Swallow	Witkeelswael	Hirundo	albigularis
		Wire-tailed Swallow	Draadstertswael	Hirundo	smithii
		Pearl-breasted Swallow	Pêrelborsswael	Hirundo	dimidiata
		Rock Martin	Kransswael	Ptyonoprogne	fuligula
		Common House Martin	Huisswael	Delichon	urbicum
		Greater Striped Swallow	Grootstreepswael	Cecropis	cucullata
		Lesser Striped Swallow	Kleinstreepswael	Cecropis	abyssinica
Fa mil y	Macrosphenidae	Crombecs and African Warblers			
		Rockrunner	Rotsvoël	Achaetops	pyncopygius
		Long-billed Crombec	Bosveldstompstert	Sylvietta	rufescens
Fa mil y	Phylloscopidae	Leaf Warblers and Allies			
		Willow Warbler	Hofsanger	Phylloscopus	trochilus
Fa mil y	Acrocephalidae	Reed Warblers and Allies			
		Lesser Swamp Warbler	Kaapse Rietsanger	Acrocephalus	gracilirostris
		Sedge Warbler	Europese Vleisanger	Acrocephalus	schoenobaenus
		African Reed Warbler	Kleinrietsanger	Acrocephalus	baeticatus
		Marsh Warbler	Europese Rietsanger	Acrocephalus	palustris
Fa mil y	Cisticolidae	Cisticolas and Allies			
		Rattling Cisticola	Bosveldtinkinkie	Cisticola	chiniana
		Tinkling Cisticola	Rooitinkinkie	Cisticola	rufilatus
		Grey-backed Cisticola	Gysrugtinkinkie	Cisticola	subruficapilla
		Zitting Cisticola	Landeryklopkloppie	Cisticola	juncidis
		Desert Cisticola	Woestynklopkloppie	Cisticola	aridulus
		Tawny-flanked Prinia	Bruinsylangstertjie	Prinia	subflava
		Black-chested Prinia	Swartbandlangstertjie	Prinia	flavicans
		Yellow-breasted Apalis	Geelborskleinjantjie	Apalis	flavida
		Green-backed Camaroptera		Camaroptera	brachyura
		Grey-backed Camaroptera		Camaroptera	brevicaudata
		Barred Wren-Warbler	Gebande Sanger	Calamonastes	fasciolatus
		Yellow-bellied Eremomela		Eremomela	icteropygialis
		Burnt-necked Eremomela		Eremomela	usticollis
Fa mil y	Leiothrichidae	Laughingthrushes			
		Black-faced Babbler	Swartwangkatlagter	Turdoides	melanops
		Hartlaub's Babbler	Witkruiskatlagter	Turdoides	hartlaubii
		Southern Pied Babbler	Witkatlagter	Turdoides	bicolor

		Bare-cheeked Babbler	Kaalwangkatlagter	Turdoides	gymnogenys
Fa mil y	Sylviidae	Sylviid Babblers			
		Chestnut-vented Tit-babbler	Bosveldtjeriktik	Sylvia	subcoerulea
		Layard's Tit-babbler	Grystjeriktik	Sylvia	layardi
Fa mil y	Sturnidae	Starlings			
		Wattled Starling	Lelspreeu	Creatophora	cinerea
		Cape Glossy Starling	Kleinglansspreeu	Lamprotornis	nitens
		Meves's Starling	Langstertglansspreeu	Lamprotornis	mevesii
		Violet-backed Starling	Witborsspreeu	Cinnyricinclus	leucogaster
		Pale-winged Starling	Bleekvlerkspreeu	Onychognathus	nabouroup
Fa mil y	Buphagidae	Oxpeckers			
		Yellow-billed Oxpecker	Geelbekrenostervoël	Buphagus	africanus
		Red-billed Oxpecker	Rooibekrenostervoël	Buphagus	erythrorynchus
Fa mil y	Turdidae	Thrushes			
		Groundscraper Thrush	Gevlekte Lyster	Turdus	litsitsirupa
Fa mil y	Muscicapidae	Chats and Old World Flycatchers			
		Kalahari Scrub Robin	Kalahariwipstert	Cercotrichas	paena
		White-browed Scrub Robin		Cercotrichas	leucophrys
		Chat Flycatcher	Grootvlieëvanger	Melaenornis	infuscatus
		Marico Flycatcher	Maricovlieëvanger	Melaenornis	mariquensis
		Spotted Flycatcher	Europese Vlieëvanger	Muscicapa	striata
		Ashy Flycatcher	Blougrysvlieëvanger	Muscicapa	caerulescens
		Angolan Cave Chat	Angolajanfrederik	Cossypha	ansorgei
		Rufous-tailed Palm Thrush		Cichladusa	ruficauda
		Short-toed Rock Thrush	Korttoonkliplyster	Monticola	brevipes
		Karoo Chat	Karoospekvreter	Emarginata	schlegelii
		Tractrac Chat	Woestynspekvreter	Emarginata	tractrac
		Ant-eating Chat	Swartpiek	Myrmecocichla	formicivora
		Mountain Wheatear	Bergwagter	Myrmecocichla	monticola
		Capped Wheatear	Hoëveldskaapwagter	Oenanthe	pileata
		Familiar Chat	Gewone Spekvreter	Oenanthe	familiaris
		Herero Chat	Hererospekvreter	Namibornis	herero
Fa mil y	Nectariniidae	Sunbirds			
		Scarlet-chested Sunbird	Rooiborssuikerbekkie	Chalcomitra	senegalensis
		White-bellied Sunbird	Witpensuikerbekkie	Cinnyris	talatala
		Dusky Sunbird	Namakwasuikerbekkie	Cinnyris	fuscus

Fa mil y	Passeridae	Old World Sparrows			
		House Sparrow	Huismossie	Passer	domesticus
		Great Sparrow	Grootmossie	Passer	motitensis
		Cape Sparrow	Gewone Mossie	Passer	melanurus
		Northern Grey-headed Sparrow		Passer	griseus
		Southern Grey-headed Sparrow		Passer	diffusus
Fa mil y	Ploceidae	Weavers and Widowbirds			
		Red-billed Buffalo Weaver		Bubalornis	niger
		White-browed Sparrow-Weaver		Plocepasser	mahali
		Sociable Weaver	Versamelvoël	Philetairus	socius
		Scaly-feathered Finch	Baardmannetjie	Sporopipes	squamifrons
		Spectacled Weaver	Brilwewer	Ploceus	ocularis
		African Golden Weaver	Goudwewer	Ploceus	xanthops
		Lesser Masked Weaver	Kleingeelvink	Ploceus	intermedius
		Southern Masked Weaver		Ploceus	velatus
		Chestnut Weaver	Bruinwewer	Ploceus	rubiginosus
		Red-billed Quelea	Rooibekkwelea	Quelea	quelea
		Yellow-crowned Bishop	Goudgeelvink	Euplectes	afer
Fa mil y	Estrildidae	Waxbills, Munias and Allies			
		Green-winged Pytilia	Gewone Melba	Pytilia	melba
		Red-headed Finch	Rooikopvink	Amadina	erythrocephala
		Red-billed Firefinch	Rooibekvuurvinkie	Lagonosticta	senegala
		Jameson's Firefinch	Jamesonvuurvinkie	Lagonosticta	rhodopareia
		Blue Waxbill	Gewone Blousysie	Uraeginthus	angolensis
		Violet-eared Waxbill	Koningblousysie	Uraeginthus	granatinus
		Angolan Waxbill	Angolaswie	Coccopygia	bocagei
		Cinderella Waxbill	Angolasysie (Swartoogsysie)	Estrilda	thomensis
		Common Waxbill	Rooibeksysie	Estrilda	astrild
		Black-faced Waxbill	Swartwangsysie	Estrilda	erythronotos
		Quailfinch	Gewone Kwartelvinkie	Ortygospiza	atricollis
Fa mil y	Viduidae	Indigobirds and Whydahs			
		Village Indigobird	Staalblouvinkie	Vidua	chalybeata
		Shaft-tailed Whydah	Pylstertrooibekkie	Vidua	regia
		Long-tailed Paradise Whydah		Vidua	paradisaea
Fa mil y	Motacillidae	Wagtails and Pipits			
		Western Yellow Wagtail	Geelkwikkie	Motacilla	flava
		Cape Wagtail	Gewone Kwikkie	Motacilla	capensis
		African Pied Wagtail	Bontkwikkie	Motacilla	aguimp
		African Pipit	Gewone Koester	Anthus	cinnamomeus
		Long-billed Pipit	Nicholsonkoester	Anthus	similis
		Buffy Pipit	Vaalkoester	Anthus	vaalensis
		Tree Pipit	Boomkoester	Anthus	trivialis
Fa mil y	Fringillidae	Finches and Canaries			

		Black-throated Canary	Bergkanarie	Crithagra	atrogularis
		Yellow Canary	Geelkanarie	Crithagra	flaviventris
		White-throated Canary	Witkeelkanarie	Crithagra	albogularis
Family	Emberizidae	Buntings and New World Sparrows			
		Lark-like Bunting	Vaalstreepkoppie	Emberiza	impetuari
		Cinnamon-breasted Bunting		Emberiza	tahapisi
		Cape Bunting	Rooivlerkstreepkop pie	Emberiza	capensis
		Golden-breasted Bunting	Rooirugstreepkoppi e	Emberiza	flaviventris