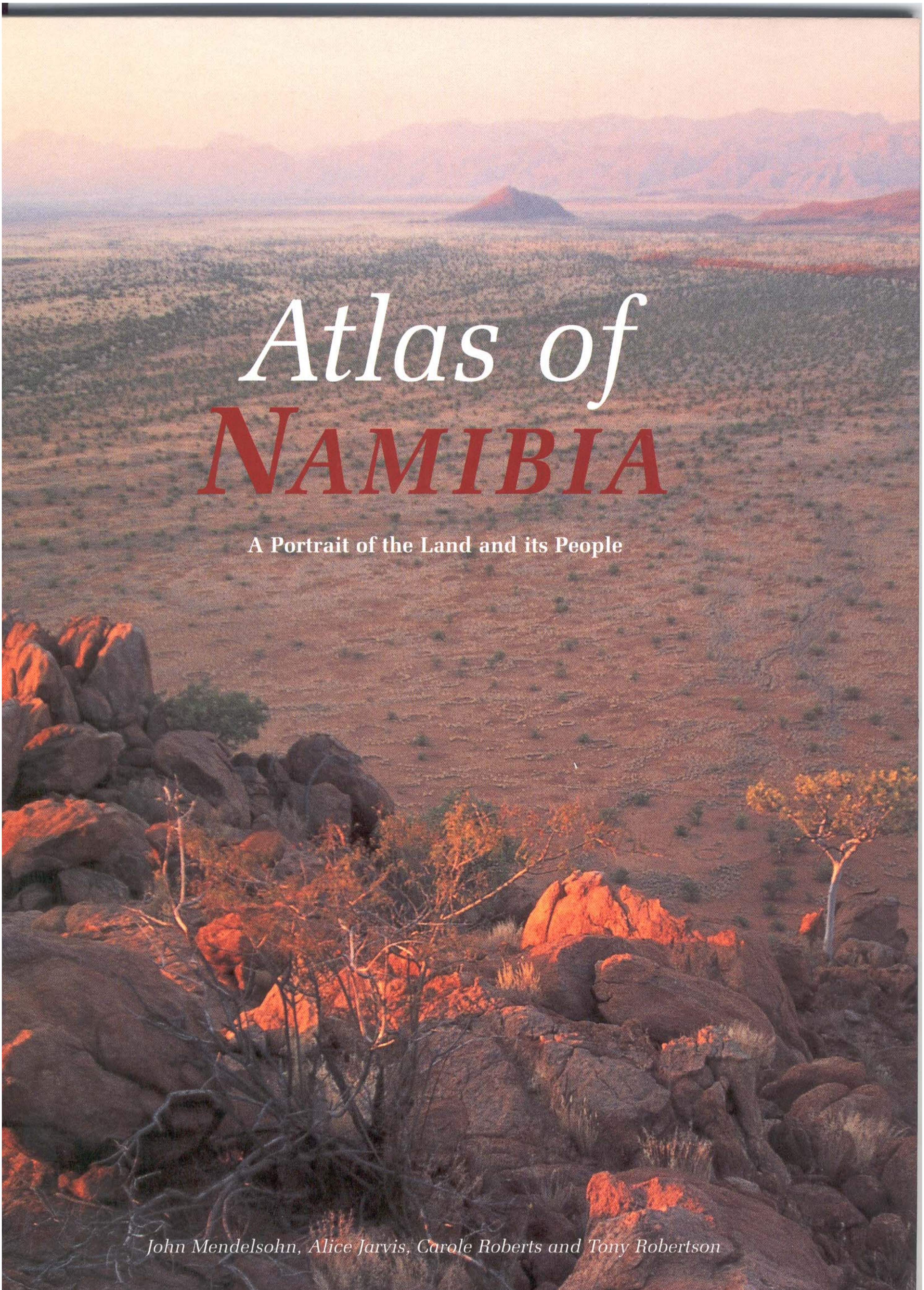

Atlas of NAMIBIA

A Portrait of the Land and its People

John Mendelsohn, Alice Jarvis, Carole Roberts and Tony Robertson

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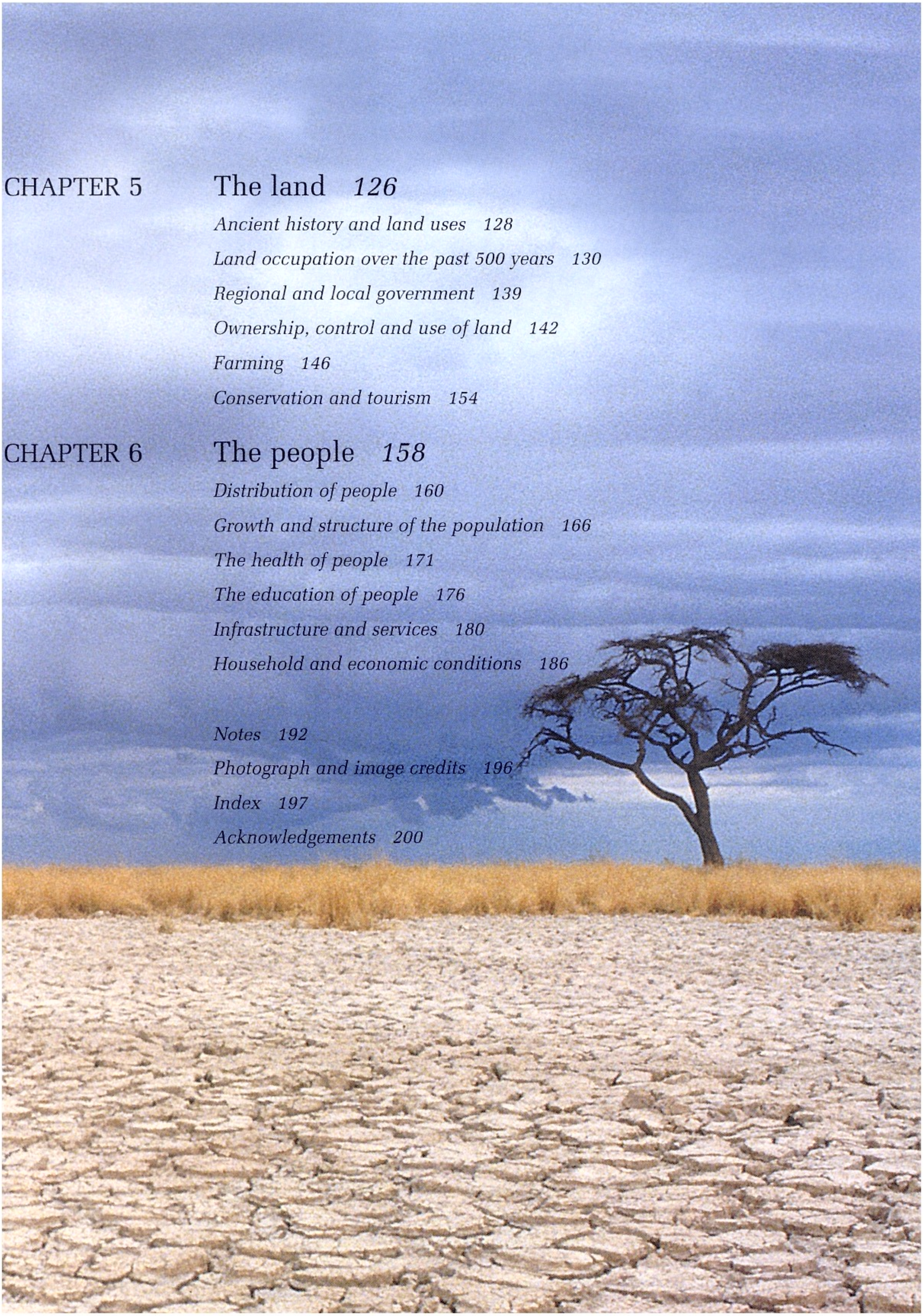


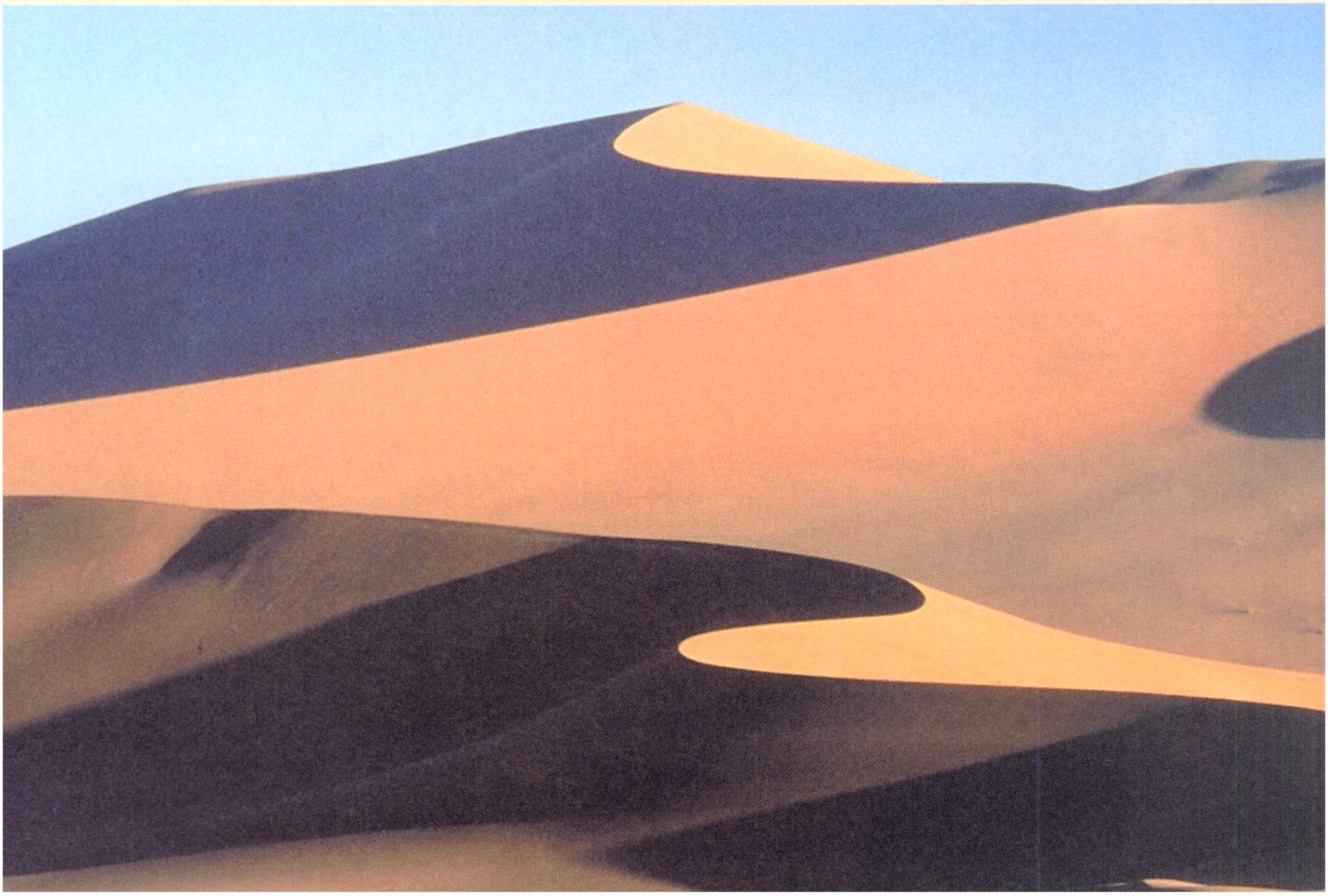
PREFACE

Namibia has many features to be admired and appreciated: spectacular scenery, abundant wildlife, people diverse in culture and outlook, a sunny climate, and other wonderful qualities. While it is easy to appreciate beautiful landscapes, for example, the degree to which we cherish these and other features often depends on our knowledge and understanding of them. The simple aim of this Atlas is to provide information to improve that knowledge and to foster an appreciation of all that makes Namibia the country it is.

Two factors provided the motivation to produce the Atlas. The first was the considerable amount of new geographical information that has been assembled or updated in recent years. The second reason was the lack of any recent compilation on the geography of Namibia, and it was therefore logical to use this new information to meet that need. The production of the Atlas was made possible by the generosity of people who made information available to the Atlas Project, and by the Government of Finland, which kindly provided the funds to compile and publish the work.

Every effort was made to use the most recent information available, and most of the maps were compiled from data collected during the past five years. Some maps are based on extremely detailed and accurate data at much higher resolution than can be appreciated from the mapping scales used in this book. Other maps are more approximate, either because the data were more generalised or because they were intended to show only broad trends. Sources of information and additional details are given in the notes at the back of the book.

The Atlas Project was designed to produce two products. One is this book, and the second is the data that were assembled and processed to produce the printed maps. These data have come from many sources and include some sets that the Atlas Project compiled afresh. All the data we have been able to make available for public use can be obtained from the website of the Directorate of Environmental Affairs at www.dea.met.gov.na. The data have been made publicly available in the hope that they will be widely used, be analysed further, be published in other



formats, and contribute to wise decision-making at all levels. We also hope that new and updated information based on these data will, similarly, be made available for public use.

The Atlas covers a variety of subjects, and we hope that it will be of interest to a broad audience. Many of the topics are clearly connected. For example, present-day land uses are strongly influenced by such varied features as soil qualities, history, climate and underground water supplies. The Atlas draws attention to many of these linkages but others are beyond the scope of this book. One aspect that is important, however, is that a considerable number of the linkages between different topics may be expressed in terms of supply and demand. This provides an underlying approach for the book in that the early chapters focus on the supply of resources while the later ones are concerned more with aspects of demand.

The book comprises six chapters. Chapter 1 introduces the country and provides information that is useful for orientating oneself in Namibia. Chapter 2 describes the country's physical resources, especially those that provide the foundation of soils, water, minerals and geological resources. Chapter 3 is concerned with climate and deals with such issues as variation in rainfall, how evaporation rates change across the country, and what factors make the coastal environment so different. Features covered in these first three chapters strongly affect all the aspects covered in the remaining chapters. Thus, Chapter 4 deals with the distribution and abundance of plants and animals in terms of diversity and resources, and highlights areas where Namibia has a special responsibility for the conservation of these resources. Chapter 5 is concerned with land and its uses, including how land occupation has changed over the past 125 years, how land is now controlled, and how farming activities differ from place to place. The final chapter, Chapter 6, is about the people of Namibia, focusing on such features as the distribution, growth and structure of the population, as well as household economies and social services. We hope that the contents of the pages ahead will provide an informative perspective on Namibia.

CHAPTER 1: *Introduction*

Namibia is a large country, covering an area of about 823,680 km² and spanning some 1,320 km at its longest and 1,440 km at its widest points. Its coastline of approximately 1,570 km separates the land from the Atlantic Ocean. But Namibia is also big in several other respects. Amazing landscapes present enormous vistas, their horizons stretching far into the hazy distance; tall mountains push upwards into open, clear skies; while vast seas of sand dunes blanket areas about the size of Switzerland. Great expanses free of any sign of human life provide solitude and a pristine environment. An abundance of wildlife is found in certain areas, with many species that occur nowhere else in the world. Brilliant arrays of thousands of stars light up the clear night skies. The coastal waters harbour a rich fishing industry, and an abundance of large diamonds form part of Namibia's mineral wealth.

It is the geological history and climate, more than anything else, that make Namibia the country it is. Geological processes over the last 2,600 million years placed various rock formations in different areas, shaped the landscape and produced a variety of important mineral deposits. Broadly speaking, there are two geological zones. One is in western Namibia, where there is a great variety of rock formations, most of them exposed in a rugged landscape of valleys, escarpments, mountains and large open plains. The other is in the east, where sands and other sediments that were deposited relatively recently cover most of the surface, and where the landscapes are much more uniform than in the west. The highest point in the country, at 2,579 m above sea level, is the peak of the Brandberg massif – the most impressive of several large inselbergs in western Namibia.

Over much of the country and for most of the year, the climate is best described by one word: arid. The overall absence of moisture is due to Namibia's south-western position on the continent, where the country straddles an area several hundred kilometres to the north and south of the Tropic of Capricorn. Namibia is consequently located between two climate systems: the Intertropical Convergence Zone, which feeds in moist air from the north, and the Subtropical High Pressure Zone, which pushes the moist air back with dry air. It is the latter system that usually dominates Namibian skies with dry weather, and it is the lack of water in the atmosphere – rather than an absence of rain – which makes Namibia dry. The dry air means that there are few clouds, radiation from the sun is intense, daytime temperatures are high, and water evaporates rapidly.

Most rain falls during sporadic storms in the summer months from September to February, and total annual rainfalls vary greatly from year to year. The flow of moisture from the north also makes northern Namibia considerably wetter than other areas in the country, and there is a clear gradient from the wettest areas in the Caprivi to the arid, desert areas along the coast and in the south.

Namibia's climate has been generally arid for many millions of years. One result of this is the absence of deep soils over much of the country and the low levels of nutrients in most soils. Another consequence is the overall scarcity of water in most areas, which limits almost all aspects of life in the country. All the rivers that drain areas within Namibia are dry for most of the time, only flowing after heavy falls of rain. The perennial rivers along Namibia's borders

flow from catchment areas in neighbouring countries with much higher rainfalls. Most Namibians live close to these perennial rivers or in localised areas and towns to which river or underground water has been pumped.

There are numerous important and unusual characteristics of plant and animal life in Namibia, and most of these features are linked to a climate that is often dry, variable and relatively harsh. The more moist and tropical areas in north-eastern Namibia have the greatest overall diversity of species, but most species endemic to Namibia occur in more arid areas in and around the escarpment and on isolated highlands. Plant life is dominated by tall woodlands in the north-east; from here the vegetation becomes progressively shorter and more sparse to the west and south. To cope with variable conditions, many animals move over great distances, their nomadic wanderings taking them to places where new plant growth and food become available following local falls of rain.

Human beings and their evolutionary ancestors have been living in Namibia for hundreds of thousands of years, but most Namibians today are descendants of groups that arrived here during the past 500 years to settle in northern Namibia. The more recent arrivals of settlers from Germany and South Africa over the last 125 years caused major changes in the way land was allocated and used. Communal areas shrank while progressively more land was apportioned for freehold farming. Approximately 43% of Namibia is now allocated as freehold land, 39% as communal land, and 18% as government land.

The majority of people are directly dependent on natural resources obtained from the land, and much more land is used for agriculture than for any other purpose, mostly for farming cattle, goats and sheep. About 3,000 km^2 is cultivated each year, mainly for millet, sorghum and maize. Proclaimed nature reserves and national parks make up about 14.1% of the country, while declared conservancies constitute a further 9.6% of Namibia.

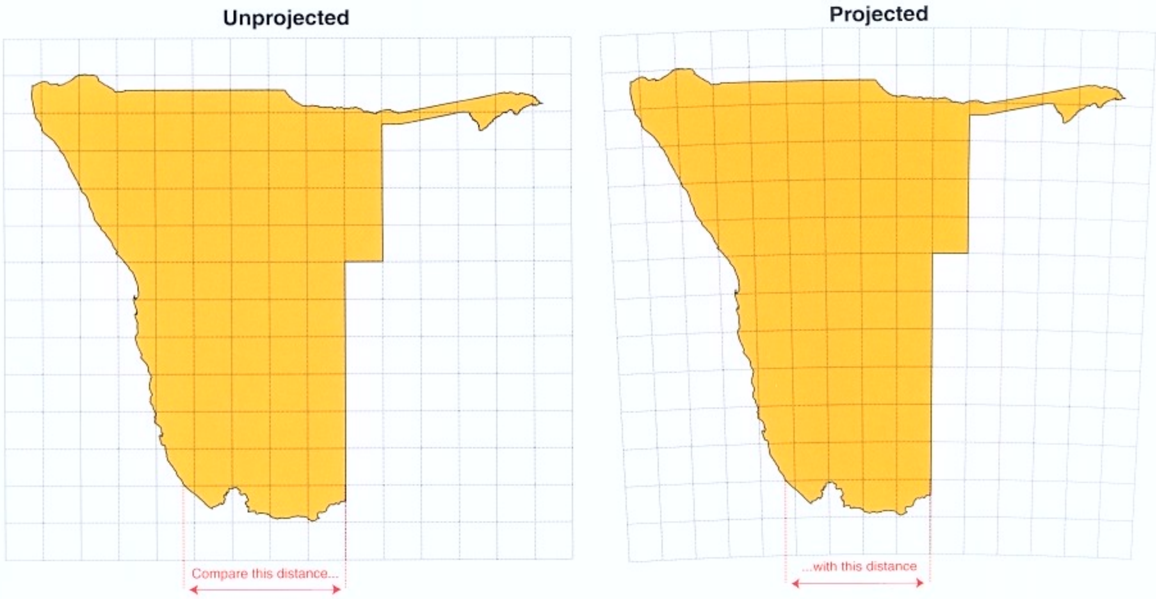
The population of some 1.83 million people is comparatively small in relation to the size of the country. Approximately 39% of people live in urban areas, while the great majority of the remaining rural population lives in northern Namibia. Younger people make up a large proportion of the population, with 43% of all Namibians being under the age of 15. Population growth has been relatively rapid at 3% per year in recent decades, but it is now slowing as a result of lower fertility and increasing mortality due to AIDS. Fertility rates and life expectancies both declined by about one-third during the 1990s. Cultural diversity is reflected in the 25 distinct languages or major dialects spoken in Namibia, and most of these are based in the northern areas of the country. This diversity reflects patterns of historical settlement and the way crop-producing communities live in relatively discrete areas.

Few aspects in Namibia vary quite as much as people's social and economic circumstances. This variation is true both for levels of economic well-being and for the nature of livelihoods and sources of income. On a national scale, much of Namibia's overall wealth comes from the use of natural resources for farming, mining, marine fishing and tourism.

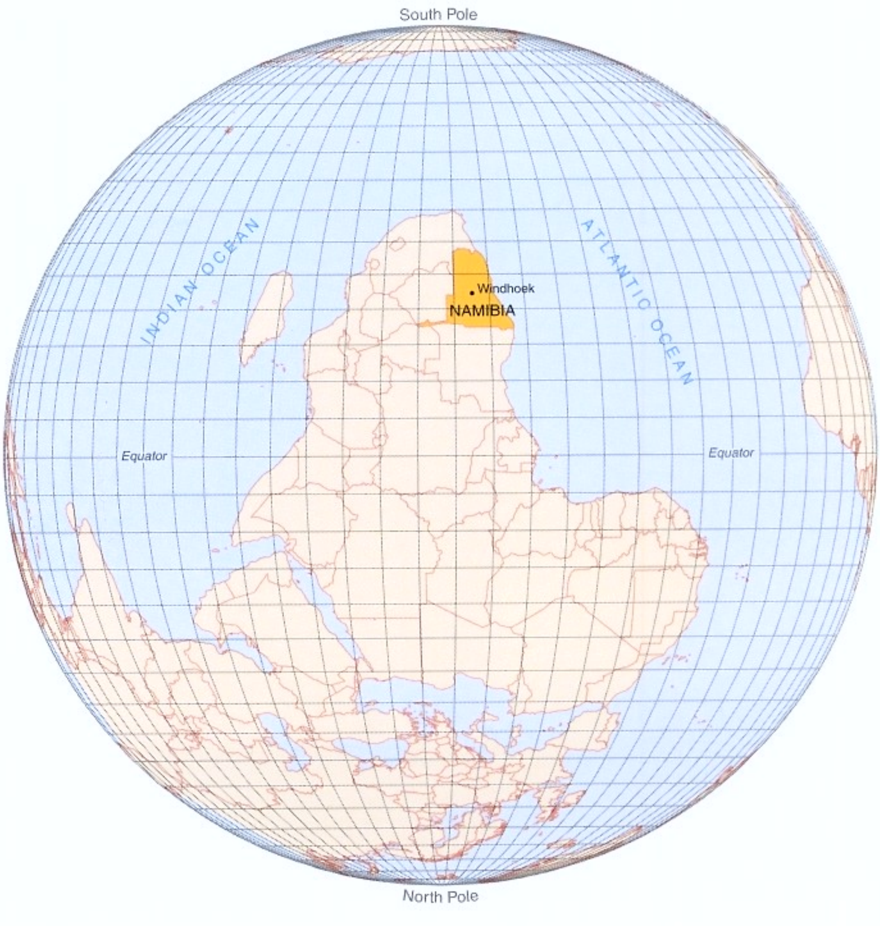
1.1 Several views of Namibia

One problem in drawing maps is that the positions of features on the curved surface of the earth become distorted once they are represented on a flat paper surface. The same happens when an orange peel is squashed onto a flat surface. Map projections are used to minimise these distortions. The projections transform points of reference from degrees of latitude and longitude into measurements that provide less distortion of area, shape or direction. The map on the left shows Namibia 'unprojected', with squares of one degree of latitude and longitude, while the right-hand map has been projected. One noticeable difference is that southern Namibia appears narrower in the projected map because lines of longitude converge on the North and South Poles. Lines of latitude actually go round the earth as straight lines or parallels, but they become slightly curved in the projected view because of the projection parameters. This is also why the straight line that forms the border between Namibia and Angola appears curved.

The projection used here is an Albers Equal Area projection: any area on the map portrays true surface area irrespective of where it is in Namibia. The projection is based on the 1841 Bessel Spheroid, a central meridian of 18.5°E, a reference and first parallel at 27°S and a second parallel at 19°S. This is the map projection used for all maps in this Atlas showing the whole country.



On a lighter note, it is normal practice to show the north as being at the top of a map. Consider, then, how perspectives would change if Namibia were close to the top of the world and its 'northern' borders with Angola and Zambia were down below, as shown here.



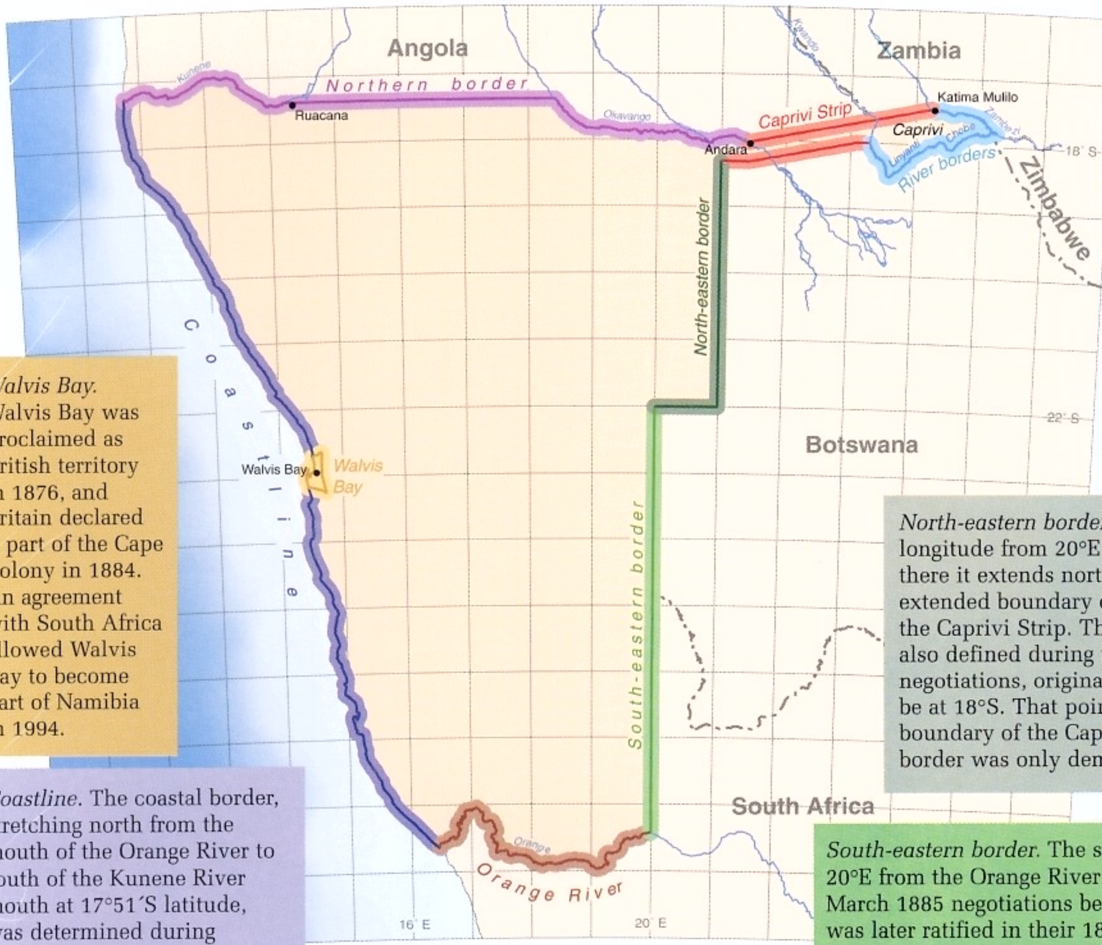
1.2 Namibia's borders[1]

Like all sovereign countries, Namibia has a set of defined borders that give it its shape, area and territorial integrity. How did Namibia come to have these borders? Answers are to be found in a long series of events stretching back almost 150 years, consisting of endless negotiations, a multitude of treaties, and delimitation and geodetical commissions. Most of these were conducted between the German, British and Portuguese governments during their scramble for colonial influence in the 19th century. More recent treaties and commissions have also involved the Botswanan and South African governments.

Northern border. The border from the mouth of the Kunene River to a point near Ruacana, and then due east to the Okavango River, and then along the river to Andara, was first fixed in the December 1886 German–Portuguese treaty. However, there was uncertainty and disagreement in later years about exactly which point near Ruacana was intended. A neutral zone, 8 miles wide, was declared in 1891 until the border could be surveyed and beacons planted. The neutral zone fell away in 1928 when a proper survey of the area was done.

Caprivi Strip. The idea of the Caprivi Strip was first agreed to during the Portuguese–German treaty of December 1886, when the northern boundary was defined as running in a straight line from Andara to the rapids at Katima Mulilo. However, the general area in and around today's Caprivi region fell under British influence at the time, and it was during the negotiations for the Heligoland–Zanzibar treaty of 1890 that the Strip was first declared as being part of the German colony of German South West Africa. This treaty also fixed the width of the Strip as 20 miles. The survey and marking out of the northern boundary were only completed in 1931.

Although the southern boundary of the Strip was fixed during the 1890 Heligoland–Zanzibar treaty, the British and German governments interpreted its position differently. This was especially true along the western section of the boundary, where it was supposed to be 20 miles wide. However, it was difficult to determine how that width should relate to the northern border winding along the Okavango River, and it was only in 1930 that the southern border's position was fixed.



Chobe, Kwando, Linyanti and Zambezi river borders. Various treaties fixed these borders as being the centre lines of the four deepest channels of the four rivers. However, the rivers meander into channels in many places, making it difficult to determine the centre lines of the deepest channels. This is why there have been several recent disagreements between the Namibian and Botswanan governments about sovereignty over certain islands in the rivers. The courses and depths of the channels also change over the years.

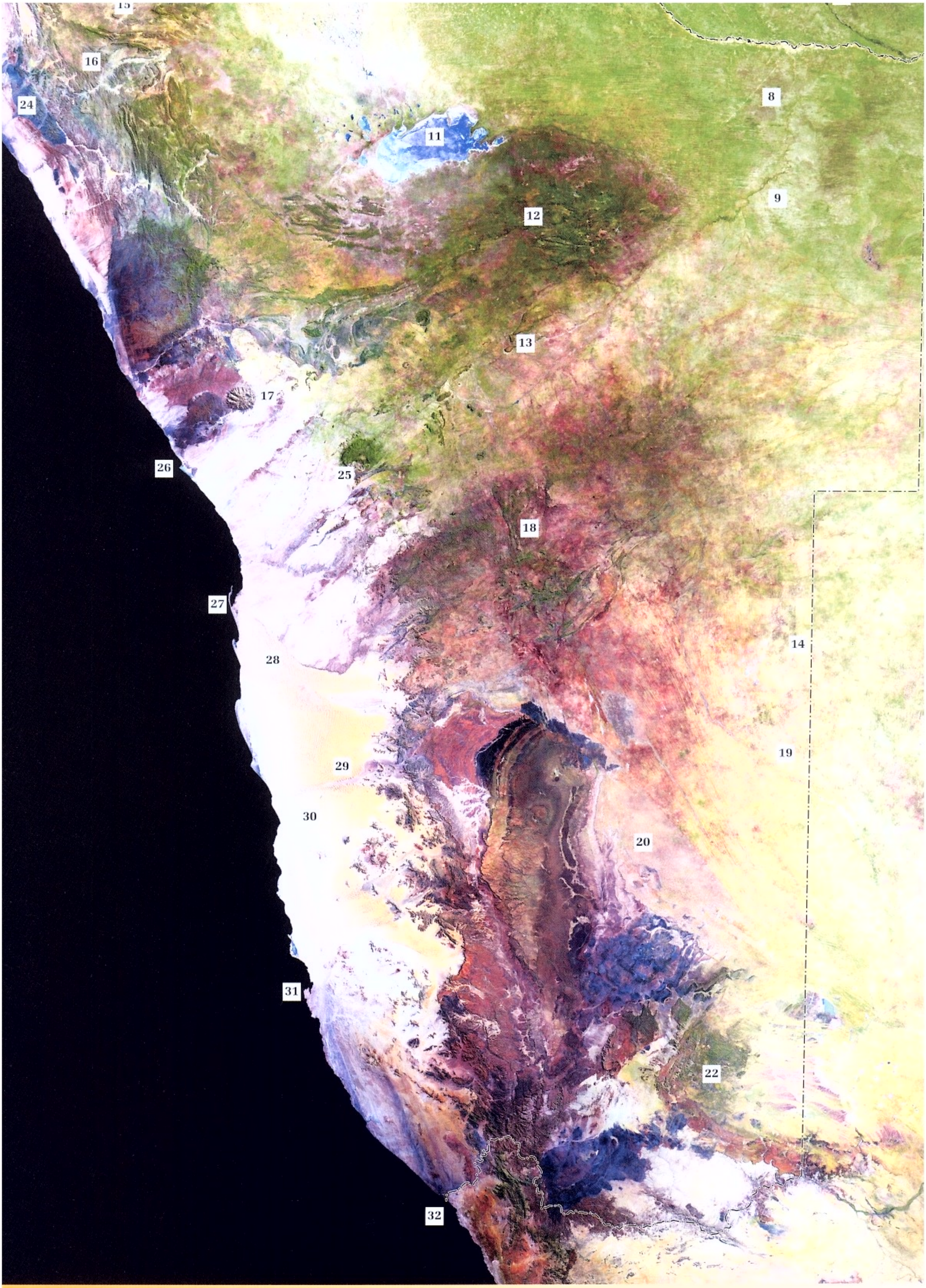
Walvis Bay. Walvis Bay was proclaimed as British territory in 1876, and Britain declared it part of the Cape Colony in 1884. An agreement with South Africa allowed Walvis Bay to become part of Namibia in 1994.

North-eastern border. This runs east for one degree of longitude from 20°E and 22°S to 21°E and 22°S. From there it extends north along 21°E to the southern and extended boundary of what was formerly known as the Caprivi Strip. The first delimitation of this border, also defined during the March 1885 British–German negotiations, originally intended the northern point to be at 18°S. That point was adjusted when the southern boundary of the Caprivi Strip was fixed in 1930. The border was only demarcated with beacons in 1964.

Coastline. The coastal border, stretching north from the mouth of the Orange River to south of the Kunene River mouth at 17°51´S latitude, was determined during negotiations between the British and German governments in March 1885. The northern point was later extended to the mouth of the Kunene River by the German–Portuguese treaty of December 1886. An exclusive economic zone now extends 200 nautical miles (about 370 km) off the coast.

South-eastern border. The straight line extending north along 20°E from the Orange River was first determined during the March 1885 negotiations between Britain and Germany, and was later ratified in their 1890 treaty. It was demarcated with beacons during a geodetical survey between 1899 and 1903.

Orange River. The border was defined during the March 1885 German–British negotiations as following the northern bank at its highest flood level. This was later confirmed in their 1890 treaty. The border extended from the mouth of the river to a point where it meets 20°E longitude. In 1991 the governments of South Africa and Namibia agreed to move the border to the centre of the river, but this has yet to happen because the exact position of the border has not been demarcated.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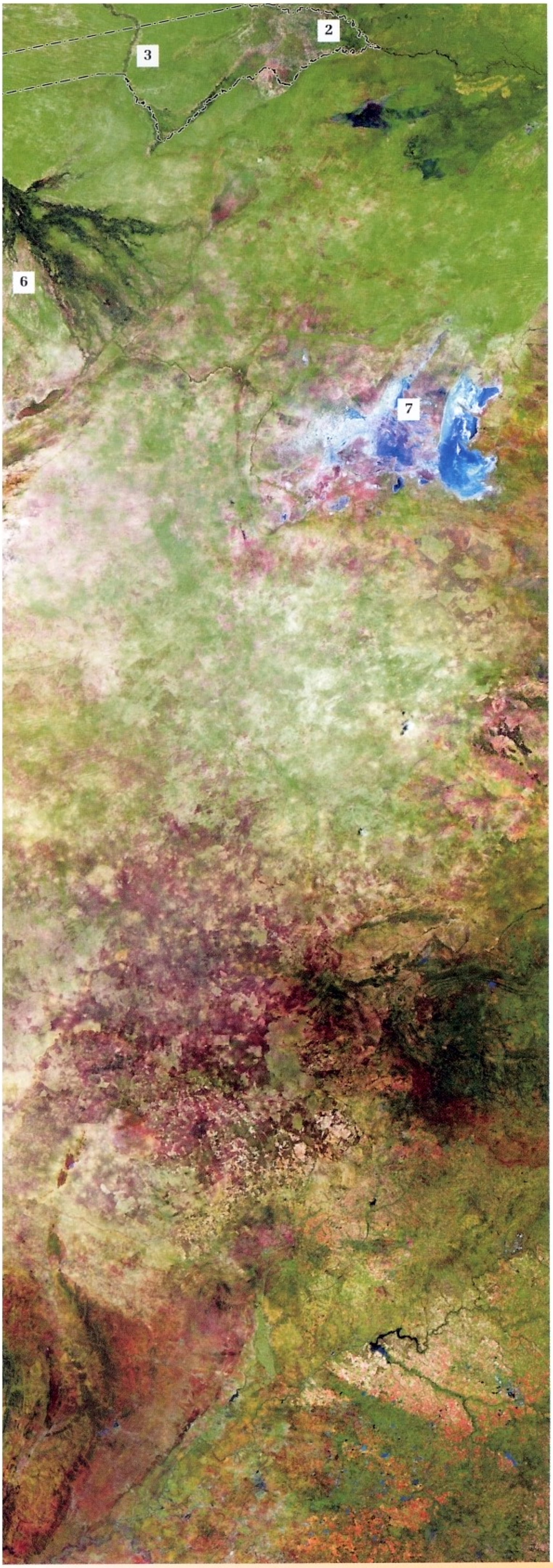


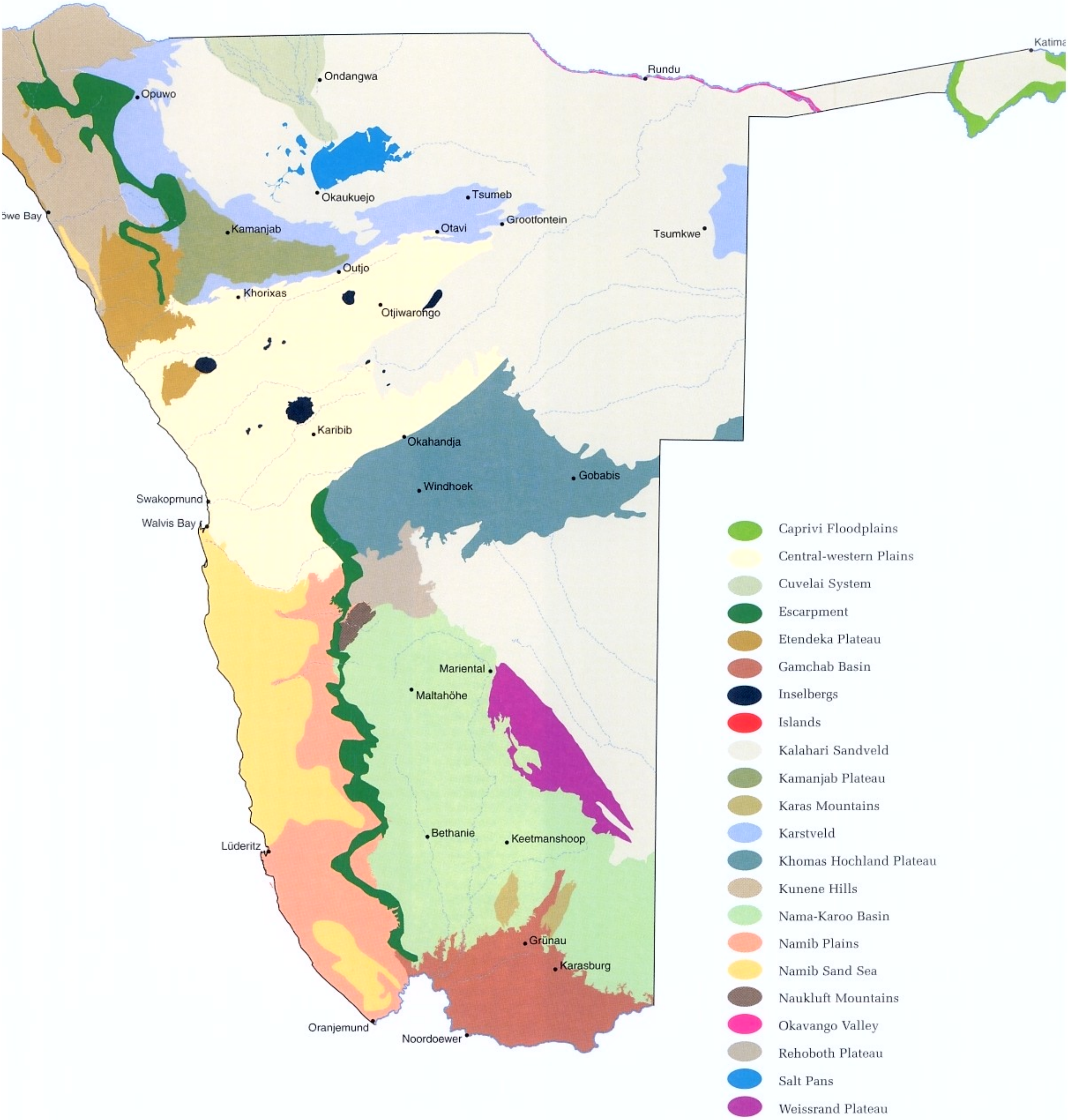
1.3 Namibia from space

This is a mosaic of images captured from a LandSat satellite orbiting above Namibia. It clearly shows many of Namibia's major features and landscapes, some of which are labelled. The border between Angola and central northern Namibia is clear because so much of the Namibian side has been cleared of vegetation. Similarly, the Aminuis Corridor area on the border of Botswana is also visible because of overgrazing on the Namibian side.

1 Zambezi River
2 Caprivi Floodplains
3 Kwando River
4 Cuito River in Angola
5 Okavango River
6 Okavango Swamps in Botswana
7 Makgadikgadi Pan in Botswana
8 Main road to Rundu
9 Omuramba Omatako
10 Angola–Namibia border and Cuvelai System
11 Etosha Pan
12 Otavi Mountains
13 Waterberg
14 Aminuis Corridor farms
15 Zebra Mountains
16 Hoarusib glacial valley
17 Brandberg
18 Windhoek
19 Nossob River
20 Weissrand Plateau
21 Orange River
22 Karas Mountains
23 Kunene River mouth
24 Etendeka Mountains
25 Erongo Mountains
26 Cape Cross
27 Walvis Bay
28 Kuiseb River
29 Sossusvlei
30 Namib Sand Sea
31 Lüderitz
32 Orange River mouth

1.4 Namibia's landscapes[2]

Namibia can be divided into a number of landscapes or land forms. The nature of these areas is largely determined by a combination of characteristics of relief or topography (see Figure 2.1), geological processes (Figure 2.4) and drainage (Figure 2.21). These three features often have a great influence on other aspects of Namibian geography, and each landscape therefore has distinctive aspects to its climate, soils, plant and animal life, and land uses. The map shown here excludes many smaller features (like the Fish River Canyon) that are important in their own right, but cannot be shown at this scale.



CAPRIVI FLOODPLAINS *Flood waters from the Zambezi and Kwando rivers have formed these floodplains, which consist of a network of channels, many spectacular oxbow lakes, and large areas of surrounding grasslands. Flooding only occurs, however, after good rainfall in the catchment areas in Zambia and Angola (see Figure 2.22). Water in these two rivers also flows into two others: the Linyanti River (an extension of the Kwando) and the Chobe River (a backwater of the Zambezi). Soils in the floodplain are comparatively fertile, and many people live and grow crops there as a result.*

CENTRAL-WESTERN PLAINS *Stretching back from the coast, this broad area of plains extends inland for about 450 km in places. The plains were largely formed by erosion cutting back into higher ground and carving out the catchment areas of several major rivers. The Khan, Omaruru, Swakop and Ugab rivers are the most prominent of these. Much of the area lies between 500 and 1,000 m above sea level, and consists of metamorphic rocks that were forced up out of the sea during the formation of the Gondwana continent some 550 million years ago (see Figure 2.8). This photograph shows the Ugab River as it cuts westwards through the Central-western Plains just to the north of the Brandberg mountain.*

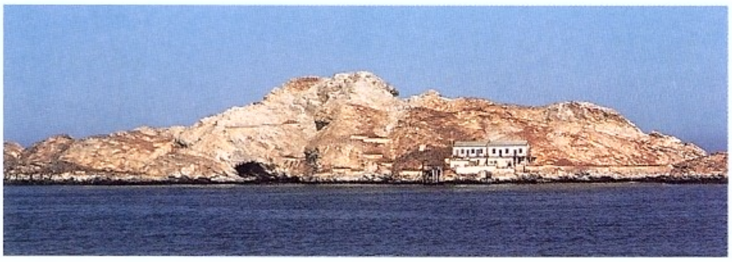
ESCARPMENT *The Escarpment divides much of the country into two general landscapes: the low-lying coastal plain to the west, and the higher, inland plateau to the east. The division is especially sharp in central and southern Namibia where altitudes rise several hundred metres over short distances in many areas (see Figure 2.3). However, the escarpment is broader and less obvious in many areas in north-western Namibia, and it has been cut back and obliterated in the Central-western Plains.*

CUVELAI SYSTEM *About a quarter of Namibia's population lives in this unusual drainage system, their homes spread across a flat landscape dominated by a network of shallow channels, or 'oshanas'. These oshanas periodically carry water after heavy local rains or good falls in highland areas some 300 km to the north in Angola (see Figure 2.22). The presence of relatively fertile soils (see Figure 2.20) and access to water in shallow wells attracted people to settle here hundreds of years ago. Much of the area is much more densely populated than immediately to the north in Angola, and a great deal of vegetation has been cleared in Namibia. This is why the border is so clearly visible from space (see Figure 1.3).*

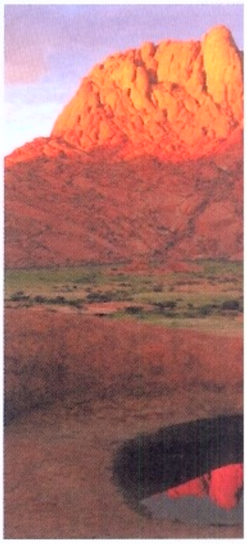
ETENDEKA PLATEAU *The word 'etendeka', which means 'layered' or 'stacked' in Otjiherero, describes much of this landscape, which consists of flat-topped hills underlain by volcanic rocks of the Etendeka Group lavas and some sedimentary rocks of the Karoo Supergroup (see Figures 2.9 and 2.12). The lavas spewed out of volcanoes when Africa and South America started to split apart some 132 million years ago. The spectacular Grootberg and the surrounding flat hills are good examples of this land form. Loose rocks cover the surface in most areas of this arid landscape.*

Kamanjab Plateau *Most of this area is underlain by granites and gneiss rocks, some of which are Namibia's oldest rocks (see Figure 2.4). The area is drained by the Huab and Ombonde rivers, which deeply dissect the western areas as they cut their way down to the coast. Elsewhere, the terrain consists largely of flat to rolling ground, with some granite inselbergs breaking the surface in places.*

Gamchab Basin *This large basin was formed by rivers eroding away the terrain to the north of the Orange River. These rivers flow and erode the landscape only sporadically after heavy falls of rain. The landscape is dominated by large, open valleys of gently sloping ground covered with a sparse layer of grass. There are many prominent dolerite sills in the Basin. The landscape is named after the Gamchab River, the largest of several rivers that drain the basin shown in this satellite image.*



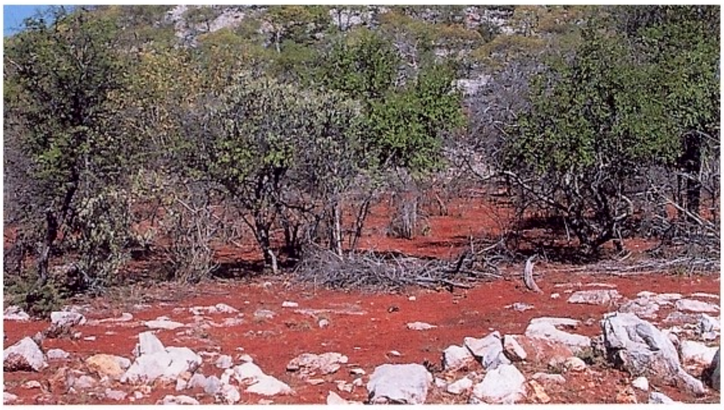
Islands *Twelve islands lie close to the shore between Walvis Bay and the mouth of the Orange River. These are the Albatross, Halifax, Hollams Bird, Ichaboe, Long, Mercury, Penguin, Pomona, Possession, Plumpudding, Seal and Sinclair's islands (see pages 30 & 32). The islands are best known as important breeding sites for sea birds, and the rich resources of seabird guano harvested long ago. For example, guano was stripped to a depth of 10 m at Ichaboe, and about 6,000 men worked on Ichaboe at any one time during 1844 and 1845. Guano is no longer harvested on the islands.*



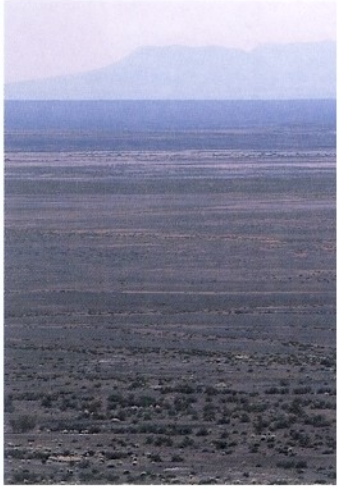
Inselbergs *The Central-western Plains are punctuated by several large free-standing mountains or 'inselbergs', the best known of which are Brandberg, the Erongo Mountains, the Paresis Mountains and Spitzkoppe. Only the largest of a great number of these mountains are shown on the map. Most of the inselbergs consist of granites, whilst Mount Etjo and the Waterberg Plateau are capped with sandstone. Many endemic plants and animals occur on these inselbergs, and numerous archaeological sites are found on and around them.*

Kalahari Sandveld *Much of northern and eastern Namibia is dominated by savanna woodlands growing on sands deposited by wind over the last 70–65 million years (see Figure 2.13). The landscape is particularly flat, although the sands have been moulded into dunes in some areas. Altitudes are highest in the centre and west, from where the whole landscape slopes gently down to lower ground in the east and south. Several rivers cut through the sandveld, but those that drain out of Namibia very seldom flow for any distance. The large perennial rivers flowing from Angola and Zambia form their own distinctive landscapes in the Okavango Valley and Caprivi Floodplains.*

Karas Mountains *The two ranges that make up the Karas Mountains are landmarks in southern Namibia, where they stand proudly above the rather flat surrounding terrain. The mountains consist of uplifted blocks of sandstones, limestones and shales. These blocks have been so eroded and dissected in some areas that it is difficult to imagine the mountains originally had flat tops. Because moist air is forced up over the mountains, they often receive slightly more rain than lower areas nearby.*



KARSTVELD *Most of this landscape extends as a narrow, raised margin that encircles the lower-lying Owambo Basin (Figure 2.13) in central northern Namibia. The rocks are dominated by limestone that dissolves easily in water, forming large underground caverns, lakes (such as Lake Otjikoto and Lake Guinas) and aquifers of underground water. There is little surface water run-off from the Karstveld landscape, and no major rivers drain it. Typically, areas with greater elevations around Grootfontein, Otavi and Tsumeb receive higher rainfall than the surrounding lowlands (Figure 3.18). White calcrete rocks litter the surface in most lower-lying areas.*



NAMA-KAROO BASIN *This large, flat-lying plateau dominates much of southern Namibia. Sedimentary rocks deposited first in the Nama Basin and, later, in the same area, in the Karoo Basin (see Figures 2.8, 2.9 & 2.13) form the foundations of the landscape. The basin slopes from the north, where elevations are about 1,400 m above sea level, to the south, where altitudes are approximately 900 m above sea level. The Fish, Löwen and Konkiep rivers drain the landscape, all flowing south to the Orange River.*

KHOMAS HOCHLAND PLATEAU *This is the large ridge of higher ground in the centre of the country. Altitudes range between 1,700 and 2,000 m above sea level in most places, with the highest areas right in the centre of Namibia. Much of the Khomas Hochland Plateau consists of rolling hills, especially in the west, where rivers have eroded many deep valleys. The biggest rivers that flow through this landscape are the Black Nossob, the Kuiseb, the Seeis, the Swakop and the White Nossob. Some of the flatter areas were eroded by glaciers some 300–280 million years ago.*

NAMIB SAND SEA *This landscape consists of several large areas of sand dunes along the coast; the one stretching between Lüderitz and Walvis Bay is perhaps Namibia's most prominent hallmark. This great sea of sand is 100–150 km in breadth and 400 km in length. Transverse and barchan dunes cover coastal areas where the winds are strongest, while linear dunes running roughly south to north dominate the inland areas. A few grasses grow on the inland dunes, but the most mobile dunes near the coast are devoid of plants. On the other hand, the dunes are home to a diverse fauna of insects and other small animals. The Hoanib, Kuiseb and Kunene rivers stop the northward march of three of the main dune fields.*

KUNENE HILLS *This is an area of rugged and heavily dissected terrain, especially inland, where altitudes range between 1,000 and 1,900 m above sea level. Much of the landscape consists of metamorphic and folded rocks formed between 1,800 and 2,600 million years ago. Many river valleys cut through the landscape. Some of these valleys, for example those of the Hoarusib and Kunene rivers, were originally gouged out by glaciers some 300–280 million years ago. The landscape includes the well-known Baynes and Zebra mountains, as well as the Marienfluss Valley.*

NAMIB PLAINS *Gravel and thin layers of sand cover most of the Namib Plains, out of which many rocky outcrops and hills protrude. Some of these are large hills or mountains that are included under the 'inselberg' category of landscapes, but there are also many smaller outcrops of granites, as well as dykes and sills. The very arid coastal climate means that water erosion is limited and the overall landscape is predominantly flat. However, several large rivers flow along valleys that cut through to the sea, occasionally carrying water from heavy rains in the interior. The Namib Plains and the Namib Sand Sea together make up much of the coastal plain, which, although generally flat, rises up to about 800 m above sea level in places in the east.*

Okavango Valley *Varying between 2 and 6 km in width, this valley has been formed by local erosion of the surrounding Kalahari Sandveld. Approximately 7% of Namibia's population lives in the valley, most of them descendants of people attracted here hundreds of years ago by the relatively fertile soils and the availability of water from the Okavango River. Marshes and grasslands form an immediate margin to much of the river itself. Dense, tall trees once covered the higher ground, but most of the indigenous riverine woodland has been cut down over the years.*

Salt Pans *A series of large salt pans in central northern Namibia collectively forms this landscape. The largest and best-known of the pans is Etosha Pan. All these depressions were probably formed by the wind blowing fine sediments off their surfaces. The pans are usually dry, becoming flooded by shallow waters only after heavy local rains or, in the case of Etosha Pan, from water flowing down the Ekuma River. The pans are rich in salts that accumulate on the surface after the water has evaporated, and some pans yield salt suitable for human consumption. There are many other pans in the Kalahari Sandveld and along the coast* (see Figure 2.21).

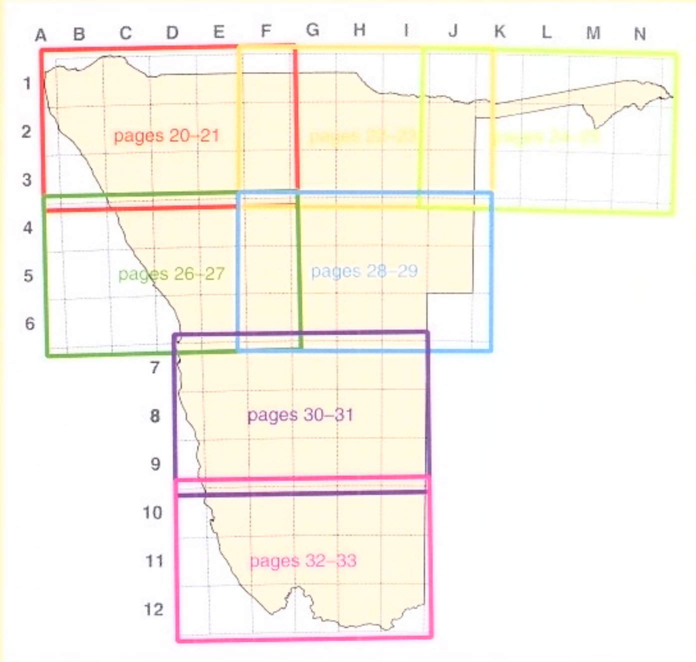
Naukluft Mountains *Perched on the edge of the escarpment, this highland consists largely of limestone and shale. The mountains were formed from sediments forced up during the formation of the continent of Gondwana some 550 million years ago, but then shifted south-westwards for about 120 km. The highest points are just over 1,900 m above sea level. The area is deeply dissected into valleys by many small rivers. Some of these are tributaries of the Tsondab River, which flows along a valley formed by a glacier that cut through the mountain.*

Rehoboth Plateau *Many inselbergs dot this high plateau of rolling terrain in the centre of the country. Altitudes, ranging between 1,500 and 1,700 m above sea level, are slightly higher in the north and west. Granites and complexes of metamorphic rocks underlie the plateau in most areas. Most of the small rivers drain in a south-easterly direction, and this is also where the Fish River has its origins.*

Weissrand Plateau *The plateau lies sandwiched between the Nama-Karoo Basin (in the west) and the Kalahari Sandveld (in the east). Previously it was probably covered by Kalahari sand that has now been stripped away, leaving a surface of calcrete that extends eastwards under the present sands. As clearly shown in this satellite image, the whole plateau is pockmarked with dolines, which are shallow, funnel-shaped depressions into which rainwater drains, often along clear drainage lines that converge into the dolines.*

Namibia in detail

Features are shown in the following seven detailed maps, which cover the whole country. Each map overlaps with those that surround it, and all the maps are printed at a scale of 1:1,340,000. The grid around the maps is in degrees of latitude and longitude, while the letters A, B, C, etc. and the numbers 1, 2, 3, etc. given to the grids are used as references for place names listed in the gazetteer (see pages 34 & 35). A Transverse Mercator projection was used for these maps, the parameters for which are printed below each map's scale bar.



Every effort has been made to present the most recent and accurate information in these maps. However, choices had to be made on what to include and what to leave out, as well as what spellings to adopt for names that are sometimes spelt differently.[3] Other details have been omitted, e.g. schools and smaller powerlines, because their inclusion would simply clutter the presentation. Readers who require more detailed information on these and other features should obtain the relevant data from www.dea.met.gov.na.

Key to the maps on pages 20–33

Sea depth (m): 0, 800, 1,600, 2,400, 3,200

Altitude (m):
- 0–100
- 101–200
- 201–500
- 501–1,000
- 1,001–1,500
- 1,501–2,000
- More than 2,000

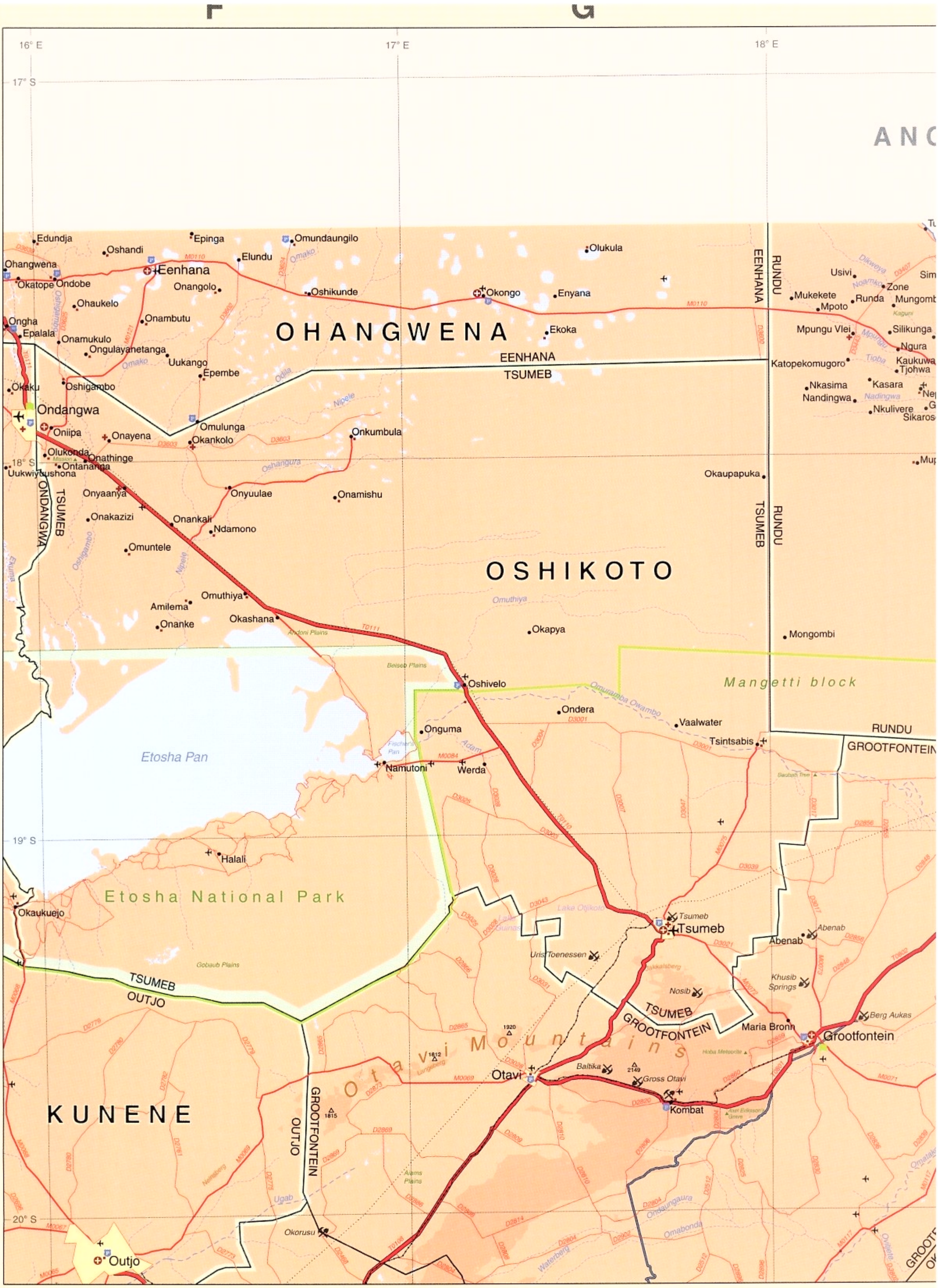
- Joubert Mtns — Highland/mountain
- 1785 — Trig. beacon with height (m)
- Falls — Other feature of interest

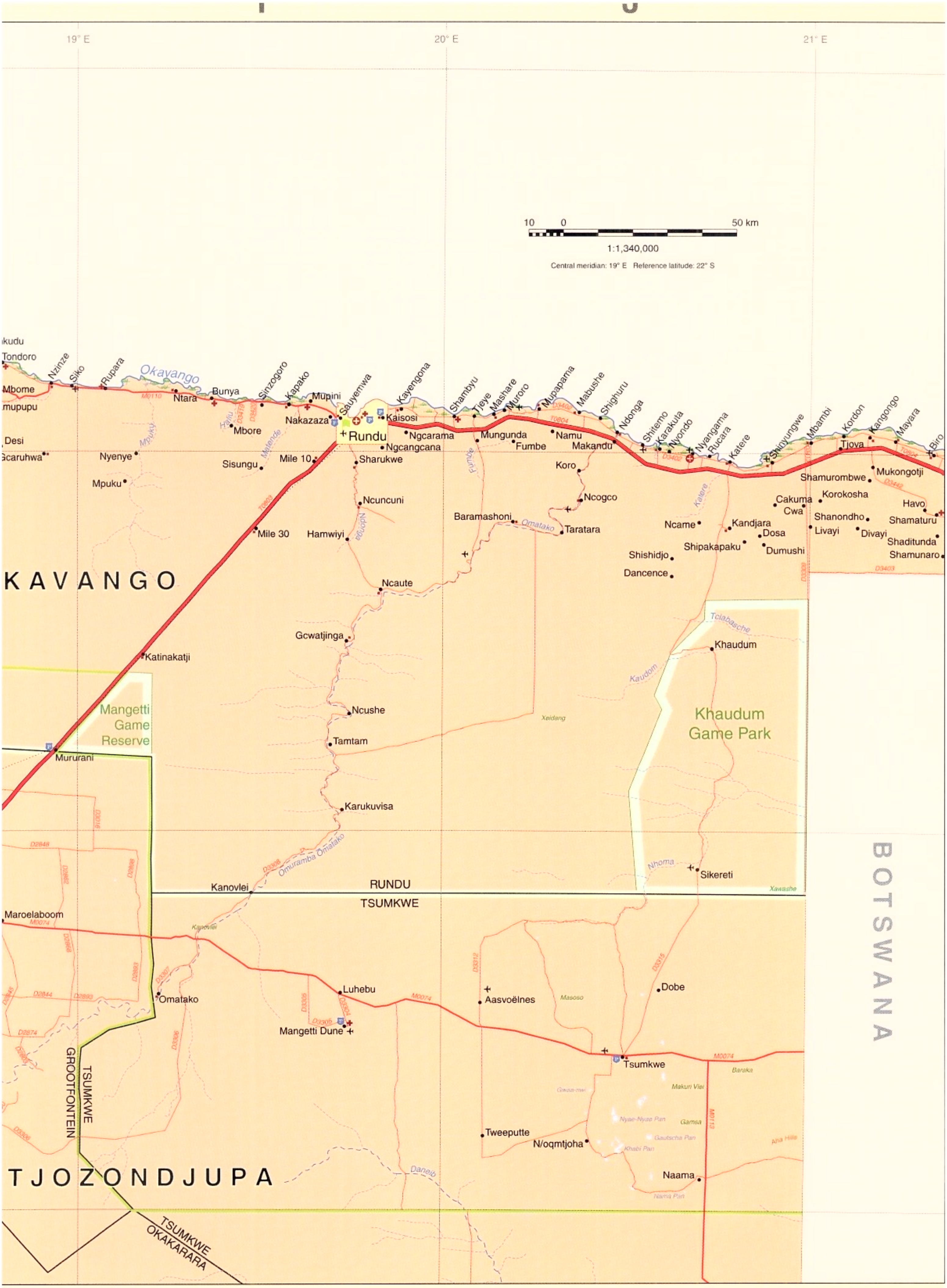
- Kunene — Perennial river
- Ugab — Major, non-perennial river
- Omuramba Omatako — Minor, non-perennial river
- Canal
- Pan *Fischer's Pan*
- Oshana
- Dam *Olushandja*
- Lake *Omadhiya Lakes*
- Swamp
- Major airport (Class A)
- Aerodrome (Class B)
- Airstrip (Class C and other)
- Police station
- Clinic
- Health centre
- Hospital
- Border post

- Etosha National Park — Protected area
- KARAS — Regional boundary
- EENHANA / TSUMEB — District boundary
- Veterinary fence
- Sperrgebiet
- Outjo — Townland (municipality, town or village council area)
- Otjikondavirongo — Settlement
- Trunk road
- Main road
- Other road
- Railway line
- Major powerline (132 kV or more)
- Swartbooisdrif — Mine – active
- Kopermyn — Mine – inactive

A
B
C
12° E
13° E
14° E
17° S
18° S
19° S
20° S
Kunene
Orokane
Epupa Falls
Otjihandjavero
Baynes Mtns
Omahevha
Oheuva
Ombuka
Zebra Mtns
Otjinhungwa
1915
Hartmann Mtns
Otjipemba
1897
Otjihipa Mtns
Swartbooisdrif
Onduzu
Ruacana Falls
Bosluis Baai
Omuhonga
1699
Okangwati
Otjitango
Ondoto
Etengwa
Otjianjasemo
Ehomba
Epembe
1867
Etoto
Otjitanda
Omuhonga
Ombuka
Otjitango
Okamwe
Steilrand Mtns
1836
Ondoto
Ohandungu
Okahozu
Onjaraka
White Hills
Ondusengo
Hartmann Mtns
Otjihipa
Etanga
Otjiwero
Otjakati
Orotjitombo
Hoarusib
Oukongo
Onjuva
Opuwo
Khumib
Tönnesenberge
1772
Orukwapa
1624
Otjerunda
Orupembe
Otjiu
Orumana
Angra Fria
Munutum
Nadas
Sanitatis
Kaoko Otavi
Okumutati
Giraffenberge
Joubert Mtns
Erora
E T E N D E K A
Hoarusib
Cape Fria
Okavaru
Otjitoko
1505
Schwarze Kuppen
1785
Hoarusib
Sechomib
Omao
Otjondek
Ombombo
Kabere
Purros
Otjikondavirongo
Gomatum
Gomadimmi
Nadas
1693
Skeleton Coast Park
Khumib
Hoarusib
Ganamub
Tomakas
Oruvand
Rocky Point
Gelgamso
Sesfontein
Omarumba
Obias
Ganamub
Warmquelle
ATLANTIC OCEAN
Ganias
Sawurogab
Tsuxab
OPUWO
KHORIXAS
Hoanib
Ombonde
Hoanib
Möwe Bay
Obeb
Muderib
Hunkab
KUN
Kharokhaoe Plains
Barab
Samanab
Kawakab
Gaes
Kharugaiseb
Aub
Uniab
Grootberg
10
0
50 km
1:1,340,000
Central meridian: 15° E Reference latitude: 22° S
Terrace Bay
Dune Point
Shallow Breakers
Obob
Uniab
Achab


E
F
15° E
16° E
17° E
ANGOLA
OHANGWENA
OMUSATI
OSHANA
OSHIKOTO
OTJOZONDJUPA
EENHANA
TSUMEB
UUTAPI
OSHAKATI
ONDANGWA
OUTJO
GROOTFONTEIN
Etosha National Park
Etosha Pan
Omadhiya Lakes
Oshikango
Edundja
Epinga
Omundaungilo
Mahenene
Onawa
Okalongo
Onheleiwa
Ongenga
Engela
Ohaingu
Ohangwena
Oshandi
Elundu
Eenhana
Outapi
Epoko
Oshaala
Onesi
Etaka
Oshitudha
Iilyateko
Eengolo
Okathitu
Omuthitugwonyama
Okando
Omagalanga
Oshikuku
Ogongo
Iipanda
Yaamiti
Olupandu
Osheetekela
Omutundungu
Omungwelume
Onamunkulo
Okatope
Ondobe
Onangolo
Oshikunde
Endola
Onekwaya
Ongha
Epalala
Ohaukelo
Onambutu
Onamukulo
Ongulayanetanga
Uukango
Epembe
Tsandi
Iumbashe
Onamandongo
Oluteyi
Olutsiidhi
Othika
Elim
Ekamba
Oshakati
Okatana
Onamutayi
Ongwediva
Okaku
Oshigambo
Omege
Ondangwa
Oniipa
Okahao
Ongandjera
Onaanda
Enkono
Ompundja
Eheke
Ehafo
Onayena
Omulunga
Okankolo
Onkumbula
Okatseidi
Etilyasa
Otamanzi
Olukonda
Onathinge
Ontananga
Uukwiyuushona
Onyaanya
Onyuulae
Onamishu
Onkani
Onakazizi
Onankali
Ndamono
Omuntele
Amarika
Omuthiya
Amilema
Onanke
Okashana
Uutsathima
Andoni Plains
Beisebi Plains
Omuramba Ovaiso
Onguma
Namutoni
Halali
Okaukuejo
Kopermyn
Kamanjab
Otjikondo
Anichab
St. Michael's Mission
Outjo
Okorusu
Otavi Mtns
Gobaub Plains
Twyfelspruit
Ugab


F
G
16° E
17° E
18° E
17° S
18° S
19° S
20° S
ANG
OHANGWENA
OSHIKOTO
KUNENE
EENHANA
TSUMEB
RUNDU
ONDANGWA
GROOTFONTEIN
OUTJO
Edundja
Oshandi
Epinga
Omundaungilo
Elundu
Olukula
Ohangwena
Eenhana
Okatope
Ondobe
Onangolo
Oshikunde
Okongo
Enyana
Ohaukelo
Ongha
Epalala
Onambutu
Onamukulo
Ongulayanetanga
Uukango
Epembe
Ekoka
Okaku
Oshigambo
Ondangwa
Oniipa
Onayena
Omulunga
Okankolo
Onkumbula
Olukonda
Onathinge
Ontananga
Uukwiyuushona
Onyaanya
Onyuulae
Onamishu
Onakazizi
Onankali
Ndamono
Omuntele
Omuthiya
Amilema
Okashana
Onanke
Okapya
Okaupapuka
Mongombi
Usivi
Zone
Mukekete
Runda
Mungomb
Mpoto
Mpungu Vlei
Silikunga
Ngura
Katopekomugoro
Kaukuwa
Tjohwa
Nkasima
Kasara
Nandingwa
Nkulivere
Sikaros
Oshivelo
Mangetti block
Ondera
Onguma
Vaalwater
Tsintsabis
Etosha Pan
Namutoni
Werda
Halali
Etosha National Park
Okaukuejo
Tsumeb
Abenab
Uris Toenessen
Nosib
Khusib Springs
Berg Aukas
Maria Bronn
Grootfontein
Otavi Mountains
Otavi
Baltika
Gross Otavi
Kombat
Okorusu
Outjo
M0110
T0111
T0110
M0084
D3001
Omuthiya
Andoni Plains
Beisebi Plains
Gobaub Plains
Lake Otjikoto
Hoba Meteorite
Ugab
Omaruru Owambo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21° E
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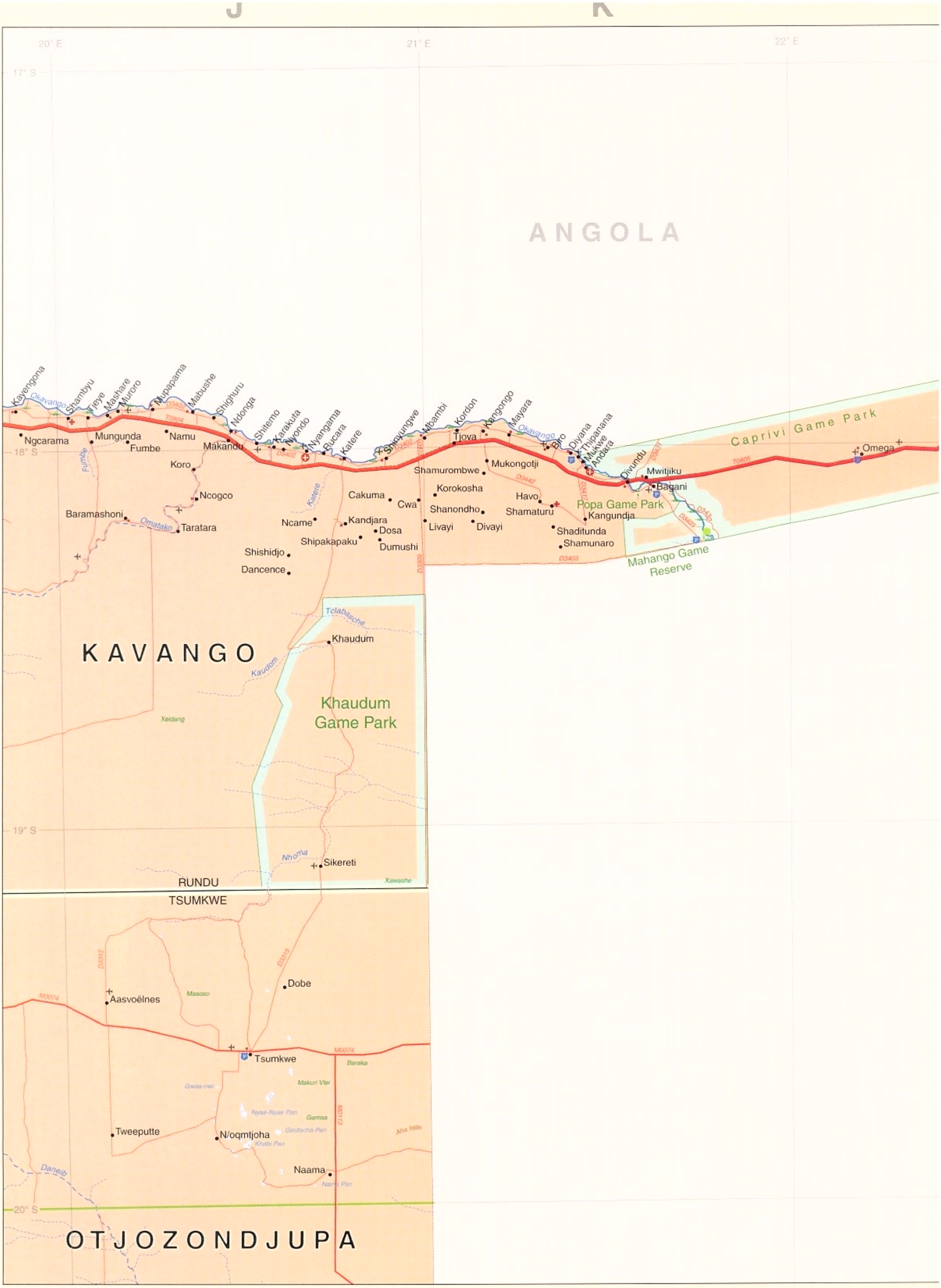
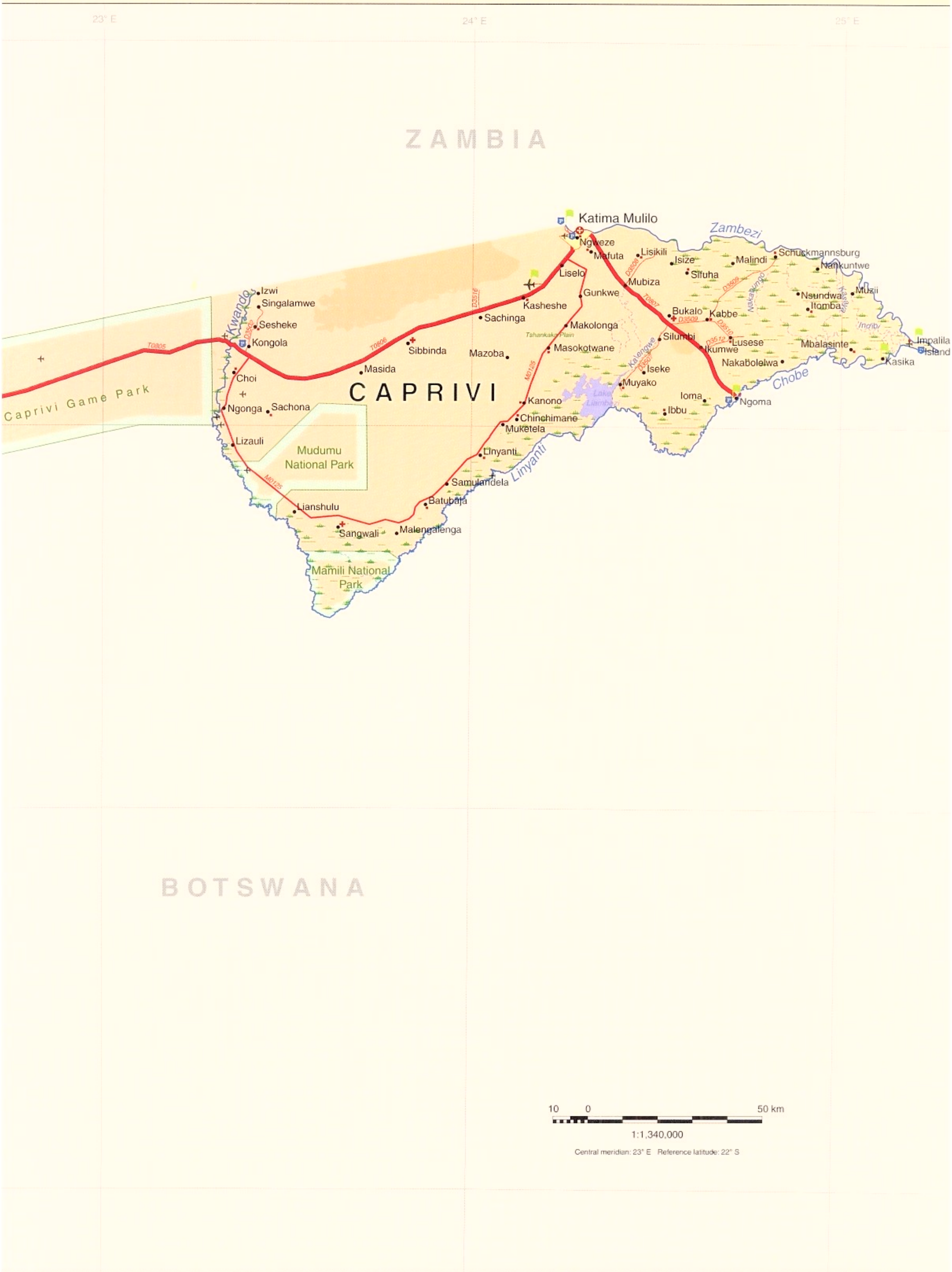
Nzinze
Siko
Rupara
Mbome
Ntara
Bunya
Sinzogoro
Kapako
Mupini
Sauyemwa
Kayengona
Shambyu
Tjeye
Mashare
Muroro
Mupapama
Mabushe
Shighuru
Ndonga
Shitemo
Karakuta
Nyondo
Nyangama
Rucara
Katere
Shinyungwe
Mbambi
Kordon
Kangongo
Mayara
Biro
Nakazaza
Kaisosi
Rundu
Mbore
Ngcarama
Mungunda
Namu
Fumbe
Makandu
Ngcangcana
Desi
Gcaruhwa
Nyenye
Sisungu
Mile 10
Sharukwe
Koro
Tjova
Mukongotji
Shamurombwe
Mpuku
Ncuncuni
Ncogco
Cakuma
Korokosha
Cwa
Havo
Baramashoni
Omatako
Taratara
Ncame
Kandjara
Shanondho
Shamaturu
Dosa
Livayi
Divayi
Shaditunda
Mile 30
Hamwiyi
Shipakapaku
Dumushi
Shishidjo
Shamunaro
KAVANGO
Dancence
Ncaute
Tciabasche
Gcwatjinga
Khaudum
Katinakatji
Kaudom
Mangetti Game Reserve
Ncushe
Xeidang
Khaudum Game Park
Tamtam
Mururani
Karukuvisa
Omuramba Omatako
Nhoma
Sikereti
BOTSWANA
Kanovlei
RUNDU
TSUMKWE
Xawashe
Maroelaboom
Luhebu
Aasvoëlnes
Masoso
Dobe
Omatako
Mangetti Dune
Tsumkwe
Baraka
Makuri Vlei
GROOTFONTEIN
TSUMKWE
Tweeputte
N/oqmtjoha
Ana Hills
Daneib
Naama
TJOZONDJUPA
TSUMKWE
OKAKARARA

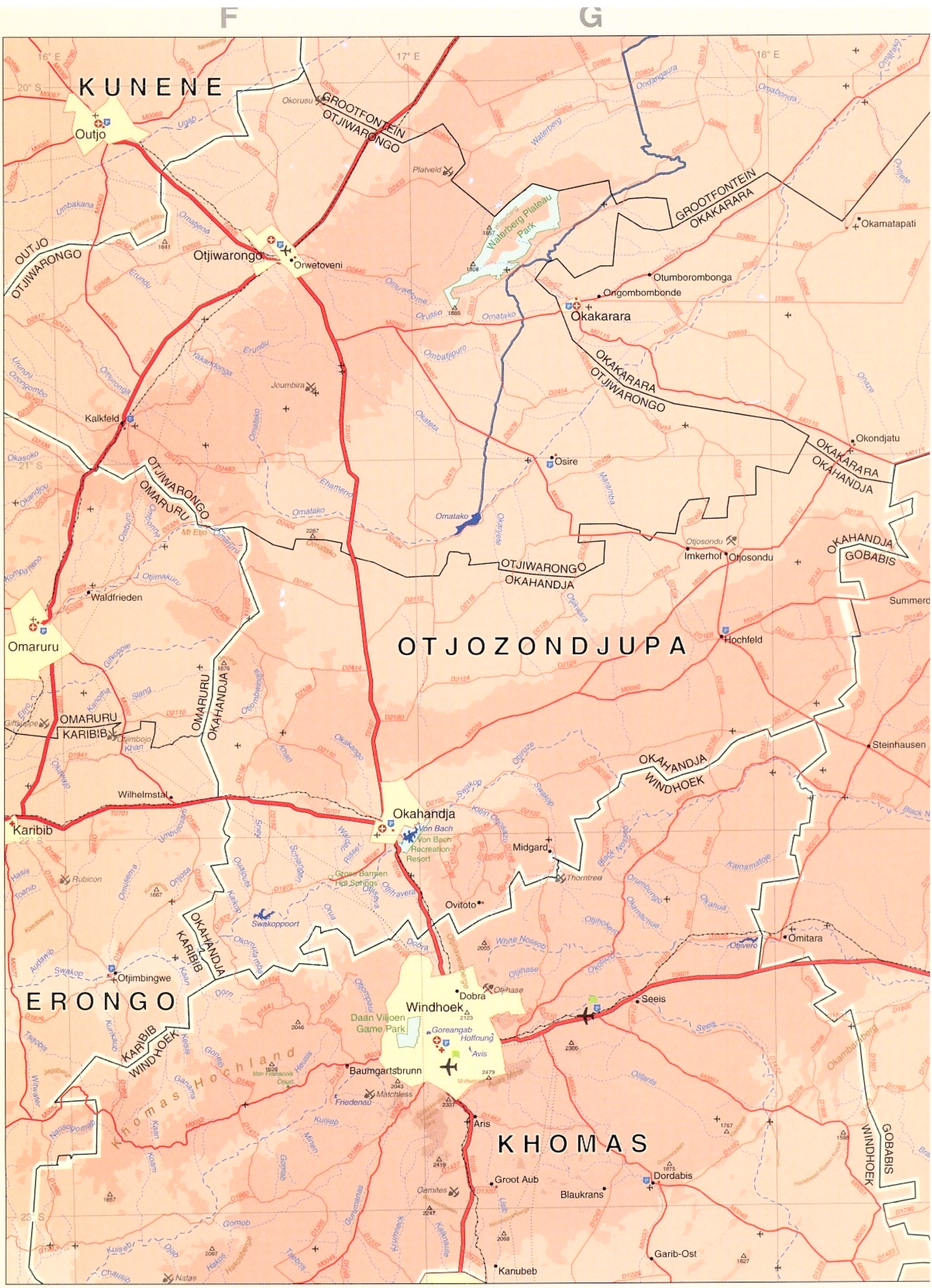


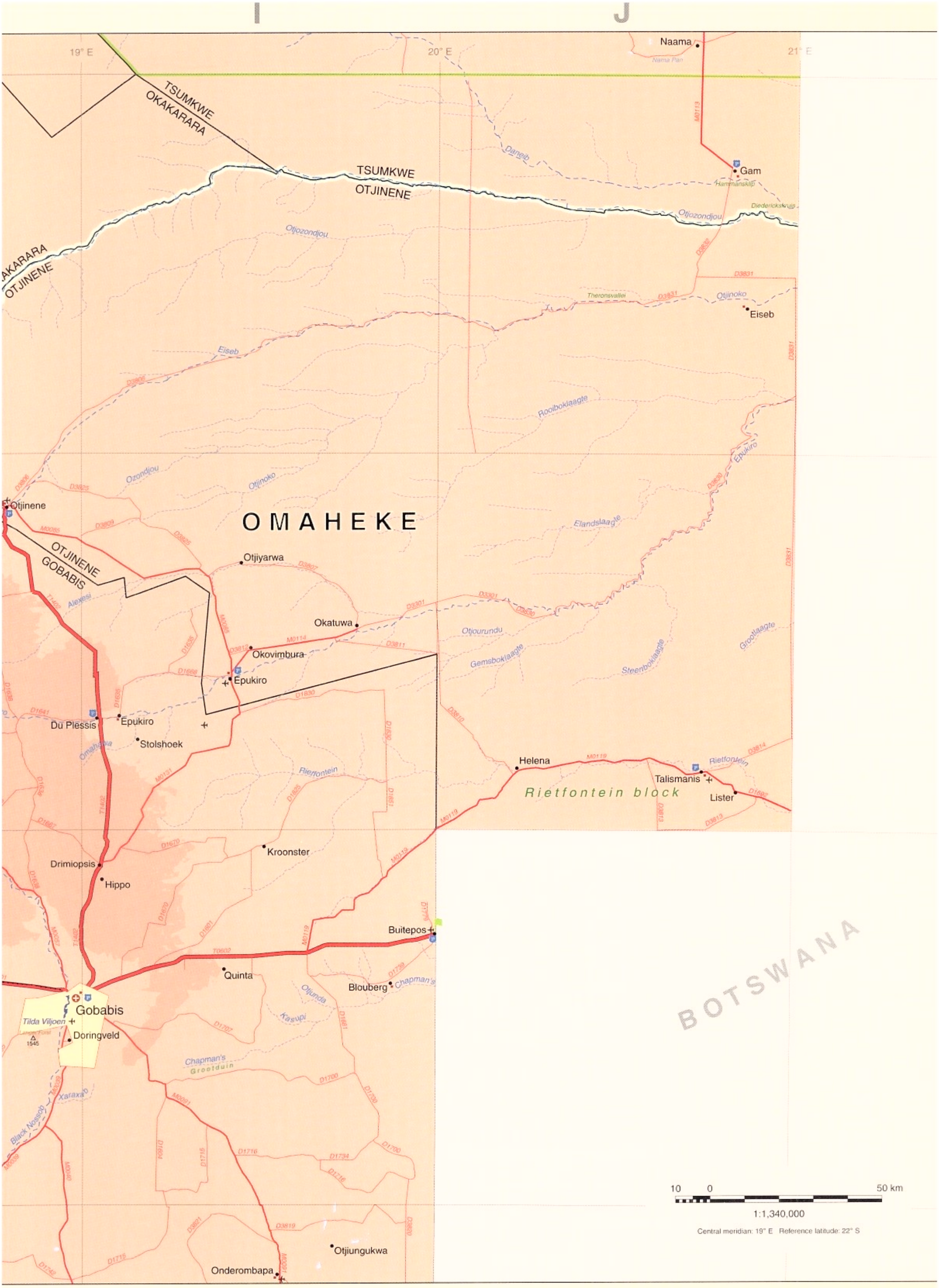
J
K
20° E
21° E
22° E
17° S
18° S
19° S
20° S
ANGOLA
Kavengona
Okavango
Shambyu
Tjeye
Mashare
Mupapama
Mabushe
Shighuru
Ndonga
Shitemo
Karakuta
Nyondo
Nyangama
Rucara
Katere
Shinyungwe
Mbambi
Kordon
Kangongo
Mayara
Diyana
Thipanana
Mukwe
Andara
Divundu
Ngcarama
Mungunda
Fumbe
Namu
Makandu
Koro
Ncogco
Baramashoni
Omatako
Taratara
Cakuma
Cwa
Ncame
Kandjara
Dosa
Shipakapaku
Dumushi
Shishidjo
Dancence
Tjova
Shamurombwe
Mukongotji
Korokosha
Havo
Shanondho
Shamaturu
Livayi
Divayi
Popa Game Park
Kangundja
Shaditunda
Shamunaro
Mwitjiku
Bagani
Caprivi Game Park
Omega
Mahango Game Reserve
KAVANGO
Khaudum
Kaudom
Khaudum Game Park
Xeidang
Nhoma
Sikereti
Xawashe
RUNDU
TSUMKWE
Dobe
Aasvoëlnes
Masoso
Tsumkwe
Baraka
Makuri Vlei
Gwaa-nwi
Nyae-Nyae Pan
Gamsa
Tweeputte
N/oqmtjoha
Naama
Daneib
OTJOZONDJUPA


23° E
24° E
25° E
ZAMBIA
BOTSWANA
CAPRIVI
Caprivi Game Park
Mudumu National Park
Mamili National Park
Katima Mulilo
Ngweze
Mafuta
Liselo
Kasheshe
Sachinga
Sibbinda
Masida
Mazoba
Makolonga
Masokotwane
Gunkwe
Mubiza
Lisikili
Isize
Sifuha
Malindi
Schuckmannsburg
Nankuntwe
Nsundwa
Itomba
Muzii
Bukalo
Kabbe
Silumbi
Ikumwe
Lusese
Mbalasinte
Nakabolelwa
Impalila Island
Kasika
Iseke
Muyako
Ioma
Ibbu
Ngoma
Kanono
Chinchimane
Muketela
Linyanti
Samulandela
Batubaja
Malengalenga
Sangwali
Lianshulu
Lizauli
Ngonga
Sachona
Choi
Kongola
Sesheke
Singalamwe
Izwi
Kwando
Zambezi
Chobe
Linyanti
Kalengwe
Tshankaka Plain
Lake Liambezi
T0805
T0806
T0807
D3516
D3502
D3508
D3509
D3510
D3512
M0125
10 0 50 km
1:1,340,000
Central meridian: 23° E Reference latitude: 22° S


A
B
C
12° E
13° E
14° E
20° S
21° S
22° S
23° S
Terrace Bay
Dune Point
Shallow Breakers
Uniabmond
Torra Bay
Palgrave Point
Koigabmond
Huabmond
Toscanini
Ambrose Bay
Ogden Rocks
Ugabmond
Durissa Bay
Bandom Bay
Mile 105
Bocock's Bay
Horing Bay
Cape Cross Reserve
Cape Cross Salt Pan
Mile 72
Henties B
Skeleton Coast Park
KHORIXAS
SWAKOPMUND
Bergsig
Grootberg
Samanab
Aub
Uniab
Obob
Achab
Koigab
Springbok
Huab
Ugab
Messum
Orawab
Doros Crater
M0127
D3245
D2302
D2303
ATLANTIC OCEAN
10
0
50 km
1:1,340,000
Central meridian: 15° E Reference latitude: 22° S


E
F
15° E
16° E
17° E
KUNENE
OTJOZONDJUPA
ERONGO
KHOMAS
OUTJO
KHORIXAS
OMARURU
OTJIWARONGO
GROOTFONTEIN
OKAHANDJA
KARIBIB
WINDHOEK
SWAKOPMUND
WALVIS BAY
Anichab
St. Michael's Mission
Outjo
Fransfontein
Khorixas
Petrified Forest
Okorusu
Platveld
Otjiwarongo
Orwetoveni
Waterberg Plateau Park
Okongwe
Ondundu
Joumbira
Kalkfeld
Anixab
Otjohorongo
Otjongoro
Ozondati
Okapere
Omatjete
White Lady
Uis
Omatako
Waldfrieden
Okombahe
Omaruru
Nainais
Uigaran
Kranzberg
Tubusis
Erongo Mtns
Giftkuppe
Otjimbojo
Onguati
Spitzkoppe
Grootspitzkop
Omdel
Sandamap Tin
Goabeb
Cameron
Wilhelmstal
Okahandja
Von Bach
Von Bach Recreation Resort
Usakos
Navachab
Karibib
Henderson
Rubicon
Arandis Tin
Gross Barmen Hot Springs
Swakoppoort
Ovitoto
Creation Area
Kainkaghas
Sphinx
Otjimbingwe
Arandis
Dobra
Windhoek
Otjihase
kasbaken
Khan
Rössing
Namib Lead
Daan Viljoen Game Park
Goreangab
Hoffnung
Avis
Khomas Hochland
Baumgartsbrunn
Husab
Ida
Matchless
Friedenau
Aris
Namib-Naukluft Park
Groot Aub
Oamites
Natas
Kanubeb


F
G
16° E
17° E
18° E
20° S
21° S
22° S
23° S
KUNENE
Outjo
Okorusu
GROOTFONTEIN
OTJIWARONGO
Platveld
Waterberg Plateau Park
GROOTFONTEIN
OKAKARARA
Okamatapati
OUTJO
OTJIWARONGO
Otjiwarongo
Orwetoveni
Otumborombonga
Ongombombonde
Okakarara
Joumbira
OKAKARARA
OTJIWARONGO
Kalkfeld
Okondjatu
OKAKARARA
OKAHANDJA
Osire
OTJIWARONGO
OMARURU
Mt Etjo
Omatako
Otjosondu
Imkerhof
Otjosondu
OTJIWARONGO
OKAHANDJA
OKAHANDJA
GOBABIS
Waldfrieden
Summerdown
Omaruru
OTJOZONDJUPA
Hochfeld
OMARURU
OKAHANDJA
OMARURU
KARIBIB
Steinhausen
OKAHANDJA
WINDHOEK
Wilhelmstal
Okahandja
Von Bach
Von Bach Recreation Resort
Karibib
Midgard
Rubicon
Gross Barmen Hot Springs
Thorntree
Ovitoto
Swakoppoort
OKAHANDJA
KARIBIB
Omitara
Otjimbingwe
Dobra
Otjihase
ERONGO
Windhoek
Seeis
Daan Viljoen Game Park
Goreangab
Hoffnung
Avis
KARIBIB
WINDHOEK
Khomas Hochland
Von Francois Court
Baumgartsbrunn
Auas Mtns
Matchless
Friedenau
Aris
KHOMAS
Dordabis
Groot Aub
Blaukrans
Oamites
GOBABIS
WINDHOEK
Garib-Ost
Kanubeb
Natas


I
J
19° E
20° E
21° E
Naama
Nama Pan
TSUMKWE
OKAKARARA
TSUMKWE
OTJINENE
Daneib
Gam
Hammanskrip
Diedericksdruis
Otjozondjou
OKAKARARA
OTJINENE
Otjozondjou
Theronsvallei
D3831
Otjinoko
Eiseb
Eiseb
D3806
Rooiboklaagte
Epukiro
Ozondjou
Otjinoko
Otjinene
OMAHEKE
Elandslaagte
OTJINENE
GOBABIS
Otjiyarwa
Alexesi
Okatuwa
D3301
Okovimbura
Otjourundu
Gemsboklaagte
Steenboklaagte
Grootlaagte
Epukiro
Du Plessis
Epukiro
Stolshoek
Omaheke
Rietfontein
Helena
M0119
Rietfontein
Talismanis
Lister
Rietfontein block
Kroonster
Drimiopsis
Hippo
Buitepos
T0602
Quinta
Blouberg
Chapman's
Otjunda
Kasupi
Gobabis
Tilda Viljoen
Doringveld
1545
Chapman's
Grootduin
Xaraxab
Black Nossob
BOTSWANA
Otjiungukwa
Onderombapa
10
0
50 km
1:1,340,000
Central meridian: 19° E Reference latitude: 22° S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F
15° E
16° E
17° E
24° S
25° S
26° S
Pelican Point
Walvis Bay
Walvis Bay Salt Works
Die Rondeduin
Sandwich Harbour
Anichab
Ilhea Point
Tropic of Capricorn
Gobabeb
Hope
ERONGO
SWAKOPMUND
WALVIS BAY
KARIBIB
WINDHOEK
WALVIS BAY
MALTAHÖHE
SWAKOPMUND
MALTAHÖHE
WINDHOEK
SWAKOPMUND
WINDHOEK
REHOBOTH
WINDHOEK
MALTAHÖHE
REHOBOTH
MALTAHÖHE
MALTAHÖHE
LÜDERITZ
MALTAHÖHE
BETHANIE
BETHANIE
LÜDERITZ
Tumas
Tinkasvlakte
Kuiseb
Gomab
Natas
Naos
Kwakwas
Weissenfels
Oanob
Golden Valley
Gamsberg
Kobos Copper
Kobos
Kanga
Nauchas
Witkrans
Groendraai
Slaaipoort
Klein Aub
Karanas
Solitaire
Rietoog
Remhoogte
Büllsport
Nabaseb
Namib-Naukluft Park
Naukluft
Black Cliff
Conception Bay
Tsondabvlei
Tsondab
Sesriem
Tsauchab
Sossusvlei
Tsaris Mtns
Maltahöhe
Meob Bay
Black Reef
Hollams Bird Island
Salt Flats
St. Francis Bay
Easter Point
Oyster Cliffs
Black Cliffs
Knoll Point
ATLANTIC OCEAN
Spencer Bay
Mercury Island
Dolphin Head
Duwisib Castle
Sinclair
Helmeringhausen
Tirasberge
Gibraltar
Aurus
Hottentot's Bay
Offshore areas
Sperrgebiet
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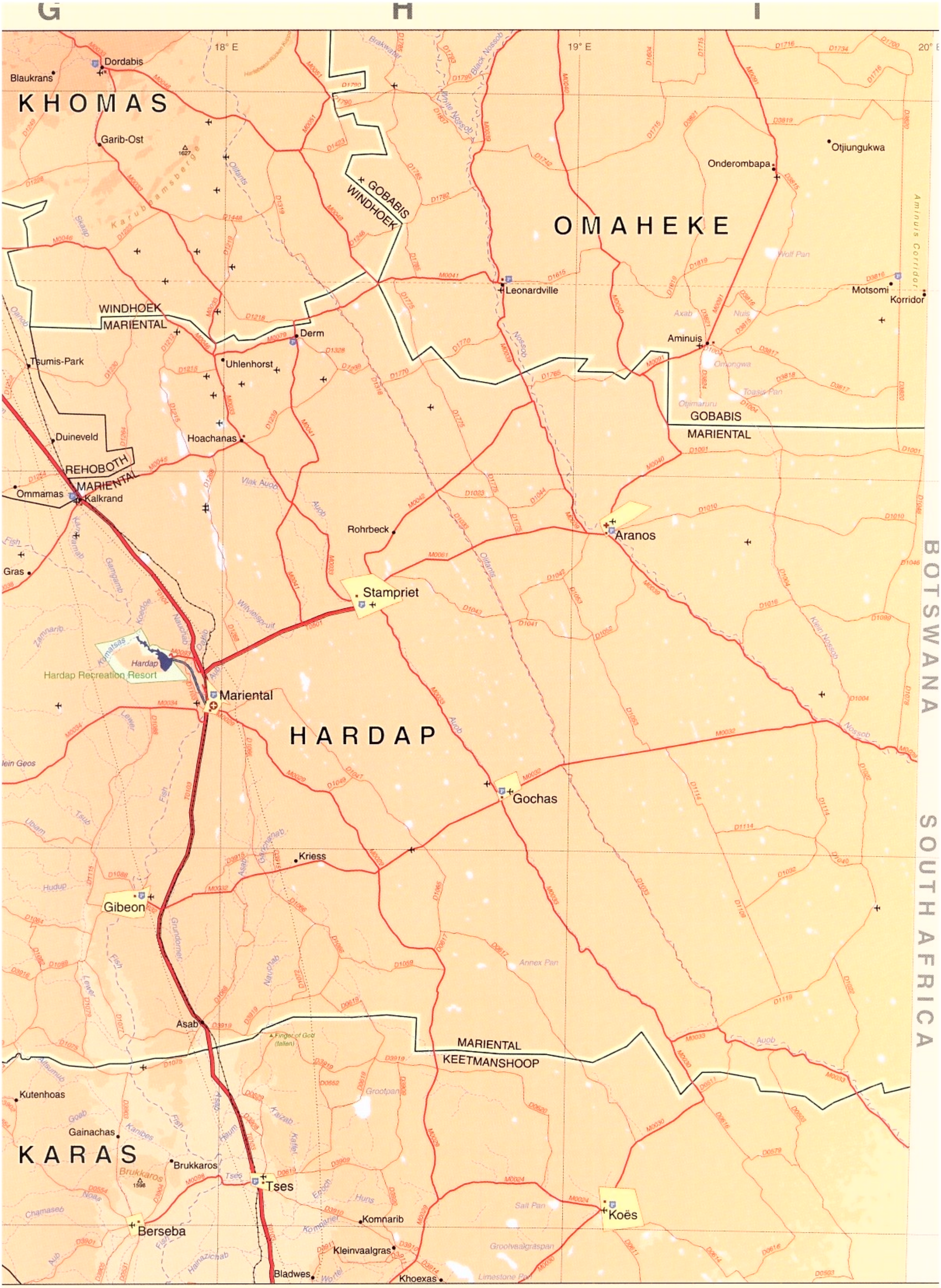
Central meridian: 17° E Reference latitude: 22° S


G
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18° E
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KHOMAS
OMAHEKE
HARDAP
KARAS
BOTSWANA
SOUTH AFRICA
GOBABIS
WINDHOEK
WINDHOEK
MARIENTAL
GOBABIS
MARIENTAL
REHOBOTH
MARIENTAL
MARIENTAL
KEETMANSHOOP
Dordabis
Blaukrans
Garib-Ost
Otjiungukwa
Onderombapa
Leonardville
Motsomi
Korridor
Aminuis
Derm
Tsumis-Park
Uhlenhorst
Hoachanas
Duineveld
Ommamas
Kalkrand
Rohrbeck
Aranos
Gras
Stampriet
Hardap
Hardap Recreation Resort
Mariental
Gochas
Kriess
Gibeon
Asab
Kutenhoas
Gainachas
Brukkaros
Tses
Komnarib
Berseba
Kleinvaalgras
Bladwes
Khoexas
Koës
Aminuis Corridor
Wolf Pan
Annex Pan
Salt Pan
Grootvaalgraspan
Limestone Pan
Grootpan
Finger of God (fallen)

10 0 50 km

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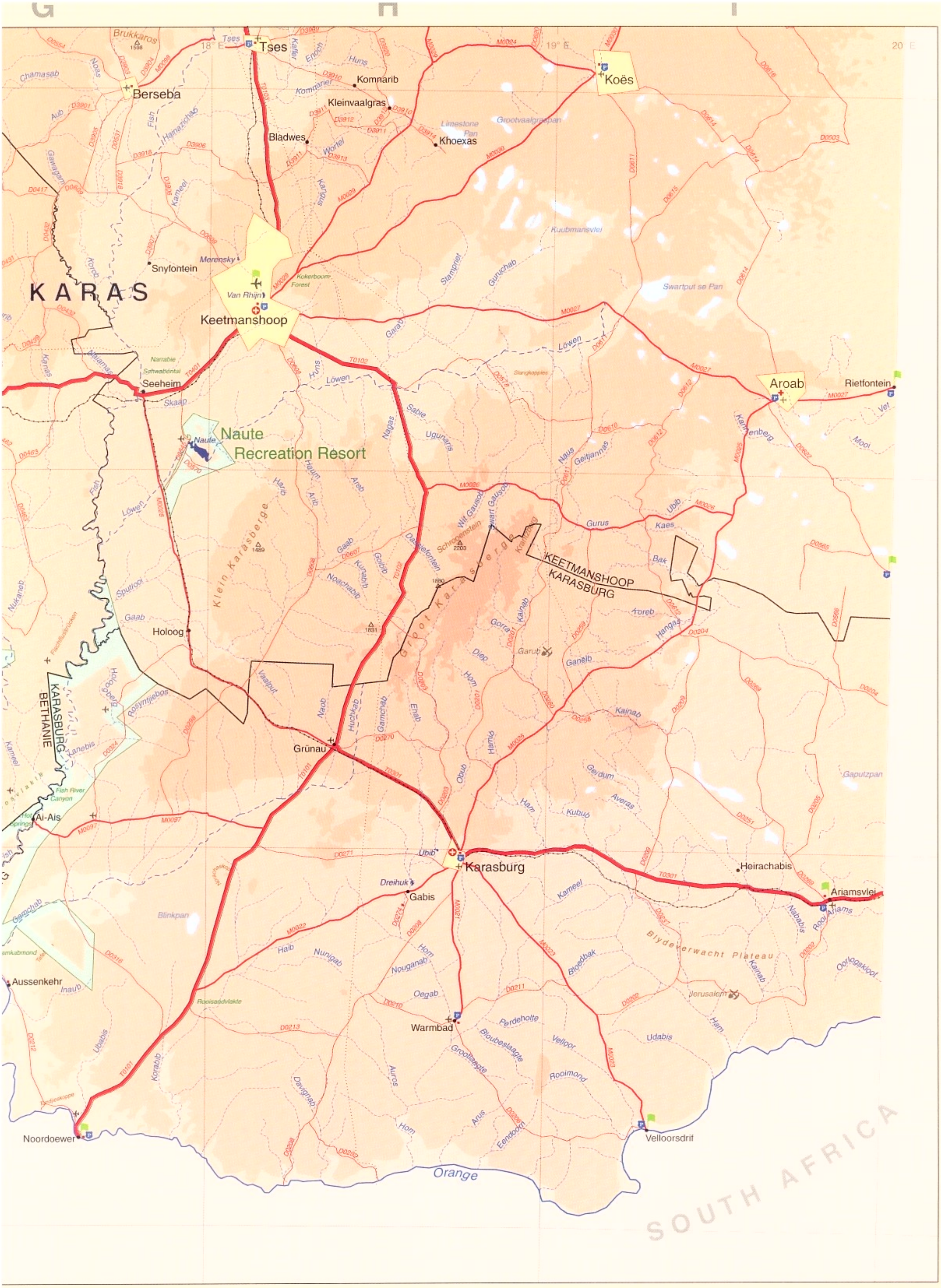
Central meridian: 17° E Reference latitude: 22° S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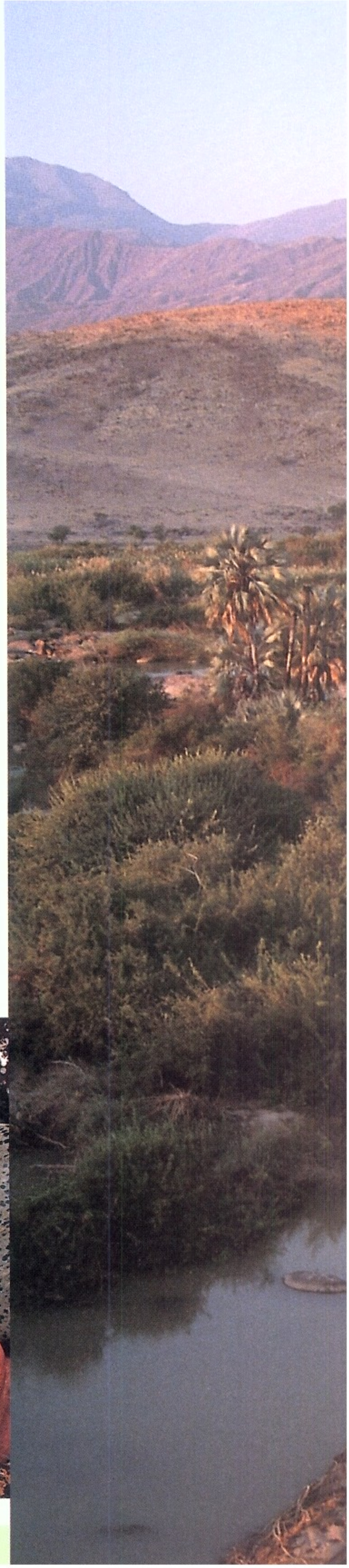
KARAS
Tses
Berseba
Brukkaros
Komnarib
Kleinvaalgras
Bladwes
Khoexas
Koës
Limestone Pan
Grootvaalgraspan
Kuubmansvlei
Snyfontein
Merensky
Van Rhijn
Kokerboom Forest
Keetmanshoop
Swartput se Pan
Seeheim
Narrabie
Schwabental
Naute
Naute Recreation Resort
Aroab
Rietfontein
Klein Karasberge
Groot Karasberge
Schroffenstein
2203
1489
1831
1880
KEETMANSHOOP
KARASBURG
KARASBURG
BETHANIE
Holoog
Garub
Grünau
Fish River Canyon
Ai-Ais
Hot Springs
Karasburg
Dreihuk
Gabis
Heirachabis
Ariamsvlei
Blinkpan
Blydeverwacht Plateau
Jerusalem
Aussenkehr
Warmbad
Noordoewer
Velloorsdrif
Orange
SOUTH AFRICA

CHAPTER 2:
Physical geography



The foundations of Namibia are its physical features: the very ground upon which all plants, animals and people depend. The rocks, minerals, soils, underground water, rivers and pans represent the country's most valuable resources. For example, rock formations provide minerals that can be mined, yielding substantial economic benefits to the nation. Rocks also produce soils that vary in nature and fertility, and these properties dictate what kinds of plants are present and how well they grow. Plant life, in turn, has a major influence on the abundance and diversity of animal life. Soil quality also controls what crops can be grown, and the fertility of soil largely determined where most immigrant groups settled hundreds of years ago. Those settlement patterns have had a lasting impact, and the current distribution and density of people in many areas remain closely linked to the presence of soils that are suited to crop cultivation.

The perennial rivers and underground reserves are the primary and most important sources of water for animals and plants; they provide people with water for domestic, agricultural and industrial uses. These sources of water are a lifeline in an otherwise arid environment, and also play a major role in determining where people can live. And, as a last example, the striking beauty of Namibia's natural and physical features attracts the many tourists who contribute to the country's economy.

Shape and size

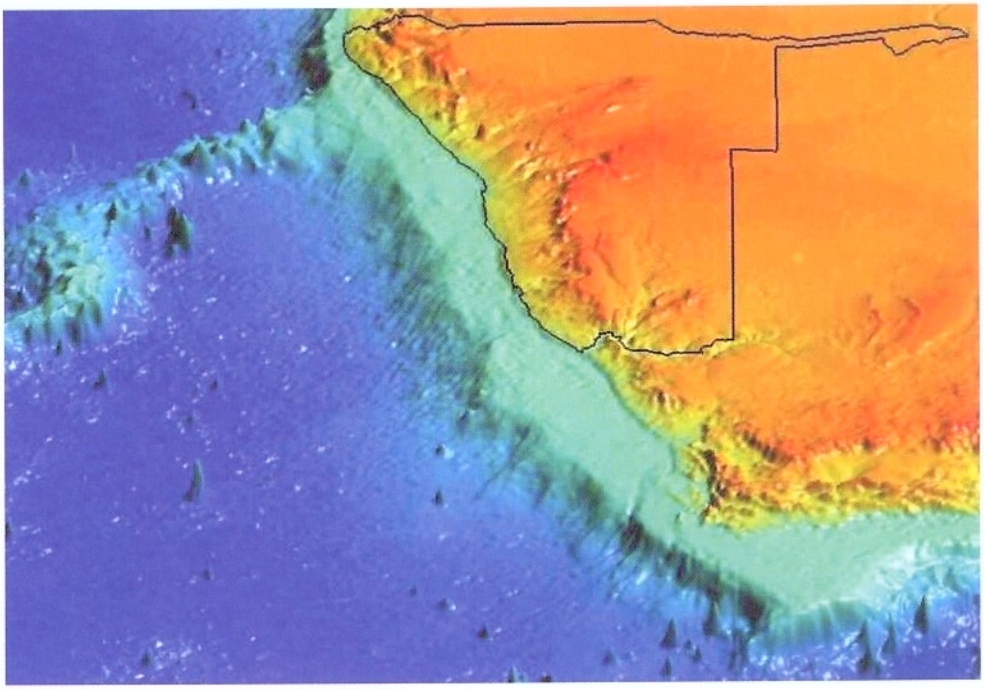
Namibia's land surface covers an area of approximately 823,680 km^2, stretching about 1,320 km between the northernmost and southernmost points. The country is approximately 350 km in breadth at its narrowest point in the south, while it spans a distance of some 1,440 km where it is widest, between the mouth of the Kunene River and Impalila Island, far to the east where the borders of Namibia, Botswana, Zambia and Zimbabwe converge on a single point. The overall perimeter of the country amounts to about 5,760 km, of which some 1,570 km is coastline between the mouths of the Kunene and Orange rivers.

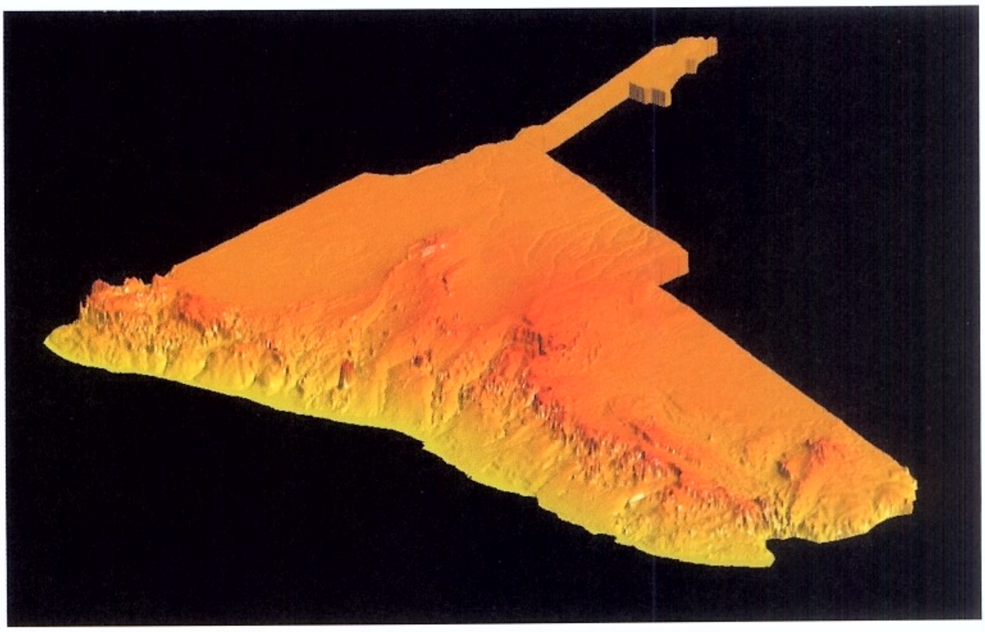
In addition to the land surface, Namibia's exclusive economic zone stretches 200 nautical miles off the coast, covering an area of about 526,000 km^2.

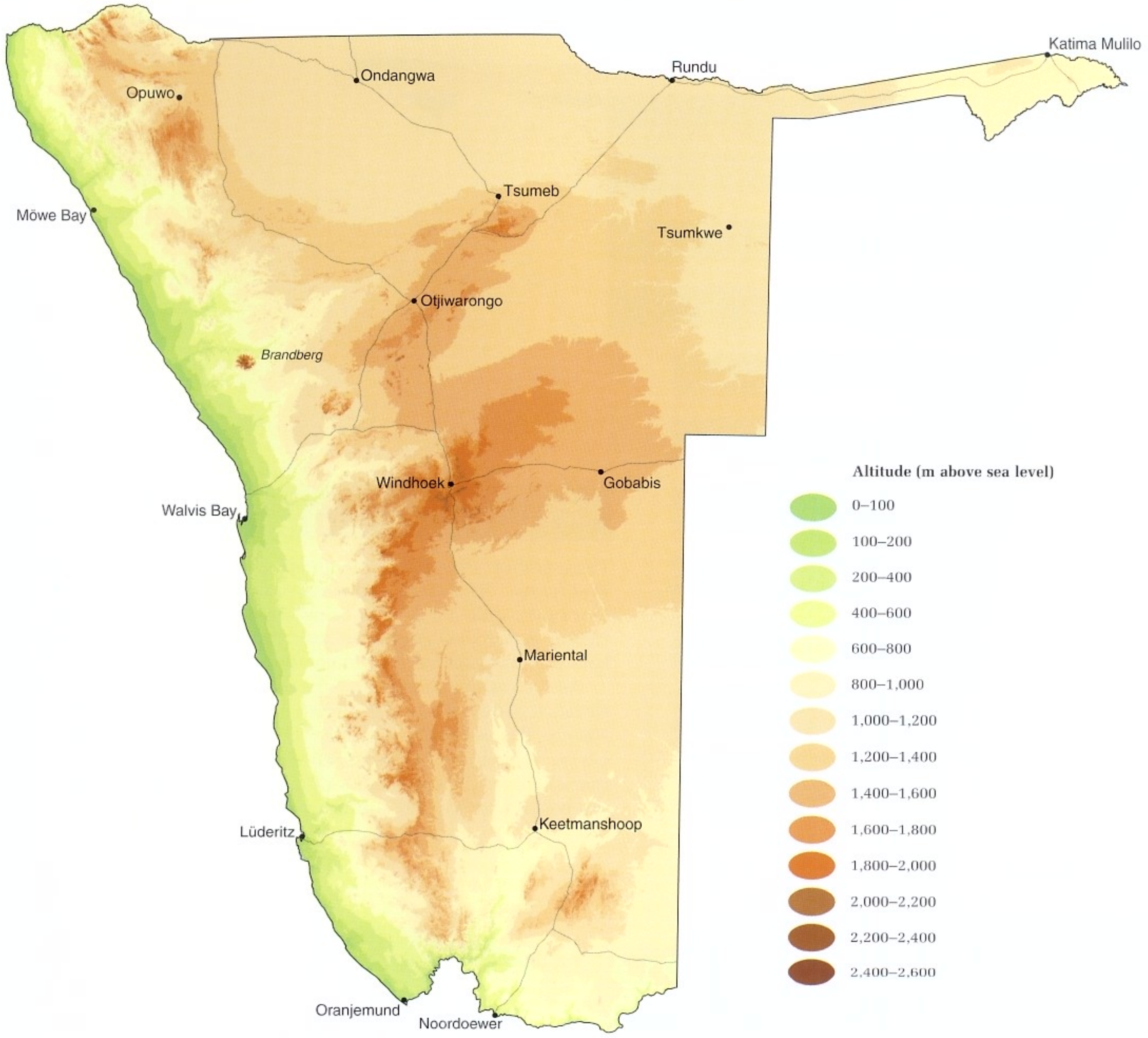
2.1 A bird's-eye view of Namibia

The model to the right (top) provides a subcontinental perspective on Namibia's shape and relief. The view is from the south. Most of the area consists of a relatively flat plateau. The dissected and raised western margins of Namibia form part of an elevated rim that extends more or less right around southern Africa. Further west in Namibia is the coastal plain, the coastline, the continental shelf and, finally, the deep ocean. The great belt of oceanic hills, known as the Walvis Ridge, extends south-westwards from the northern Namibian coast for about 2,000 km. The continental shelf is approximately 100 km wide south of the Walvis Ridge and about 35 km wide north of it. Isolated seamounts (oceanic equivalents of inselbergs) are scattered here and there on the Atlantic Ocean floor, which is at a depth of more than 4,500 m below the sea surface.

The more detailed view of Namibia on the right (bottom) is from the south-west. The steep, southern escarpment is prominent, as well as the central Khomas Hochland highlands, the hills around Otavi, and many of the river valleys that lead to the coast or into the central Kalahari.





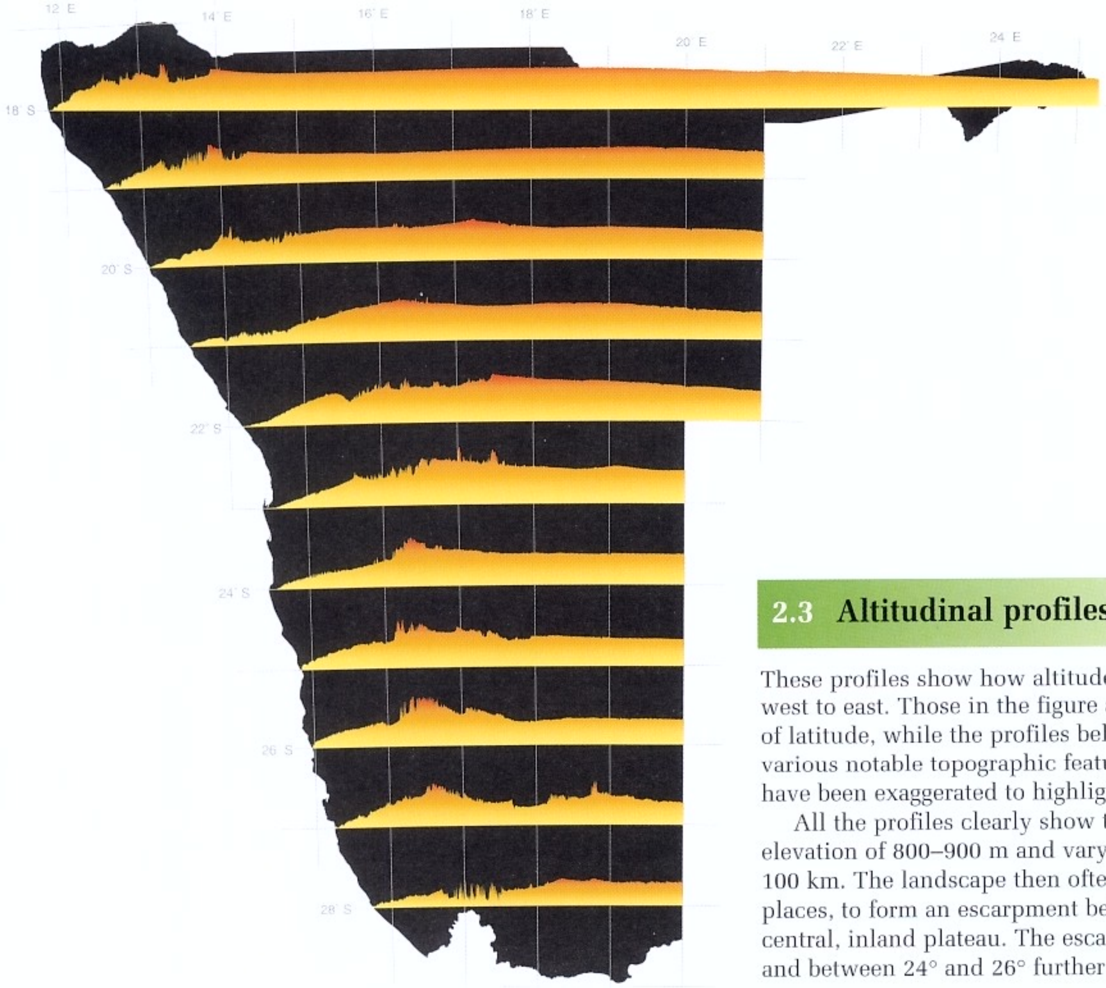


2.2 Elevations and relief

Much of Namibia consists of a wide, rather flat plateau that continues north, south and east into Botswana and other neighbouring countries. The height of the plateau ranges between about 900 and 1,300 m above sea level. However, there is great variation in altitude to the west and south, where the escarpment rises from the coast. The incisions into the landscape made by major river systems are often spectacular, especially so in the case of the Fish River Canyon, where some of Namibia's oldest rocks are now exposed.

The highest point in Namibia is the Brandberg, at 2,579 m above sea level, followed by the Moltkeblick (2,479 m) in the Auas Mountains a few kilometres south of Windhoek.

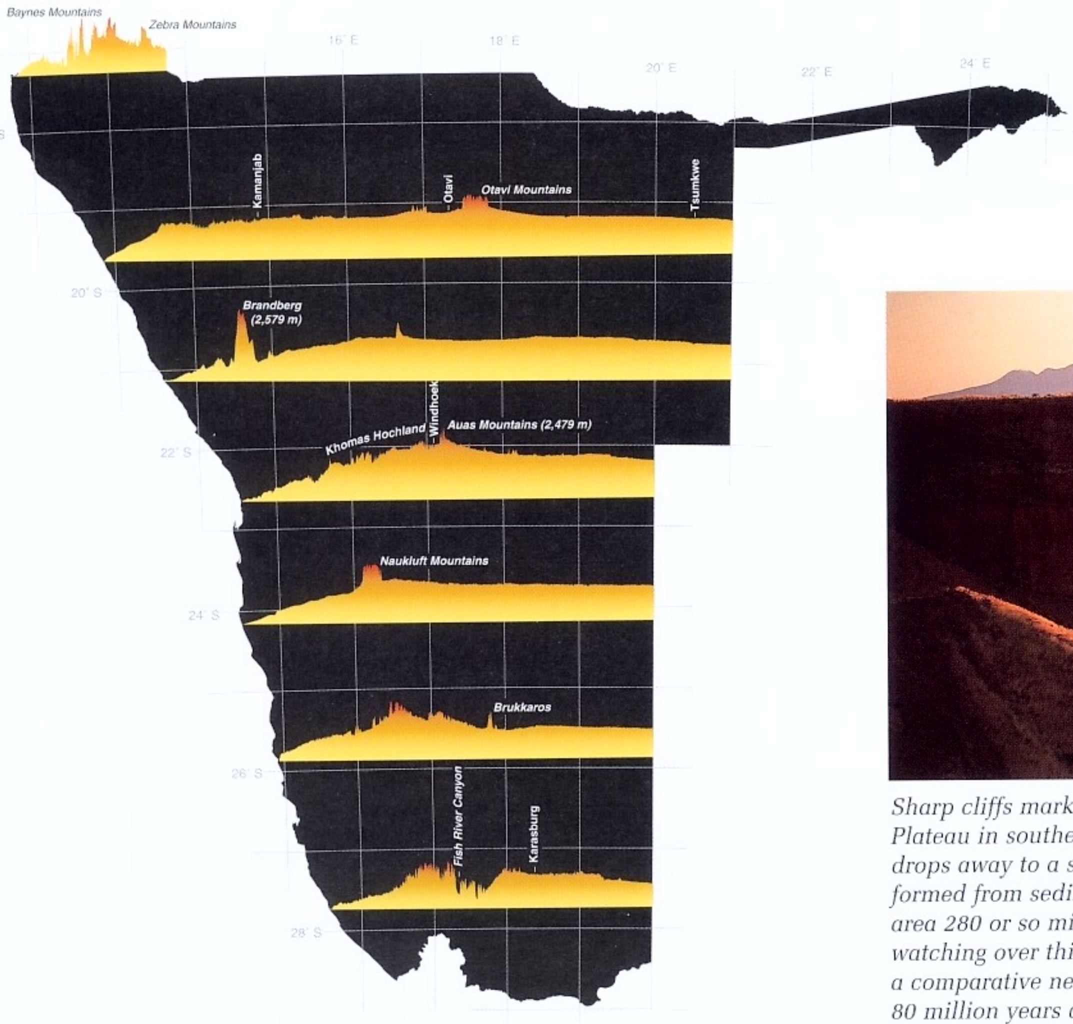
Landscapes in many parts of western Namibia are carved and dissected by water erosion, especially after sporadic falls of heavy rain when torrents wear away the ground, cutting gulleys and river channels ever deeper into the surface. Heavy falls of rain are rare today, however, and so much of the relief in this lunar landscape of the Swakop River was formed during wetter periods long ago.



2.3 Altitudinal profiles

These profiles show how altitudes change across the country from west to east. Those in the figure above were taken at each degree of latitude, while the profiles below were selected to cut through various notable topographic features. Note that the vertical scales have been exaggerated to highlight the changes in altitudes.

All the profiles clearly show the coastal plain rising to an elevation of 800–900 m and varying in width between 50 and 100 km. The landscape then often rises, quite sharply in some places, to form an escarpment between the coastal plain and central, inland plateau. The escarpment is steepest in the north and between 24° and 26° further south.



Sharp cliffs mark the western edge of the Weissrand Plateau in southern Namibia (see page 18). The ground drops away to a surface of shale and sandstone rocks formed from sediments deposited in great lakes in this area 280 or so million years ago. Brukkaros Mountain, watching over this landscape in the background, is a comparative newcomer, having been formed only 80 million years ago.

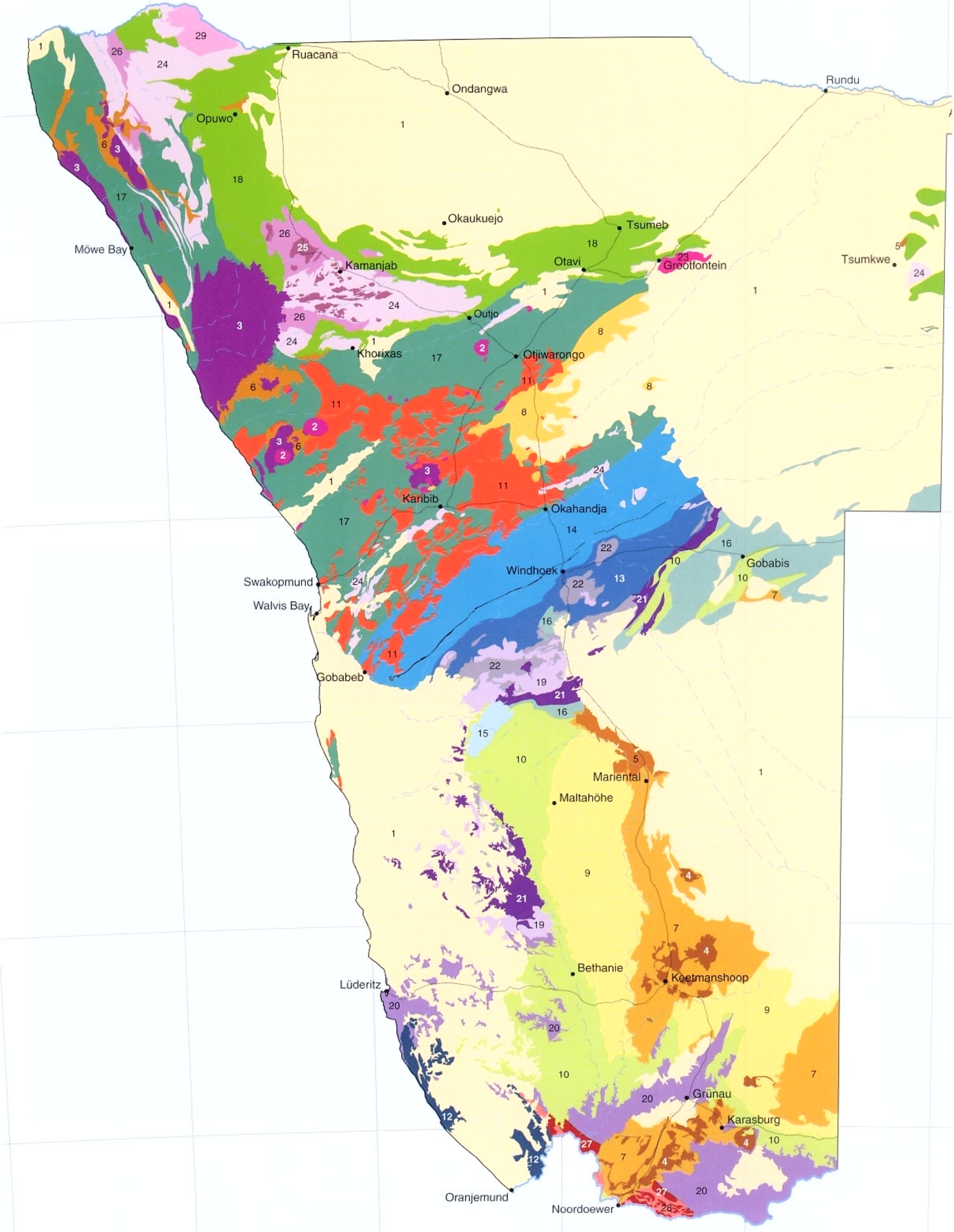
Geology

One reason for Namibia's landscapes being so magnificent is that its rock formations are clearly visible in many places. Much of this is due to the current arid environment, which has produced little topsoil and vegetation to cover the underlying rocks. Equally, long and exciting periods of tumultuous history have also produced a diversity of landscapes and different rock formations. Great rifting events split the region apart several times as a consequence of tectonic movements of the earth's crust. At various times the region's surface was also blanketed by huge sheets of ice, oceans, fields of volcanic lava or wind-blown sand. Evidence of all these events is to be seen in the geological record, consisting of distinctive rocks that formed at various times and in different environments.

Periods of active rock formation are interspersed with intervals of 'inactivity' or erosion in geological history. For example, the rocks on which Windhoek lies were produced from sediments deposited deep below the sea and then later pushed up above the ocean in a mountain belt. This period of rock formation was followed by 200 million years of erosion during which no new rocks were formed. Indeed, erosion continues today as rocks in and around Windhoek are gradually weathered, and washed or blown away. Most of these tiny bits of rock or sand end up as sediments on the floor of the Atlantic Ocean. Perhaps they, too, will be solidified into new sedimentary rocks millions of years from now.

One way of seeing the geological profile of Namibia is as a sequence of layers. Erosion has removed some layers in certain places, while additional layers have been deposited in other areas. Thus, what is visible on the surface depends on which layers of rock have been deposited most recently, and which have been revealed when other layers were stripped away.

Namibia is a geologists' paradise because of its interesting ancient history and the fact that so many spectacular rock formations are clearly exposed. The layers seen in these rocks near the Ugab River were formed from different layers of sediments that slumped down into the depths of the Khomas Ocean between 750 and 550 million years ago. The sediments were then folded into bizarre and wonderful shapes as massive forces squeezed and pushed them up and out of the ocean some 550 million years ago.


Ruacana
Ondangwa
Rundu
Opuwo
Okaukuejo
Tsumeb
Möwe Bay
Kamanjab
Otavi
Grootfontein
Tsumkwe
Outjo
Khorixas
Otjiwarongo
Karibib
Okahandja
Windhoek
Gobabis
Swakopmund
Walvis Bay
Gobabeb
Mariental
Maltahöhe
Bethanie
Keetmanshoop
Lüderitz
Grünau
Karasburg
Oranjemund
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2.4 The geology of Namibia: its major rock formations and sequences[1]

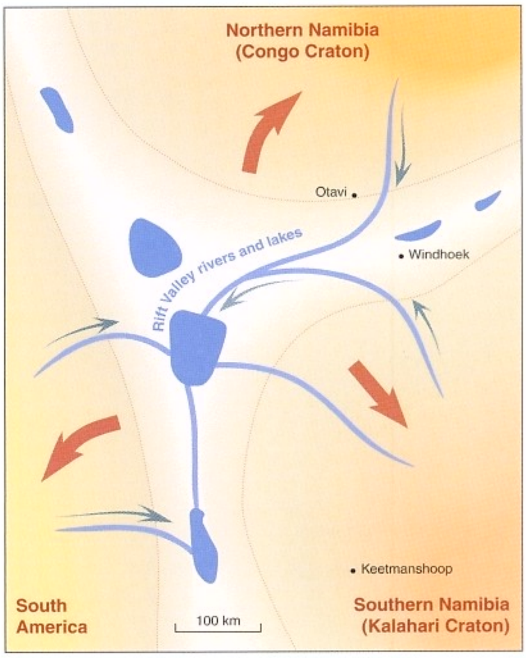
The map of Namibia's geology is like a gigantic jigsaw puzzle built over hundreds of millions of years. The sequence of diagrams that follow in the pages ahead provides a summary of how the different formations were assembled over the last 2,600 million years. Small maps accompany the diagrams to show where each piece of the 'puzzle' fits.

Namibia can be divided into two broad geological areas, one covering the western parts and the other in the east. The western part consists of a great variety of rock formations, most of them exposed in a rugged landscape of valleys, escarpments, mountains and large open plains. Most of these rocks were formed long ago in the depths of primeval oceans or by movements of the earth's crust. In eastern Namibia these rocks are now covered by sands and other sediments that were deposited much more recently. The predominance of Kalahari sands on the surface means that there is much less variation from one area to another in the eastern parts of the country, and the eastern landscape is also rather uniform. Western Namibia is, therefore, much more interesting geologically, and this is where most mineral deposits have been found (see Figure 2.17).

Distinctive names are given to periods of active rock formation to characterise the times and processes that led to the formation of different rocks. These names are given in the map's legend within the time period when the different groups of rocks were formed.

AGE	MAJOR GEOLOGICAL DIVISIONS (age in millions of years)		GROUP (ROCK TYPE)
0	Kalahari Group (70–present)	1	Kalahari and Namib Sands (S)
70			
130	Damaraland Igneous Province (137–132)	2	Igneous Intrusions (Ls Ss)
		3	Etendeka Group (Ss)
180			
	Karoo Supergroup (300–180)	4	Dykes and sills (V)
		5	Kalkrand Basalts (B)
300		6	Huab Basin (Ss Sh)
		7	Main Karoo Basin (Ss Sh)
400		8	Waterberg Basin (Ss C)
500			
550	Nama Group (600–543)	9	Fish River Subgroup (Ss)
		10	Kuibis and Schwarzrand Subgroup (Ss C)
650	Damara Granite Intrusions (650–470)	11	Damara Granites (G)
	Damara Supergoup and Gariep Complex (850–600)	12	Gariep Complex (Cx)
		13	Hakos Group (Ss)
850		14	Khomas Group (Sch)
		15	Naukluft Mountains (Ls Sh)
		16	Witvlei Group (Ls Ss)
		17	Swakop Group (Sch)
		18	Otavi Group (Ls)
		~	Matchless Belt (A)
1,200	Namaqua Metamorphic Complex and related rocks (1,400–1,050)	19	Gamsberg and associated granites (G)
		20	Namaqua Metamorphic Complex (Cx)
		21	Sinclair Group and equivalents (Cx)
1,400			
	Oldest rocks (2,600–1,650)	22	Rehoboth Group and associated rocks (Cx)
		23	Grootfontein Metamorphic Complex (Cx)
		24	Epupa, Huab and Abbabis Metamorphic Complexes (Cx)
		25	Fransfontein Granite Suite (G)
		26	Khoabendus Group and Okapuka Formation (R Ss)
1,800		27	Vioolsdrift Granite Suite (G)
		28	Haib Group (Gn)
		29	Kunene Complex (Cx)

Rock types: A = amphibolite; B = basalt; C = conglomerates; Cx = complex; G = granites; Gn = gneisses; Ls = limestone; R = rhyolites; S = sands; Sch = schists; Sh = shales; Ss = sandstones; V = volcanic



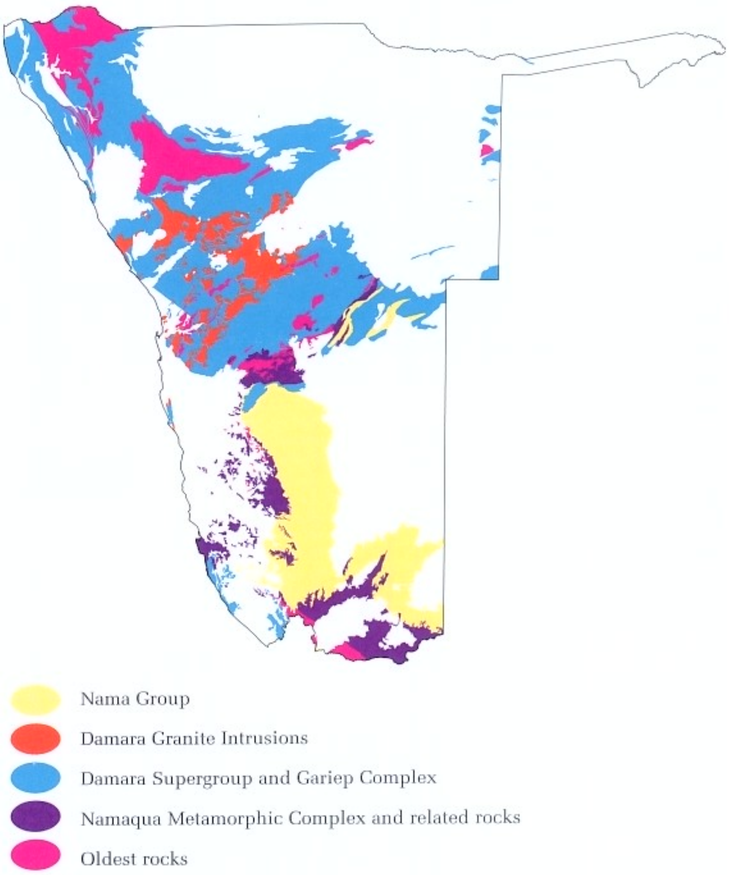
2.5 From 2,600 to 850 million years ago: the oldest rocks [2]

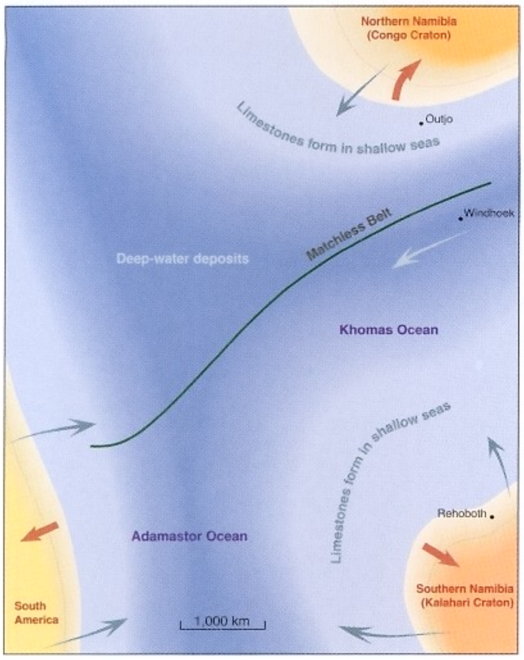
Even though the earth's history goes back 4,600 million years, most of what can be seen on the surface in Namibia today was formed during the last 1,000 million years. Rather little is known of how the land masses were arranged before then. Some rocks in the Kunene Region formed about 2,600 million years ago, but they were then obscured by complex rock-forming events that lasted until about 1,800 million years ago. These oldest rocks are now included in the Epupa Metamorphic Complex, which consists of a mixture of igneous and metamorphic rocks. Some economically valuable deposits of base and precious metals – such as gold, copper, lead and zinc – may be found in them. Other volcanic rocks (the Khoabendus Group) and related granites (the Fransfontein Granite Suite) occur in north-western Namibia as well, while other old metamorphic complexes are to be found in north-eastern and central Namibia.

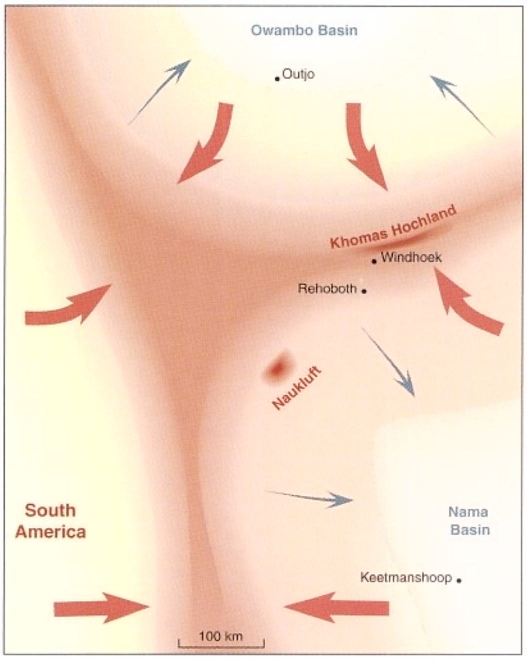
Evidence suggests that two or more huge land masses collided to form the great continent of Rodinia (a name derived from the Russian word for 'motherland') between about 1,400 and 1,200 million years ago. The collisions produced enormous volcanic upheavals, sedimentary basins and a huge mountain belt in what is now southern Africa. Remnants of the many different rocks formed then remain in an arc that extends from South Africa north-westwards through Karasburg and Solitaire on the edge of the Namib Desert, and then swings north-eastwards to Rehoboth and on into Botswana. The rocks are called the Namaqua Metamorphic Complex. Elsewhere they, and other rocks related to the formation of Rodinia, lie buried below deposits of sands and younger rocks where their presence is revealed to us by magnetic survey information (see Figure 2.15).

2.6 The break-up of Rodinia

Shifts in the earth's mantle (the layer between the crust and the core) started to break the continent of Rodinia apart about 850 million years ago. Africa split from South America, and Namibia broke up into two land masses. At first, giant rift valleys formed between these continental fragments. Large rivers flowed into the valleys, depositing various sediments. Many highly saline lakes also formed in the valleys, much like the lakes of the East African Rift Valley today. The maps here show the approximate original positions of some present-day Namibian towns.







2.7 From 750 to 550 million years ago: the Adamastor and Khomas oceans

The Adamastor and Khomas oceans formed between the three land masses as they continued moving apart. These were deep oceans. Windhoek was submerged deep beneath the sea, and may have been thousands of kilometres from the land mass on which Rehoboth is situated today.

Vast quantities of sediments from the surrounding land masses were deposited in the oceans, with different sediments being deposited in various areas and at various depths. Sediments rich in organic matter and calcium carbonate, which would later become limestone and dolomite, accumulated in the calm, shallow seas on the margins of the land masses. The climate at the time was probably rather warm and dry since warm conditions are required for the extensive formation of limestone, and also because the sediments in the shallow seas contained very little material of the kind normally deposited by rivers. Environmental conditions in the shallow waters were probably rather similar to the tropical conditions experienced today along the Great Barrier Reef off the northern coast of Australia.

Other sediments were deposited in much deeper water from material that had first begun to accumulate on the edges of continental shelves. After they had reached critical masses and were shaken loose by tremors or earthquakes, these sediments slumped down in great mudslides to the ocean depths below. Rocks that formed later from these deep-water sediments are called turbidites.

Continental movement

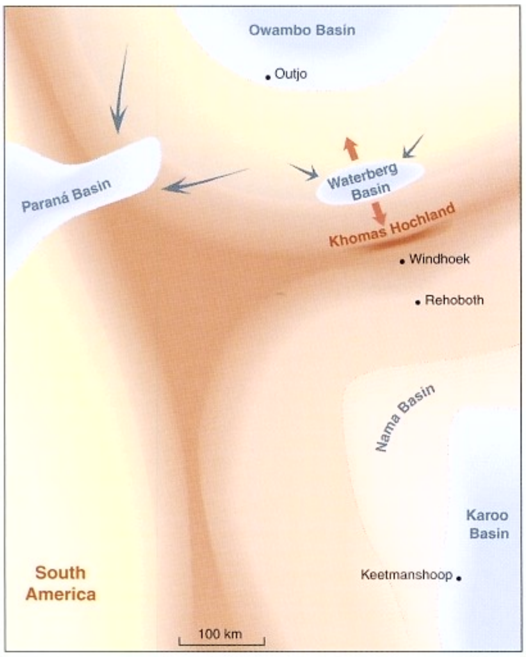
Sediment transport

2.8 The formation of the continent of Gondwana

The three land masses started moving together again about 700 million years ago, and the movements culminated in the formation of Gondwana about 550 million years ago. As the land masses converged, sediments on the ocean floors were folded and heated to form new metamorphic rocks. The sediments were also pushed up into mountain belts in the same way as the Himalayas rose up when India collided with Asia. The remains of all the deep- and shallow-water deposits make up the rock formations of the Damara Supergroup and Gariep Complex, many of which are now prominent features. Thus, the Khomas Hochland and other large areas of west-central and coastal Namibia were formed from deep-water deposits. Shallow-water deposits, by contrast, produced belts of limestone and dolomite hills, including the Otavi–Grootfontein–Tsumeb hills extending west to Outjo and north to Ruacana. Another belt of limestone lies between the Gamsberg and near Steinhausen. Otjikoto and Guinas lakes near Tsumeb, and the Arnhem Cave near Seeis, formed in these limestones. One giant piece of limestone went its own way when the continents collided, sliding south-westwards for about 120 km to form the Naukluft Mountains.

Volcanic rocks produced by a mid-oceanic ridge in the Khomas Ocean possibly formed the Matchless Belt, from which copper has been extracted at the Otjihase and Matchless mines. The Belt is between 500 and 3,000 m wide, and extends for 350 km from near Gobabeb in a north-easterly arc to Windhoek and beyond. Similar volcanic rocks in southern Namibia form part of the Gariep Complex.

Where continents collide, their margins generally fold upwards into mountains, and basins often form away from their ridges, almost as if the earth's crust counters uplift in one area by subsidence behind it. This happened when the Khomas Hochland and the northern dolomite hills were forced upwards, producing behind them the Nama and Owambo basins, respectively. Both basins were later filled with sediments carried in by wind, rivers and glaciers, and this is how the shales, sandstones, limestones and conglomerates of the Nama Group were formed. The compressive forces of the colliding continents also forced molten rock upwards from under the earth's crust as intrusions of igneous rocks, which formed the Damara Granite Intrusions.



2.9 Namibia from 300 to 200 million years ago

The whole sequence of Karoo Supergroup rocks started to form when ice sheets and glaciers covered most of Gondwana during an ice age lasting from 300 to 280 million years ago. The ice age may have been due to a combination of changes in the nature of the earth's orbit around the sun and a shift in the positions of continents in relation to the poles. An extensive sheet of moving ice covered the main Karoo Basin (a basin overlying the Nama Basin in southern Namibia) while smaller ice sheets and glaciers formed in the north and north-west. The sheets of ice flattened the landscape, while glaciers cut through the land surface to gouge out new valleys. One of the best-known of these is the Kunene Valley. It was only much later that it became a large river with a catchment area draining a large part of Angola. Some glacial deposits lie deep below the sands that now cover the Owambo Basin.

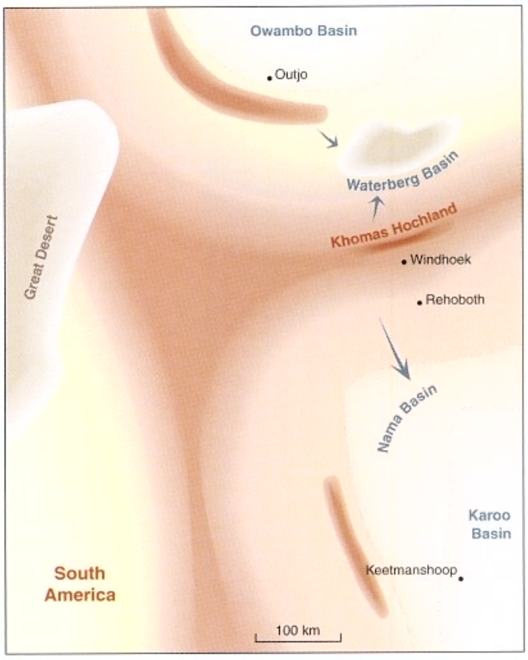
Other sediments of the Karoo Supergroup accumulated once the glaciers started to melt and retreat. Large rivers flowed out from the retreating glaciers, depositing sediments into big deltas and lakes that spread over the Karoo Basin. These sediments are now shales and sandstones, and the abundant reserves of water in the Stampriet aquifer (see Figure 2.24) are held in some of these sandstones.

Another large basin also formed about 280–250 million years ago. Most of this (the Paraná Basin) was in what is now South America, but part of it also extended into Namibia, where it is known locally as the Huab Basin. Sediments deposited by rivers into this basin now remain as limestones, shales and sandstones.

Parts of Gondwana started to splinter and form rift valleys between about 250 and 230 million years ago. The only one of these valleys in Namibia was situated in the vicinity of Waterberg, where it is called the Waterberg Basin, but the basin extended north-east to the Okavango Delta and perhaps beyond. Arid river systems flowed into the Basin from the north-west, leaving deposits which are now called the Omangonde Formation. Numerous fossils of mammal-like reptiles and other animals have been found in these rocks.

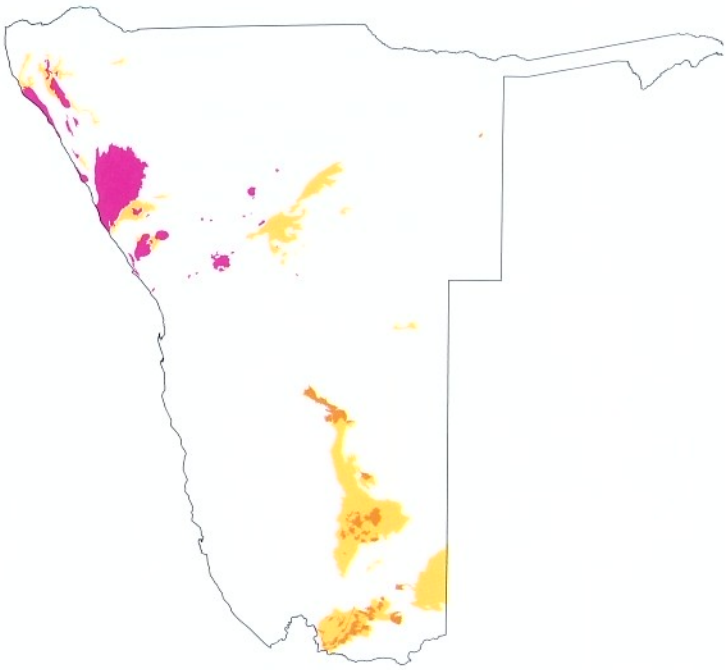
Continental movement

Sediment transport



2.10 Namibia from 200 to 132 million years ago

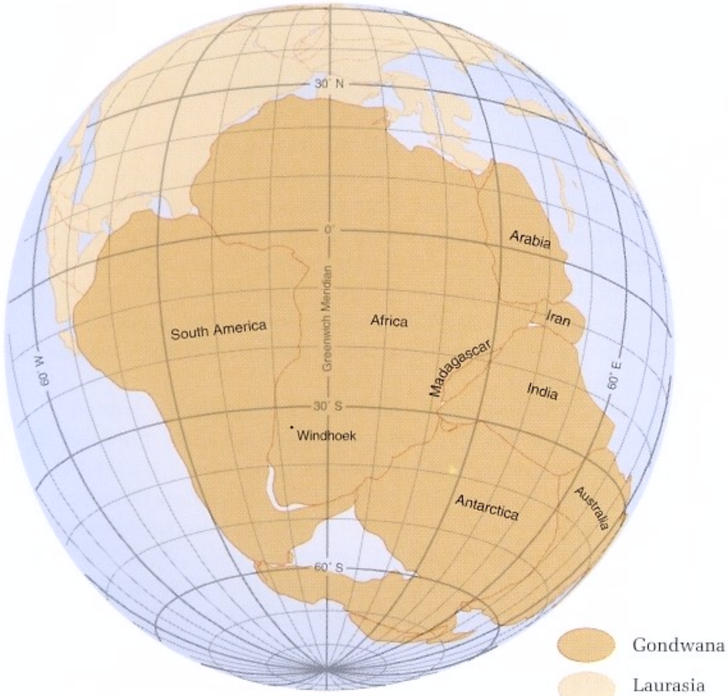
Two seas of sand formed over parts of Gondwana. The first of these covered much of southern Africa during an arid phase between 200 and 170 million years ago. Remnants of the dunes and sands that formed then in the Waterberg Basin now cap the Waterberg Plateau, Mount Etjo and several other hills in this area. The other sea of sand formed largely in what is now South America, covering a massive area of about 1,600,000 km², which is almost twice the size of Namibia. Part of it extended into north-western Namibia, where remnants of the sand now remain in fossilised dunes such as those at Twyfelfontein. The life of this gigantic area of sand in Namibia was, however, cut short when Gondwana started to break apart 132 million years ago (see Figure 2.12).

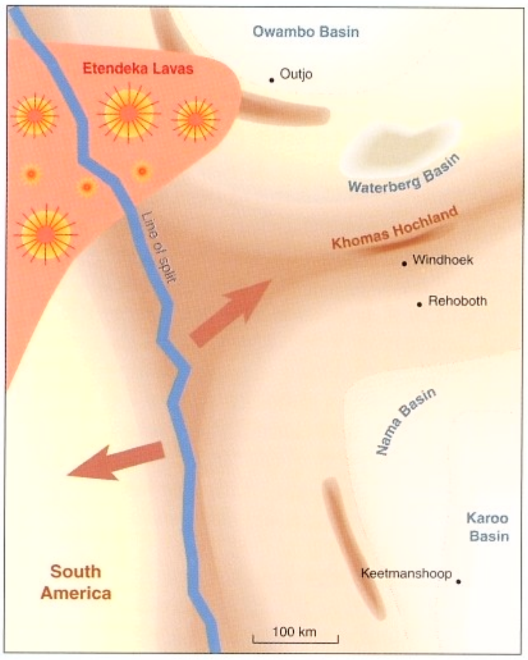


Damaraland Igneous Province

Karoo Supergroup: dykes, sills and basalts

Karoo Supergroup: basins





2.11 The continent of Gondwana [3]

Gondwana was a huge continent, consisting of India and all the present-day continents of the southern hemisphere. It remained stable for 350 million years. Then, in a rather similar fashion to the previous break-up of Rodinia (see Figure 2.6), Gondwana started to split apart about 180 million years ago. The split meant that the earth's crust – a layer some 30–40 km thick – broke apart. Enormous bursts of volcanic activity accompanied the break, with some of the earliest eruptions occurring when Antarctica and South Africa separated. These eruptions produced the Kalkrand Basalts and associated dykes and sills, and also the layers of basalt that cap the Drakensberg range in South Africa.

Gondwana continued to break apart over a period of 125 million years. In fact, the movements of the earth's crust that started the split so long ago continue today, with South America and Africa drifting ever further apart. The last major rift occurred about 55 million years ago, when India split away from Madagascar and moved northwards. The map also shows the continent of Laurasia (comprising North America, Europe and Asia north of the Himalayas), which is the northern hemisphere's counterpart to Gondwana.

2.12 Namibia and South America split apart

The split between South America and southern Africa started about 132 million years ago when volcanic activity bombarded this part of the world over a period of between one and five million years. The volcanism produced a pile of lava and volcanic ash up to 1.6 km thick over huge areas of Brazil and north-western Namibia. Molten rock erupted from many volcanoes, including the Messum and Doros craters. Large areas of the sea of lava – known as the Etendeka Group lavas – remain visible in the area between the Huab and Hoanib rivers and in other areas northwards into Angola.

Many other noteworthy features of Namibia's landscape appeared at the same time. Great masses of molten rock were forced up, into and through the earth's crust as volcanoes or as relatively subdued intrusions of igneous rock, producing the Erongo Mountains, Brandberg, Spitzkoppe and the Paresis Mountains. Hundreds of dykes and sills were also formed, as were many kimberlite pipes that intruded into the crust. Many of these pipes are in the Gibeon area and in the southern parts of the Khaudum Game Park, but no diamonds worth mining have yet been found in them. Brukkaros was also produced by more recent volcanic activity only 80 million years ago, but the circumstances leading to its later appearance are unknown.

The Spitzkoppe granite hills are a conspicuous landmark, but how were they formed? They are actually remnants of great masses of volcanic rocks that were forced up through the crust of the earth when Namibia and South America started to move away from each other about 132 million years ago.

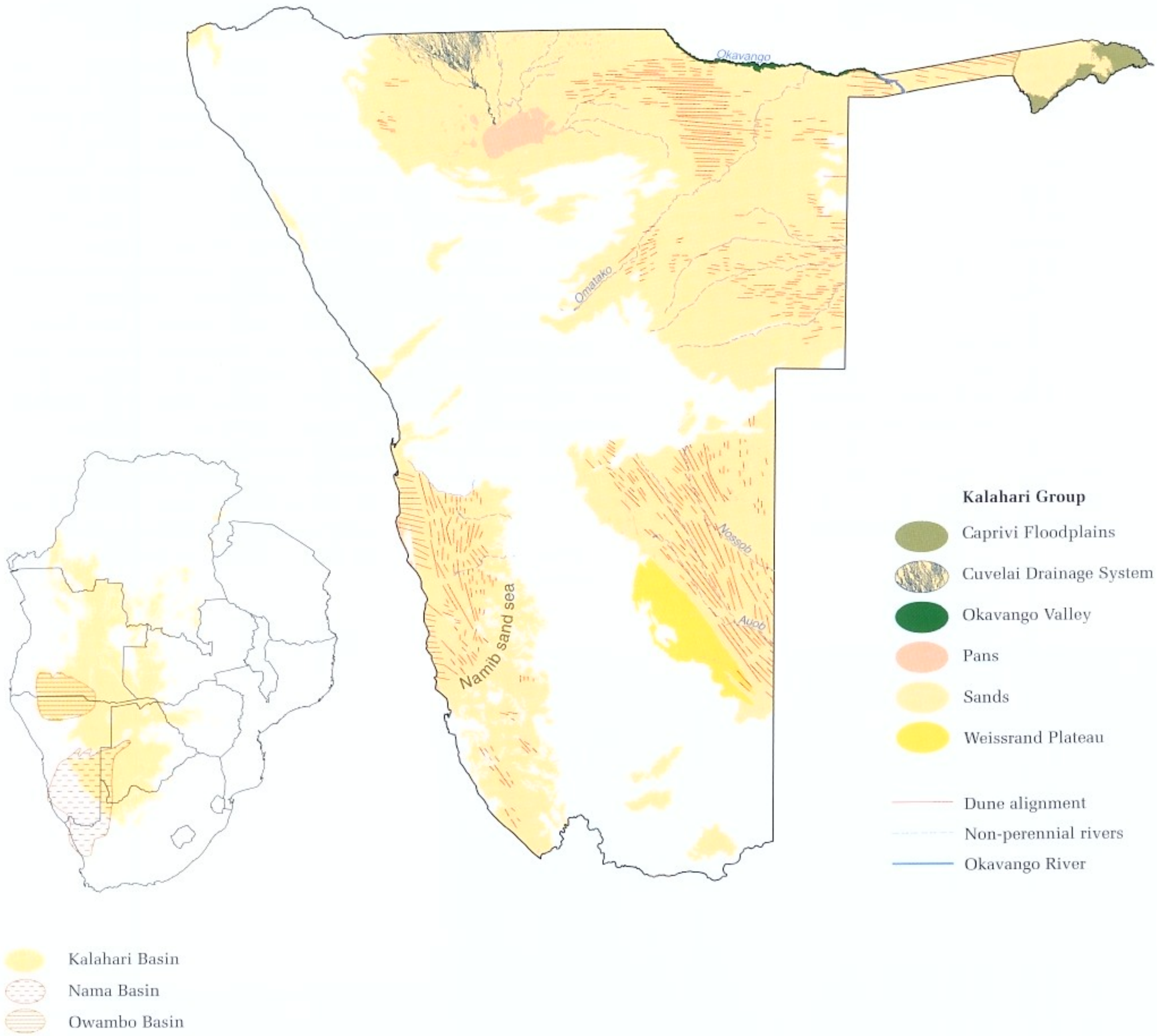
2.13 The Kalahari and recent deserts

The margins of southern Africa lifted up when Namibia and South America finally parted ways about 128 million years ago. Erosion then slowly ate away the edge of southern Africa, so that the broad coastal plain that is now the Namib Desert had been formed by about 70–65 million years ago. This left a gigantic basin in the centre of southern Africa. Part of this is the Kalahari Basin, which now extends from the northern Cape, north through Namibia, Botswana and Zambia, and into the area around the Congo River. The Kalahari Basin has progressively filled up with sands and water-borne deposits, the nature of which vary according to whether the area was going through a phase of high or low rainfall. The deposits of sands, clays and calcretes that make up the Kalahari Group cover the eastern parts of the Nama Basin and almost all of the Owambo Basin (see Figure 2.8). The large sand seas of the Namib Desert have approximately the same age as the Kalahari sands.

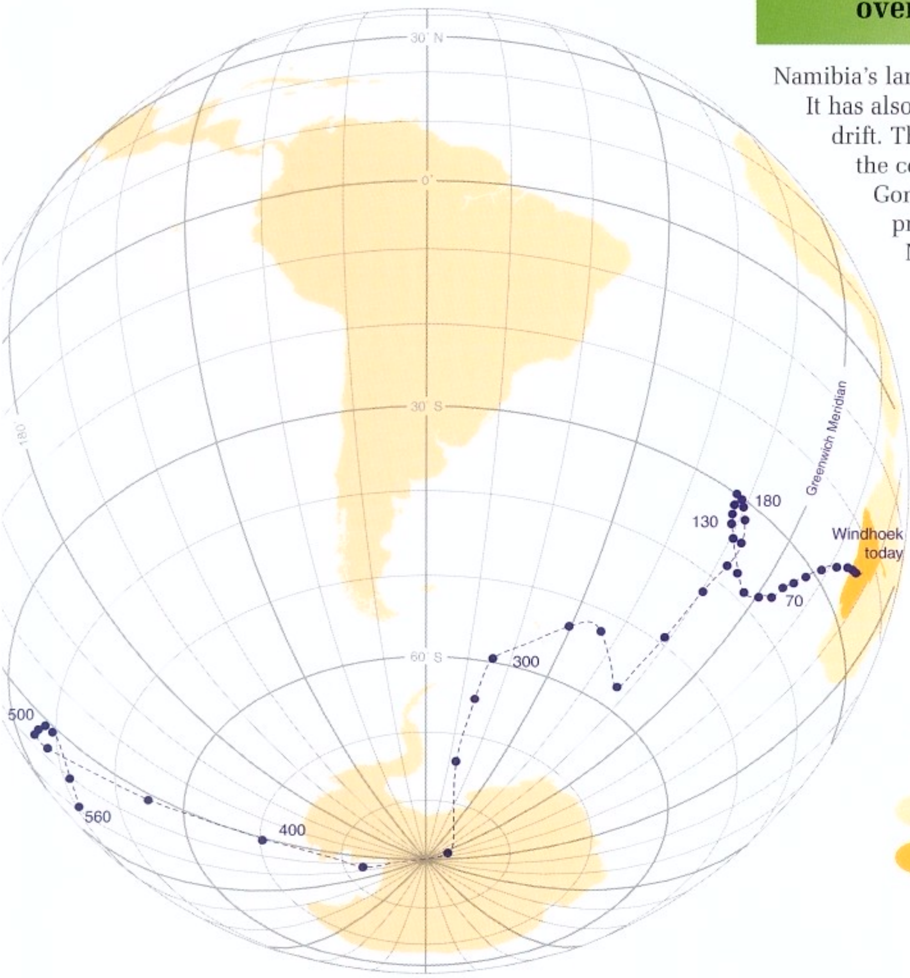
Some of the river systems in the vast area covered by the Kalahari Group remain active (such as the Okavango River), some flow intermittently (for example, the Cuvelai Drainage System and the Nossob and Aub rivers), while others are essentially dormant at present (most of the Omuramba Omatako, for example).

Dune fields have likewise come and gone, and many of the neatly arranged linear dunes in various areas were formed during much drier times long ago. The alignment of dunes reflects the direction of the prevailing winds when the dunes were formed. In fact, the present sea of sand in the Namib provides a picture of what much of northern and eastern Namibia could have looked like during drier periods.

Present evidence suggests that the Namib probably formed between 16 and 15 million years ago, about the same time that the Antarctic became as cold as we know it today (see Figure 2.14). A wetter period, lasting perhaps from 12 to 7 million years ago, broke this long, dry period. The dry climate on the west coast is partly due to the cold Benguela Current (see page 74), which flows northwards from the Antarctic Ocean. However, since the cold Benguela Current only formed about 5 million years ago, the dry environment in the Namib Desert must have been associated with other climatic circumstances.



2.14 The geographical position of Namibia over the last 560 million years[4]



Namibia's land surface has been here for an extremely long time. It has also moved a great deal as a consequence of continental drift. The points on the map are the approximate centre of the country at different times from the formation of Gondwana 560 million years ago (see Figure 2.8) to the present day. One can only wonder where on earth Namibia was before this!

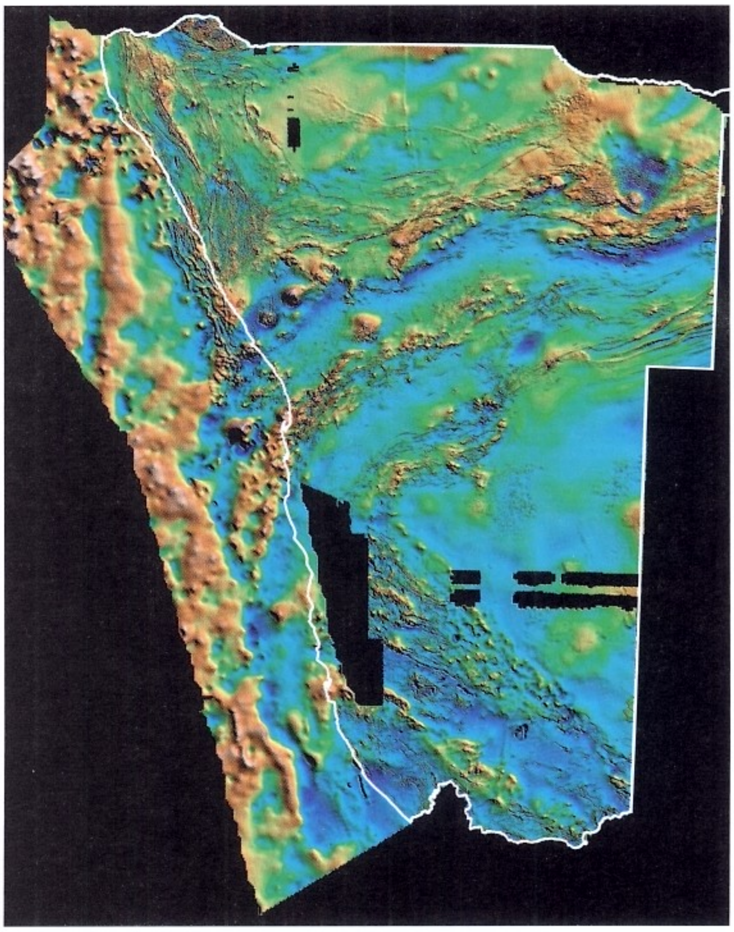
These movements have been the result of shifts of the earth's crust. With the displacement of the land masses, Namibia moved from an area that would now be in the South Pacific, through the South Pole (360 million years ago), and then north towards its present position. Although we associate the South Pole with ice sheets and glaciers, its sub-zero temperatures only developed 15–13 million years ago when the gap between South America and Antarctica opened sufficiently for the cold current that sweeps around the Southern Ocean to form. It is this current that now prevents warm, tropical air from reaching and heating Antarctica.

- ● Position of Windhoek
- 70 Millions of years ago
- Land masses today
- Namibia today

2.15 Aeromagnetic map of Namibia

The question of what rocks lie below the surface is difficult to answer. Exploration holes have been drilled, but these are expensive and each hole covers just a small spot. One modern solution is to collect information using magnetic sensors attached to aeroplanes. The sensors record the magnetic 'signatures' of rocks deep below the surface. Ore deposits have specific signatures, allowing areas with mineral potential to be identified and explored more intensively. Potential sources of water may also be found since sedimentary rocks containing water have low magnetic values.

Colours on this image represent different magnetic signatures, and a comparison between the image and the geological map (Figure 2.4) shows that great differences exist between what is seen on the surface of the earth and what lies below. Whilst it is difficult for the layperson to interpret the image, it is clear that the huge sea of Kalahari sand in Kavango and Otjozondjupa covers different kinds of rocks, for example. The converse is also true in the Owambo Basin, where little variation is found below the surface layers of sand and clays. Areas shown as black blocks had not been surveyed when this map was compiled.



Mineral resources [5]

Wealth produced by a number of prominent mines has contributed a great deal to Namibia's economy and fostered the view that Namibia is rich in minerals. For example, mines at Oranjemund produce a large proportion of the world's gem-quality diamonds, the Rössing Mine at Arandis produces uranium (it was once considered the largest low-grade uranium mine in the world), large-scale mining of copper and other metals has taken place in and around Tsumeb, and gold is extracted from the Navachab Mine near Karibib. The presence of these and other mineral resources and mining enterprises is mapped out on the pages that follow.

Mining has been an important component of the economy for many years. Up to 10,000 people are directly employed in the formal mining sector, while there are about another 1,000 informal miners who independently excavate semi-precious stones, tantalite, tin and other minerals. The value of minerals mined in Namibia currently makes up about 12% of GDP, and is expected to rise to 15% when the new Skorpion Zinc Mine operates at full capacity. This is a good deal less than the 25% contributed by mining to the GDP in the 1980s. Part of the reduction is due to the greater contributions made by other sectors of the economy, but the drop is also a result of declining demand and prices for many minerals. For example, the value of copper, gold and lead dropped by at least 25% between 1995 and 2000.

Three special processes have helped create this mineral wealth. First, Namibia has been part of violent continental movements over the past billion years or so and in earlier times (see page 41). Rocks were heated and compressed to such a great degree during the movements that the heat and pressure transformed molecules in the rocks into new and valuable minerals.

The second process is the torrential flooding of the Orange River. For much of the time the river flows calmly down to the Atlantic Ocean, but sporadic heavy rains in the central areas of southern Africa turn the Orange into a mighty current which sweeps huge rocks in its path – together with diamonds – down to the sea where they have been mined along and off the coast. The diamonds originate in the many volcanic kimberlite pipes in Botswana (Jwaneng, for example, now the world's richest diamond mine) and South Africa (the famous Kimberley mine is the best example).

The third process has been passive, one that has preserved rather than created Namibia's mineral wealth: a long-standing arid climate (see page 69). If rain had been more plentiful, many valuable deposits of minerals would have been eroded away. Even more importantly, deep layers of topsoil and vegetation would cover up many rock surfaces in a wetter climate, making mineral resources much harder to find and extract.

2.16 Prospecting licences

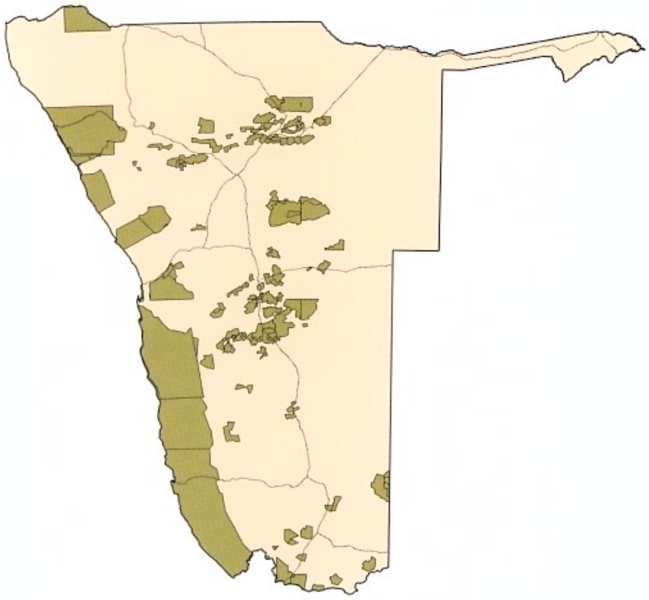
A great deal of work needs to be done before a mineral resource can be mined profitably. Basic research by geologists to map out different rock formations and structures is a first step, which then allows mining companies to begin exploring potentially promising areas. In Namibia, these exploration activities are regulated, so that companies who have lodged claims can be allowed exclusive prospecting rights over certain areas. The series of maps here shows how areas covered by prospecting licences have changed over the past 40 years.

Changes in the areas covered by licences largely reflect changing interest in minerals as well as a greater knowledge of what mineral resources may be found in specific areas. For example, the award of many prospecting licences in the area between Swakopmund and Usakos in the 1970s followed the discovery of the uranium deposits (used as a nuclear fuel) that eventually led to the start of the Rössing Uranium Mine. Likewise, the idea that diamonds possibly existed in kimberlite pipes in the Kavango Region only gained momentum in the 1970s. Claims over large areas off the coast in the 1990s followed the discovery of diamonds on the floor of the Atlantic Ocean, in tandem with the development of suitable methods for sucking them up onto processing ships. New prospecting activities for copper and other base metals started north of Gobabis in the 1990s.

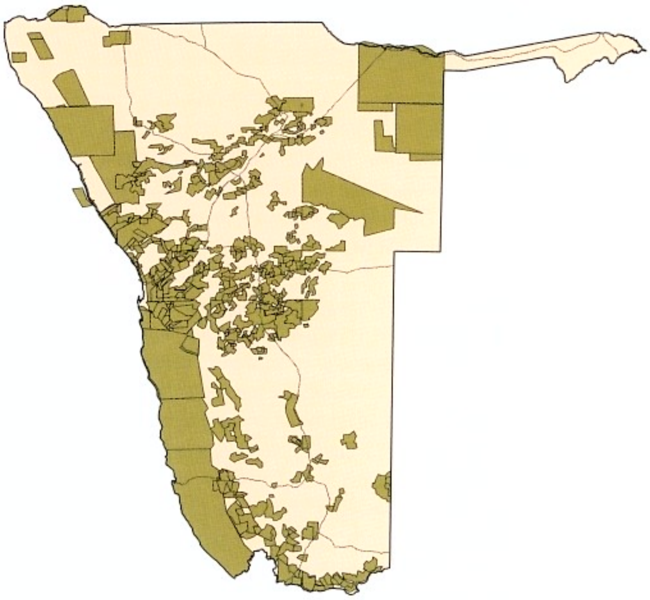
Early interest in possible oil and gas reserves focused on the Owambo and Nama basins (see Figure 2.13). During the 1960s, four exploration wells were drilled in and around Etosha. More recently, several large international companies have begun exploration for petroleum reserves, particularly off the coast, following the discovery of the huge Kudu Gas Field (about 300 km^2), some 170 km west of Oranjemund in 1974.

Since the early 1900s, much of south-western Namibia was allocated as a sole diamond concession to De Beers Diamond Mining Company. This whole area was known as Diamond Area No. 1 and Diamond Area No. 2, but it has been progressively opened up to prospecting and potential mining by other companies.

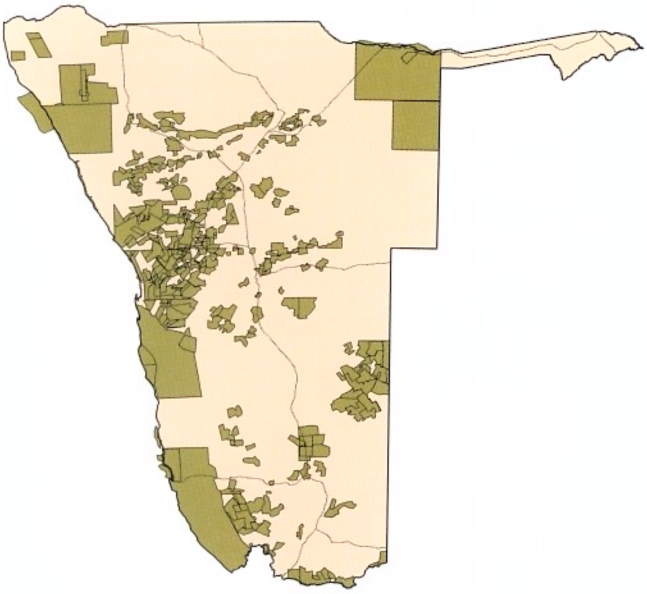
1960–1969



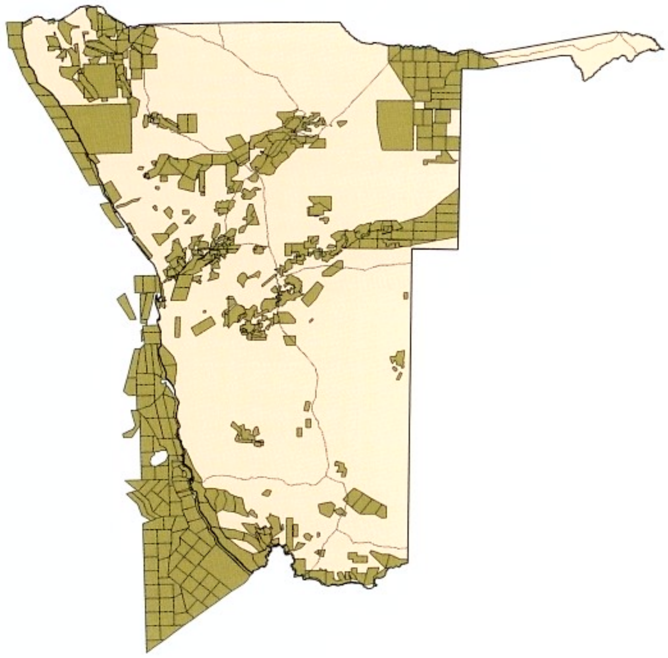
1970–1979



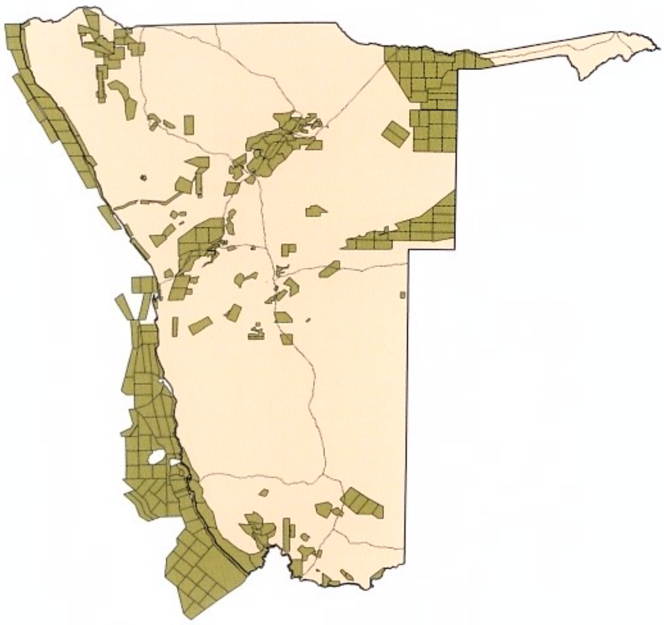
1980–1989



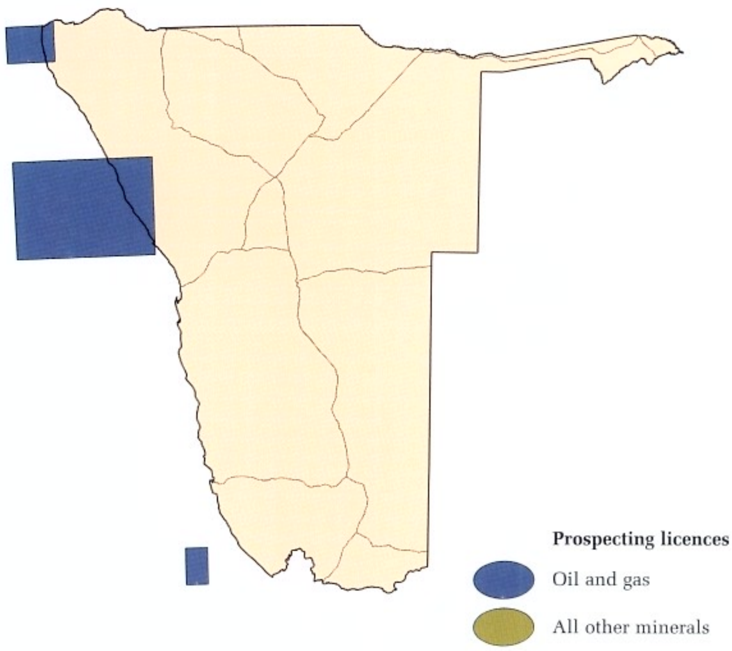
1990–1999



2000



Petroleum in 2001



2.17 Mineral deposits

These nine maps show where various minerals have been found in Namibia. Mines have been established to exploit some of these deposits (see Figure 2.18), but many remain untouched because the ore bodies are too small or costly to mine. However, some deposits may be mined in the future if mineral prices rise, extraction methods become more efficient, or new uses are found for the minerals.

Apart from diamonds, almost all of Namibia's valuable mineral resources have been found in western Namibia where the oldest rocks are exposed at the surface (see Figure 2.4, i.e. the metamorphic complexes and the Damara Supergroup). In contrast, very few deposits have been identified in rocks formed in the last 600 million years, for example below sedimentary layers of the Karoo, Nama and Kalahari groups, or in the younger igneous rocks that make up the Damaraland Igneous Province. It is clearly difficult as well as costly to discover and mine deposits below thick layers of sands. Most of the minerals shown in the maps here are familiar, but the so-called rare earth metals include a family of lesser-known but valuable minerals such as germanium, gallium and niobium (used as alloys in high-tech electronic equipment).

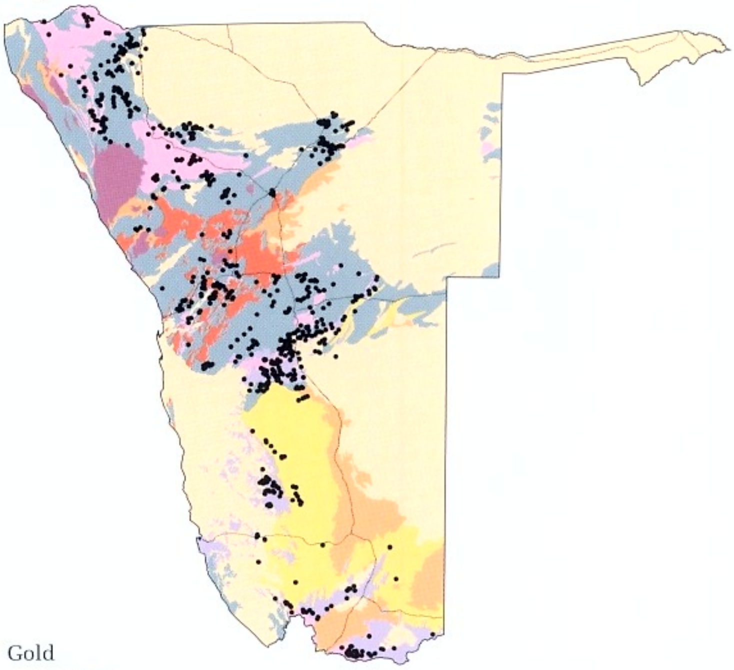
All diamonds mined in Namibia were eroded out of kimberlite pipes in central southern Africa and then swept down the Orange River. This explains why they are concentrated along the length of the Orange River and off its mouth. The Benguela Current (see Figure 3.4) has also carried many diamonds great distances northwards along the coast.

The discovery of the Kudu Gas Field in 1974 was an exciting and important event, but the economic potential of the fields has yet to be evaluated fully. In addition, oil, gas and bitumen (degraded oil) deposits have been found in a few places, though in amounts too small to be economically viable.

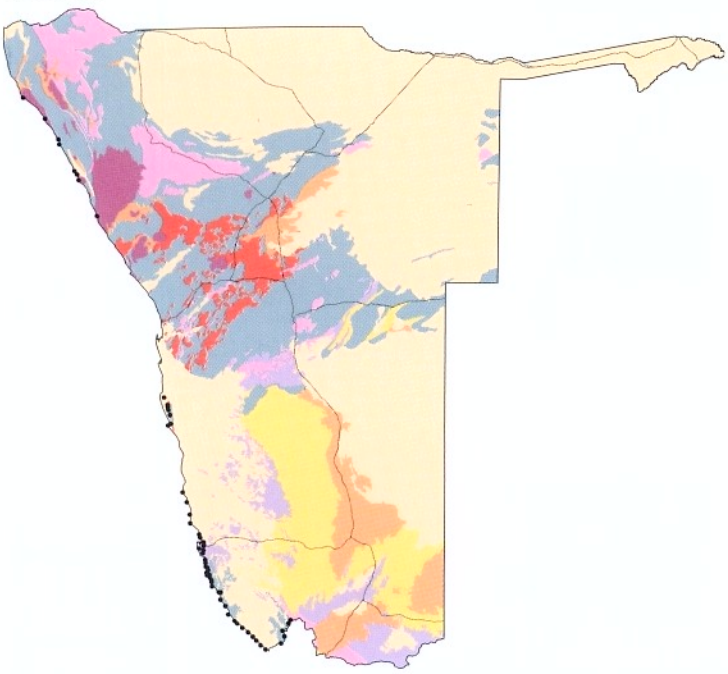
Geological complex (and age in millions of years)

- Kalahari Group (70 – present)
- Damaraland Igneous Province (137–132)
- Karoo Supergroup (300–180)
- Nama Group (600–543)
- Damara Granite Intrusions (650–470)
- Damara Supergroup and Gariep Complex (850–600)
- Namaqua Metamorphic Complex and related rocks (1,400–1,050)
- Oldest rocks (2,600–1,650)
- • Mineral deposit

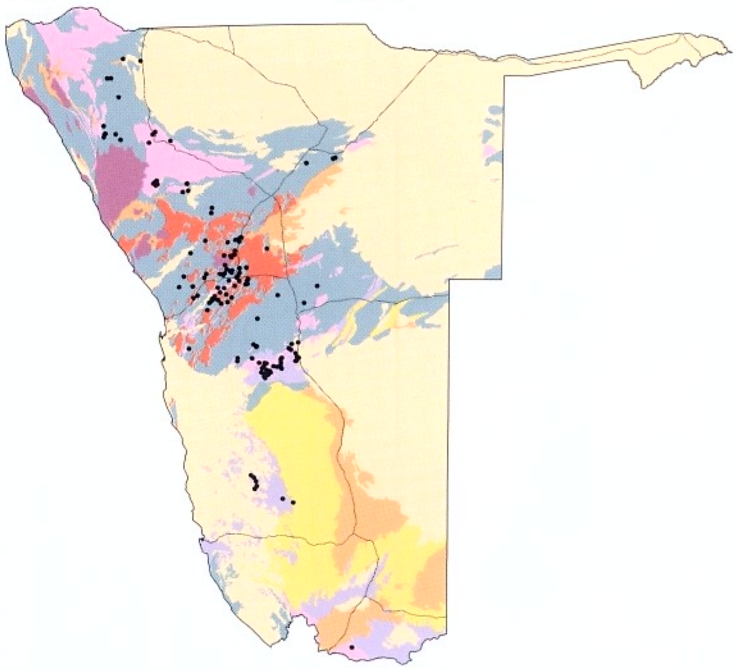
Copper



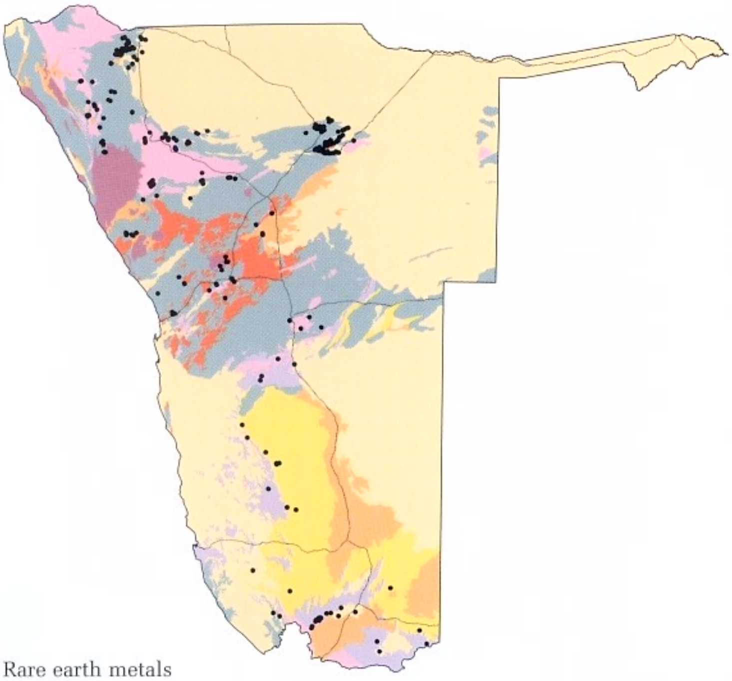
Diamonds



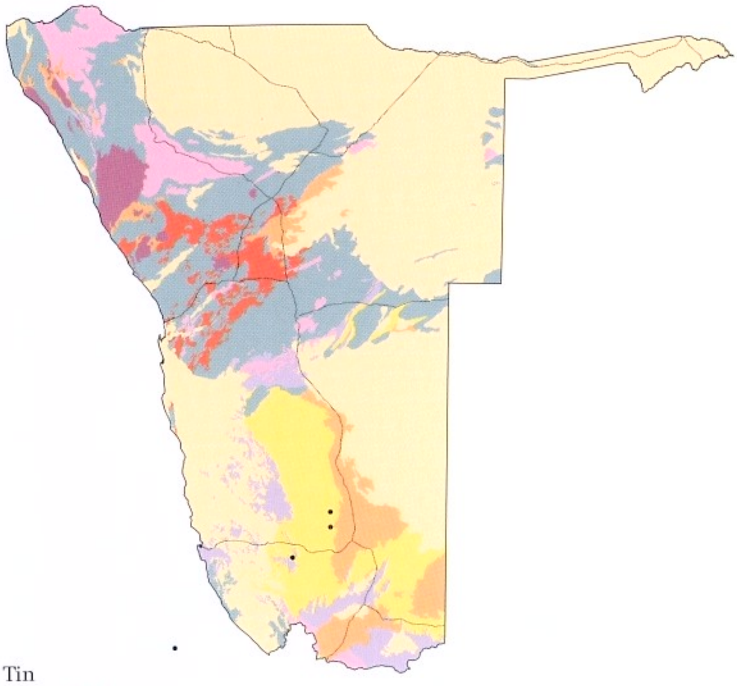
Gold



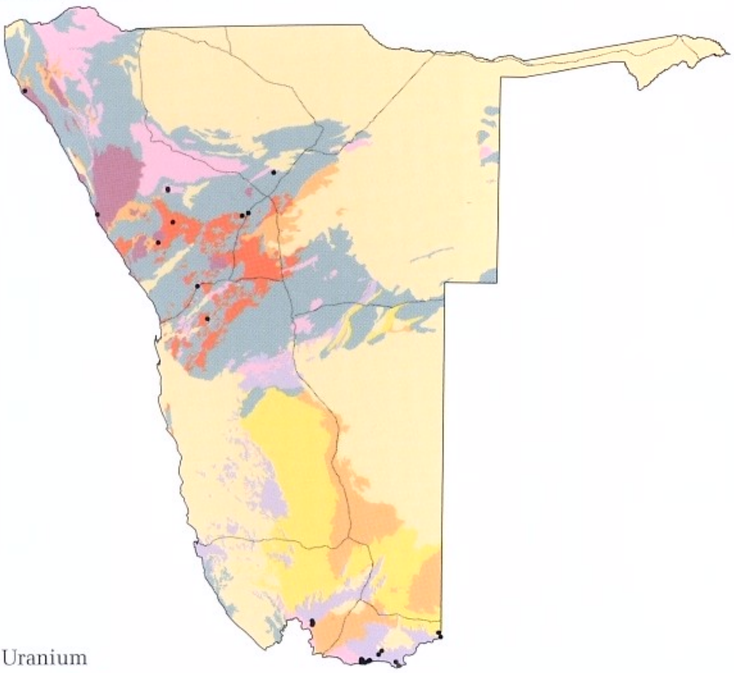
Lead



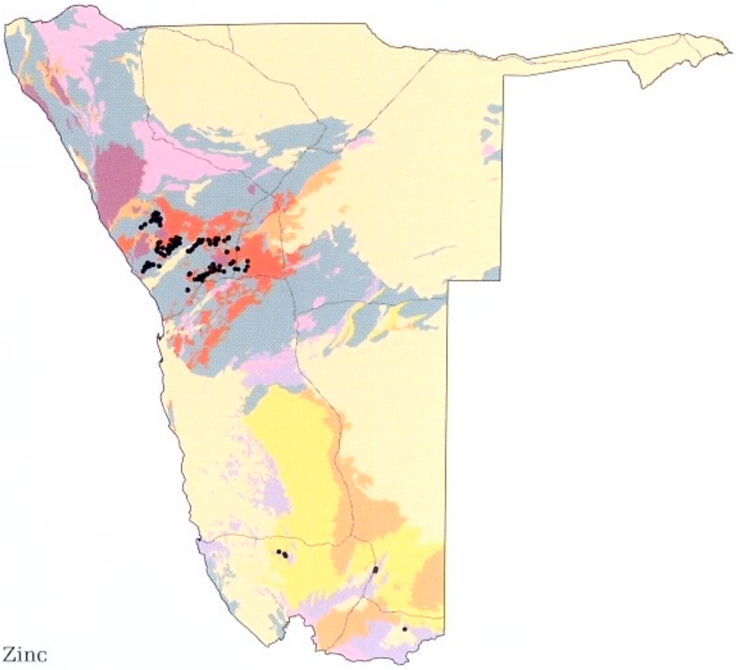
Oil and gas



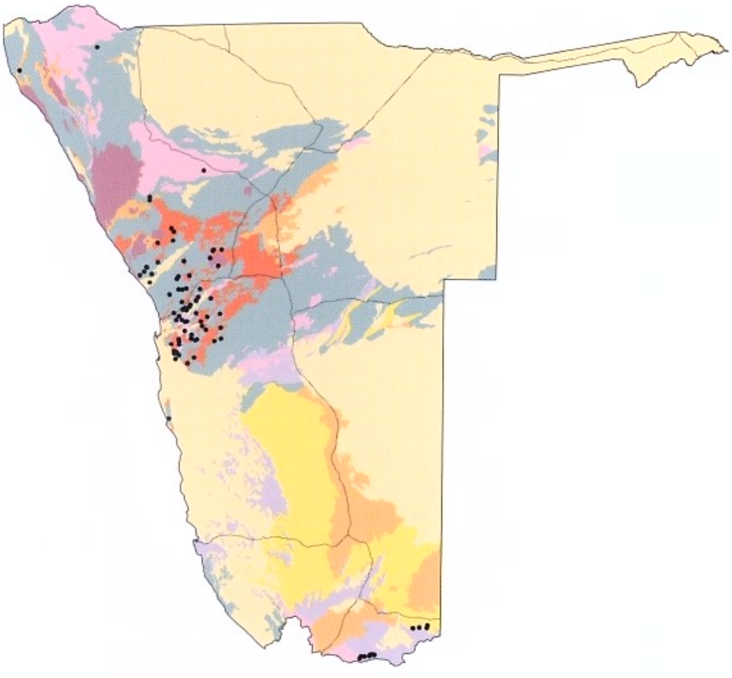
Rare earth metals



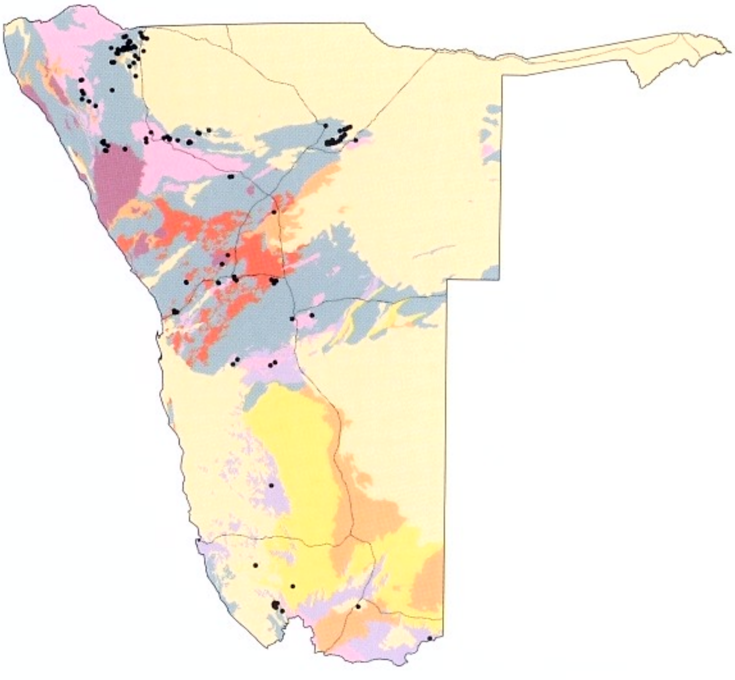
Tin



Uranium



Zinc



Huge volumes of rock have been excavated and mined to extract uranium from the Rössing mine near Arandis. Exports of the mineral earned valuable income for the country in the early years of the mine, but demand (and prices) for uranium have dropped in recent decades.

Active mines

Active diamond fields

Planned gas field

Dormant mine

Ag	silver	Nb	niobium
Am	amethyst	Pb	lead
Au	gold	sda	sodalite
Be	beryllium	Sn	tin
Cs	caesium	Ta	tantalite
Cu	copper	Ti	titanium
di	diamonds	tu	tourmaline
flu	fluorite	U	uranium
gas	gas	V	vanadium
hal	salt	W	tungsten
Li	lithium	Zn	zinc
Mn	manganese		

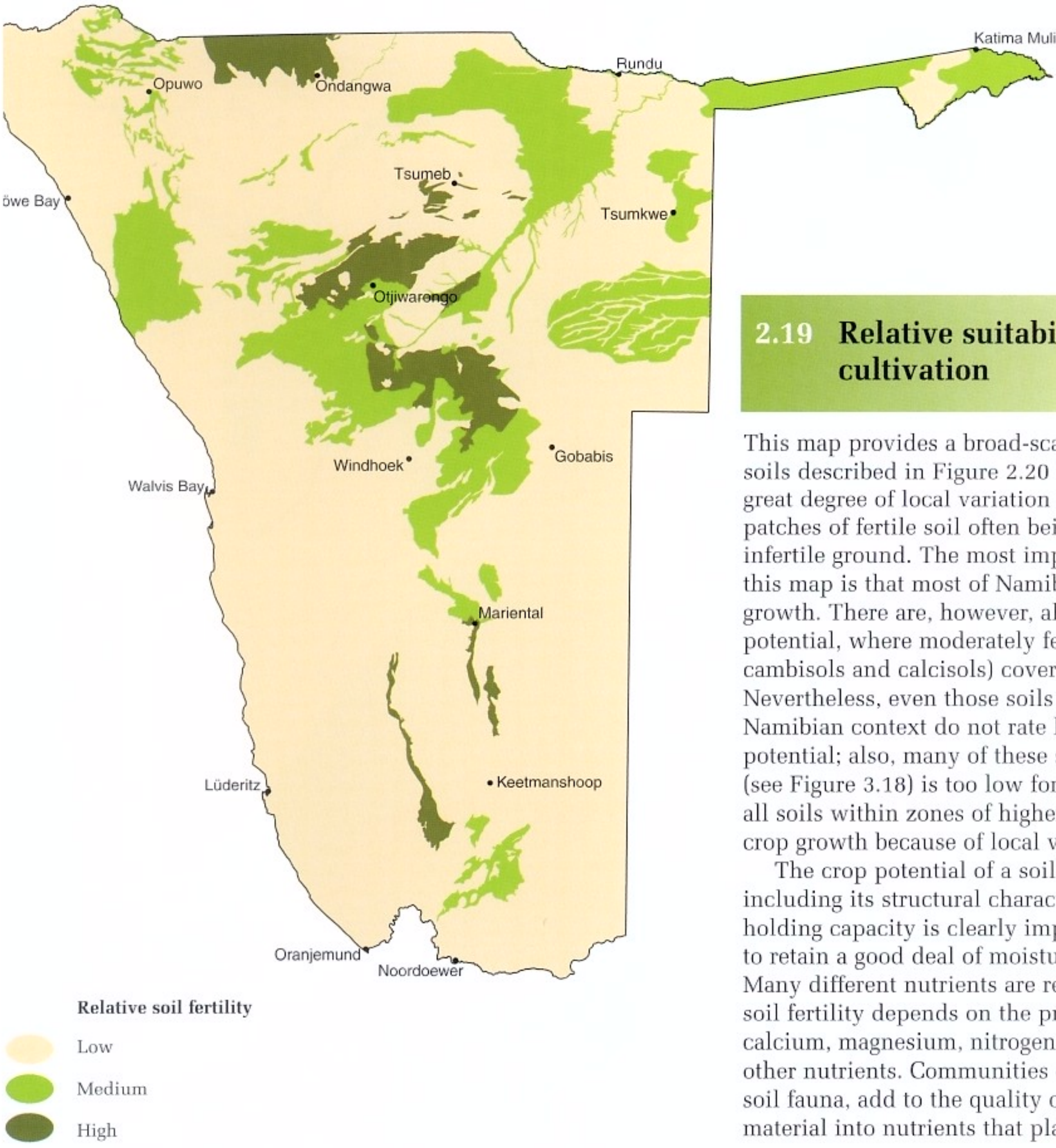
2.18 Mines in Namibia

Other than the complex of diamond mines held by NAMDEB Diamond Corporation and various smaller companies, there are currently only 12 major mines operating in Namibia. One of these, the Skorpion Zinc Mine, is in the process of development, while the Kudu Gas Field is still being evaluated. Over 50 different mines have closed since the 1920s, some because the deposits have been exhausted, others because the mines were no longer profitable. The few mines that are active, therefore, produce an impressive quantity of minerals, including over 1.5 million carats of gem diamonds, 3,200 tonnes of uranium, 66,000 tonnes of fluorite, 2,400 kg of gold, and over 500,000 tonnes of salt in the year 2000. Namibia is also the world leader in marine diamond production, while Rössing is the world's second-largest open-pit mine for uranium in the world. Skorpion Mine is expected to produce 150,000 tonnes of refined zinc per year.

Soils [6]

Soils are often taken for granted, in that we simply accept that the ground beneath us supports grasses, trees and crops, and soaks up rainwater. Exactly how the soil gives this support depends on its depth, structure and chemical composition. These qualities determine, for example, how much water the soil retains, the depth to which a plant's roots may extend, and what nutrients the soil contains for plants to grow. The combination of these qualities in any one area is fundamental in dictating which plant species are present and, thus, the diversity of the vegetation community. Soils also affect the structure of plant communities. For example, individuals of a species may remain stunted in one area of shallow or nutrient-poor soil but grow tall in deep soils rich in nutrients. In short, by providing the growing medium for plants, soils form the basis for all animal and human life.

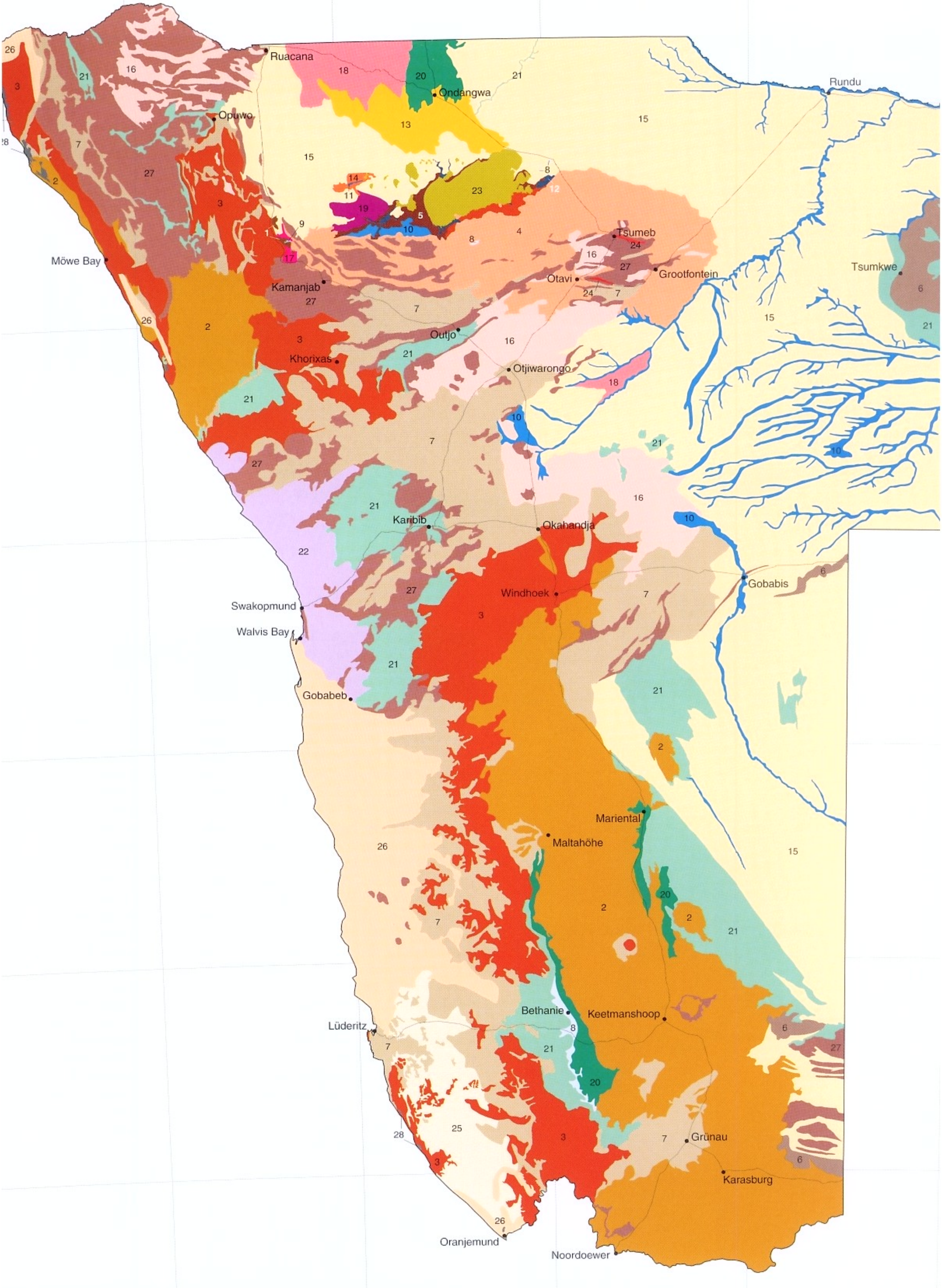
Each type of soil is mainly recognised by the way its mineral, organic, water and air components are arranged within the soil body. The vertical distribution of these components varies, such that each soil type consists of a unique combination of different layers or horizons.

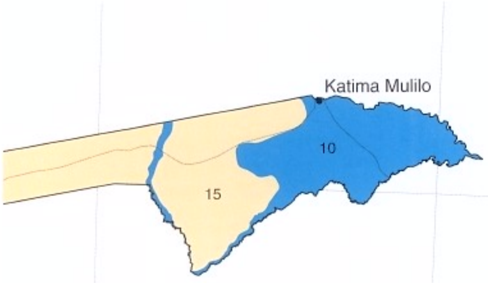


2.19 Relative suitability of soils for crop cultivation

This map provides a broad-scale assessment of the potential of the soils described in Figure 2.20 for crop growth. There is, of course, a great degree of local variation in the properties of soils, with small patches of fertile soil often being surrounded by larger areas of infertile ground. The most important conclusion to be drawn from this map is that most of Namibia consists of soils unsuited to crop growth. There are, however, also zones rated as having medium potential, where moderately fertile associated soils (usually cambisols and calcisols) cover between 20% and 50% of the area. Nevertheless, even those soils that are the most fertile in the Namibian context do not rate highly on a world scale of soil potential; also, many of these soils occur in areas where rainfall (see Figure 3.18) is too low for rain-fed cultivation. Moreover, not all soils within zones of higher potential are actually suited for crop growth because of local variation.

The crop potential of a soil is based on a variety of factors including its structural characteristics and nutrient content. Water-holding capacity is clearly important, with the best soils being able to retain a good deal of moisture without becoming waterlogged. Many different nutrients are required for plant growth. The overall soil fertility depends on the presence of appropriate amounts of calcium, magnesium, nitrogen, phosphorus, potassium, sodium and other nutrients. Communities of tiny animals, collectively called soil fauna, add to the quality of the soil by breaking down organic material into nutrients that plant roots can absorb.


Ruacana
Ondangwa
Rundu
Opuwo
Möwe Bay
Kamanjab
Tsumeb
Otavi
Grootfontein
Tsumkwe
Outjo
Khorixas
Otjiwarongo
Karibib
Okahandja
Gobabis
Windhoek
Swakopmund
Walvis Bay
Gobabeb
Mariental
Maltahöhe
Bethanie
Keetmanshoop
Lüderitz
Grünau
Karasburg
Oranjemund
Noordoewer



1 Dystric Leptosols
2 Eutric Leptosols
3 Lithic Leptosols
4 Mollic Leptosols

5 Calcaric Regosols
6 Dystric Regosols
7 Eutric Regosols

8 Calcaric Fluvisols
9 Dystric Fluvisols
10 Eutric Fluvisols
11 Mollic Fluvisols
12 Salic Fluvisols

13 Cambic Arenosols
14 Chromic Arenosols
15 Ferralic Arenosols

16 Chromic Cambisols
17 Dystric Cambisols
18 Eutric Cambisols
19 Vertic Cambisols

20 Haplic Calcisols
21 Petric Calcisols

22 Petric Gypsisols

23 Sodic Solonchaks and Solonetzes

24 Chromic Luvisols

25 Alluvium, sand, gravel, calcrete plains
26 Dune sands
27 Rock outcrops
28 Coastal salt pans

2.20 Dominant soils

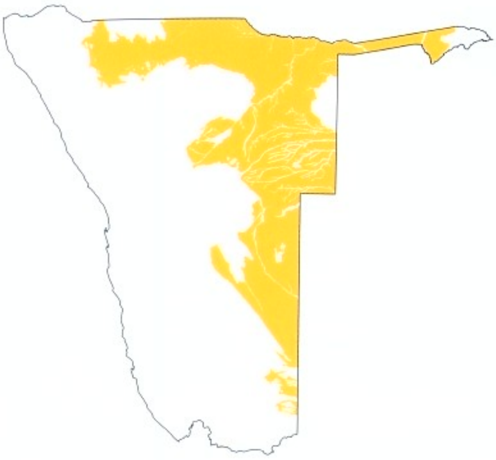
Namibian soils vary a good deal. Along with the deep sands of the Kalahari, we have the clayey and salty soils in the Cuvelai, and the shallow, mica-rich soils found in many rocky areas. These variations occur on a broad scale, but there is also a high degree of variability at a local level. Most areas consist of a mosaic of soil types, usually comprising one dominant soil that generally covers more than half of an area, and one or more associated soils. For simplicity it is often best to group areas according to the dominant soil. Consequently, this map presents information on the dominant soils only. Moreover, large areas of Namibia consist of sand dunes or rock outcrops, neither of which are really soils.

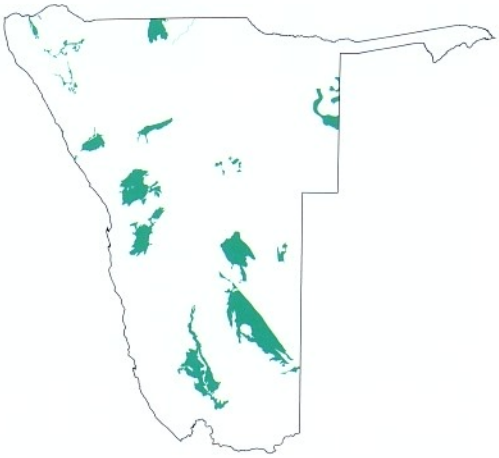
The name of each soil, for example 'calcaric fluvisols', comprises two parts. The first part of the name provides information on the properties of the soil, as follows:

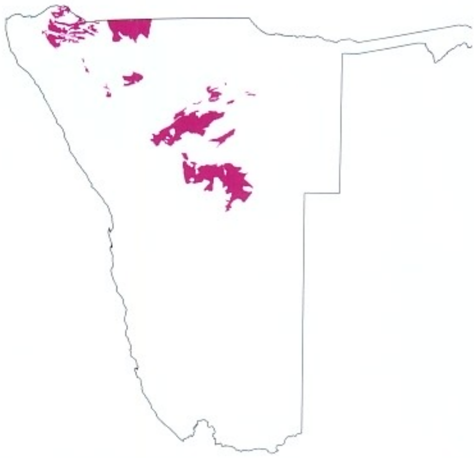
calcaric	soils containing calcareous (usually calcium carbonate) material
cambic	soils characterised by changes in colour, structure and consistency
chromic	soils with bright colours
dystric	infertile soils with a low base saturation
eutric	fertile soils with high base saturation
ferralic	high contents of combined oxides of iron and aluminium (sesquioxides)
haplic	soils with a simple, normal horizon
lithic	very thin or shallow soils
mollic	soils with a good surface structure
petric	soils with a solid layer at a shallow depth that remains hard even when wet (an 'indurated' layer)
salic	soils containing high concentrations of salts
sodic	soils with high concentrations of sodium
stagnic	soils subject to surface flooding
vertic	soils that have had the surface layers of horizons turned over or mixed
xanthic	soils that are yellow in colour

The second name, which is the soil group name, reflects the conditions or processes that led to the soil's formation. Fluvisols, for example, were deposited by rivers. The following series of figures describes the soil formations of the dominant soil types identified and shows their locations within Namibia.

Sands cover much of Namibia, especially in the huge area of Kalahari Sandveld that dominates the eastern and northern regions of the country. Although these regions receive more rain than the rest of the country, it is difficult to produce crops in them because the sands contain few nutrients and water percolates through them rapidly.







Arenosols

Arenosols are formed from wind-blown sand and usually extend to a depth of at least one metre, with sand generally making up more than 70% of the soil. The rest of the soil usually consists of particles of clay and silt. The sandy texture allows water to drain through the soil rapidly, leaving very little moisture at depths to which most plant roots can reach. Few nutrients are retained in the porous sand. The loose structure of sand means that there is little run-off and water erosion, although it makes the soils susceptible to wind erosion. Arenosols are by far the biggest soil units, covering much of eastern and north-eastern Namibia.

Calcisols

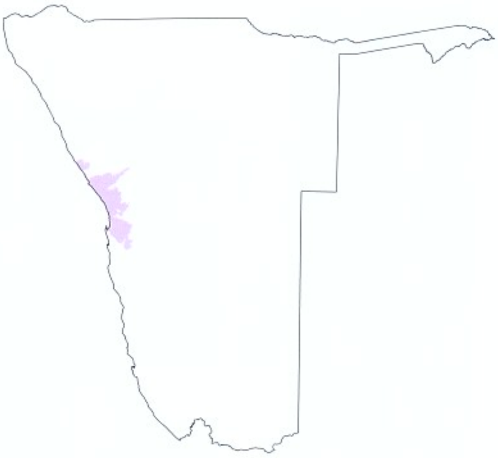
Calcisols are found in depressions or other low-lying areas of the landscape, and typically contain accumulations of calcium carbonate, often in a cemented form called calcrete. Although large white blocks of calcrete are often visible on the surface, calcrete is generally formed beneath the surface and is also often present in a soft powdery form. These soils are potentially fertile but iron and zinc may not be available to plants because of the high concentrations of calcium.

Cambisols

The cambisols are soils that were formed quite recently in geological time, mainly from medium- and fine-textured parent material deposited during sporadic flooding. Since the parent material is only slightly weathered, cambisols are characterised by the absence of appreciable quantities of accumulated clay, organic material, and aluminium and iron. Nevertheless, their fertility is usually moderate or high, in part because of their good water-holding capacity and internal drainage. The high fertility of the eutric cambisols in the central northern regions gives them the highest potential for crop cultivation, and this is one reason why so many people have settled in that area.

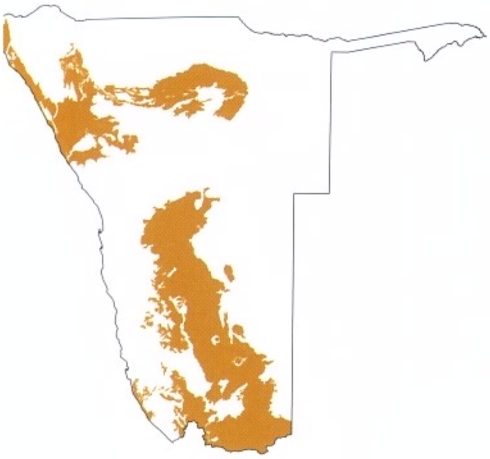
Fluvisols

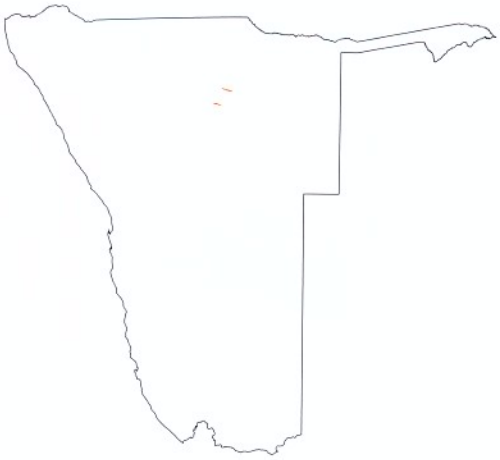
Soils along the margins and valleys of larger river courses in eastern Namibia are called fluvisols. Some are flooded regularly, especially those in and around the Zambezi River and the eastern Caprivi Floodplain, while others along the dry omurambas probably last saw flood water hundreds of years ago. Some fluvisols provide nutrient-rich soils for crop cultivation, a quality exploited by many farmers in Caprivi and Kavango.

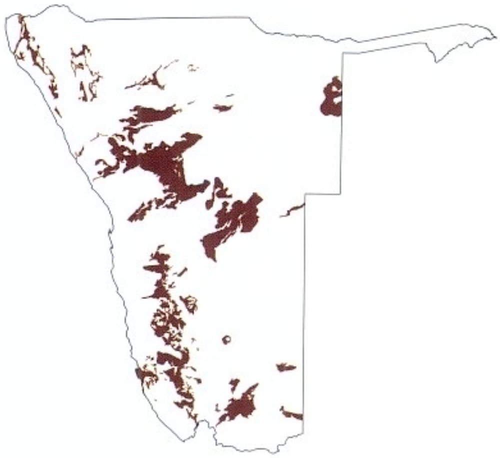


Gypsisols

Accumulations of calcium sulphate are characteristic of gypsisols, which are restricted to the very dry areas of the central Namib. The calcium sulphate is dissolved out of the rock and soil, and then carried by percolating water beneath the surface, where it remains in a variety of forms: as powder, pebbles, stone or gypsum crystals. Some crystals grow large enough to become the famous desert roses that many people collect as ornaments. The crystals may also form a compact layer or crust just below the surface. Gypsisols generally have very low levels of fertility, so only the hardiest of plants will grow in them.







Leptosols

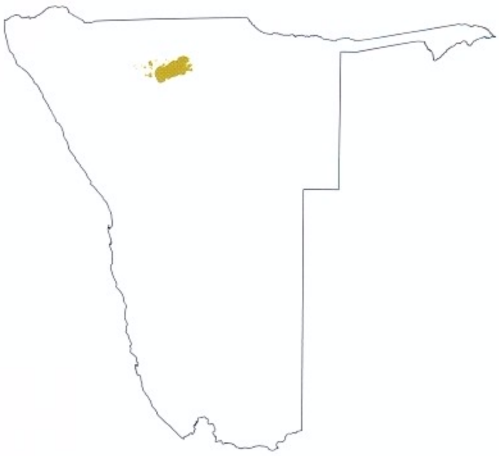
Leptosols typically form in actively eroding landscapes, especially in the hilly or undulating areas that cover much of southern and north-western Namibia. These coarse-textured soils are characterised by their limited depth caused by the presence of a continuous hard-rock, highly calcareous or cemented layer within 30 cm of the surface. The leptosols are, therefore, the shallowest soils to be found in Namibia and they often contain much gravel. As a result, their water-holding capacity is low, and vegetation in areas in which they occur is often subject to drought. Rates of water run-off and water erosion can be high when heavy rains fall. At best, these soils can support low densities of livestock and wildlife.

Luvisols

Soil units belonging to the luvisols are confined to two small areas west of Grootfontein. They are suited to a range of agricultural uses because of their good water-holding capacity and well-drained, porous and aerated structure. Luvisols typically comprise an accumulation of clay that has settled some depth below the surface.

Regosols

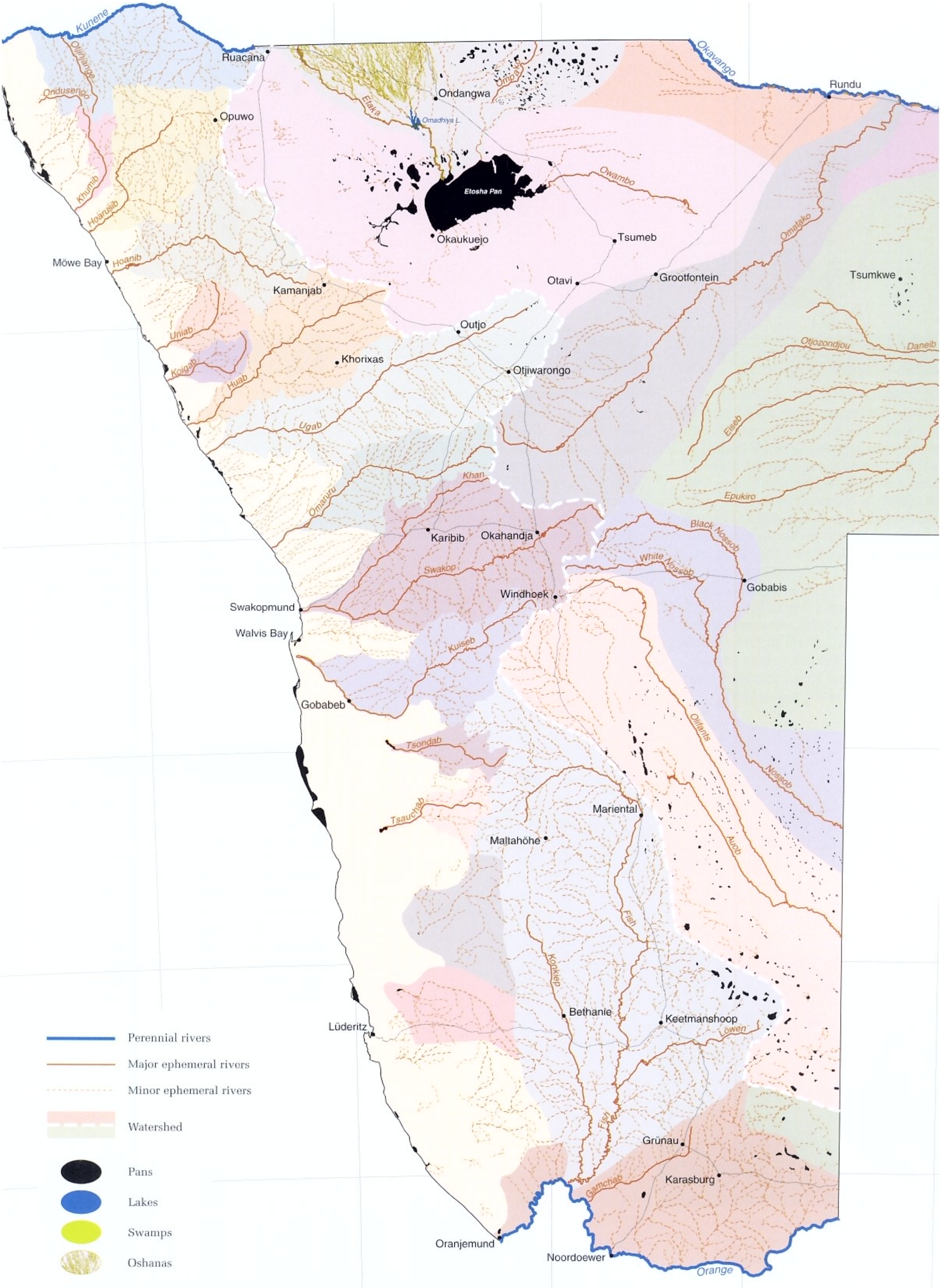
Regosols are medium- or fine-textured soils of actively eroding landscapes, the thin layers lying directly above the rock surfaces from which they formed. Although not as shallow as the leptosols, these soils never reach depths of more than 50 cm. The central regions of the country are dominated by regosols, which are especially susceptible to erosion where there is any degree of slope. Vegetation cover on these thin soils is generally sparse because they cannot provide most plants with sufficient water or nutrients. Areas with regosols can support low-density stock farming or wildlife.



Solonchaks and solonetzes

These are the saltiest or most saline soils. Etosha Pan is the only large area of solonchaks in Namibia, while a sizeable area of solonetz soils lies along its north-eastern border. There are also very many tiny patches of solonetz soils in pans elsewhere, and there are a few small areas of solonchaks along the coast. The soils typically form where salts are abundant and rates of evaporation are particularly high. Only a few species of specialised plants can grow in such saline soils.

Desert roses are ornate crystals formed from concentrations of calcium sulphate that accumulate in gypsisols along the coast.



Kunene
Okavango
Orange
Ruacana
Ondangwa
Rundu
Opuwo
Omadhiya L.
Etosha Pan
Etaka
Omuramba Ovambo
Oshigambo
Otjinjange
Ondusengo
Khumib
Hoarusib
Hoanib
Möwe Bay
Okaukuejo
Tsumeb
Kamanjab
Otavi
Grootfontein
Tsumkwe
Outjo
Khorixas
Otjiwarongo
Uniab
Koigab
Huab
Ugab
Omaruru
Khan
Omatako
Otjozondjou
Daneib
Eiseb
Epukiro
Black Nossob
White Nossob
Karibib
Okahandja
Swakop
Swakopmund
Walvis Bay
Windhoek
Gobabis
Kuiseb
Gobabeb
Tsondab
Tsauchab
Olifants
Nossob
Auob
Mariental
Maltahöhe
Fish
Konkiep
Bethanie
Keetmanshoop
Löwen
Lüderitz
Grünau
Karasburg
Gamchab
Oranjemund
Noordoewer
Perennial rivers
Major ephemeral rivers
Minor ephemeral rivers
Watershed
Pans
Lakes
Swamps
Oshanas

Surface water

There is not much water to be seen on the surface in Namibia. The little rain that falls evaporates, seeps into the ground, or is rapidly drained by ephemeral rivers. The rivers that can hold surface water are, however, extremely varied, ranging from the great rivers that define the country's borders, to a host of smaller rivers and channels that flow at varying frequencies. There are also thousands of pans that are sometimes filled or covered by a shallow layer of water. They, too, vary in shape, size and nature: from the giant Etosha Pan (4,800 km^2) to other smaller, salty pans, or to tiny freshwater pans that support a few large trees along their margins. Namibia also has two lakes: the Omadhiya Lake Complex and Lake Liambezi. Several man-made lakes or dams that are now important bodies of water are described in Chapter 6 (see Figure 6.37).

The more permanent and regular surface waters support a great number of people in Namibia. Thus, about 23,000 people live within 5 km of the perennial rivers and associated floodplains in eastern Caprivi. Another 124,000 live within the same distance of the Okavango River, while about 461,000 people live in and around the network of channels known as 'oshanas' that make up the Cuvelai Drainage System.[7] Altogether this amounts to about 32% of Namibia's population.

The rivers provide several kinds of resources to people living close by, such as fish for food, water for domestic and farming uses, building materials and, perhaps most importantly, fertile soils on which to grow crops. The rivers also support a rich fauna and flora.

2.21 Rivers, basins, pans and lakes

This map provides a perspective on all surface waters within Namibia, while the next map (Figure 2.22) shows the areas drained by the large perennial rivers that have their origins in neighbouring countries. The great majority of surface-water areas are dry for most of the year. This is especially true of the intricate network of ephemeral rivers – watercourses that carry water only briefly after a heavy rainfall. Some rivers flow every year, even though the flows only last a few hours or days, while others may not flow for several years. The ephemeral rivers flow west, south or northwards, and some of the bigger rivers regularly carry enough water to reach the sea. Others, like the Tsondab and Tsauchab rivers, never reach the sea: their water filters into the ground or collects in and evaporates from large pans such as the Tsondabvlei and Sossusvlei.

All the ephemeral rivers that flow in an easterly direction are essentially dry rivers. They very seldom carry water for any distance, and many have not carried water along their whole lengths in living memory. Their river courses cut through very flat areas that are dominated by Kalahari sands, and they do not have clearly defined catchment areas as a result. This is unlike the clearly defined catchments for the other ephemeral rivers, the largest of which are, in order of size, the Fish, the Ugab, the Swakop and the Omaruru catchment areas.

Although the Etosha Pan is well known as the biggest and most famous pan in Namibia, there are thousands of other pans scattered throughout the north, south-east and coastal areas of the country. Those to the north and west of Etosha are salty, and several of those close to Etosha have been used by generations as valuable sources of salt, both for domestic consumption and for trade. Other salt pans occur along the coast, while the commercial salt works at Walvis Bay, Swakopmund and Cape Cross are simply artificially created salt pans.

Most pans elsewhere are largely freshwater in nature because water drains into the pans after heavy local falls of rain and remains trapped by the layers of clay that seal the floors of the pans. Most of these pans are very small and occur in areas of Kalahari sands (see Figure 2.13). Those in north-eastern Otjozondjupa near Tsumkwe are extremely important wetlands, especially as breeding sites for many water birds.

Namibia has only two natural lake systems: the Omadhiya Lake Complex in Oshana, and Lake Liambezi in Caprivi. Lake Oponono is the biggest and best known of the Omadhiya Lakes and regularly receives water from the Cuvelai System of oshanas (a mesh of interconnected channels) to the north. Liambezi was flooded from the 1950s until 1985, and during that time supported a substantial fishing industry. It has been dry since then, apart from temporary fillings of part of the lake area in 1989 and 2001. Whilst Lake Guinas and Lake Otjikoto are also called lakes, they are really sinkholes which contain underground water that is now visible because the ceilings of the caverns that used to conceal the water have disappeared (see Figure 2.27 and page 64).

2.22 Perennial rivers and the Cuvelai System

The major river systems that form a large portion of Namibia's borders drain huge areas of the neighbouring countries. The Zambezi, for example, carries by far the greatest volume of water (an average of 40,000 million m^3 per year), which is over 40 times more than that carried by the Kwando River. The lengths of the perennial rivers flowing within or along the borders of Namibia are as follows: Kwando–Linyanti (340 km), Kunene (344 km), Okavango (470 km), Orange (580 km) and Zambezi–Chobe (340 km).

Only three of the perennial rivers reach the ocean: the Zambezi flows eastwards through Zimbabwe and Mozambique to the Indian Ocean, while Namibia shares the Atlantic Ocean mouth of the Orange River with South Africa and that of the Kunene with Angola. By contrast, the combined Okavango and Cuito rivers end their journeys inland in the Okavango Delta in Botswana. The Kwando also ends inland, feeding the Linyanti Swamps, but its waters may mix with those of the Zambezi through the Linyanti Swamps, Lake Liambezi and the Chobe River. The Linyanti River (and associated swamps), which flows in an easterly direction towards Lake Liambezi, is an extension of the Kwando River, while the Chobe River is really a backwater of the Zambezi.

The upper catchments of the Okavango and Zambezi rivers draining parts of Angola and Zambia have been altered the least by human activity. Few dams have been built on them, there has been little artificial channelling of the rivers, and few agricultural chemicals are used in their catchment areas. By contrast, many dams – large and small – have been built on the Orange River and its tributaries, and it drains large areas of intensive farmland on which substantial amounts of pesticides and fertilisers are used.

The complex network of interconnected channels – known locally as 'oshanas' – making up the seasonal Cuvelai System originates in highland areas in Angola, where annual rainfalls often exceed 700 mm. The network initially spreads out and later converges once it crosses the Namibian border. Water flows vary each year, depending on the amounts of rain and where it falls. Much of the water in the oshanas is also often the result of heavy falls of rain within central northern Namibia. A good flow, or 'efundja', occurs in about four out of ten years on average, when water surges down to the Omadhiya Lakes, to the Ekuma River and into the Etosha Pan.

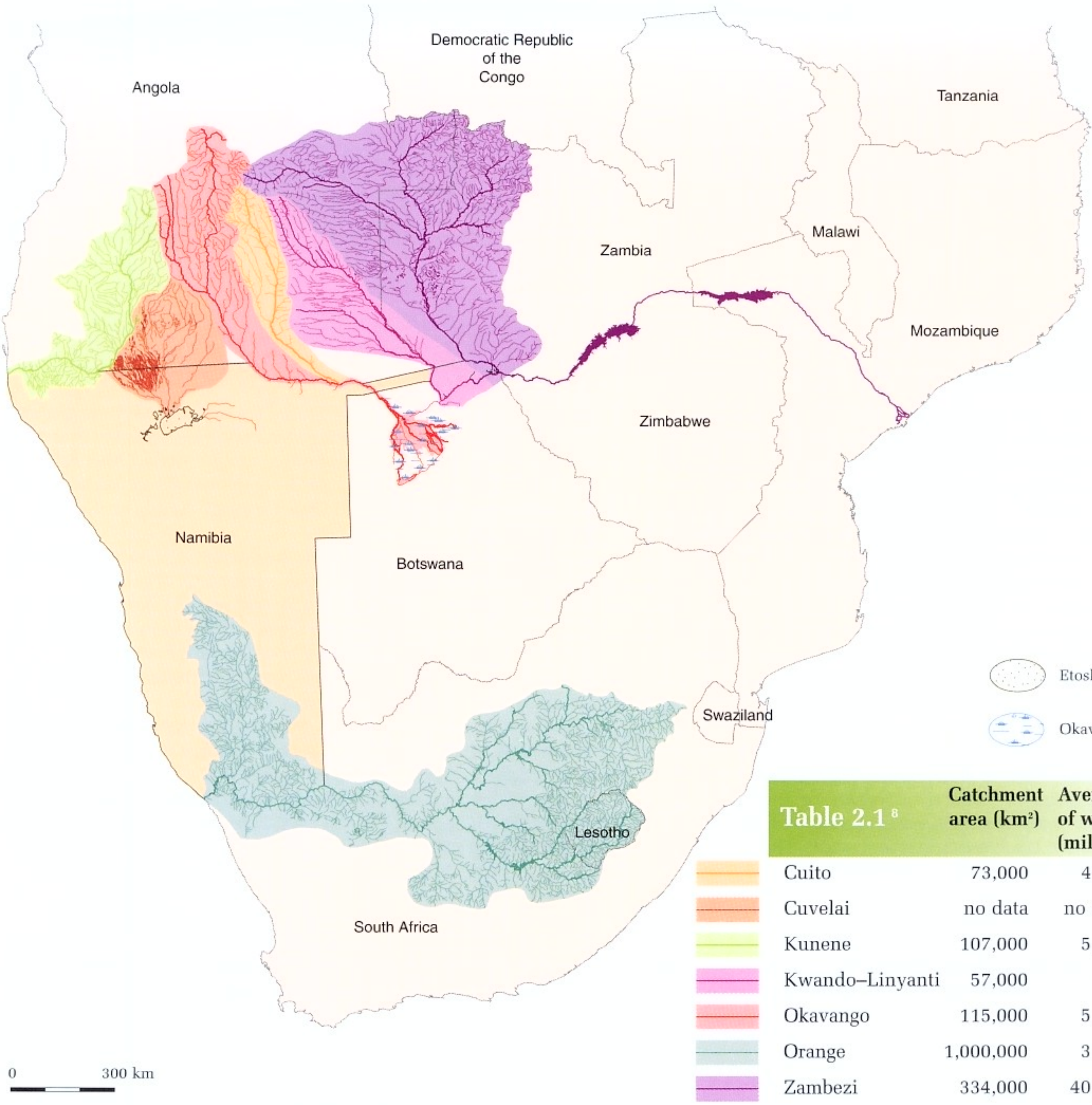
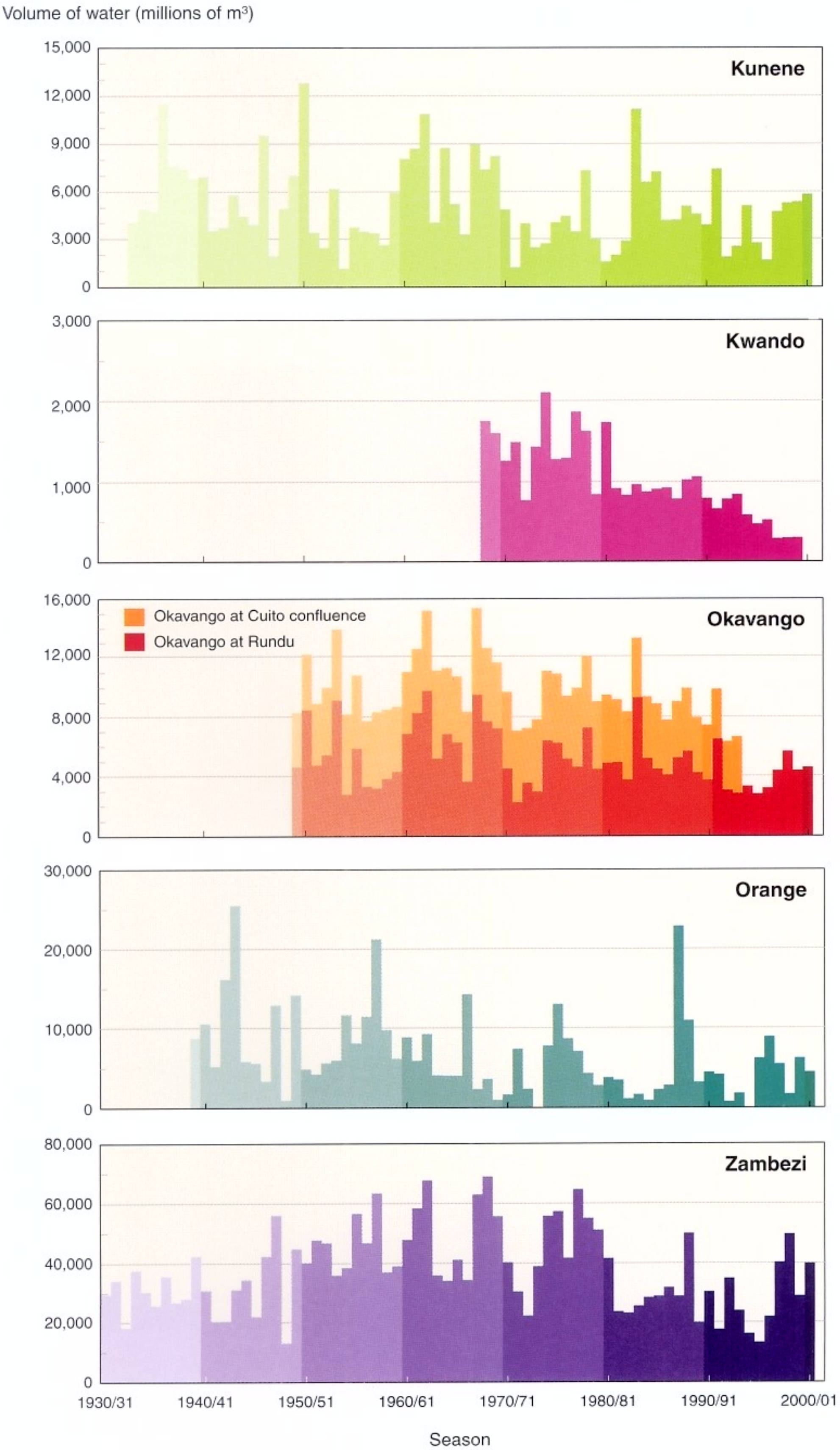
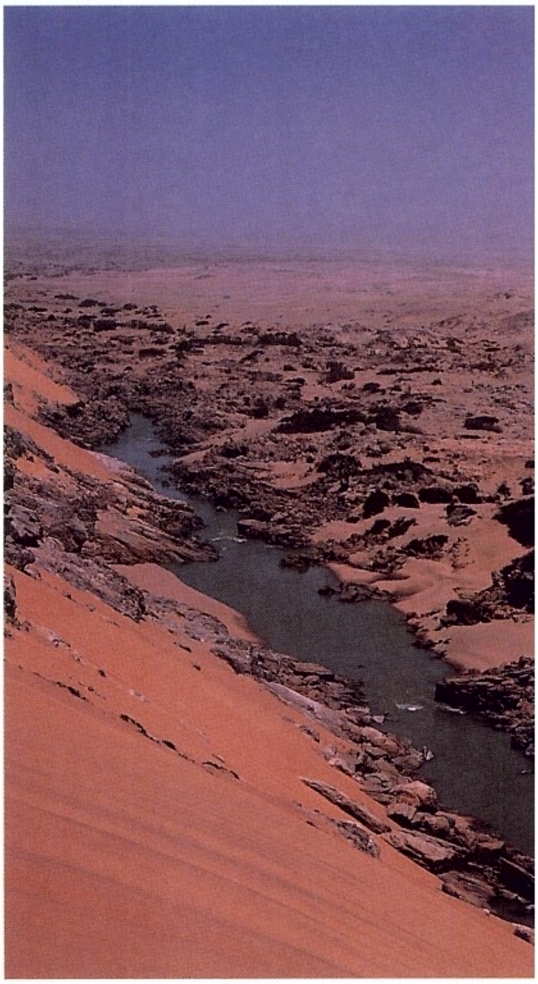


Table 2.1 [8]	Catchment area (km^2)	Average volume of water per year (million m^3)
Cuito	73,000	4,500
Cuvelai	no data	no data
Kunene	107,000	5,100
Kwando–Linyanti	57,000	915
Okavango	115,000	5,200
Orange	1,000,000	3,400
Zambezi	334,000	40,000

2.23 Total volumes of water in the perennial rivers

Water flows in the perennial rivers vary enormously from year to year, generally in response to the amounts of rain falling in their catchment areas. However, the volumes carried by some rivers fluctuate much more than others. For example, water levels in the Kwando and Cuito vary least because these rivers are fed mainly by large swamps, which act rather like sponges, absorbing rainwater and then slowly releasing it. The flow of the Orange River fluctuates less than it did before many large dams were built along its course in South Africa. The dams regulate the flow of water so that there are fewer surges of high water and also fewer periods when water levels drop very low. Moreover, average flow rates in the section of the Orange River forming Namibia's border have been reduced to around 25% of natural levels as a consequence of the dams and irrigation off-take along its course.





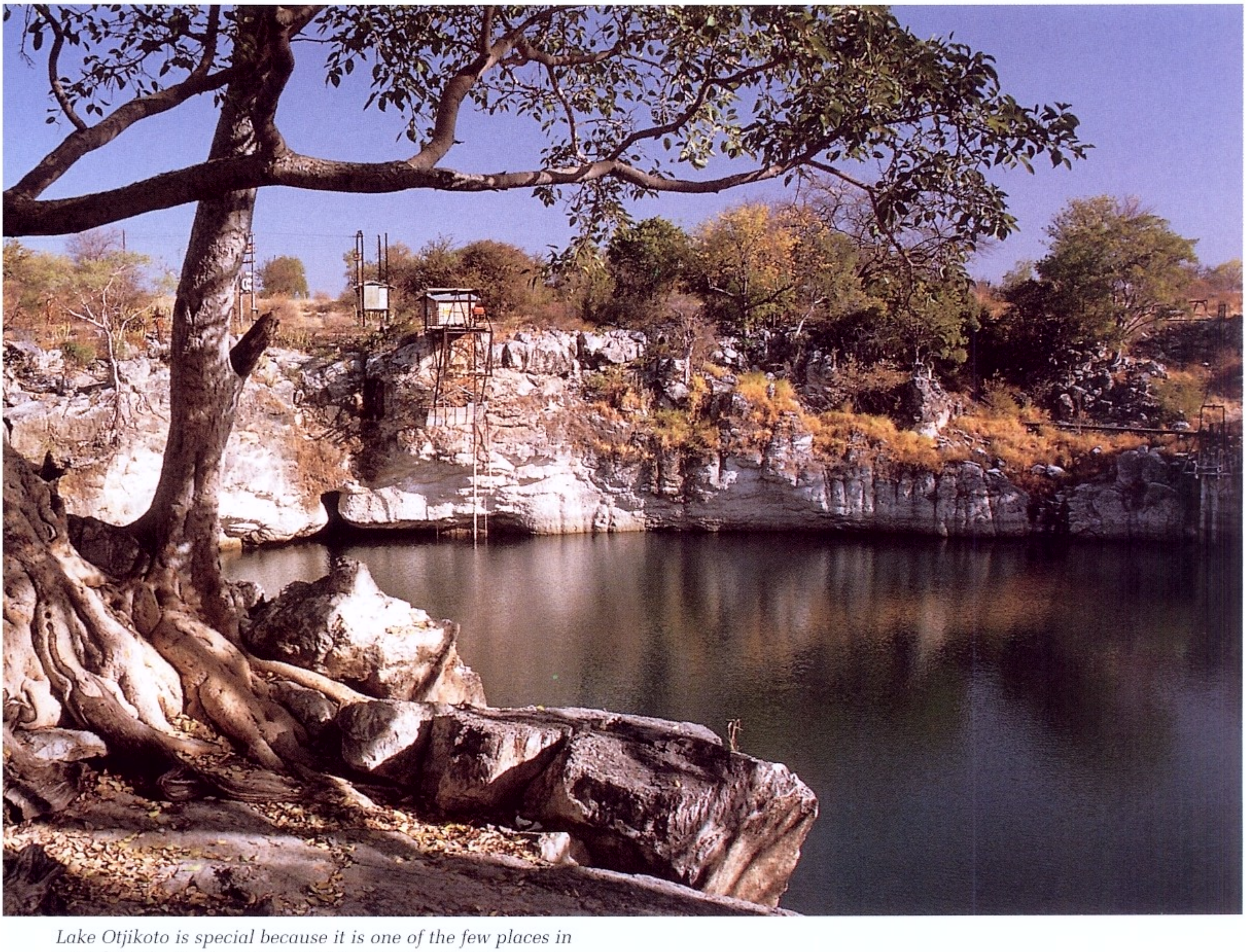
All the water carried by the Kunene River comes from catchments in much higher rainfall areas in central Angola. However, the Kunene valley, which now forms the border between Angola and Namibia, was originally formed by glaciers about 280 million years ago.

Groundwater

Most rainwater evaporates, drains away along rivers and channels, or is captured by plants. However, other rainwater seeps into the ground, and it is this water that forms the subject of this section.

In a country where surface water is so sparse, groundwater is a resource of key importance. Some estimates suggest that over half of all water used by people in Namibia is abstracted from aquifers – underground zones in which water has accumulated and remains trapped. Some of these bodies of water are close to the surface, and hand-dug wells into shallow aquifers have provided people with sources of water for hundreds of years. Other aquifers, however, lie at much greater depths (often over 100 m deep), and finding them requires a good knowledge of geological features and an understanding of the properties of different types of aquifers. It is important to note that aquifers are generally discrete or separate bodies of water, and Namibia does not have a single, large and continuous pool of water lying beneath the ground.

Much of our current understanding of aquifers comes from interpreting information collected from the drilling of over 50,000 boreholes in Namibia. These have been drilled in the search for sources of 'good' water – water that is free from high concentrations of salts and other chemicals, and which is present in sufficient quantities to provide a reliable pumped supply to the surface. The following maps provide some information on the location, yield and quality of Namibia's valuable underground water reserves.



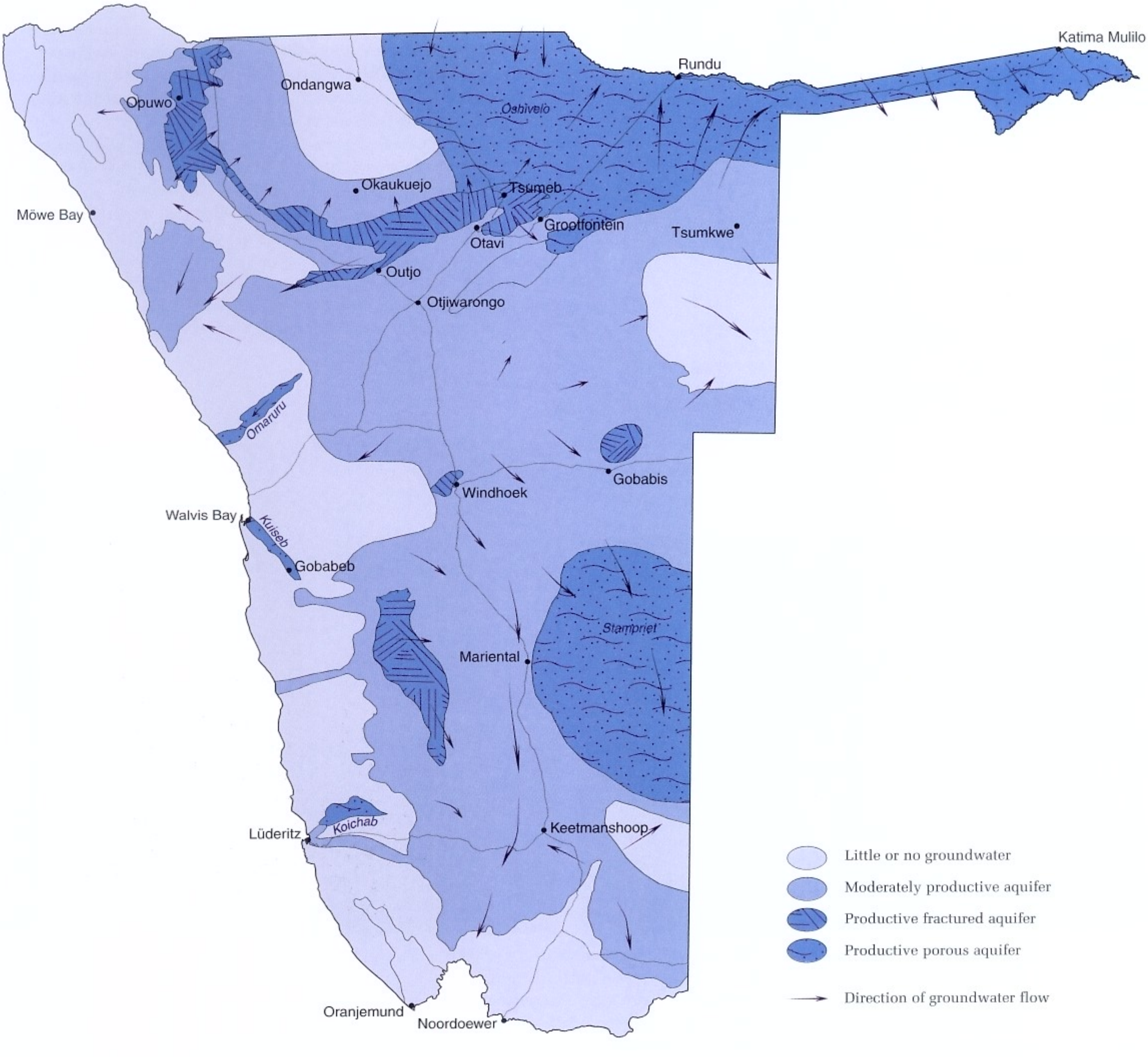
Lake Otjikoto is special because it is one of the few places in Namibia where people can actually see underground water. The lake is in fact a subterranean cavity that has been filled with groundwater to become an aquifer, and it is visible because the roof of the cavity collapsed hundreds or thousands of years ago.

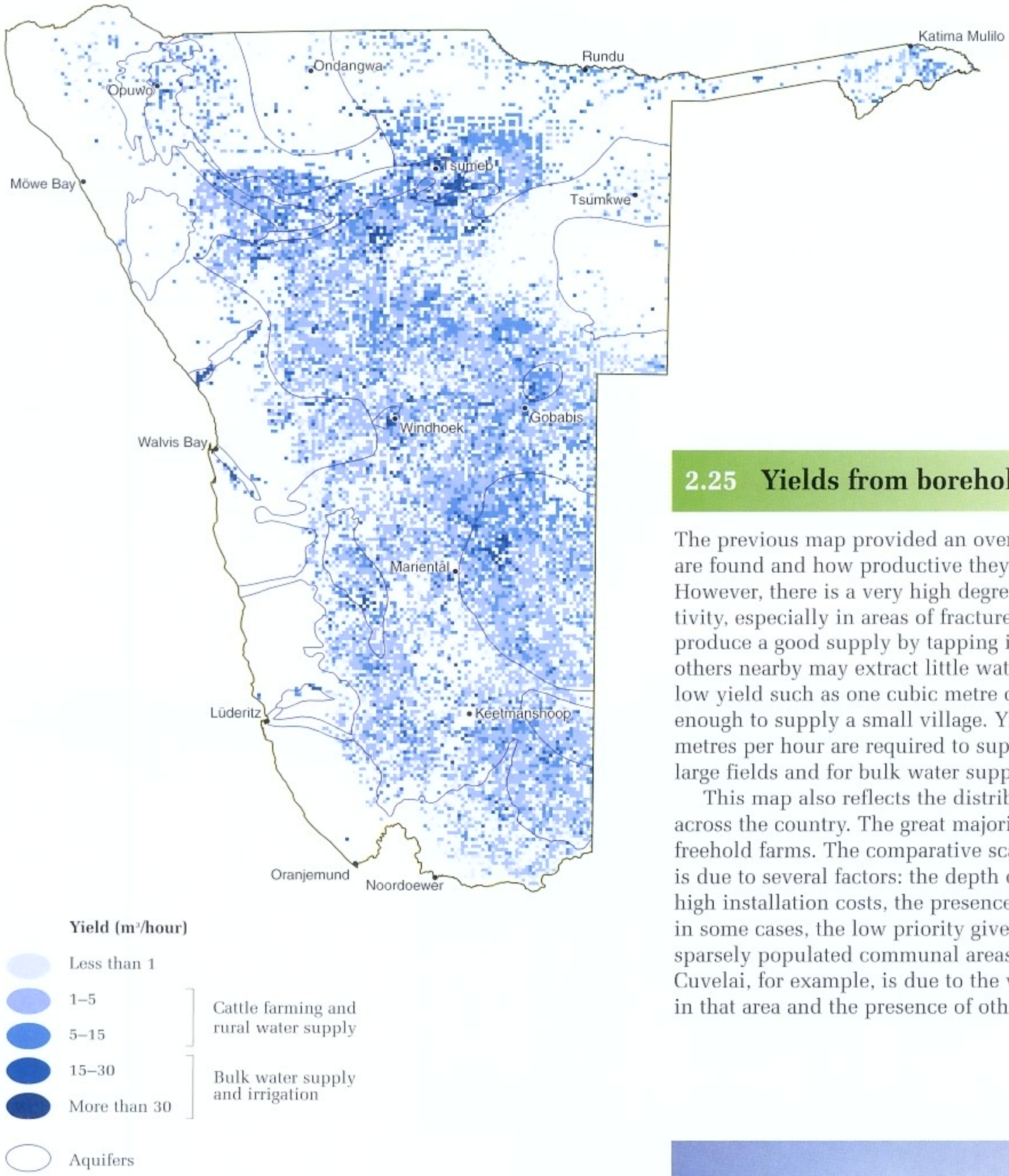
2.24 Types of aquifers and their overall productivity [9]

Namibia can be divided into zones with good reserves of groundwater, those with moderate reserves, and areas with little or no water. These reserves – or aquifers – can themselves be subdivided into the fractured or porous types. Fractured aquifers are found in hard rocks where there are joints and faults, the water seeping through the fractures and narrow crevices in the rock. In some aquifers, these spaces have been enlarged into caverns as water has progressively dissolved the rock. Those in the limestone and dolomite Karstveld near Otavi, Tsumeb and Grootfontein were formed in this way, for example. Porous aquifers, on the other hand, occur in sandy areas, where the water percolates through the sand and fills up the tiny spaces between grains. A typical porous aquifer is the Koichab aquifer (near the Koichab Pan), which supplies Lüderitz with all its water.

In many areas water simply seeps down from the surface above, but in some other areas it also flows laterally underground. The latter aquifers may, therefore, also be recharged by water that initially fell as rain some distance away. The arrows on the map show the major directions of underground flow in Namibia. Much of the flow into the Owambo and Nama basins comes from surrounding higher areas. Likewise, water flows under the ground from the escarpment to lower areas along the coast. In a few special places, underground water actually pushes up to the surface as artesian wells or fountains (for example, the Stampriet artesian wells and the springs south of Etosha Pan).

Some of the largest and most productive aquifers in Namibia are indicated on this map. The most notable ones are the Oshivelo artesian aquifer; the Stampriet aquifer, which seeps through the overlying Kalahari sands until it is trapped by a layer of Karoo sandstone; the Kuiseb and Omaruru aquifers, which supply Henties Bay, Swakopmund and Walvis Bay as well as Arandis and Rössing Mine; and the Koichab aquifer at Lüderitz. These are all porous aquifers. The best-known fractured aquifer is the one that encircles the Owambo Basin and supplies water to towns such as Grootfontein, Otavi, Outjo and Tsumeb. Some of this water is also pumped from Berg Aukas and Kombat into the Eastern National Water Carrier to supply water to users further south (see Figure 6.37).



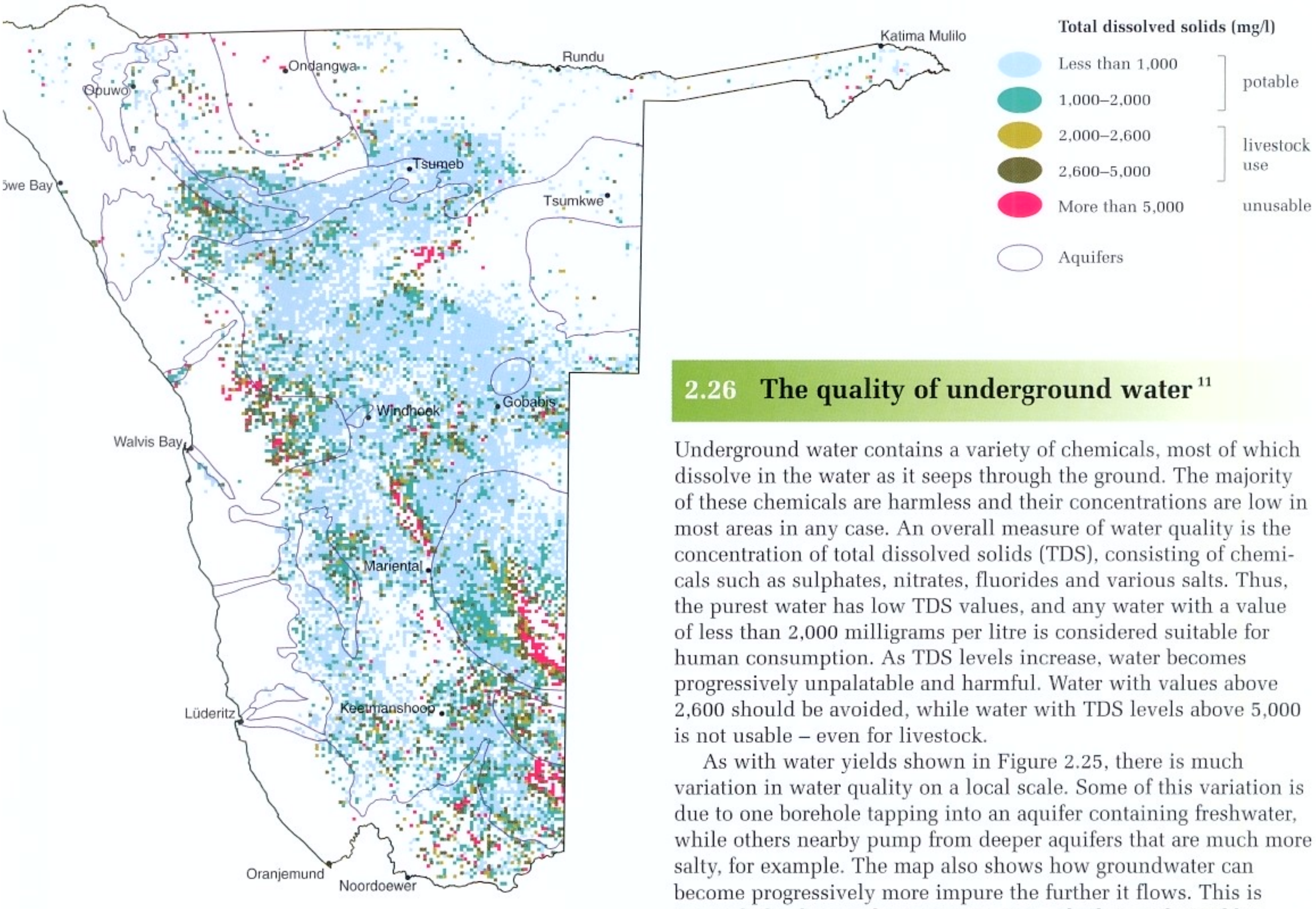


2.25 Yields from boreholes [10]

The previous map provided an overall summary of where aquifers are found and how productive they are in relation to each other. However, there is a very high degree of local variation in productivity, especially in areas of fractured aquifers. One borehole can produce a good supply by tapping into a small, rich aquifer, while others nearby may extract little water. However, even a relatively low yield such as one cubic metre of water per hour is often enough to supply a small village. Yields of 15 and more cubic metres per hour are required to supply enough water to irrigate large fields and for bulk water supplies to towns.

This map also reflects the distribution of drilled boreholes across the country. The great majority were drilled privately on freehold farms. The comparative scarcity of boreholes elsewhere is due to several factors: the depth or salinity of the groundwater, high installation costs, the presence of better sources of water and, in some cases, the low priority given in the past to water supply in sparsely populated communal areas. The lack of boreholes in the Cuvelai, for example, is due to the very salty underground water in that area and the presence of other water sources.

The availability of water is a limiting factor for livestock in many areas of the country. Thousands of boreholes have therefore been drilled and equipped with windmills and other kinds of pumps to bring groundwater to the surface. Ironically, too much water has been provided in some areas, which are now badly overgrazed because they have been stocked with many more animals than the pastures can support.



2.26 The quality of underground water [11]

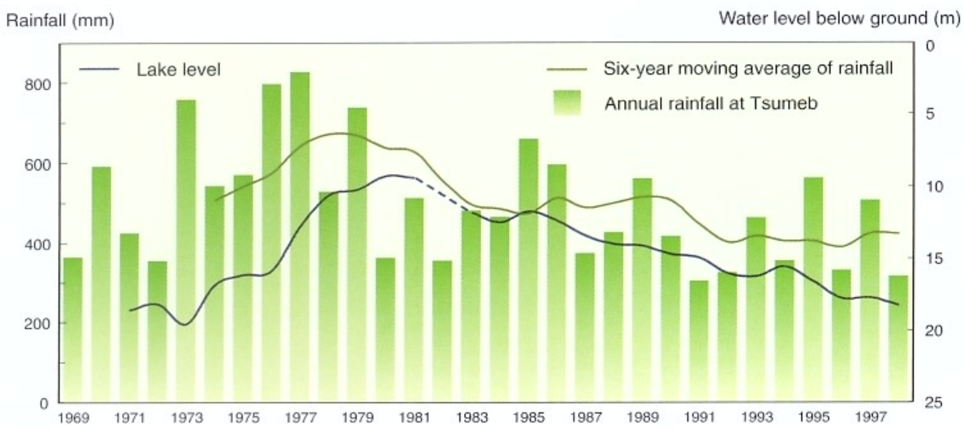
Underground water contains a variety of chemicals, most of which dissolve in the water as it seeps through the ground. The majority of these chemicals are harmless and their concentrations are low in most areas in any case. An overall measure of water quality is the concentration of total dissolved solids (TDS), consisting of chemicals such as sulphates, nitrates, fluorides and various salts. Thus, the purest water has low TDS values, and any water with a value of less than 2,000 milligrams per litre is considered suitable for human consumption. As TDS levels increase, water becomes progressively unpalatable and harmful. Water with values above 2,600 should be avoided, while water with TDS levels above 5,000 is not usable – even for livestock.

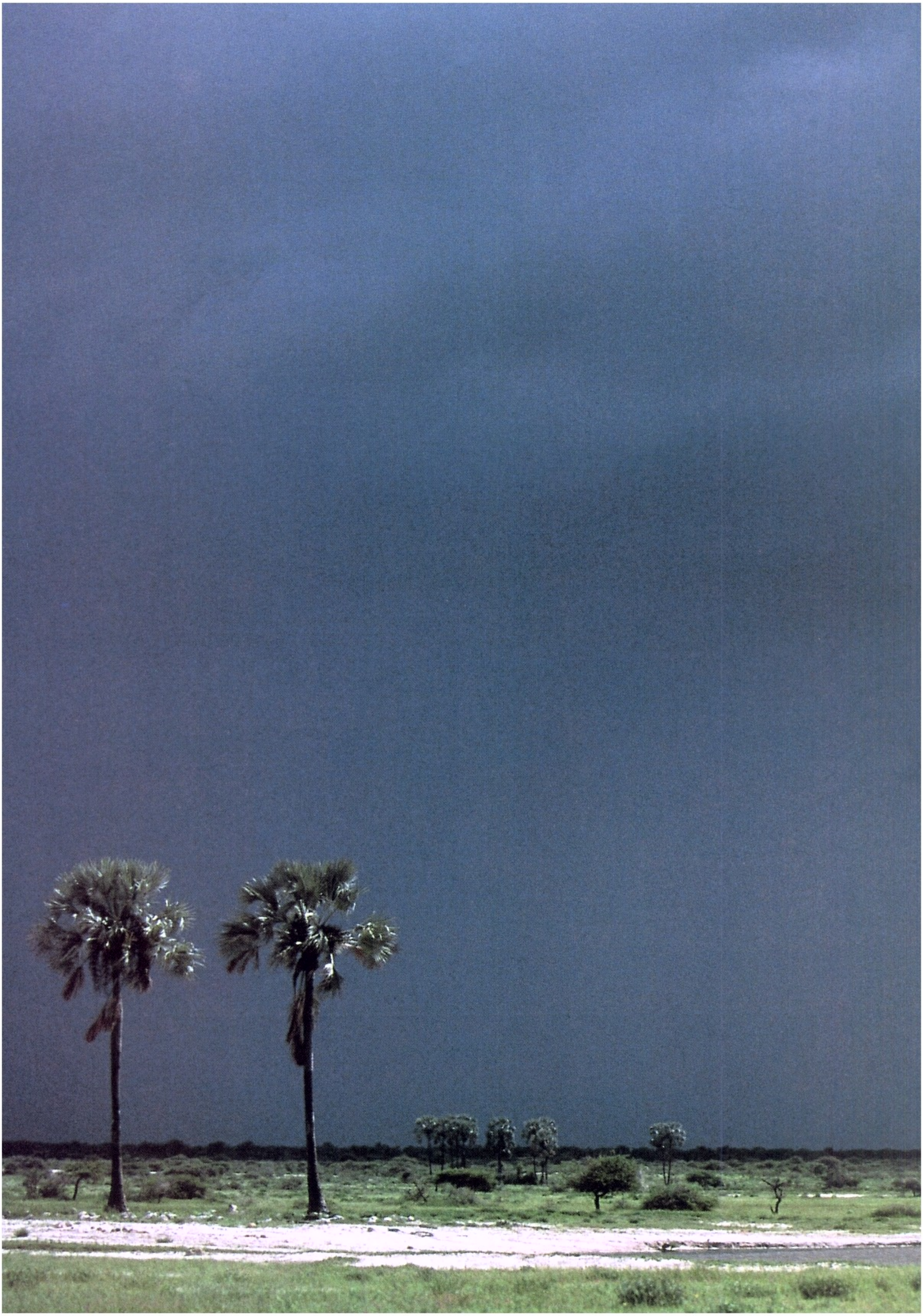
As with water yields shown in Figure 2.25, there is much variation in water quality on a local scale. Some of this variation is due to one borehole tapping into an aquifer containing freshwater, while others nearby pump from deeper aquifers that are much more salty, for example. The map also shows how groundwater can become progressively more impure the further it flows. This is particularly clear in the Stampriet area, which is recharged by water that first flows into the ground at the north-west end of the aquifer. Here, water quality is high but deteriorates as it flows south-eastwards.

2.27 Changing levels of underground water at Lake Otjikoto [12]

The levels of groundwater in Lake Otjikoto provide telling lessons about how underground water reserves change, especially if water is pumped from them more quickly than the time it takes for the reserves to be replenished. For example, the water levels in Lake Otjikoto dropped steadily during the 1980s and 1990s because rainfalls were lower and large amounts of water were pumped for use at Tsumeb and to irrigate nearby fields. Levels rose slightly following years with good rains, but the overall rate of pumping remained higher than the rate of recharge.

The dangerous overuse of water resources has occurred in many aquifers in Namibia. Some underground water (for example, in the Koichab aquifer) is estimated to be tens of thousands of years old and is therefore not a renewable resource within our life spans. Other aquifers, especially those in areas with coarse sands, are often replenished quickly, with the levels of the water rising soon after good rains have fallen.





CHAPTER 3: *Climate*

Climate has a major influence on all aspects of life in Namibia. For example, climate affects the availability of water, where and when crops can be grown, pastures for grazing, the distribution and abundance of animals and plants, and the potential for using wind and solar energy. By showing how climatic features vary geographically, maps in this chapter help provide an understanding of how the actual or possible use of natural resources varies from place to place.[1]

Although there have certainly been wetter and drier periods or cycles, Namibia's climate has probably been rather similar to what it is today for millions of years. The oldest sand dune deposits in the Namib Desert go back perhaps 13–18 million years, so the kind of dry conditions necessary for their formation have been present for a long time. Similarly, soils and salt concentrations in underground water suggest that, over tens of millions of years, the central areas of northern Namibia have been subject to patterns of sporadic flooding and high rates of evaporation similar to those that occur now.

The kind of climate seen today, therefore, has shaped the country over a long time. Most animals and plants have evolved to live in a climate that is often dry, variable and relatively harsh. Likewise, much of Namibia's topography, river systems and, most importantly, its soils have been formed by climatic conditions similar to those shown in the maps ahead. The absence of deep soils over much of the country and the low levels of nutrients in most soils, especially in the extensive sands covering much of the eastern and northern regions, are also the result of dry conditions that have prevailed for a long time.

The reader should note that many graphs showing annual trends start in July and end in June. This is because Namibia's summer rainfall season straddles the last quarter of one year and the first part of the next year.

Climate systems

Most climatic features result directly from Namibia's position, where it spans a zone roughly between 17° and 29° South of the equator, and lies along the south-western coast of the African continent. This puts Namibia in an area where it is exposed to air movements driven by three major climate systems or belts: the Intertropical Convergence Zone, the Subtropical High Pressure Zone, and the Temperate Zone.

The relative positions of the systems really determine what rainfall Namibia gets. This is especially true of the Intertropical Convergence Zone and the Subtropical High Pressure Zone, because there is an ongoing 'struggle' between the two: the Intertropical Convergence Zone feeds in moist air from the north, while the Subtropical High Pressure Zone pushes the moist air back with dry, cold air. However, it is the Subtropical High Pressure Zone that usually dominates, and gives Namibia's climate its most important feature: the dry weather that prevails for much of the year. Air in a high-pressure zone descends, heating and drying as it reaches lower levels. There is, thus, an overall absence of water in the atmosphere, and it is this – rather than a lack of rain – that actually makes Namibia dry. The lack of moisture means that there are few clouds, radiation from the sun is intense, and daytime temperatures are high. Water evaporates rapidly and little rain falls. By contrast, countries that have plenty of water vapour in the atmosphere above them are often blanketed with clouds that produce rain, shield the sun, and reduce evaporation because of the cooler and moister conditions.

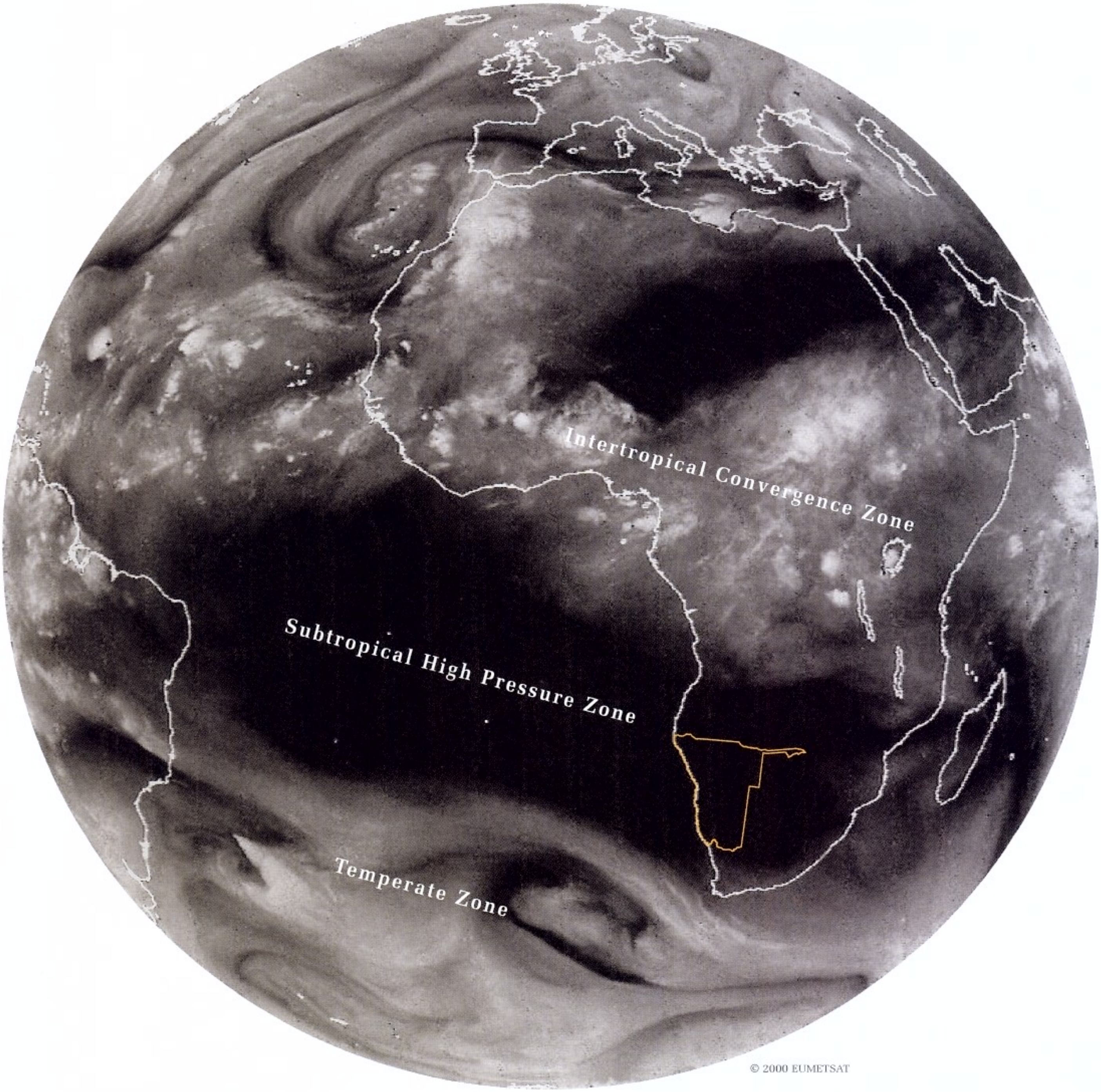
3.1 The major climate systems, as seen from space[2]

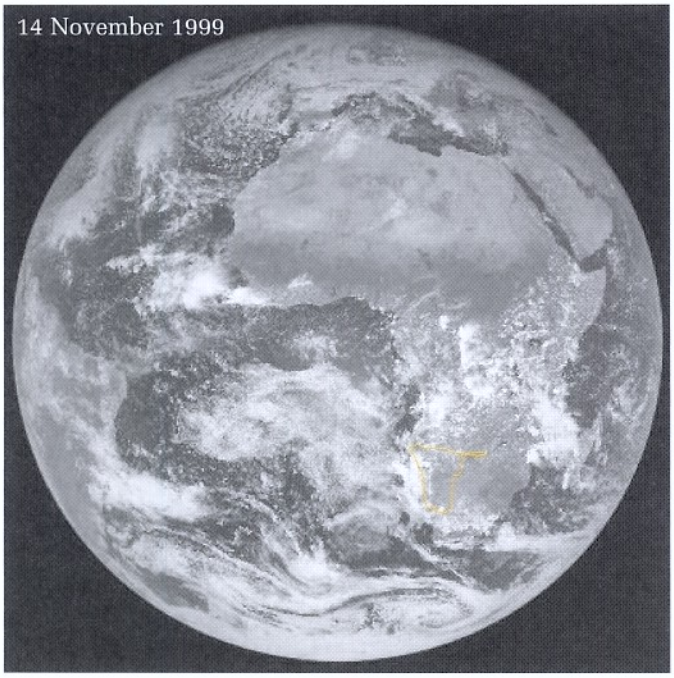
The three major climate systems (see page 70) extend right around the earth. The Intertropical Convergence Zone appears in the centre of the image as a broad band of moisture-bearing air shown as the lighter tones in the image. This is an area of intense weather activity where moist air, much of it carried by winds off the Indian and Atlantic oceans, converges in the zone of low pressure. The air rises because it is warm, cooling and condensing to form water vapour as it reaches higher levels. The giant cloud masses formed by the water vapour often produce large amounts of rain in the tropics.

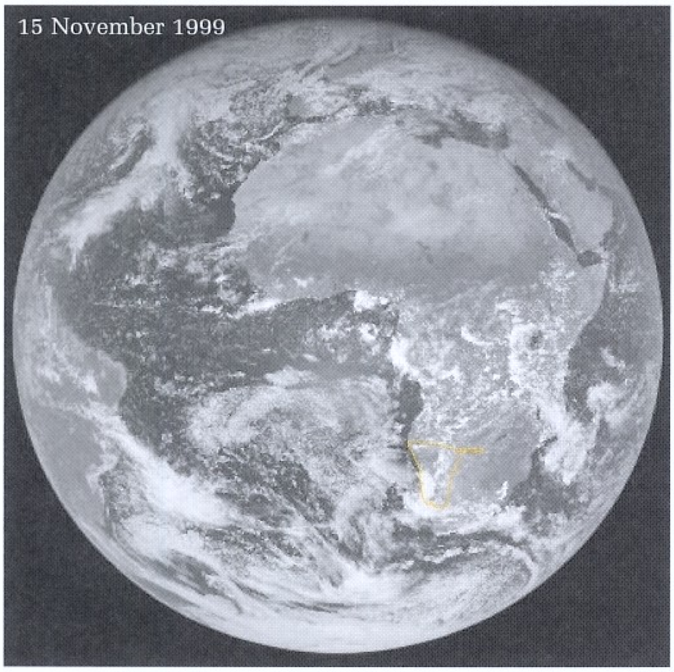
South of the Intertropical Convergence Zone lies the Subtropical High Pressure Zone, shown in the image below as a massive, dark band of dry air. Cells of high pressure dominate this broad area, and two of these cells make Namibia's climate so dry. The first is the Botswana Anticyclone, which is most prominent in winter when it feeds dry air over Namibia and obstructs the flow of moist air in from the north. The second is the South Atlantic Anticyclone, a powerful engine that blows cool air onto the coast from the south-west. This anticyclone has been in place for a long time, and it is the reason why there is a sea of sand in the Namib Desert. Its strong winds have blown sand (and, with the sand, diamonds!) from the shore inland over millions of years.

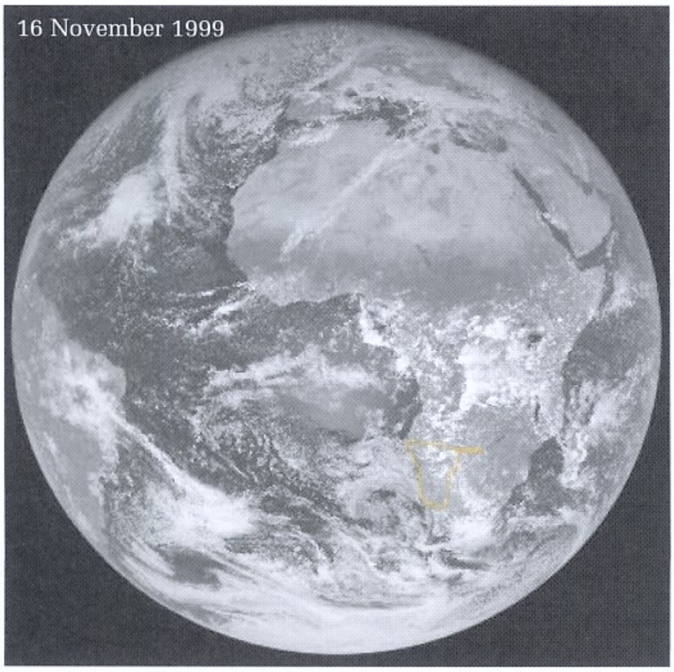
The Temperate Zone wraps the bottom of the earth in another broad band of moist air. Prevailing westerly winds carry a succession of low-pressure systems and cold fronts from west to east in the zone. The systems originate as bursts of cold air from the Antarctic, and many of the cold fronts sweep across southern Africa in winter.

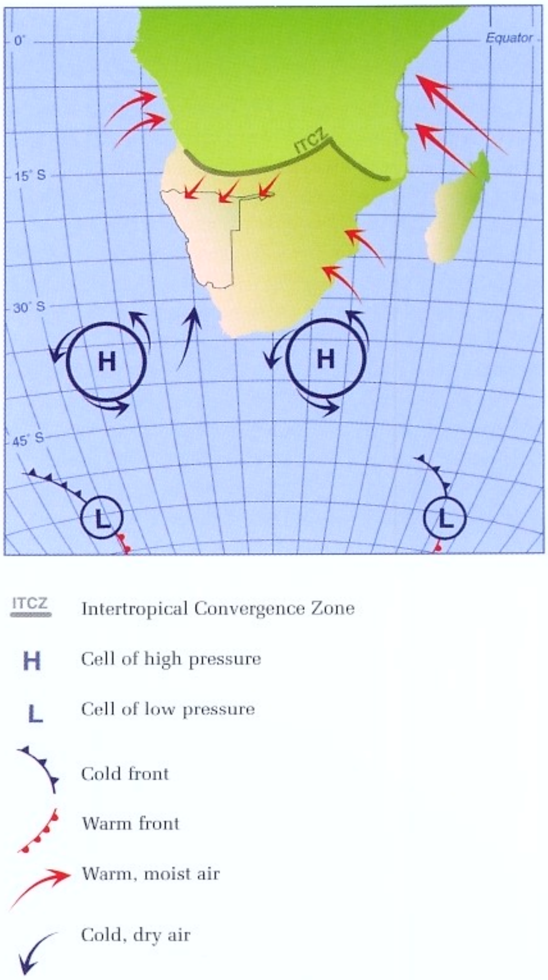
The three climate systems move during the year in response to seasonal changes in the relative position of the sun and, thus, the heating of different zones of the earth. They shift south when the southern hemisphere warms up in summer, and then return north when it cools again in winter.







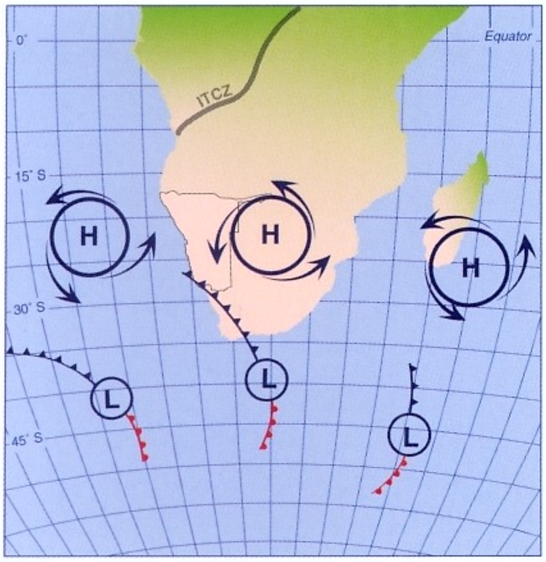




3.2 Air circulation in summer over southern Africa[3]

The map shows the major features affecting air circulation in summer, while the three images show an example of day-by-day changes in the position of cloud masses over southern Africa. Moist tropical air carries south in summer because the southern boundary of the Intertropical Convergence Zone lies close to northern Namibia, where it brings moist air and, therefore, rain into the country. The Subtropical High Pressure Zone also shifts southward, making it less effective in blocking the southward movement of tropical air.

These images were captured on 14, 15 and 16 November 1999, when good rains fell in Namibia from the dense bands of moisture-bearing clouds. In the first image, moisture had been driven into a trough of low pressure in Namibia by winds generated in a high-pressure cell lying over Zimbabwe. On the second day, the trough had shifted slightly eastward, with a large mass of dense clouds covering much of Namibia. A much greater shift had occurred by the third day, with the trough and cloud lying over eastern South Africa, where a trough of low pressure is often situated during the summer. In the absence of a source of tropical moisture, the air over Namibia is then dry, and there is little chance of rain.



ITCZ Intertropical Convergence Zone

H Cell of high pressure

L Cell of low pressure

Cold front

Warm front

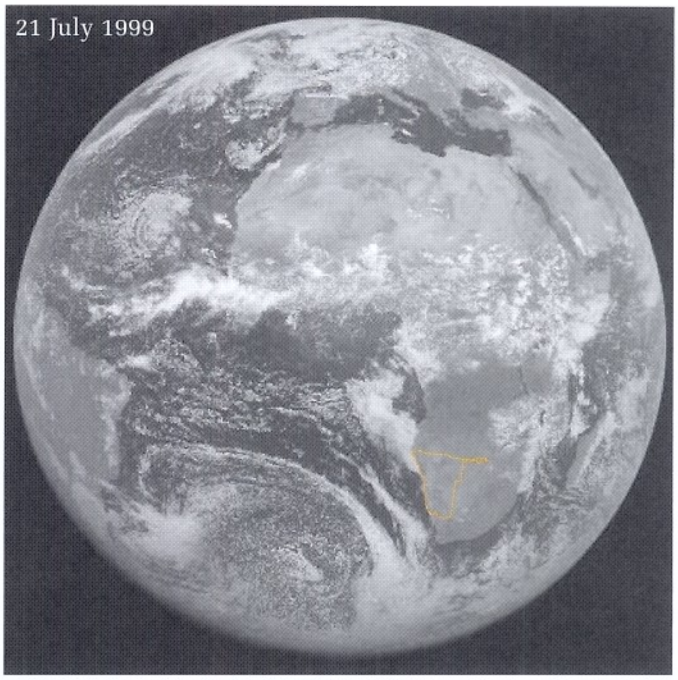
Warm, moist air

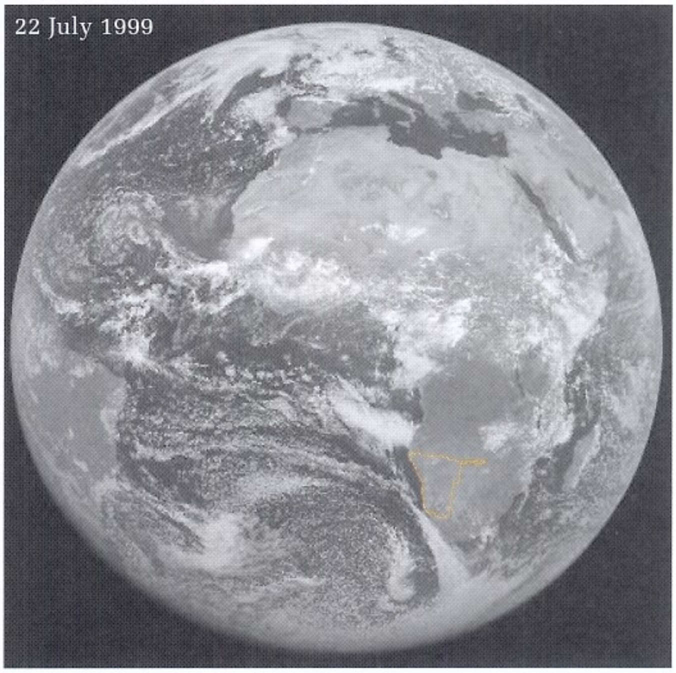
Cold, dry air

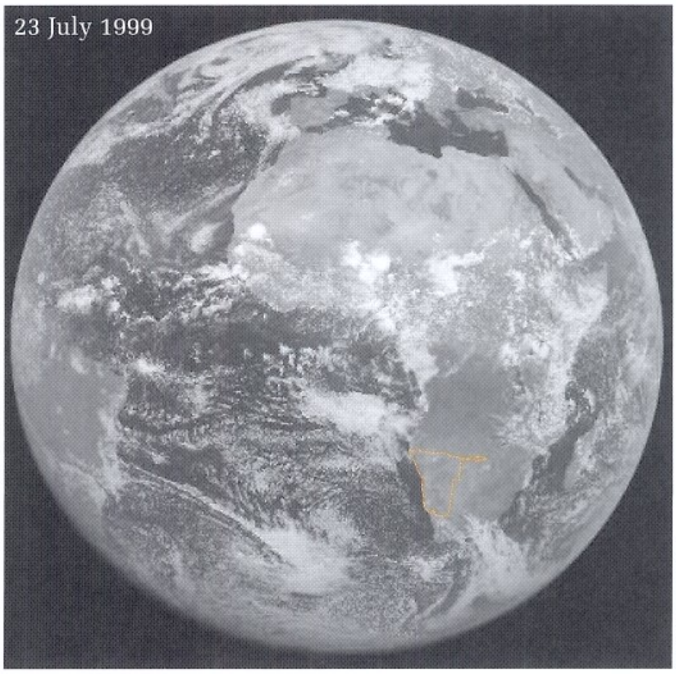
3.3 Air circulation in winter over southern Africa [4]

This map and the images illustrate typical winter conditions. Both the Intertropical Convergence Zone and the Subtropical High Pressure Zone are further north in the winter. One of the high-pressure cells, the Botswana Anticyclone, blocks the flow of any moist air from the north, and southern Africa is dominated by dry, cool air. Cold fronts sweep across the South Atlantic and Indian oceans, bringing rain to the southernmost tip of Africa and occasionally to southern Namibia. Weak warm fronts extend south of the low-pressure cells.

The first image here shows a long cold front stretching from the south-western coast of South Africa, several thousand kilometres towards South America on the left of the picture. On the second day, the front lies across the south-western tip of South Africa and some of the cloud-cover extends up into southern Namibia. By the third day, the front has moved far to the east, and the remnants of its cloud mass then cover the eastern side of South Africa.





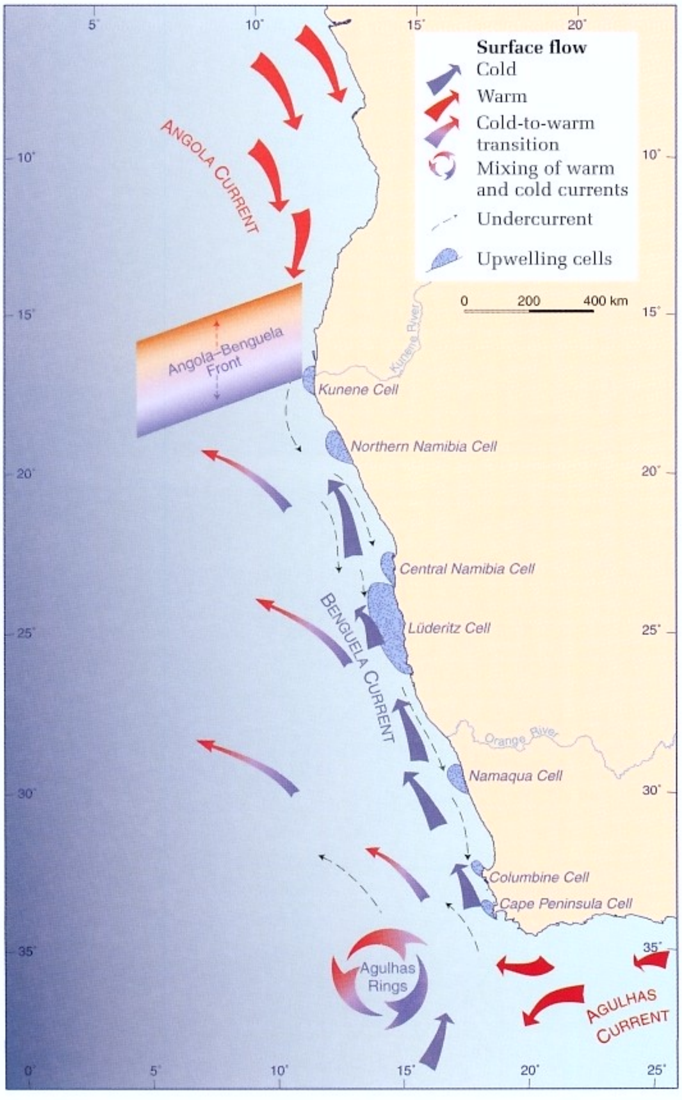


The Benguela Current and coastal climate

The weather along the coast is quite different from that in the interior of the country. There is little rain on the coast, temperatures are lower, there is less radiation and sunshine, frost is absent, winds are stronger, humidity is higher, and there is frequent fog. Most of these features are due to the influence of the Benguela Current and the South Atlantic Anticyclone. The Benguela is also important because it supports such a huge fishery, which contributes a great deal to Namibia's economy (see Figures 4.27–4.43). Fog is no longer a major hazard to sea travel, but it remains an important characteristic of the coast, both over the sea and the adjoining Namib Desert. The very low and erratic rainfall means that many plants and animals in the Namib depend upon fog to provide them with some or most of their water needs.

Why is the Namib a desert? One would expect that air blowing across the sea should pick up moisture, which could condense into rain once it reached the coast and rose upwards. However, the cold waters of the Benguela Current cool the air so much that it cannot rise high enough to develop into deep, rain-bearing clouds. This is because the sea air is cooler than the air above it, and so the sea air remains trapped at lower elevations, generally up to about 600 m above sea level. Moisture in the sea air is therefore only seen as low clouds and fog.

The Namib Desert, thus, receives little moisture from the adjoining Atlantic Ocean. However, there are two other factors that make this area a desert. Moist tropical air coming in from the north and east, which might produce rain over the coastal lowlands, is often blocked by breezes from the sea which have blown inland for some distance. In addition, any moist tropical air blowing over the escarpment towards the desert subsides, warming and drying out as it sinks down, again limiting any chance of rainfall. There are, however, occasional exceptions when moist tropical air does push down to the coast, sometimes causing unexpected downpours.



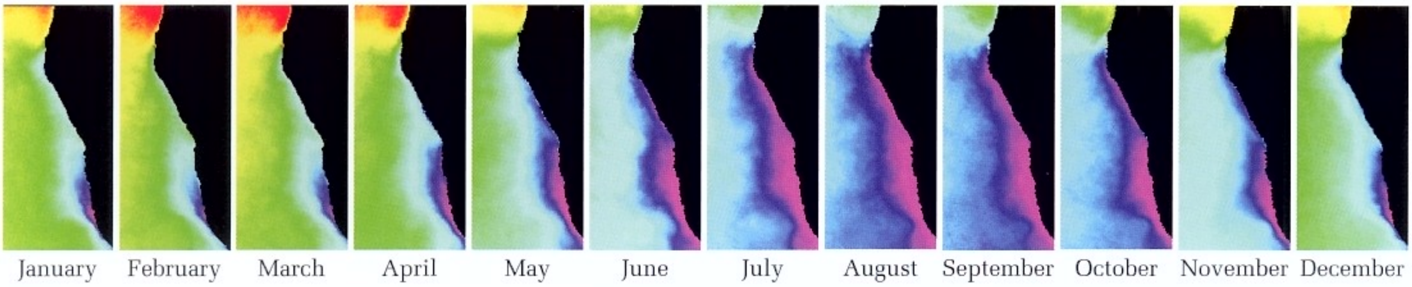
3.4 Major features of the Benguela Current

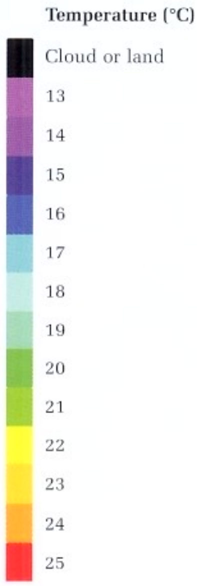
The Benguela is one of several large, cold currents that flow along the western margins of the world's continents. Much of the Benguela's cold water comes from the South Atlantic Ocean, and the cold water is carried north from its origins in a current system known as the Agulhas Rings off the Cape Peninsula in South Africa. The Angola–Benguela Front forms the northern limit of the Benguela Current, generally near the mouth of the Kunene River. To the west, the Benguela's boundary follows the continental shelf (at a depth of about 200 m) up to roughly 150 km off the coast. An undercurrent flows southwards below the Benguela, and another counter-current flows south along the shore.

Winds from the South Atlantic Anticyclone (see Figures 3.1–3.3) drive the cold water northwards, usually at speeds of between 400 and 1,000 m per hour. However, the rate varies seasonally in response to changes in wind speed, which, in turn, are caused by movements of the South Atlantic Anticyclone. The Namibian coast receives the strongest winds in winter when the Anticyclone has shifted north.

Flows away from the shore are propelled by winds driven by the South Atlantic Anticyclone and the effects of the Coriolis force (a force created by the earth's rotation, which causes moving objects to shift anticlockwise in the southern hemisphere). Upwelling cells form behind these offshore flows because deep water rises to replace the surface water that the winds have swept away from the coast. The upwelling cells are of special importance as the cold, rising waters carry nutrients from the ocean floor up to the surface. The Lüderitz Cell is the best known and largest of the upwelling areas; from here the current distributes the nutrients northwards to create a huge area of nutrient-rich water. These nutrients make the Benguela and the Namibian coast exceptionally rich in fish and other marine resources. Other, smaller and less intense upwelling areas are off Cape Fria, Palgrave Point and Conception Bay.

3.5 Average sea surface temperatures each month[5]

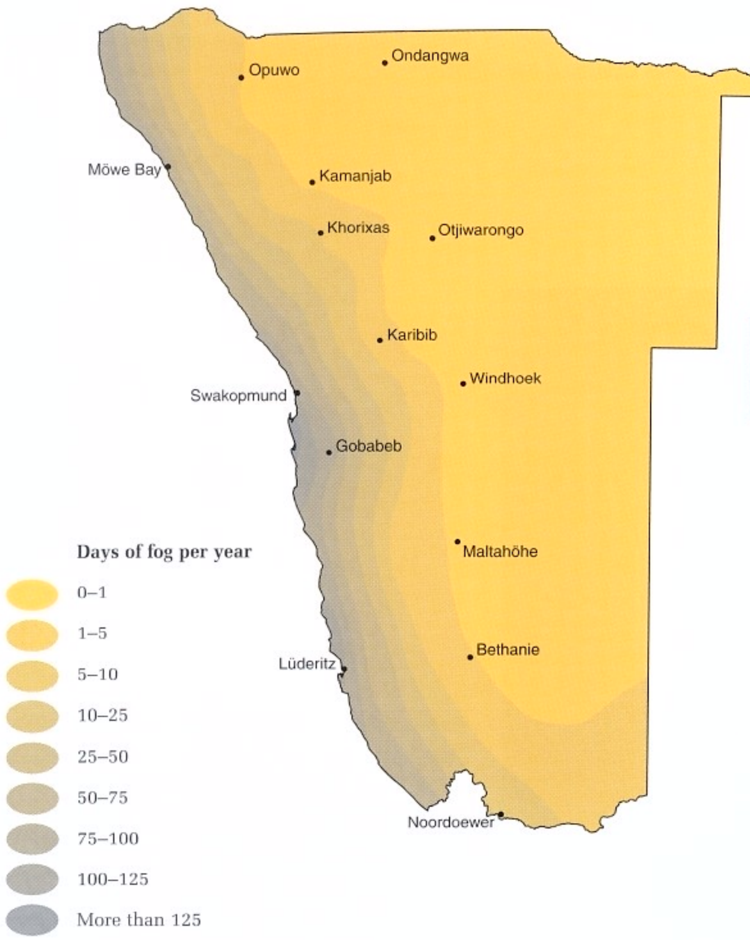




Although the Benguela is generally a cold current, water temperatures along Namibia's coastline vary a good deal. The coldest water is in the south and close to the coast, especially in the area of the Lüderitz Cell of upwelling. Cold water spreads north during winter as a result of the stronger south-westerly winds, while warmer water from the Angola Current pushes south in the summer.

Warm water from Angola sometimes persists much longer than normal, and major warm-water events occurred in 1963, 1984 and in 1995. The presence of warmer water pushing in from the north leads to less upwelling, so fewer nutrients are transported from the ocean bed to surface waters. Water temperatures off the Skeleton Coast in 1995 were about 8°C higher than normal, an event known as a Benguela El Niño.

The influx of warm water in 1995 followed a different kind of change in 1994, when oxygen concentrations in huge areas off the central coast dropped to low levels throughout the year. Massive changes in the distribution and abundance of fish occurred in both years, the fish either moving away from their normal feeding and spawning grounds or failing to breed. The Namibian fishing industry suffered a major setback that lasted several years, and species that feed on fish, such as seals, were also affected. About 300,000 seals are estimated to have died in 1994, directly or indirectly as a result of starvation.



3.6 Approximate numbers of days of fog per year

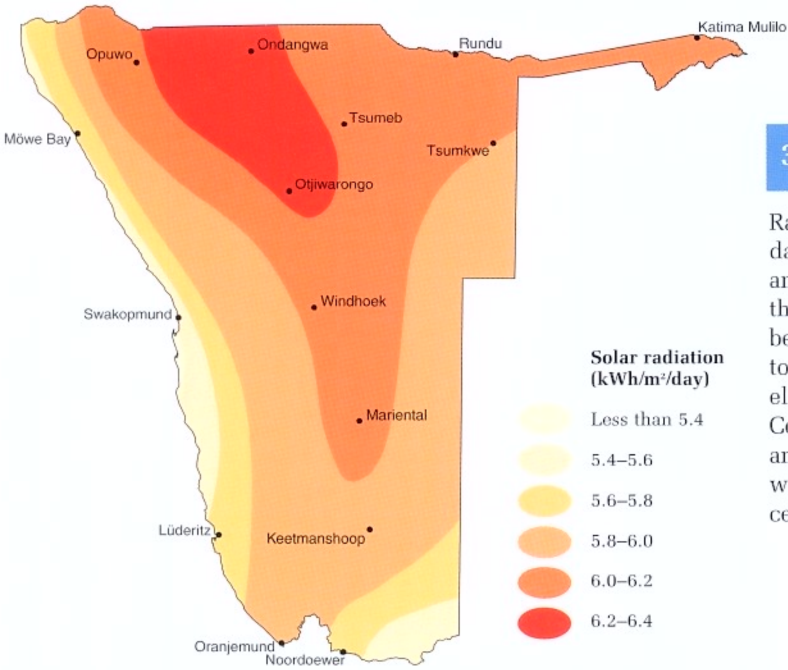
Fog occurs more frequently along the central Namib Desert than elsewhere, probably because of the upwelling off that part of the coast (see Figure 3.4). About 146 fog-days are recorded each year on average at Walvis Bay, compared with 127 at Lüderitz and 81 days at Oranjemund. Fog is recorded when visibility on the ground is reduced to 1,000 m or less.[6]

At least three processes form fog along the coast, and all three involve the cooling of air saturated with moisture from the sea. In the first process, the cold Benguela waters cool the air to such a degree that the moisture condenses into fog and low-level clouds offshore. In the second, low desert temperatures cause moist air that has come onshore on calm nights, to condense. In the third process, air may cool sufficiently to form fog when it is pushed upwards as it moves across the Namib Desert to higher elevations. Depending on the process, therefore, fog may be formed at different places: over the sea, along the coast or further inland as a result of rising air.

Sunshine and radiation[7]

Namibia is a country of sunshine, and the sunny days that repeat themselves month in and month out are one of the hallmarks of the country. Whilst Namibians take the abundance of sunshine for granted, those sunny days are one of the features that make Namibia an attractive destination for tourists. But the amount of sunshine has many other significant impacts on the country. Most importantly, sunshine is one of several factors that determine how much radiation reaches the earth's surface.

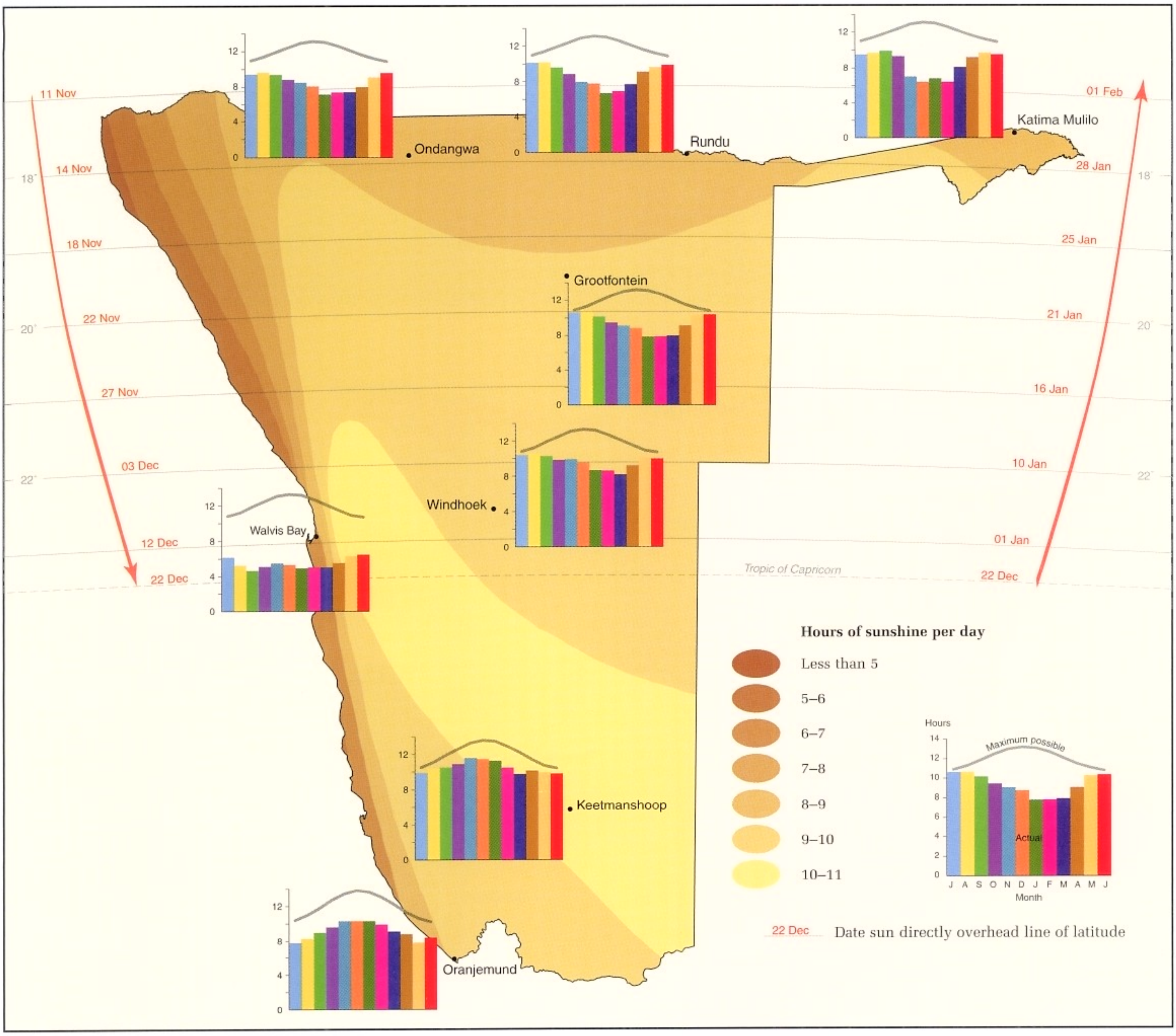
It is radiation from the sun that provides heat energy which warms the atmosphere; and high levels of radiation and, thus, heating of the air and ground surface are largely responsible for the great rates of water evaporation in Namibia (see Figure 3.27). Solar radiation also drives the general circulation of the atmosphere and wind, since air that has been heated rises and creates a relative vacuum of lower pressure. Winds are thus generated as air flows from areas of high pressure to replace the rising air.



3.7 Average values of solar radiation

Radiation levels, measured in kilowatt-hours per square metre per day (kWh/m²/day), are largely dependent on the sun's elevation and cloud-cover. Thus, more radiation is absorbed or reflected by the atmosphere in the morning and afternoon and during winter, because the sun is at a lower angle than at other times. The highest total radiation values are in central northern Namibia, where elevations of the sun are higher on average than in the south. Coastal areas have low radiation values because of frequent cloud- and fog-cover. Similarly, greater amounts of cloud-cover explain why the north-eastern regions receive less solar radiation than central northern Namibia.

Intense radiation and high temperatures often characterise Namibia's climate, especially during the middle and later hours of summer days. These springbok get some relief by sheltering in the shade. Animals use a variety of strategies and adaptations to avoid excessive heat and its various negative effects. For example, through sweating or panting extra water is lost and additional energy is used to help cool the body.



3.8 Average hours of sunshine per day

A zone stretching from the central Namib to Keetmanshoop and beyond receives more sunshine than anywhere else, while the coast receives the least sun because it is frequently covered by clouds or fog. Greater levels of cloud-cover in the north also reduce the numbers of sunshine hours.

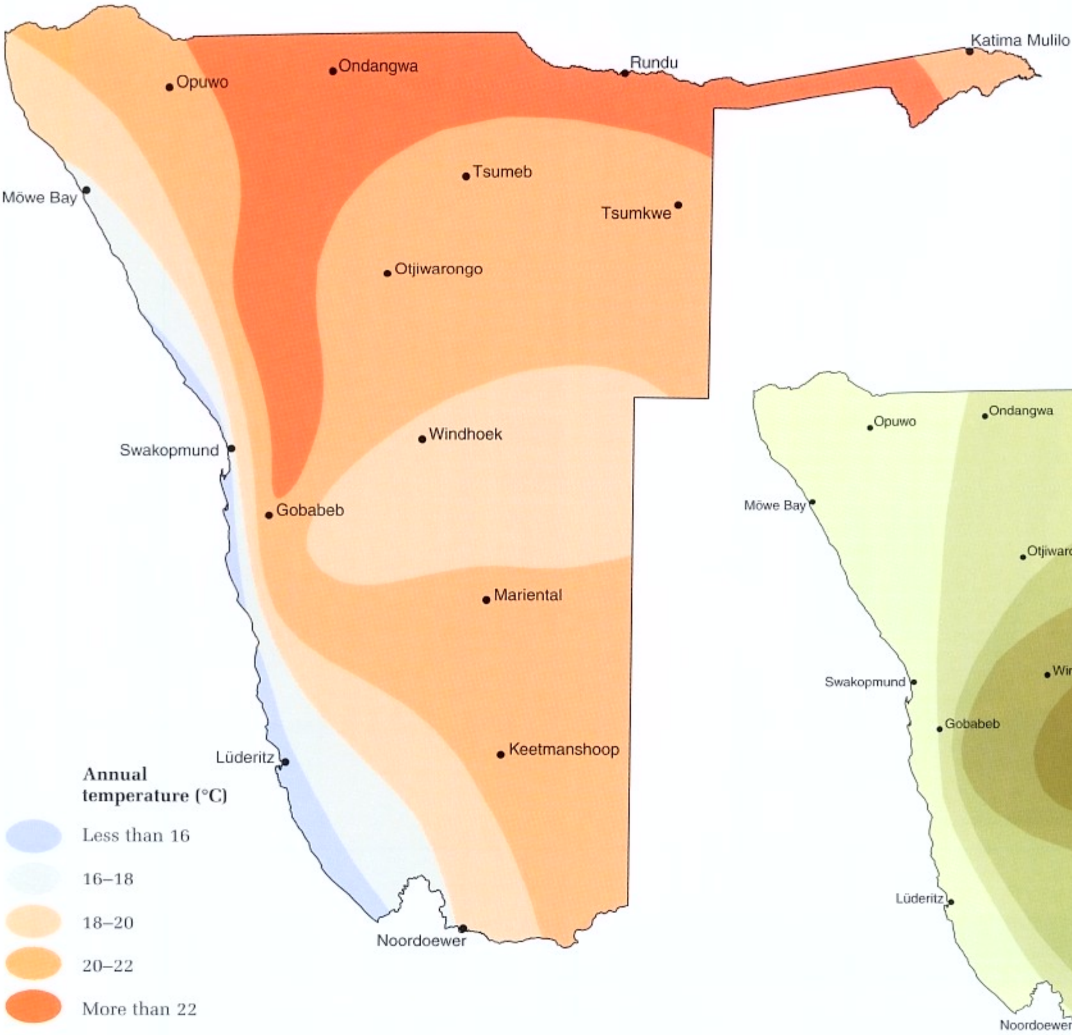
The graphs show the average number of hours of sunshine recorded per day in different months, compared with the maximum number of hours of sunshine possible if there was no cloud-cover. Shorter periods of sunshine during the summer months are the result of frequent cloud-cover, especially at places such as Ondangwa, Katima Mulilo and Windhoek. For this reason, January, February and March are the cloudiest months over much of the central and northern parts of the country. The higher number of sunshine hours during summer in the south, for example at Keetmanshoop and Oranjemund, reflects both the relative absence of clouds and longer days in the south. Walvis Bay usually receives less than half the potential number of hours of sunshine because of frequent fog and low cloud. There are roughly similar average amounts of cloud-cover throughout the year along the southern coast.

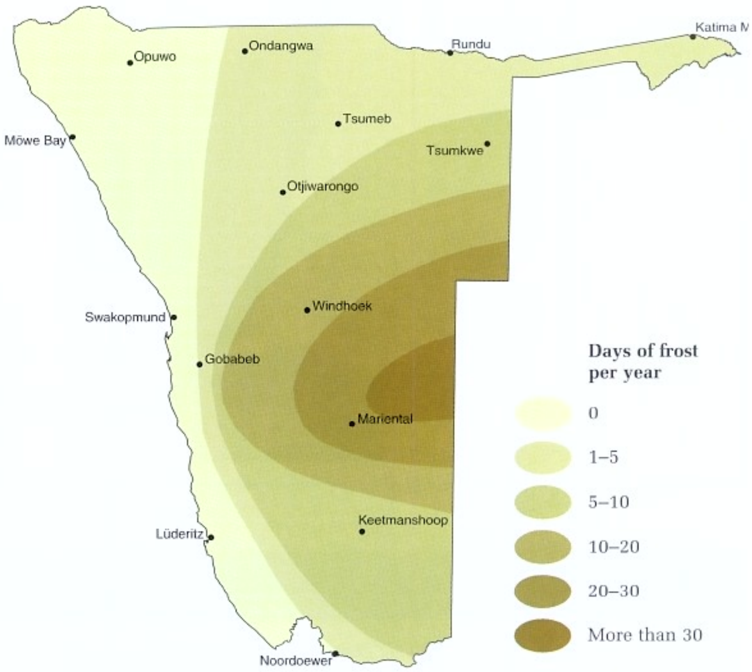
Dates on the map are those on which the sun is positioned directly overhead because the relative position of the sun shifts during the year. Those on the left are in spring, as the sun gradually moves higher in the sky until it is above the Tropic of Capricorn on 22 December.

The sun's position then reverses, moving northward and to lower elevations relative to Namibia, as shown on the right-hand side.

Temperatures

Namibia is generally considered to be a hot country, but temperatures vary a good deal – during the day, from day to day, seasonally, and over much longer periods. Most plants and animals in Namibia have, therefore, evolved to tolerate a wide range of temperatures. The most important factors to affect the temperature of the air are latitude (through its relationship to sunshine and radiation), altitude, cloud-cover and proximity to the coast. The highest temperature on official record was 43.5°C at Gobabeb on 21 February 1970, while the lowest was –10.5°C at Rohrbeck, north-east of Mariental, on 2 August 1974.





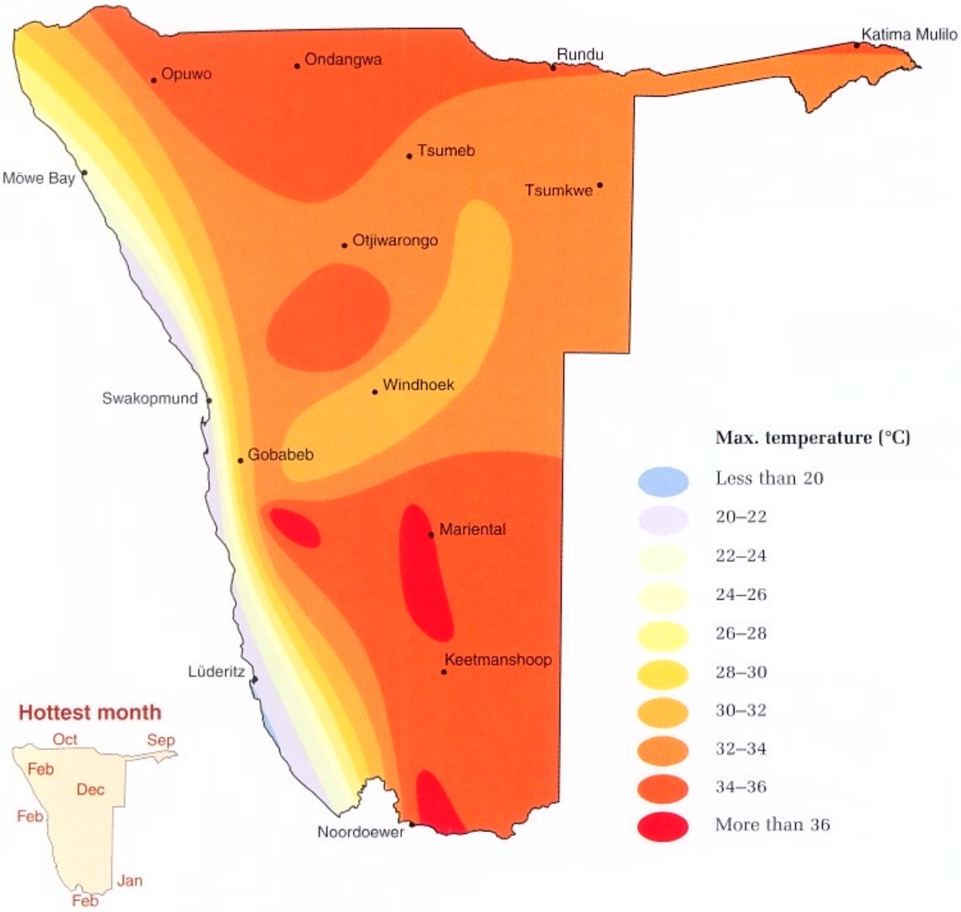
3.9 Average annual temperatures

Lower temperatures near the coast are the result of the cold, south-westerly winds and frequent fog- and cloud-cover. These are amongst the lowest temperatures at such latitudes anywhere in the world. Higher altitudes make the central highlands in the interior cooler than would otherwise be expected. The averages for each year are calculated from the average of every day's maximum and minimum temperatures.

3.10 Average number of days of frost per year

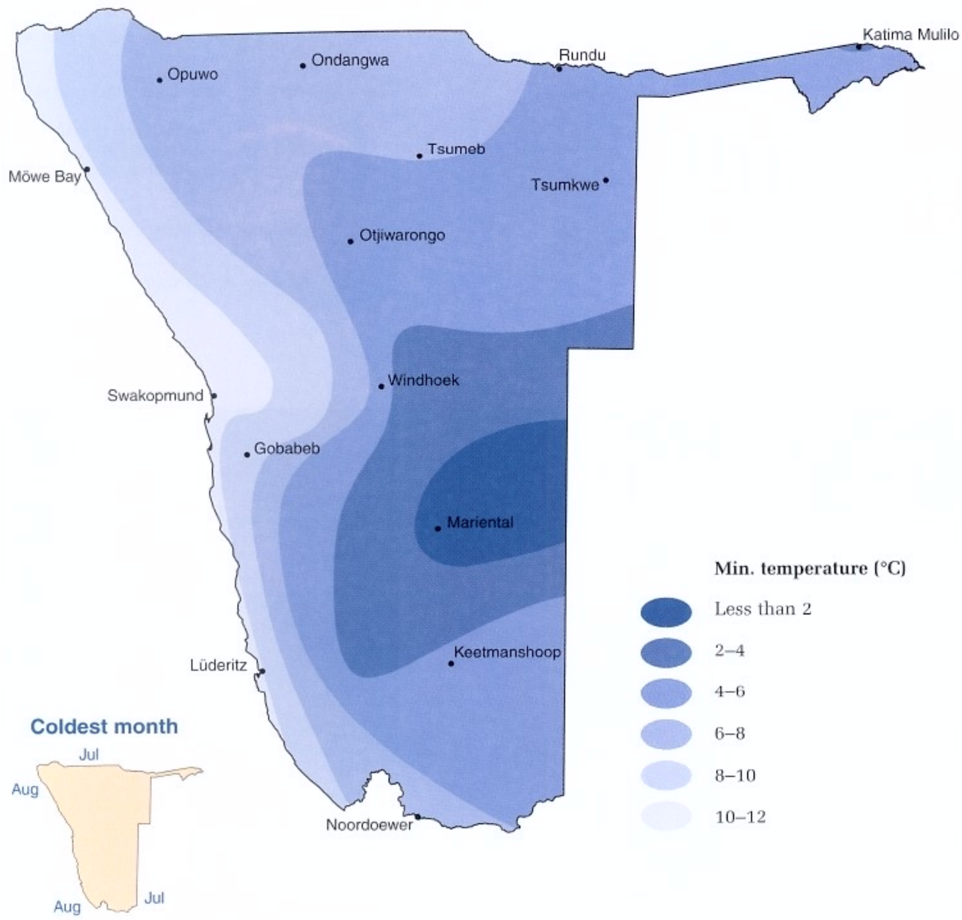
This is only a general indication of the distribution of frost because there are relatively few records. The central areas of eastern Namibia receive frost far more often than the western and northern parts, where occasional frost occurs only on the bottom of low-lying valleys. Frost has apparently never been recorded at the coast or in the Namib Desert. Some plants, such as mopane, cannot tolerate frost, and so their distribution and abundance are limited to frost-free areas.

3.11 Average maximum temperatures during the hottest month

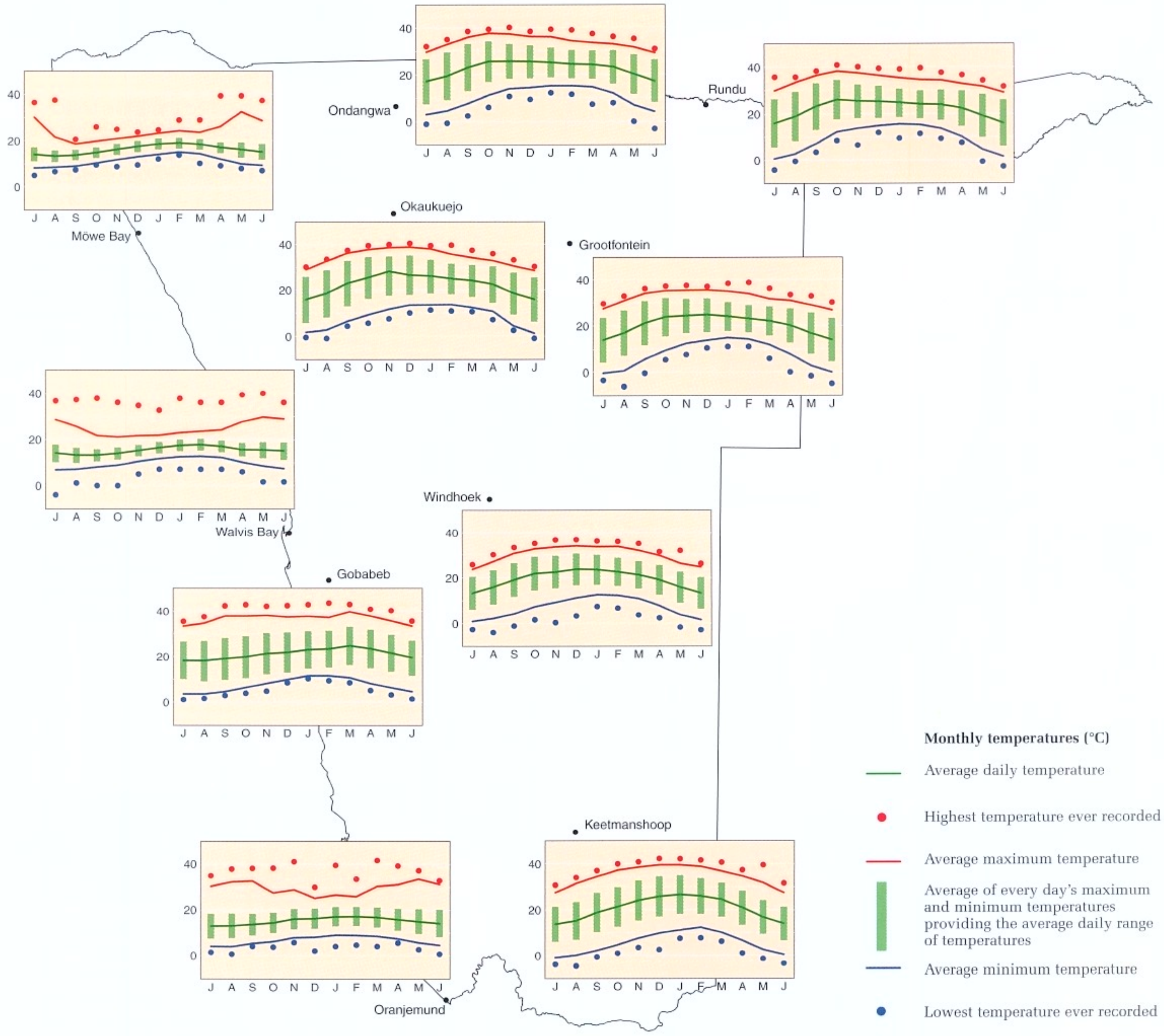


Average maximums during the hottest months are usually above 30°C over much of the country, except for the much cooler coastal belt. The cooler central highlands around Windhoek have average maximum temperatures of about 30°C. Areas in the central areas of southern Namibia are the hottest, with average maximums of more than 36°C. The hottest month in the year is generally early in summer in the north, and much later in the south. In Ondangwa, for example, the hottest month is October, compared with December and January in the central interior, and January or February further south. This is because cloud-cover and rainfall increase from October onwards and reduce the radiation reaching the northern and central areas. February is the hottest month along the coast. The hottest months in different areas are shown in the small map, and the averages are those of the maximum temperature recorded each day during those hottest months.

3.12 Average minimum temperatures during the coldest month



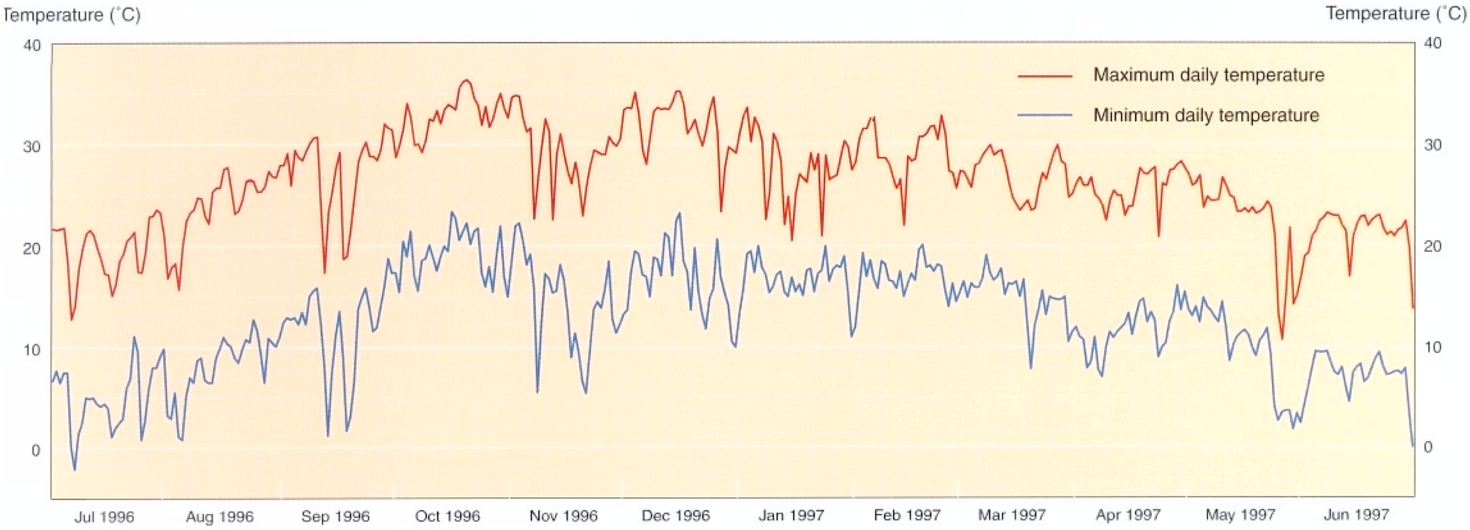
July is the coolest month over much of the country, with average minimums of less than 10°C in most areas. The coastal belt is again different because the moderating effects of coastal winds keep temperatures above 10°C. The coldest areas are around and to the east of Mariental, where average minimums are less than 2°C, and it is here that frost is much more frequent (see Figure 3.10). Inland from the coast and over much of northern Namibia, the average lowest temperatures are generally above 6°C. The coldest months in different areas are shown here in the small map. The averages are those of the minimum temperature recorded each day during those coldest months.



3.13 Temperature: averages, maximums and minimums

These graphs give an idea of how temperatures change during the year by showing long-term averages (the average of every day's maximum and minimum temperature), average daily maximums and minimums, the highest monthly maximums and lowest monthly minimums, and the highest and lowest temperatures ever recorded. Inland areas have much greater seasonal changes in temperature than along the coast, where the temperatures remain more even throughout the year. Keetmanshoop, for example, has an average daily temperature of 13.8°C in July and 26.7°C in January, a difference of 12.9°C. In comparison, differences in average temperature between the hottest and coldest months are 10.1°C at Windhoek, 8.6°C at Ondangwa and only 4.7°C at Walvis Bay. Inland areas also have greater differences between daily lows and highs than the coast.

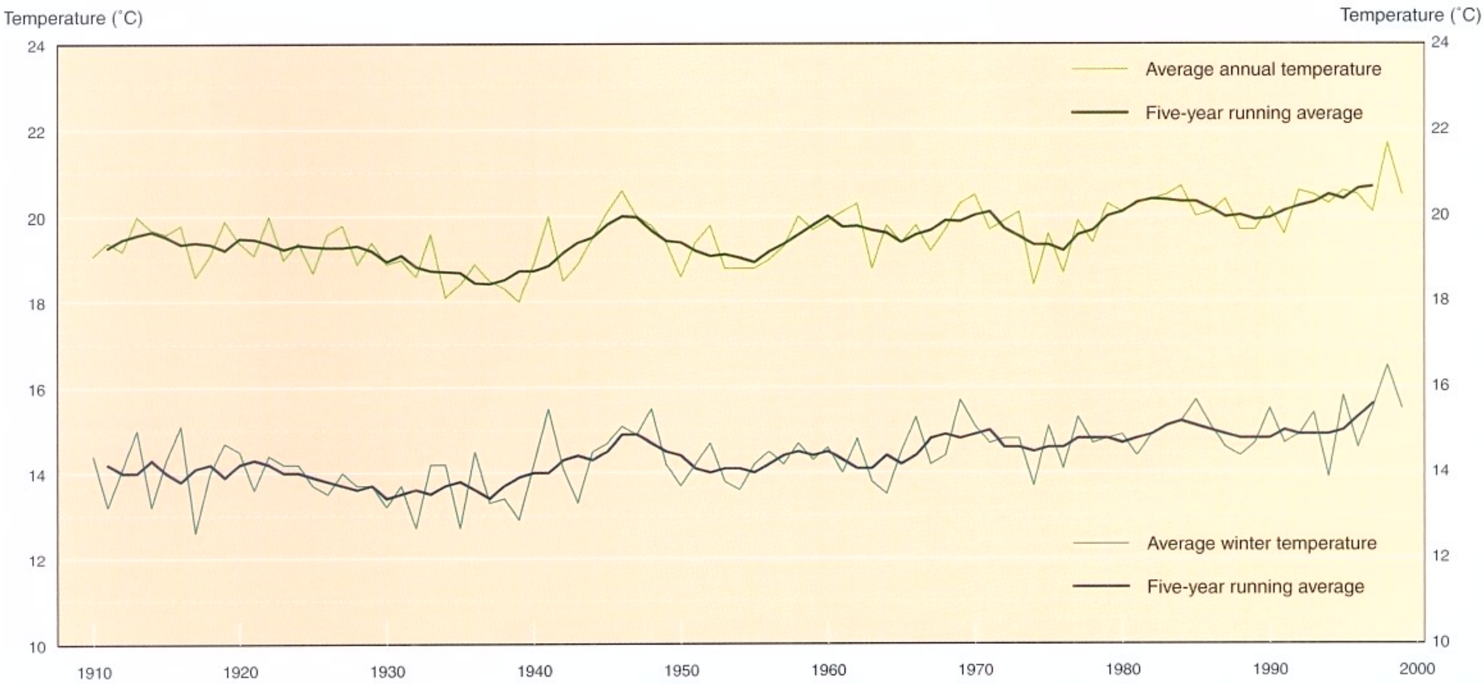
Ground squirrels turn their backs on the sun and put up their tails as umbrellas during the heat of the day. The tail is also swished back and forth to confuse any predator that comes too close, making it difficult for the latter to get a grip on the fleeing squirrel.



3.14 Maximum and minimum temperatures during one year at Windhoek

Averages mask a good deal of variation, especially changes in temperature during the day and from day to day. This example, from 1 July 1996 to 30 June 1997, shows how temperatures gradually rise during the summer and then drop off as winter approaches. It also shows how they can fluctuate widely from day to day, especially when cold air masses are suddenly pushed into central Namibia by winds driven by the South Atlantic Anticyclone. For example, between 7 and 8 November 1996 the minimum temperature fell by 10.4°C.

In January 1997, the small differences between maximum and minimum temperatures were the result of frequent cloudiness, when the clouds kept daytime temperatures down. At the same time they also kept temperatures up at night by reducing the loss of heat.



3.15 Average temperatures at Windhoek from 1910 to 1999

Over much of the twentieth century, average temperatures were between 19 and 20°C, with a noticeably cooler period during the 1930s. However, the last 20 years of the century were considerably warmer on average than before, both during the year as a whole and in the winter months of June, July and August. The highest average ever recorded (almost 22°C) was in 1998. It remains unclear whether these increasing temperatures are due to global warming or to other causes. However, there is a need to understand the possible effects of such warming on rainfall patterns, agriculture, the incidence of diseases and other aspects (see Figure 5.30).

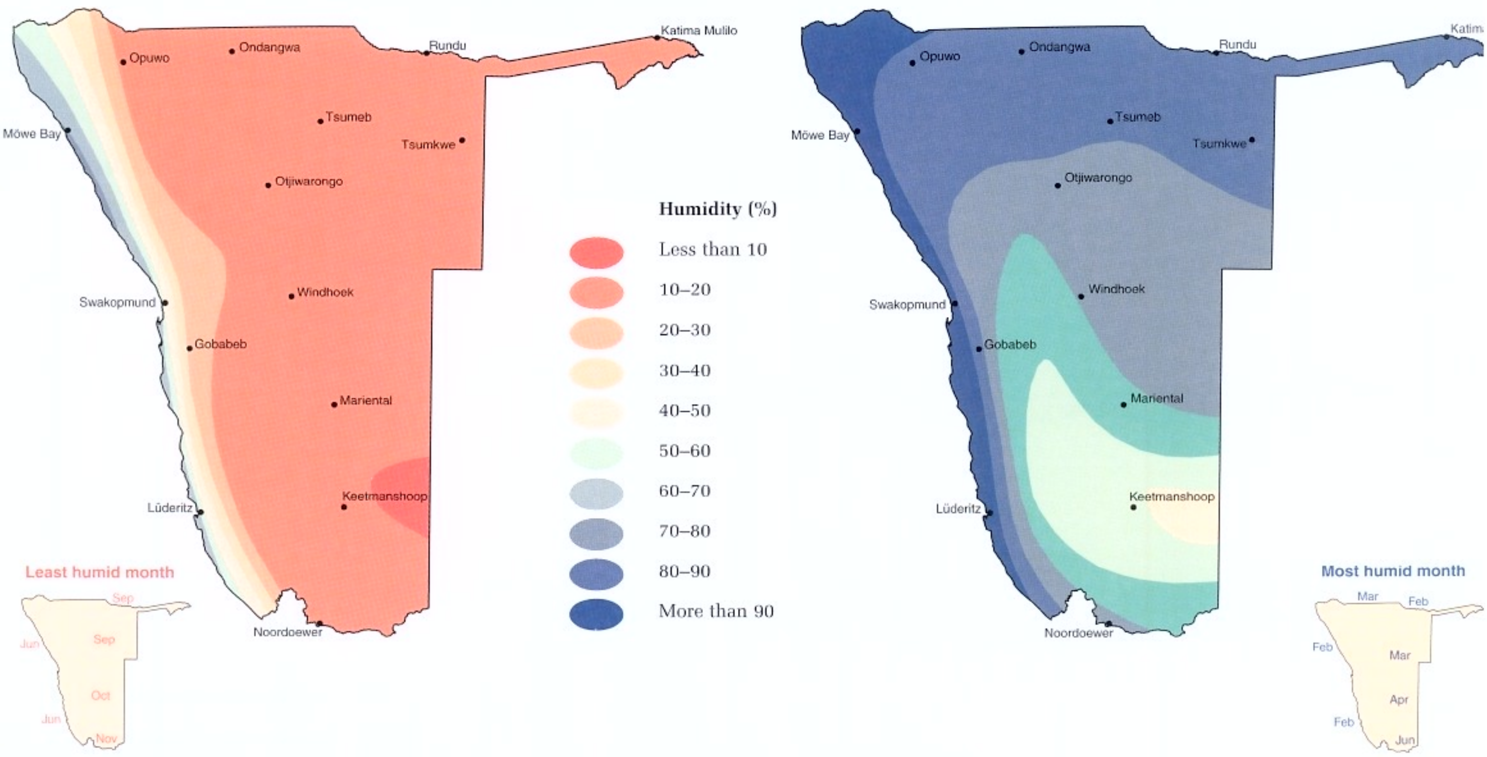
Humidity

Namibia is generally not a humid country, and the lack of moisture in the air has a major impact on its climate by reducing cloud-cover and rainfall and increasing rates of evaporation. The air's moisture content is measured in terms of its relative humidity, which is the amount of water in the air in relation to how much water the air can hold at a particular temperature. This is because warm air can potentially hold more water than cold air. Relative humidity is higher during the cooler hours of the morning for this reason.

3.16 Relative humidity values during the least and most humid months

Average values (on the left-hand map) during the least humid months are generally less than 20%, except at the coast. September, October and November are usually the least humid months because of the high levels of radiation and high temperatures, the absence of moisture being blown into the interior, and the ground being so parched after the long, dry winter.

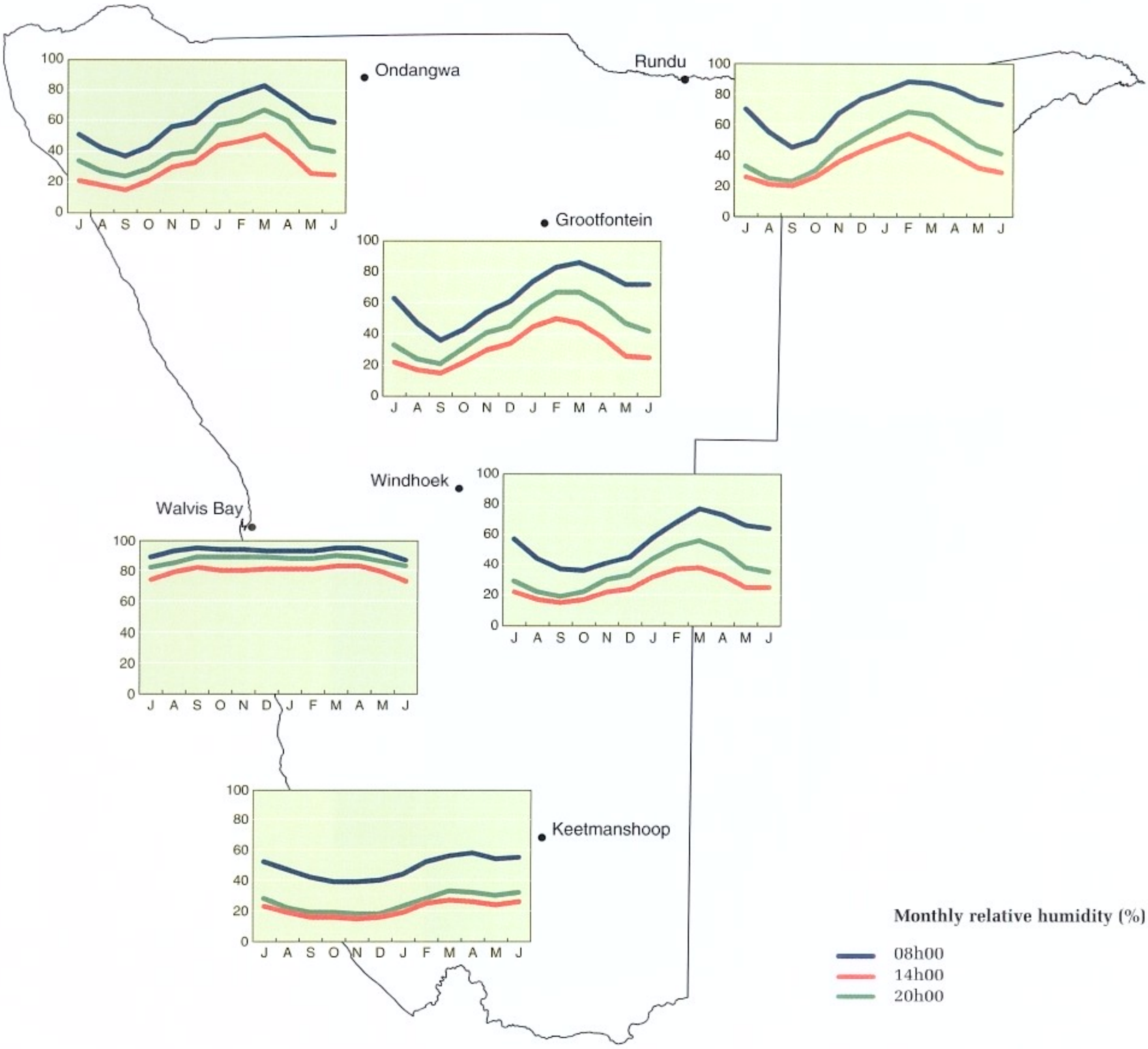
Average relative humidity values (on the right-hand map) are higher than 80% in the most humid months in northern Namibia, compared with maximums of 50–60% in the south. Humidity values in the driest months are measured at 14h00 while those in the most humid month are taken in the morning at 08h00, as these are the times when the lowest and highest values are recorded.



While most of Namibia is characterised by dry air for much of the time, air along the coast is often very humid, the moisture appearing as condensed droplets of dew on this !nara plant or as fog blowing across the coastal plains. Many plants and animals living near the coast derive most of their fresh water from dew or fog.

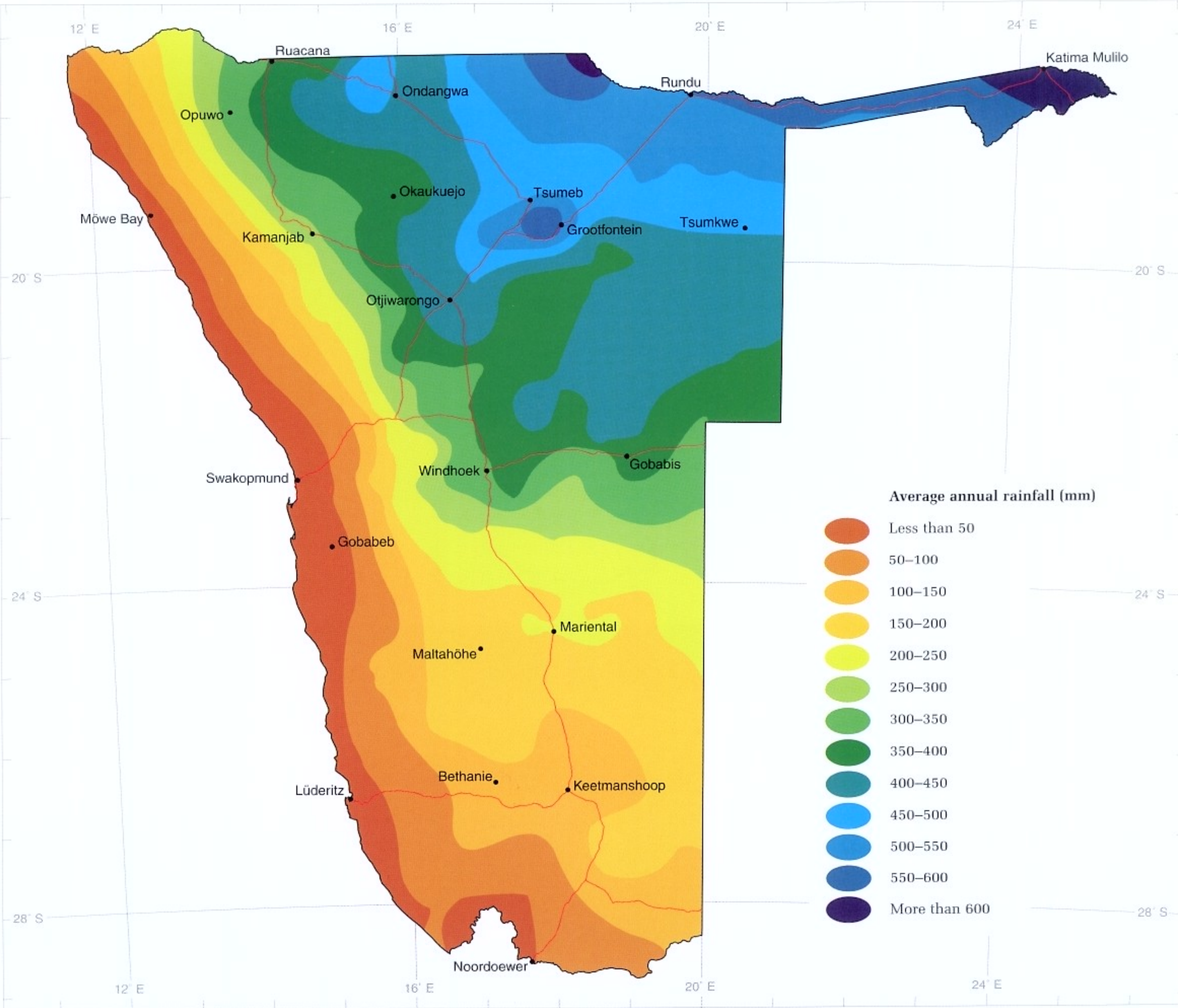
3.17 Changes in relative humidity during the year

For most of the year, during much of the day and over most of the country, humidity values are on average below 50%. The low values simply reflect the low amounts of moisture in the air. Averages are usually less than 20% during the dry winter months. The highest humidity is in February in the north-east, March in the central northern and central regions, and in April further south, as progressively more moisture feeds southwards from the Intertropical Convergence Zone (see Figure 3.1). Maximum average humidity values rarely go above 50% in the south-east, however. Along the coast, the air remains humid throughout the year as a result of moist air feeding off the Atlantic. Even at 14h00 in winter, average humidity values drop only to 60% or 70%, while they are generally above 80% at other times.



Rainfall[8]

Rainfall is treated more exhaustively than other features in this chapter because rain has such a strong influence on life in Namibia. Amounts of rain vary in a rather smooth gradient from the wettest and most tropical areas in the north-east to the extremely arid Namib Desert in the west. Much of the moisture that finds its way into Namibia does so infrequently and unpredictably. Such variability means that the highest total rainfalls in one year are often several times greater than falls in other years. Namibia is, thus, a dry country in which low and variable rainfalls are normal, and droughts are frequent and to be expected. Agricultural and many other human activities are severely limited by the shortages of moisture and variable rainfall, and much of Namibia is sparsely populated (see Figure 6.1) because farming is so difficult in this arid environment.

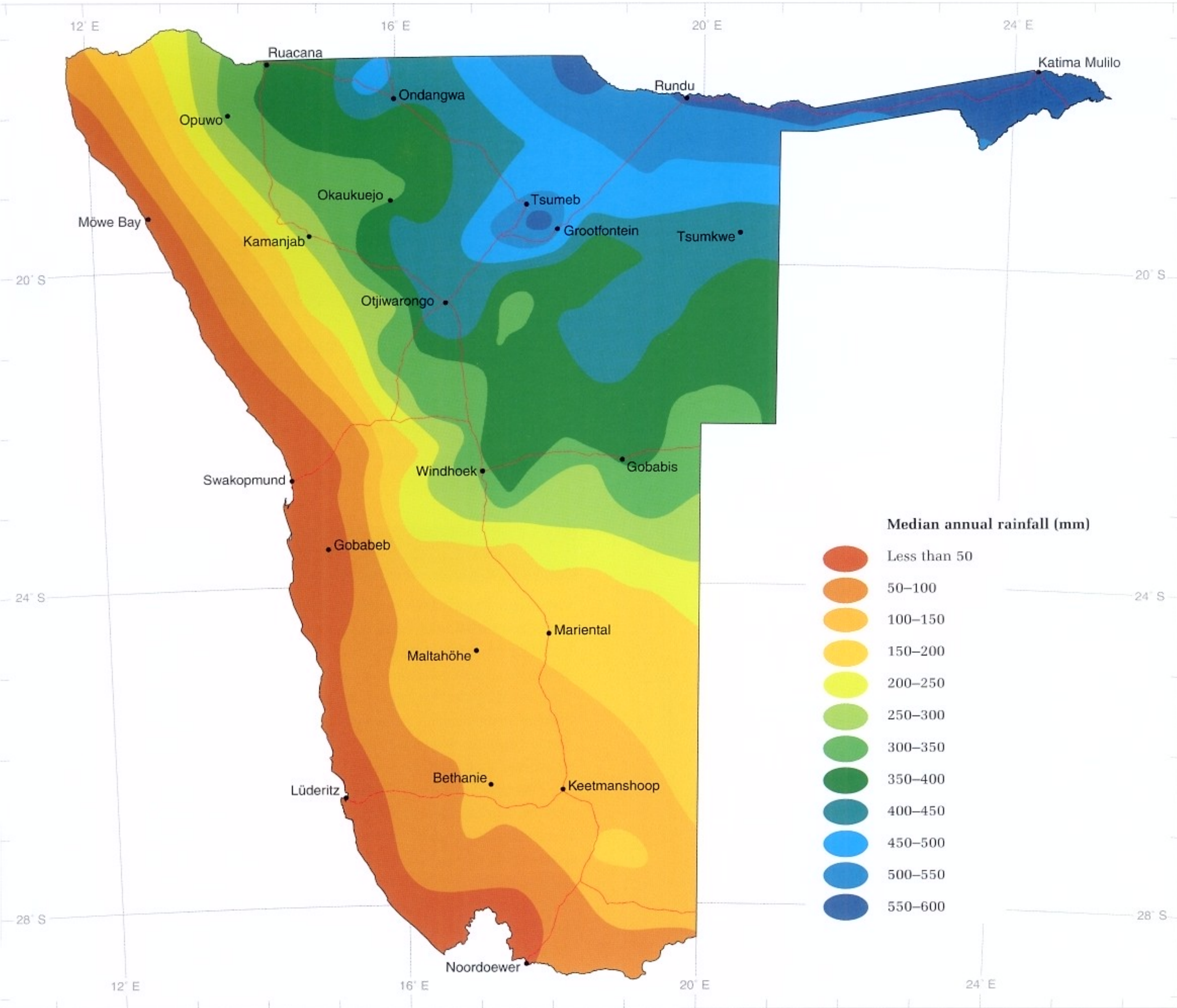


3.18 Annual rainfall

These two maps show how annual rainfall varies across the country. Although average rainfall (page 84) is a widely used measure, the median (this page) is a better reflection of which rainfall totals are normal. This is because averages are exaggerated by very high falls and medians are not. For example, annual averages in an area that usually receives about 250–300 mm would be pushed up by an exceptional total of 600 mm in one year. At Grootfontein the median annual rainfall is 495 mm compared with an average of 549 mm (see Figure 3.20). Unfortunately, the median is not familiar to many people. To work out a median, one would take 30 years of rainfall records, for example, and arrange the values in ascending order from the year with the lowest total to the year with the highest. The median is the value that separates the lowest half of all records from the half with the highest totals. In other words, total rainfall can be expected to be less than the median in half of all years, and higher in the other 50% of years.

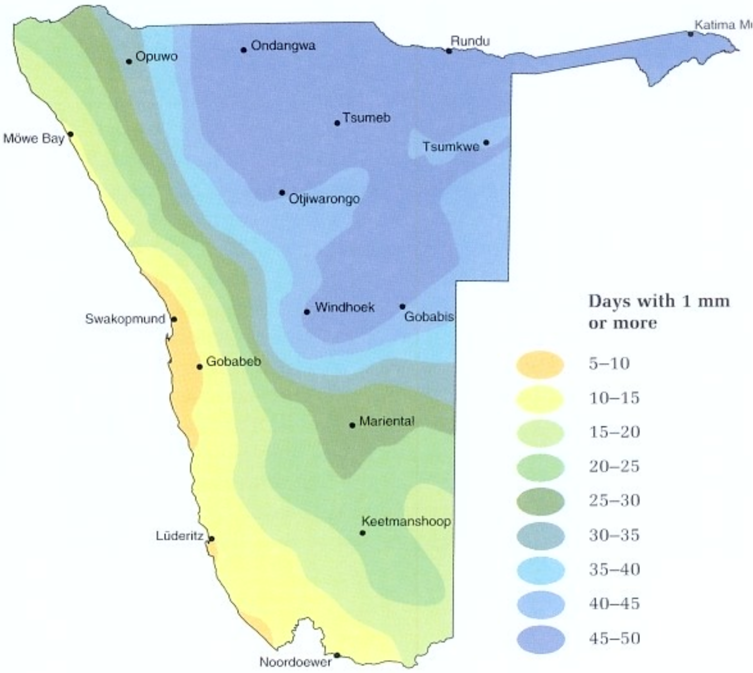
Although median values are generally lower than averages, the pattern of variation is similar. Eastern Caprivi receives the highest average rainfall of more than 600 mm or a median of over 550 mm per year, in contrast to the lowest totals of less than 50 mm in the south-west and along the coast. The gradient between the north-east and south-west is relatively even, reflecting the fact that most rain-bearing clouds are fed into the country by north-easterly winds, and less and less moisture remains in the atmosphere the further west and south the winds carry. The flow of moist air is also progressively blocked by dry air moving in from the south and west.

Higher rainfalls around Tsumeb, Otavi and Grootfontein are due to moist air being forced upward by the hills in that area: the rising air cools and the moisture that condenses falls as rain. Rainfall is also higher over the Waterberg and Karas Mountains for the same reason.



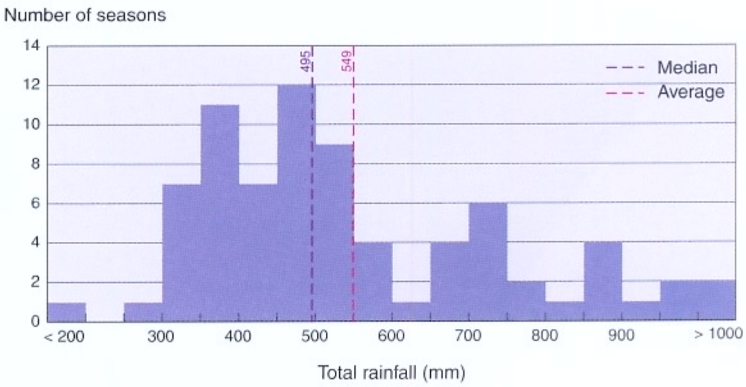
3.19 Number of days per year with 1 mm of rain or more

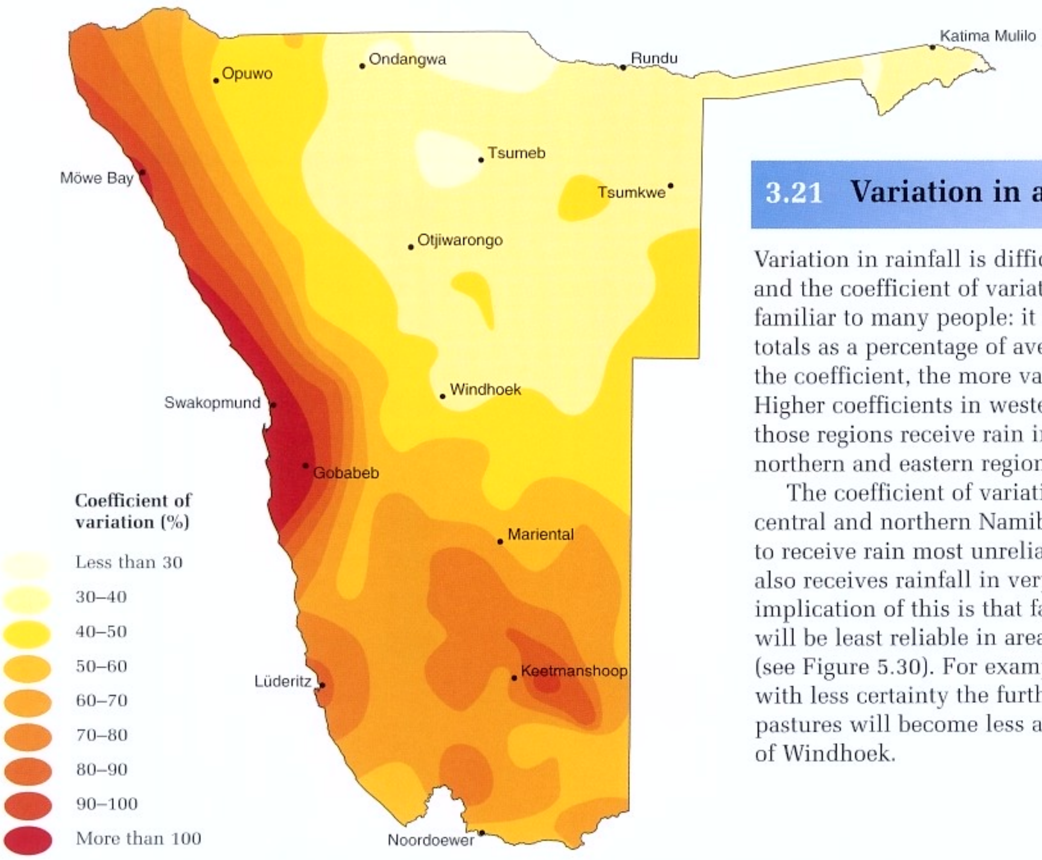
North-eastern Namibia gets rain much more often than the south and west. However, the number of days on which rain falls within the north-eastern third of the country varies rather little. For example, the average number of days on which rain falls in Katima Mulilo is only slightly higher than in Ondangwa, but Ondangwa receives an average of only about 400 mm per year, compared with 650 mm at Katima Mulilo (Figure 3.18). Thus, the higher annual totals at Katima Mulilo are largely due to heavier individual showers rather than more frequent rain. In fact, much of the north-eastern third of the country gets 1 mm or more on about 40–50 days each year. What is also significant is the rather sharp gradient separating areas with frequent rains from those getting rain far less often. The margin between these zones runs down the country, roughly from Ruacana, to Khorixas, to west of Windhoek, and then eastwards, to just south of Gobabis.



3.20 Frequencies of rainfall at Grootfontein

The graph shows the number of seasons over the past 67 years during which different total rainfalls were recorded. Like most places, Grootfontein usually has annual rainfalls that are moderately close to the average as well as the median (see Figure 3.18). Thus, in 48 of the 67 years shown, annual totals at Grootfontein were between 300 and 550 mm, in two years they were below 300 mm, and in the remaining 17 years the town received more than 550 mm.





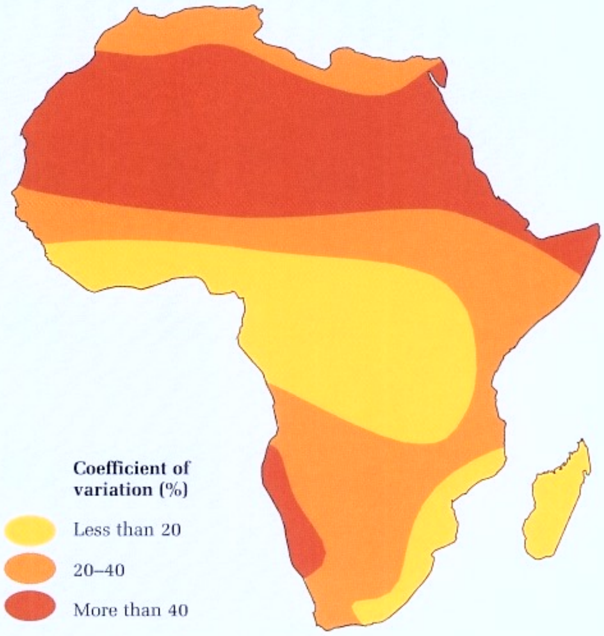
3.21 Variation in annual rainfall

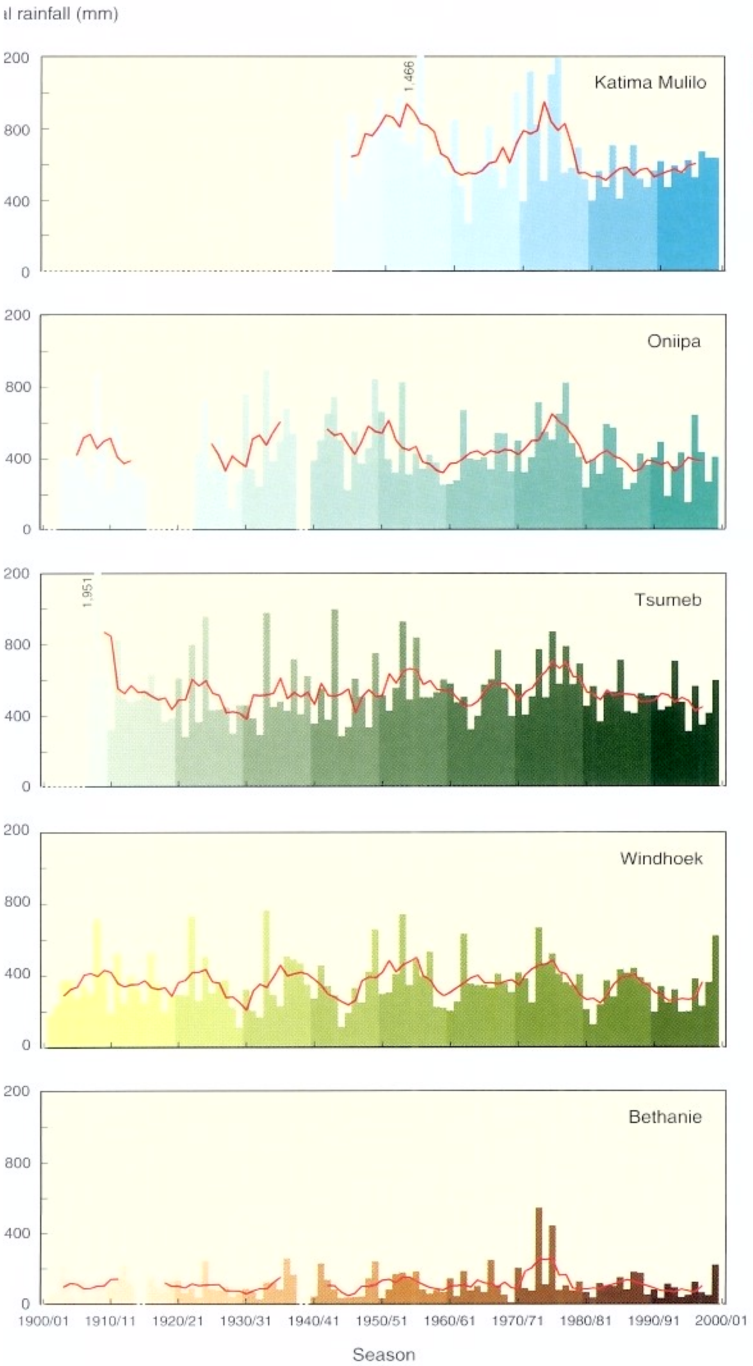
Variation in rainfall is difficult to portray and describe statistically, and the coefficient of variation of annual rainfall shown here is not familiar to many people: it is the standard deviation of annual totals as a percentage of average annual rainfall.[9] Thus, the higher the coefficient, the more variable the rainfall is from year to year. Higher coefficients in western and southern Namibia show that those regions receive rain in far more variable quantities than the northern and eastern regions.

The coefficient of variation also reflects reliability. Thus, the central and northern Namib Desert and the coastal areas can be said to receive rain most unreliably. Much of the area south of Mariental also receives rainfall in very variable quantities. An important implication of this is that farming which depends upon rainfall will be least reliable in areas that have the most variation in rainfall (see Figure 5.30). For example, good harvests will be produced with less certainty the further west one is from Ondangwa, and pastures will become less and less reliable to the west and south of Windhoek.

3.22 Variation in rainfall in Africa [10]

Together with the Sahara Desert, Namibia has the most variable rainfall in Africa. Frequent shortages of rain are normal in both areas, therefore, and rainfall totals in some years may be several times greater than the amounts received in other years.

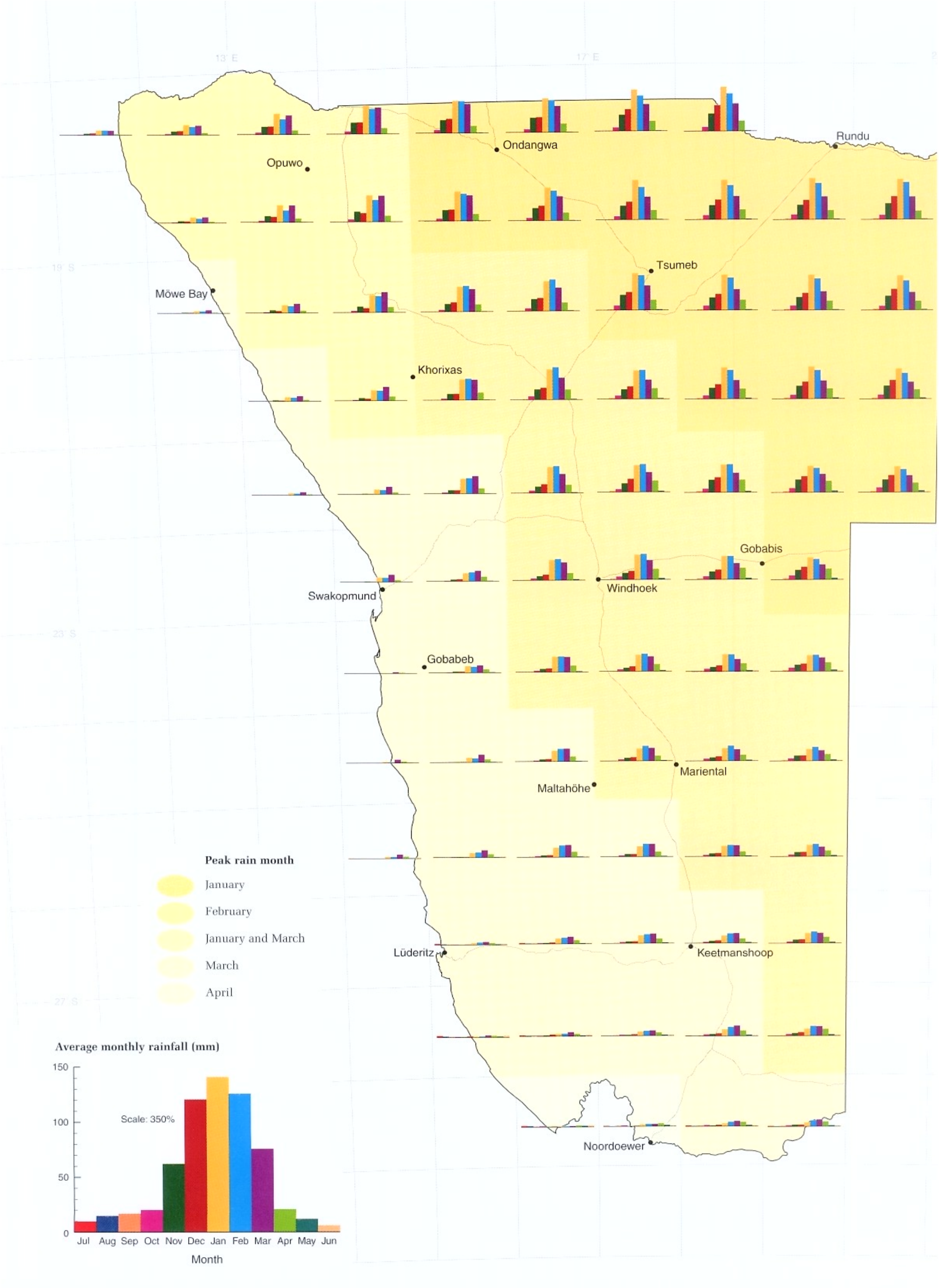




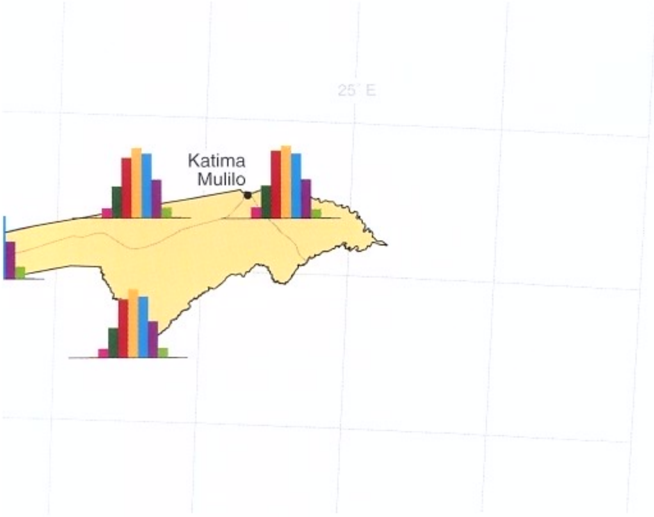
3.23 Annual rainfall over 100 years

The totals for these five stations provide a good perspective on rainfall fluctuations from year to year. Practically every year differs from the previous or next one, and annual totals in the best years can be several times higher than those in bad years. The five-year running averages also highlight the cyclical nature of longer-term changes: most years were quite wet during the 1950s, much drier in the 1960s, then wetter again in the 1970s, to be followed by a long dry period during the 1980s and 1990s. However, Windhoek and Bethanie had relatively high falls in the late 1980s.

Slight shifts in the relative positions of the three climate systems that dominate Namibia's weather (see Figure 3.1) are the major cause of changes in rainfall from year to year. Years with good rainfall generally occur when the Intertropical Convergence Zone has shifted slightly further south, while in dry years the weather is dominated more by high-pressure cells. Some of the variation in rainfall and temperature is also associated with the well-known El Niño and La Niña phases. On average, lower falls are received during El Niño years, and higher falls during La Niña years. These two events are related to changes in sea-surface temperatures and air-pressure systems in the Pacific Ocean.



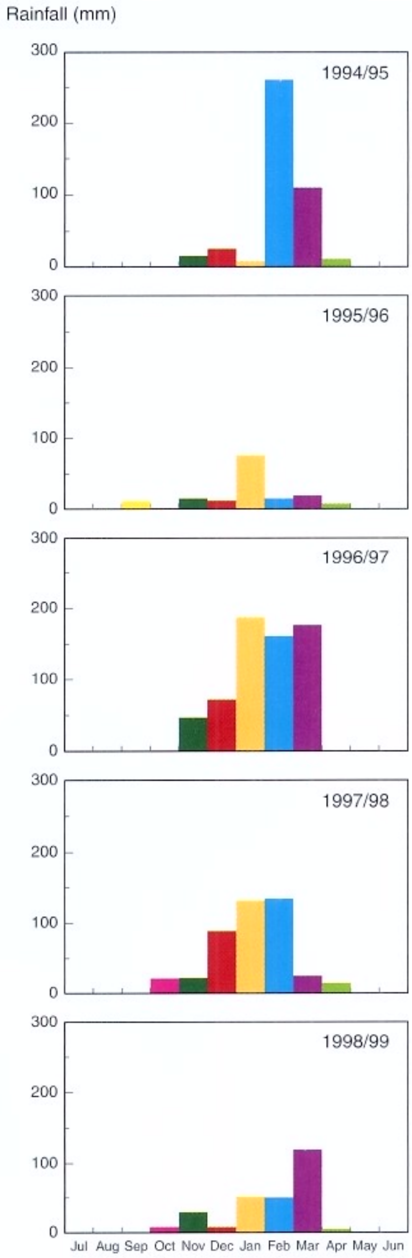
13° E
17° E
19° S
23° S
27° S
Rundu
Ondangwa
Opuwo
Tsumeb
Möwe Bay
Khorixas
Gobabis
Windhoek
Swakopmund
Gobabeb
Mariental
Maltahöhe
Lüderitz
Keetmanshoop
Noordoewer
Peak rain month
January
February
January and March
March
April
Average monthly rainfall (mm)
150
100
50
0
Scale: 350%
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Month



3.24 Average rainfall per month

In most areas in Namibia, almost all the rain that falls does so during the summer months. The only exception is the south-western corner of Namibia, commonly known as a winter rainfall area. While a significant proportion of the little rain that does fall in that area is recorded during the winter months, the graphs on the map show that average falls per month are about the same throughout the year. The graphs are from July of one year to June in the next year, and the figures are averages over each degree of latitude and longitude.

Within the summer rainfall areas there is a clear trend from the north-east – where the rains start earlier and the highest falls are in December and January – to the south and west – where the rains start later and peak falls are in January, February or March. On average, February and March are the months with the highest falls over the southern and western two-thirds of the country, and little rain can be expected before January in those areas. The far north-western area of Kunene has two peak rainfall months on average: January and March.



3.25 Monthly rainfall at Oniipa [11]

The timing of rainfall varies greatly from year to year, with different months getting more or less rain than the same months in other years. These examples also show how the rains start early in some years (1996/97) and much later in others (1994/95). In 1995/96, the total amounts that fell were not only small, but also badly timed: very little rain fell after moderate falls in January. Crops planted in January would, therefore, have received very little rainwater to keep them alive and growing, and the growth of grazing pastures would also have been limited.

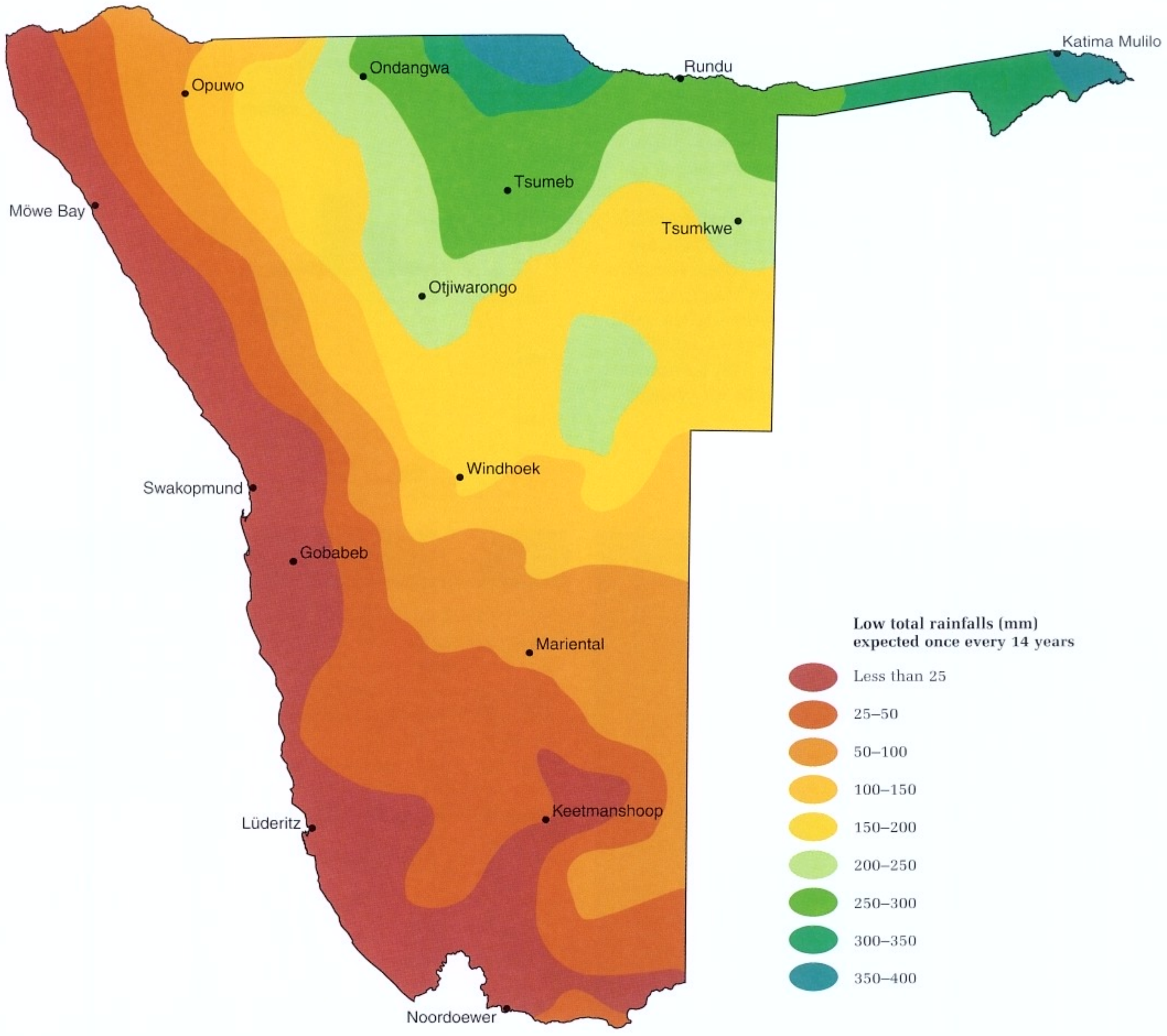
'It never rains, but it pours' is a useful way of describing patterns of rainfall in many areas over much of the year. Heavy rain is a temporary nuisance to these springbok, but this discomfort is greatly outweighed by the benefits that good rains may bring: new pastures of green grass, and the availability of fresh water nearby.

3.26 One measure of drought

Some previous maps and graphs make it clear that rainfall in Namibia is highly variable (see Figures 3.20–3.23). Having some years with high rainfall and others with low rainfall is to be expected and normal. However, certain years are exceptionally dry and may be called droughts. But how should droughts be defined in relation to what is 'normal' rainfall? One method is to say that rainfall totals in 13 out of 14 years are normal, while only those that are so low that they occur on average once in 14 years are droughts. This approach requires that a threshold be calculated between those totals expected in 13 of the 14 years, and those that can be expected only once in 14 years. The map here shows these thresholds, which are limited to rainfall totals between October and March because the significant rain over most of the country falls during those summer months.

In the Caprivi the threshold is between 300 and 350 mm, while in the central highlands around Windhoek it is between 100 and 150 mm. Further south and west the thresholds are much lower. Another way of looking at these figures is to say that any total above 100–150 mm around Windhoek is normal and to be expected because it occurs in 13 out of every 14 years.

While a drought can be defined as 'a shortage of rain', there is another important dimension to the issue, namely land use. Shortages of rain may have devastating effects for one kind of farming but not for another. For example, an annual total of 300 mm may be adequate for sheep farming but it could be disastrous on a neighbouring farm where maize is grown. Many people would argue that shortages of rain are so frequent in Namibia that crops dependent on good, frequent rain showers should not be planted in areas where that kind of rainfall only occurs in certain years. For other people, however, droughts are unpredictable natural catastrophes and the government should compensate farmers for their losses. Any shortage of rain may then be hailed as a drought, and the concept of drought assumes a measure of political relevance when the government yields to pleas for help.



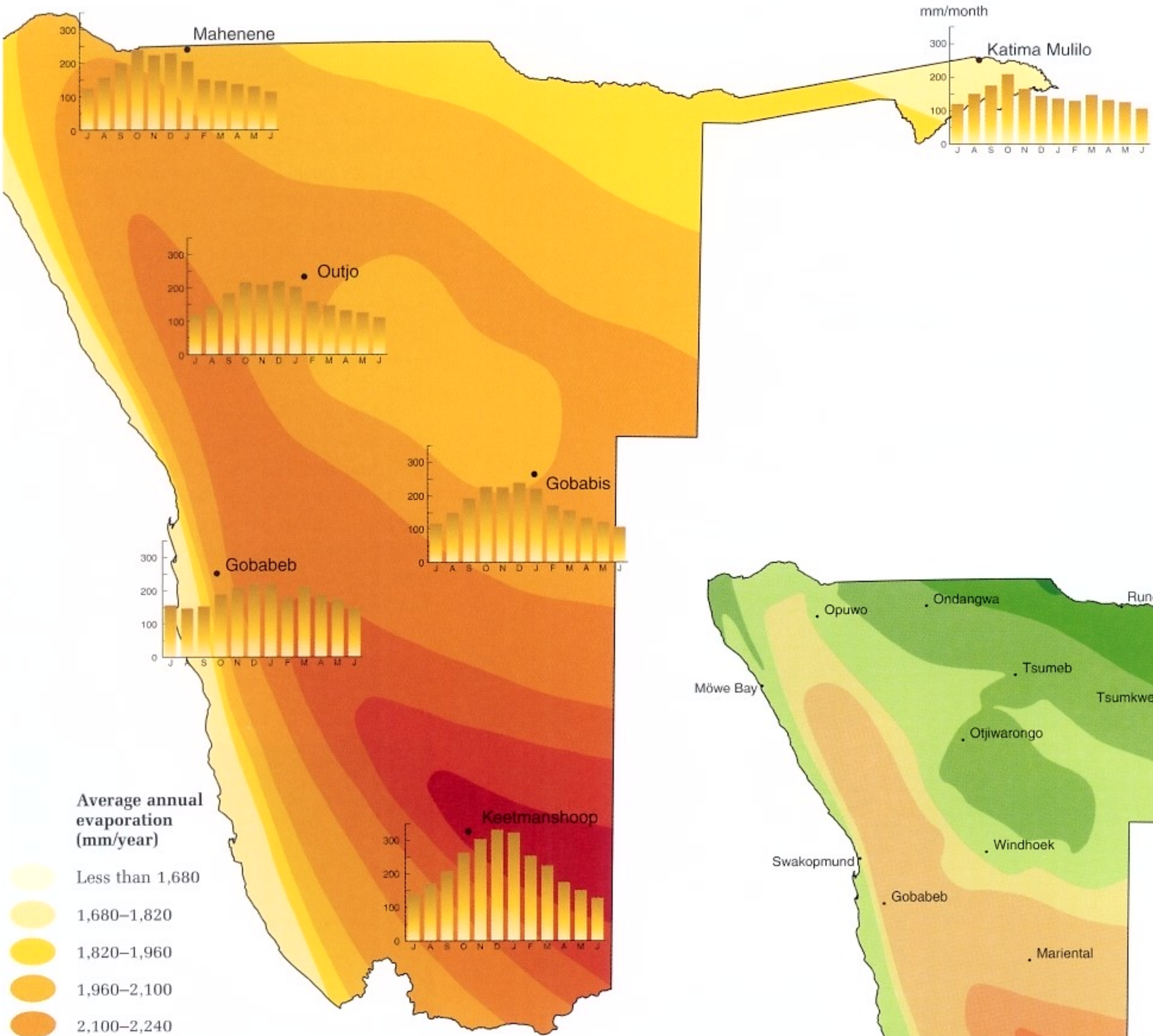
Evaporation

Namibia receives little rain on average, but it is dealt a double blow because the little water that does fall is subject to high rates of evaporation. If less water evaporated, many more pans and lakes would be filled with water for a greater part of the year, the soil would hold more water, and it would make more water available for plant growth and use by people. Rates of water loss are determined by several factors, including temperature, solar radiation, humidity, wind speed, atmospheric pressure and the surface area of open water.

3.27 Average rates of evaporation per year and month [12]

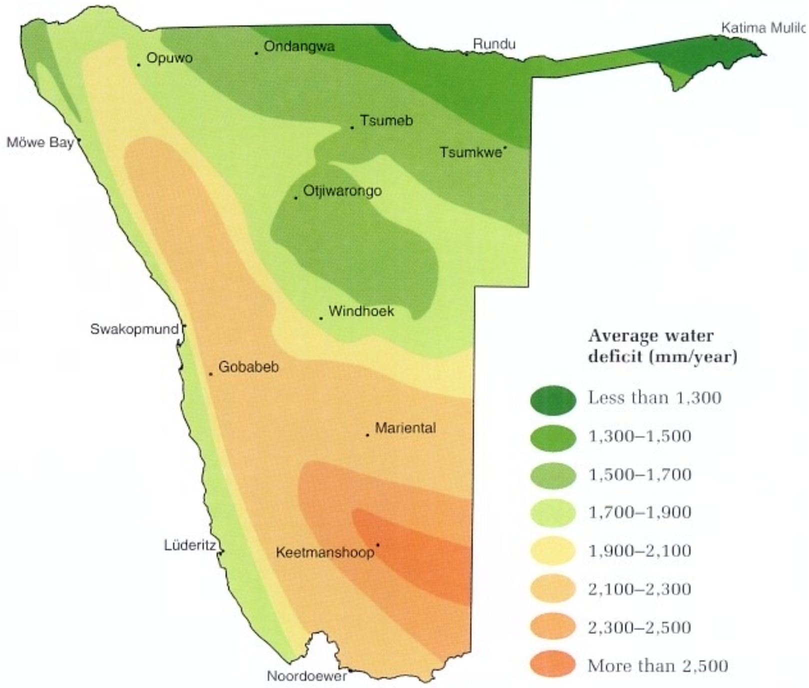
While evaporation rates are high throughout the country, southern areas lose much more water through evaporation than the north-eastern and coastal areas. The highest rates of evaporation mean that a swimming pool 2.5 m deep would lose all its water in a year. Rates of evaporation are highest during the warm summer months before the rains begin, because of greater solar radiation, higher temperatures and low humidity. Low rates of water loss along the coast are mainly due to the cool and humid conditions there.

The whole country potentially loses much more water through evaporation than it receives in rain. The degree of water deficit – the difference between average annual rainfall and average rate of evaporation – varies, however. Areas with the greatest deficits extend in a wide band from the highest values in the south-east to the north-west. Water deficits are much lower to the west and along the coast, and they gradually decrease towards the north-east as a result of higher rainfalls and less evaporation.



Average annual evaporation (mm/year)

- Less than 1,680
- 1,680–1,820
- 1,820–1,960
- 1,960–2,100
- 2,100–2,240
- 2,240–2,380
- 2,380–2,520
- 2,520–2,660
- More than 2,660

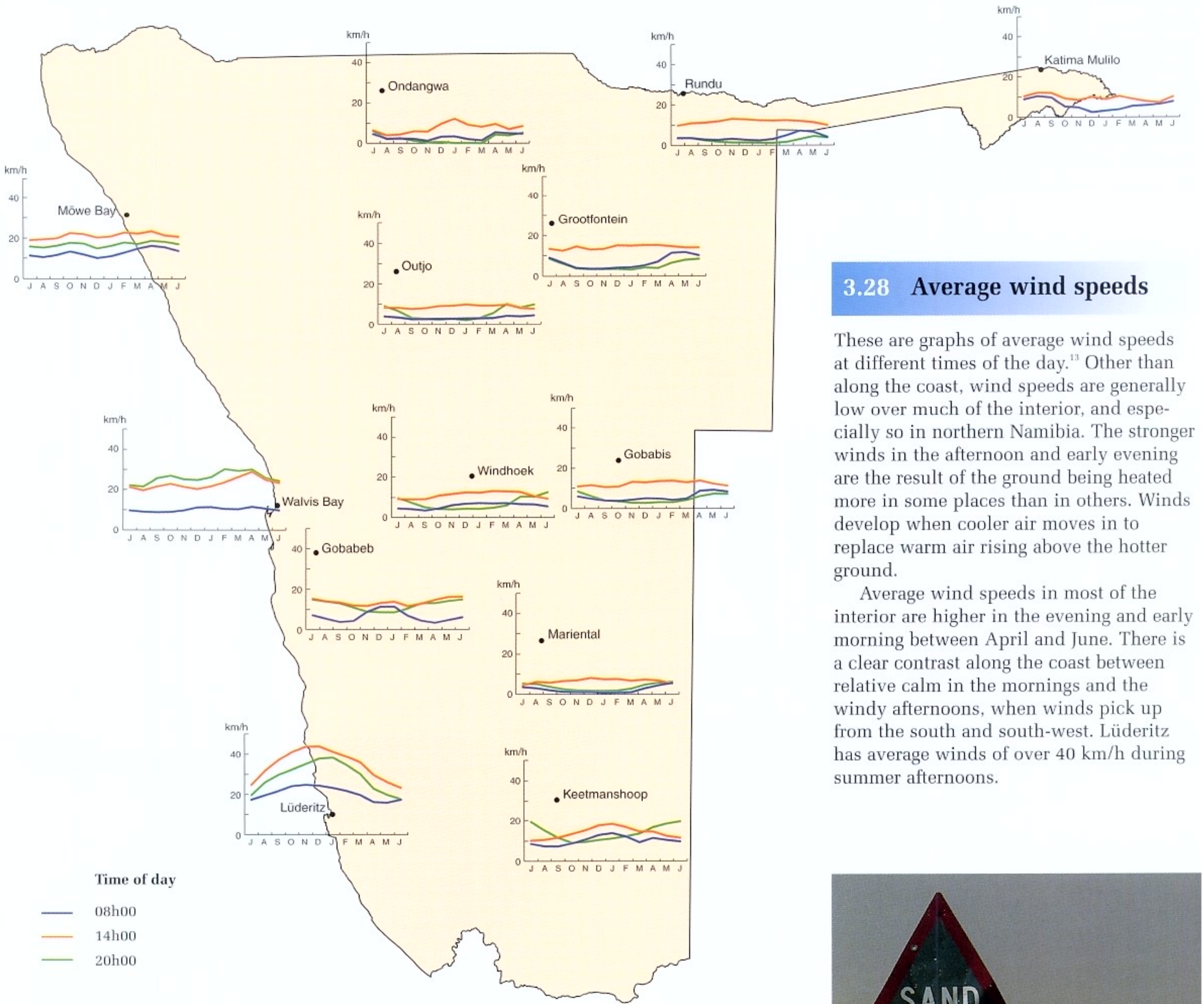


Average water deficit (mm/year)

- Less than 1,300
- 1,300–1,500
- 1,500–1,700
- 1,700–1,900
- 1,900–2,100
- 2,100–2,300
- 2,300–2,500
- More than 2,500

Wind

Wind is a dominating feature of the coastal climate because of the presence of the South Atlantic Anticyclone off the coast. The Anticyclone operates like a gigantic fan, producing strong winds that drive the Benguela Current northwards and carry sand from the shore into the vast sea of Namib dunes. These winds also cause upwelling cells on the coast (see Figure 3.4) which bring nutrient-rich water to the surface, thus producing Namibia's wealth of fish resources. Wind energy can be converted into electricity, and initiatives are being pursued near Lüderitz to do this using giant wind-driven propellers. Wind is less prominent inland, but large areas of sand dunes in the Kalahari Sandveld (see Figure 1.4) were moulded by wind during more arid times long ago (see Figure 2.13).

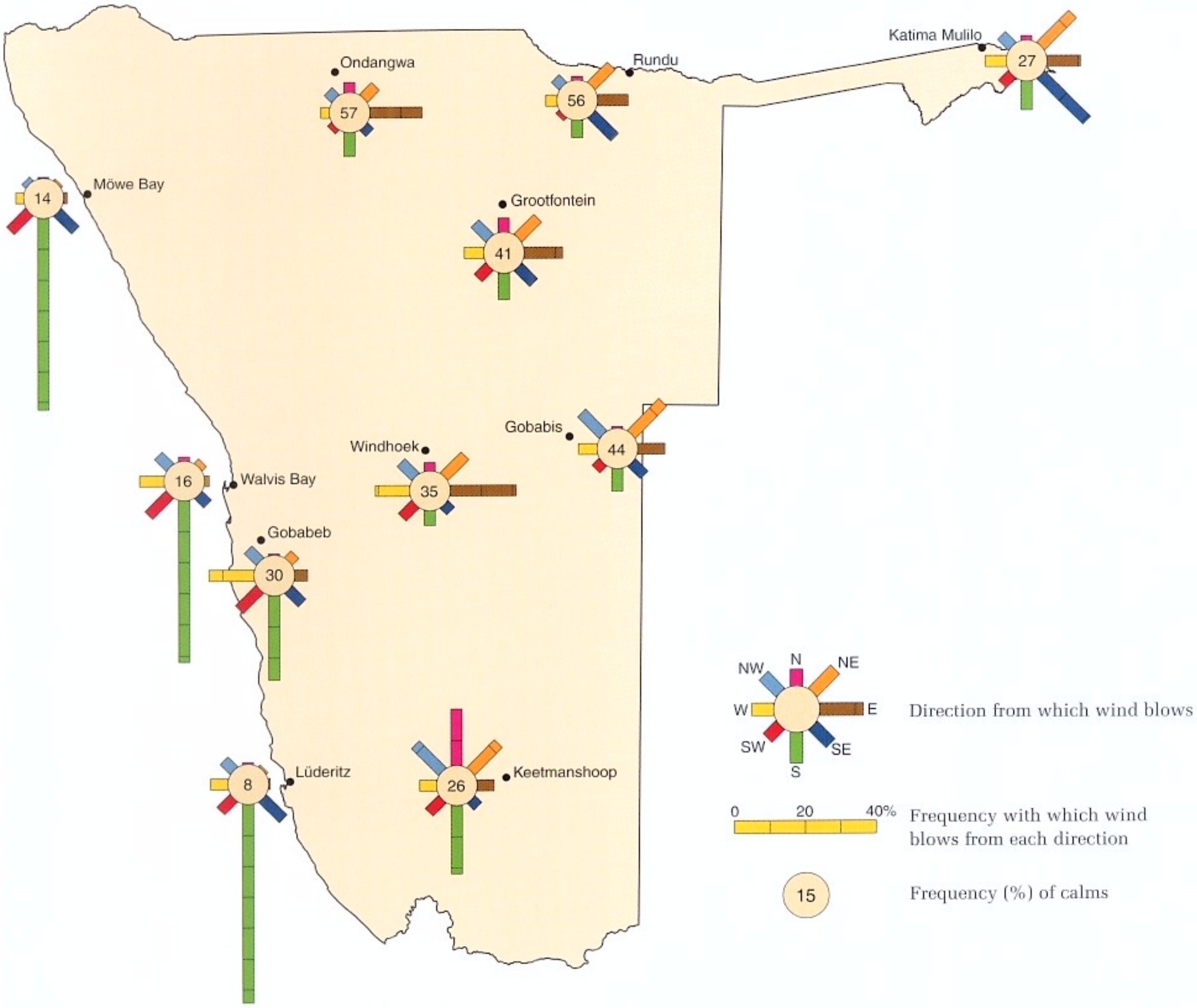


3.28 Average wind speeds

These are graphs of average wind speeds at different times of the day.[13] Other than along the coast, wind speeds are generally low over much of the interior, and especially so in northern Namibia. The stronger winds in the afternoon and early evening are the result of the ground being heated more in some places than in others. Winds develop when cooler air moves in to replace warm air rising above the hotter ground.

Average wind speeds in most of the interior are higher in the evening and early morning between April and June. There is a clear contrast along the coast between relative calm in the mornings and the windy afternoons, when winds pick up from the south and south-west. Lüderitz has average winds of over 40 km/h during summer afternoons.

Strong and persistent south-westerly winds carry sand inshore from the coast to form the Namib Sand Sea. This wind and sand can be hazardous to road-users.



3.29 Frequencies of wind from different directions

In each of the wind roses, the length of a 'petal' reflects the percentage of time the wind blows from that direction. The number in the centre of the rose is the percentage of time that it is calm. They show that it is calm for much of the time in the central northern regions. The most significant winds in the interior are from the north, north-east and east and carry moist air into Namibia. Winds from the south and west predominate along the coast, but occasional hot and dry east (or *berg*) winds create unpleasant conditions. These winds are hot because the air heats up as it drops down the escarpment and over the Namib Desert towards the coast.

Hundreds of tonnes of sand blow offshore on days such as the one captured in this image. The plumes of sand are carried by powerful easterly (or berg) winds driven by a strong high-pressure system over southern Africa.

CHAPTER 4: *Plants and animals*

Much of Namibia's well-being depends on resources found within its borders, including such obvious assets as the land, the soils, water and minerals, and the people themselves. But wild plants and animals – the subject of this chapter – also provide many benefits. Among them are wood to build homes and cook food, grazing and browse for livestock, tourist attractions, medicines, and a productive fishing industry. Indeed, the majority of people in Namibia depend to a great extent on these resources in one way or another.

In addition, each species potentially plays an important role in the functioning of ecological processes that maintain the health, productivity and beauty of the environment. Many species will no doubt be found to have new economic and medical uses. Devil's claw and marula are examples of commercially important indigenous plant species. Namibia's plants and animals also have their own intrinsic beauty and value, each organism contributing to the overall wealth of Namibia.

Physical features, such as the climate, soils and topography, largely determine the abundance and diversity of plants and animals. The most obvious effect of this is in the north, north-east and north-west of the country, where both plant and animal life are richer in the more tropical environment. This wealth is expressed in terms of both a larger number of species and a greater number of individual plants and animals. Much of northern Namibia also has more productive soils which support a greater variety of organisms than the thin layers of soils found in most other areas. In complete contrast to the north-east, an unusual assemblage of plants and animals has evolved to occupy the very arid Namib Desert, and many of these organisms are found only there and nowhere else.

In the marine environment, nutrients carried in localised upwelling centres (where nutrient-rich deep water rises to the surface) provide rich sources of food. These feed planktonic organisms and several species of fish that form the backbone of Namibia's lucrative fishing industry. The upwelling upon which this whole system depends is driven by strong southerly winds produced by the South Atlantic High Pressure Anticyclone lying between southern Africa and South America.

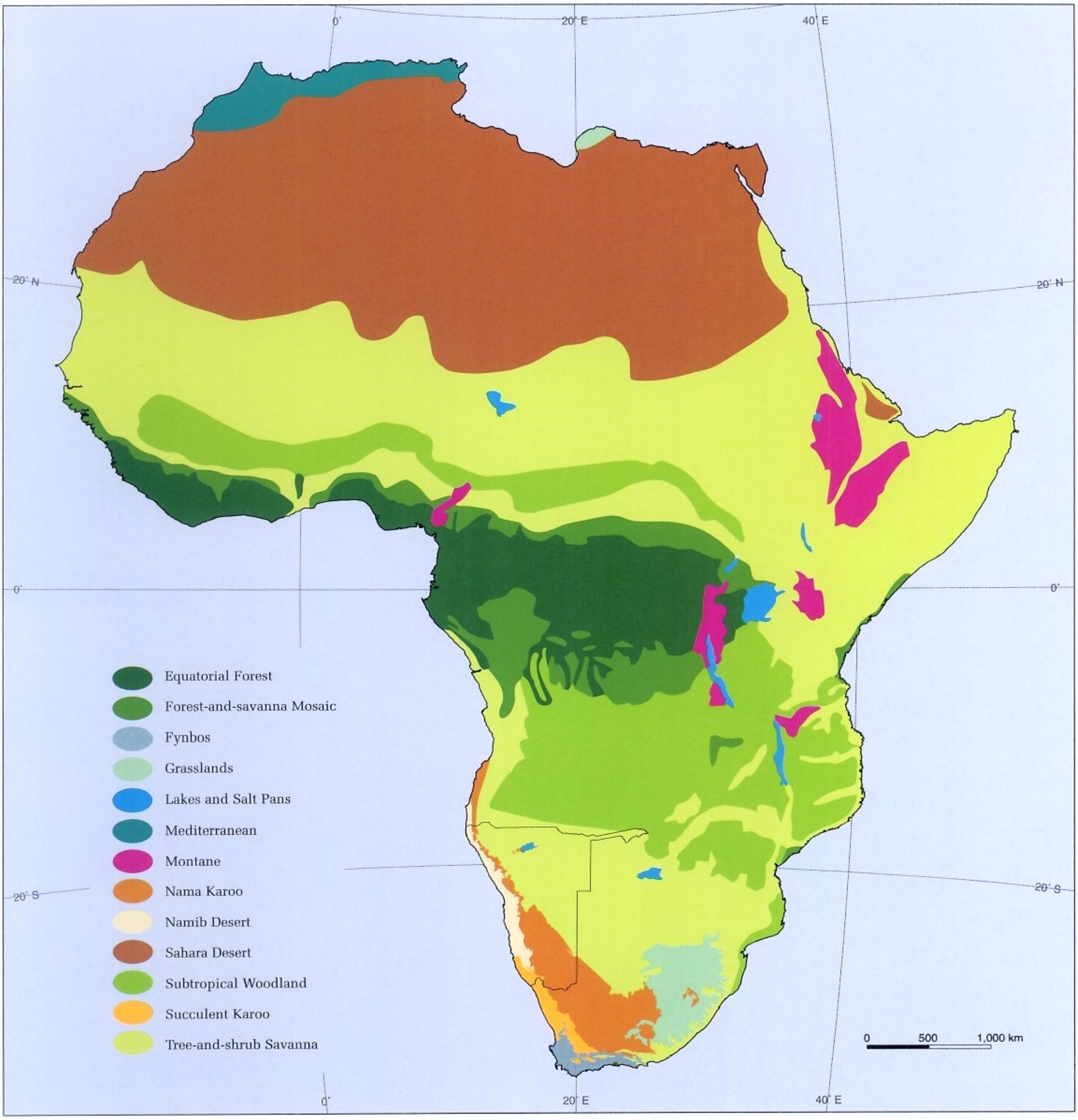
Some species – known as endemics – occur only within Namibia, giving the country a special responsibility towards them. Most plants and animals, however, range across Namibia's borders into Angola, Botswana, South Africa and Zambia. There are also much more wide-ranging links with other parts of the world. Long-distance migrants, especially the many birds that spend about half their lives in the northern hemisphere and the remainder in Namibia, forge one such connection. Another link is provided by many plants and animals that are closely related to similar populations in parts of Ethiopia, Kenya and Somalia, where the environment is rather similar to that in south-western Africa.

There are numerous important and unusual characteristics of plant and animal life in Namibia. Many of these features are linked to the generally arid conditions and unpredictable rainfall: most plants and animals have evolved tactics to survive and even thrive in such a climate. One strategy is to concentrate growth and reproduction in periods after good rains have fallen. Thus, plant growth often varies a great deal from month to month and year to year depending on the amount and distribution of rainfall. This has huge implications for humans, livestock and all other animals that depend upon plant production. Another tactic used by many animals is to move to areas where rains have fallen recently and the extent of some such movements is shown on the pages ahead. Fenced reserves often restrict species that would normally roam over huge areas, and even the larger parks do not provide enough space for some animals to move to fresh grazing. The numbers of wild animals also vary a great deal, as a result of both movements and higher rates of reproduction after good rains have fallen.

Types of vegetation[1]

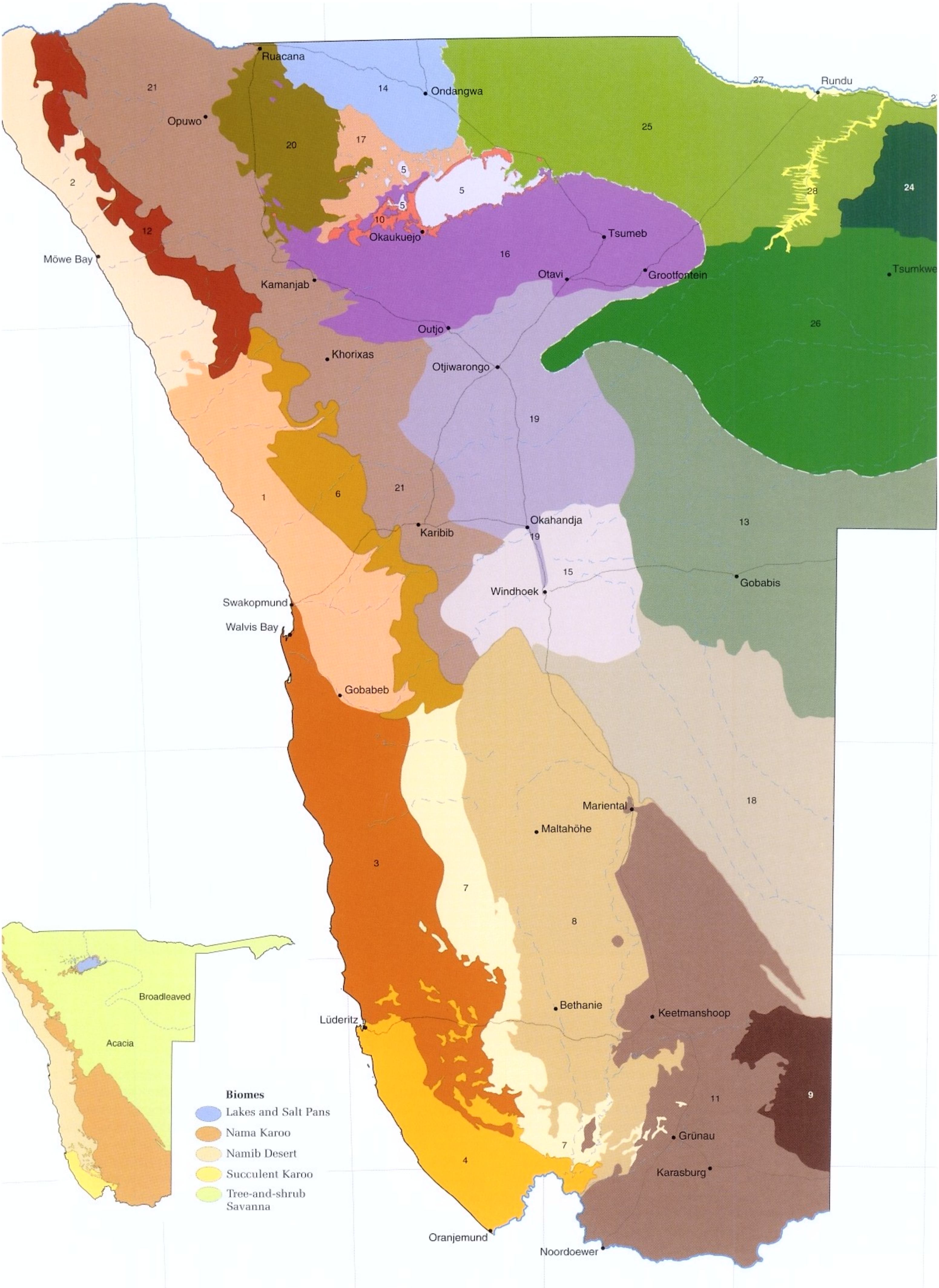
Plants are important for many reasons. As consumers of carbon dioxide, they help keep the earth cool and limit the degree of global warming. Plants also produce oxygen, and their fossilised remains provide coal, natural gas and other petroleum fuels. Most importantly, plants convert energy from the sun into chemical energy, upon which they and animals draw. Plants are, thus, primary producers of energy and nutrients for all animals, besides providing wood and thatching for houses, medicines, and wood for cooking and heating. Indeed, the types and abundance of vegetation in an area largely determine its quality for human life. It is for these principal reasons that information on the distribution of vegetation and plant resources is useful. Three scales of vegetation maps are presented in the maps that follow: biomes, broad vegetation types and smaller vegetation units. These categories form part of a more detailed set of information compiled for the Atlas.

Few plants in the world are as peculiar or as special as the welwitschia. It is apparently intermediate between cone-bearing and flowering plants; moreover, the species has a very confined distribution in extremely arid areas in western Namibia and southern Angola. Individuals may live for hundreds of years, and each plant grows just two leaves during its long life.



4.1 Biomes in Africa

Biomes provide a useful way of distinguishing areas that share broadly similar plant life and climatic features. They also often share similar animal life, soils and geological features. If one looks at the continent as a whole, the equatorial regions are dominated by a swathe of Equatorial Forest surrounded by Forest-and-savanna Mosaic. These forests usually grow on deep sands where annual rainfall is high. To their north, south and east there is a huge area first of broad-leaved Subtropical Woodland and then Tree-and-shrub Savanna, two biomes that characterise much of central Africa. The Sahara Desert dominates much of the northern half of the continent, while the Mediterranean biome covers the northernmost fringes. Highland or Montane areas are recognised as a distinct, cooler habitat of grasslands and alpine vegetation, especially in Ethiopia and other parts of East Africa. Grasslands are spread across the high central plateau of southern Africa, where regular winter frost, fires and grazing are the main factors that keep the biome largely free of trees and shrubs. A combination of varied topography and winter rainfall has produced Africa's richest community of plants in the Fynbos of the south-western tip of South Africa – a great mix of shrubs, trees and grasses that are subject to frequent burning. The five biomes found in Namibia are depicted in the next map.



Ruacana
Ondangwa
Rundu
Opuwo
Okaukuejo
Tsumeb
Möwe Bay
Otavi
Grootfontein
Tsumkwe
Kamanjab
Outjo
Khorixas
Otjiwarongo
Okahandja
Karibib
Windhoek
Gobabis
Swakopmund
Walvis Bay
Gobabeb
Mariental
Maltahöhe
Bethanie
Keetmanshoop
Lüderitz
Grünau
Karasburg
Oranjemund
Noordoewer
1
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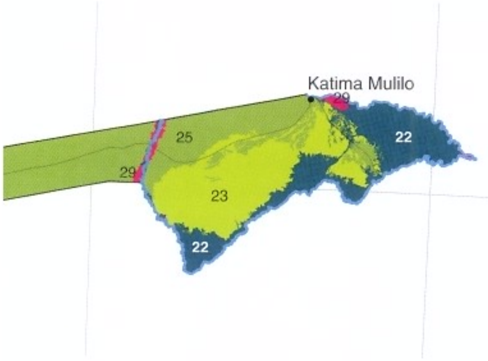
28
Broadleaved
Acacia
Biomes
Lakes and Salt Pans
Nama Karoo
Namib Desert
Succulent Karoo
Tree-and-shrub Savanna



4.2 Biomes and vegetation types in Namibia

Namibia's vegetation is strongly influenced by rainfall (see Figure 3.18), such that plant life is tallest and most lush in the north-east, and progressively more sparse and short in the west and south. This gradient is not a simple one, however, because other factors such as soil types and landscapes affect vegetation. This allows botanists to distinguish discrete vegetation types, such as the 29 broad types of vegetation shown here. Each belongs to a biome, as indicated by its arrangement in the legend. Table 4.1 below provides information on the dominant structure of the vegetation, types of soils and landscapes.

The largest biome, Tree-and-shrub Savanna, is divided into Broadleaved Tree-and-shrub Savanna and Acacia Tree-and-shrub Savanna sub-biomes. Broadleaved Tree-and-shrub Savanna grows largely on deep Kalahari Sandveld, plant life being dominated by several species of tall trees that can form a moderately thick canopy in places. Several large river systems with their associated floodplains cross through the sub-biome, in which there are eight vegetation types.

Acacia Tree-and-shrub Savanna is characterised by large, open expanses of grasslands dotted with *Acacia* trees. The trees are tallest in areas of deeper sands in the east, with plant growth becoming progressively shrubby further west where the soils are shallower and the landscape is more hilly and rocky. The most important environmental variables affecting both the Acacia and Broad-leaved Tree-and-shrub Savanna sub-biomes are the summer rainfall (which averages between 200 and 750 mm per year), frequent and widespread fires (see Figure 4.10) and grazing pressures from wildlife (Figure 4.37) and ▶

Namib Desert
1 Central Desert
2 Northern Desert
3 Southern Desert

Succulent Karoo
4 Succulent Steppe

Lakes and Salt Pans
5 Pans

Nama Karoo
6 Western-central Escarpment and Inselbergs
7 Desert – Dwarf Shrub Transition
8 Dwarf Shrub Savanna
9 Dwarf Shrub – Southern Kalahari Transition
10 Etosha Grass and Dwarf Shrubland
11 Karas Dwarf Shrubland
12 North-western Escarpment and Inselbergs

Acacia Tree-and-shrub Savanna
13 Central Kalahari
14 Cuvelai Drainage
15 Highland Shrubland
16 Karstveld
17 Mopane Shrubland
18 Southern Kalahari
19 Thornbush Shrubland
20 Western Kalahari
21 Western Highlands

Broadleaved Tree-and-shrub Savanna
22 Caprivi Floodplains
23 Caprivi Mopane Woodland
24 Eastern Drainage
25 North-eastern Kalahari Woodland
26 Northern Kalahari
27 Okavango Valley
28 Omatako Drainage
29 Riverine Woodlands and Islands

Table 4.1 The dominant types of soils, structure of plant life (see Figure 2.20) and landscapes (see Figure 1.4) for each vegetation type shown in Figure 4.2

Vegetation type	Dominant soils	Dominant structure	Dominant landscape
1 Central Desert	Petric Gypsisols and Petric Calcisols	Sparse shrubs and grasses	Mainly Central-western Plains
2 Northern Desert	Various	Sparse grasslands	Various
3 Southern Desert	Dune sands	Grassland and dwarf shrublands	Namib Sand Sea
4 Succulent Steppe	Sand, gravel and calcrete	Succulent shrubs	Namib Plains
5 Pans	Mainly Sodic Solonchaks	Pans and grasslands	Salt Pans
6 Western-central Escarpment and Inselbergs	Various	Varied shrubland and grasslands	Central-western Plains
7 Desert – Dwarf Shrub Transition	Mainly Eutric Regosols	Low shrubs and grasslands	Various
8 Dwarf Shrub Savanna	Eutric Leptosols	Low shrubs	Nama-Karoo Basin
9 Dwarf Shrub – Southern Kalahari Transition	Ferralic Arenosols and rock outcrops	Grassland and shrublands	Nama-Karoo Basin
10 Etosha Grass and Dwarf Shrubland	Mainly Calcaric Regosols	Grassland and low shrubs	Kalahari Sandveld
11 Karas Dwarf Shrubland	Eutric Leptosols and Petric Calcisols	Grasslands and low shrubs	Various
12 North-western Escarpment and Inselbergs	Various	Varied shrubland and grasslands	Kunene Hills
13 Central Kalahari	Ferralic Arenosols	Open acacia woodlands	Kalahari Sandveld and Khomas Hochland Plateau
14 Cuvelai Drainage	Eutric Cambisols	Floodplain grasslands or woodlands	Cuvelai System
15 Highland Shrubland	Lithic Leptosols and Eutric Regosols	Shrubs and low trees	Khomas Hochland Plateau
16 Karstveld	Mainly Mollic Leptosols	Mixed woodlands	Various
17 Mopane Shrubland	Mainly Ferralic Arenosols	Mopane shrub and woodlands	Kalahari Sandveld
18 Southern Kalahari	Ferralic Arenosols	Open acacia woodlands	Kalahari Sandveld
19 Thornbush Shrubland	Various	Acacia shrublands	Various
20 Western Kalahari	Ferralic Arenosols	Broadleaved woodlands	Kalahari Sandveld
21 Western Highlands	Various	Grasslands and scattered trees	Various
22 Caprivi Floodplains	Eutric Fluvisols	Floodplain grasslands	Caprivi Floodplains
23 Caprivi Mopane Woodland	Eutric Fluvisols and Ferralic Arenosols	Grasslands or woodlands	Kalahari Sandveld and Caprivi Floodplains
24 Eastern Drainage	Ferralic Arenosols	Broadleaved woodlands	Kalahari Sandveld
25 North-eastern Kalahari Woodland	Ferralic Arenosols	Broadleaved woodlands	Kalahari Sandveld
26 Northern Kalahari	Ferralic Arenosols	Broadleaved woodlands	Kalahari Sandveld
27 Okavango Valley	Eutric Fluvisols	Floodplain grasslands or woodlands	Okavango Valley
28 Omatako Drainage	Eutric Fluvisols	Floodplain grasslands or woodlands	Kalahari Sandveld
29 Riverine Woodlands and Islands	Eutric Fluvisols	Tall woodlands	Various

livestock (Figures 5.25–5.29). Nine vegetation types are included in the Acacia Tree-and-shrub Savanna sub-biome.

The Namib Desert biome with its three vegetation types extends from Lüderitz northwards, along the entire west coast into Angola. The sparse plant cover varies according to the substrate. Sand dunes, for example, support only a few grasses, while a variety of herbs, small shrubs and grasses grow on the gravel plains, and shrubs and trees are found along ephemeral river courses that cut through to the coast. Although the biome is characterised by extreme aridity, with an average of less than 50 mm of rain per year, coastal fog is a crucial source of water for many plants and animals, and moderate temperatures provide a frost-free environment. Strong south to westerly winds and occasional strong easterly winds have moulded the mobile sand dunes that are interspersed with gravel plains and isolated mountains.

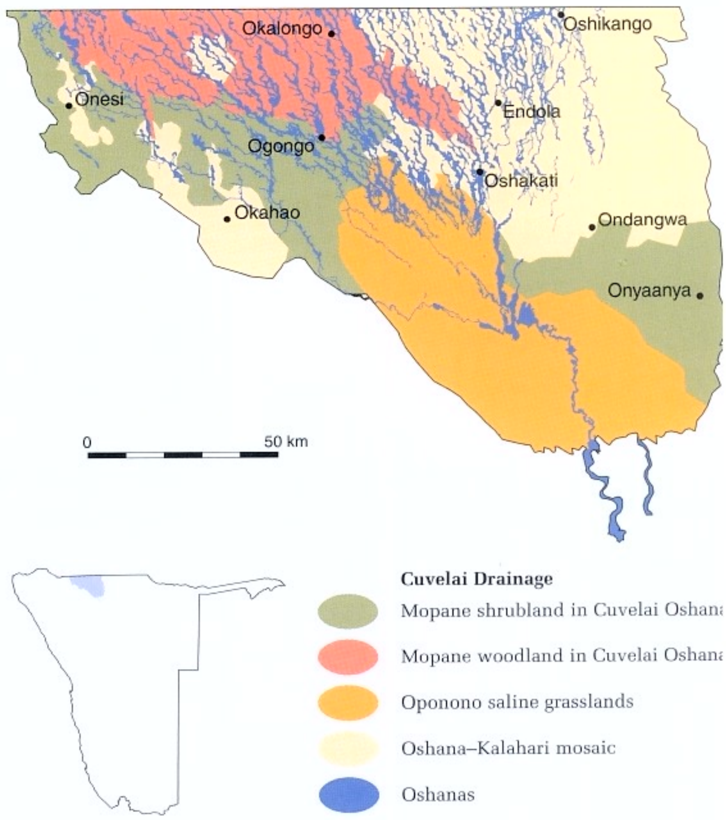
The Nama Karoo biome supports a varied assemblage of plant communities, ranging from deciduous shrub vegetation to perennial grasslands and succulent shrubs. Although dwarf shrubs dominate, there is a wealth of plant species due to the great variety of geological substrates, soils and land forms. The biome includes the escarpment zone separating the Namib Desert from the Acacia Tree-and-shrub Savanna, many dolerite outcrops, extensive pan areas, vast plains, the Karas Mountains and mountains of the Orange River valley. There are seven vegetation types in the biome, much of which is arid with an average annual rainfall exceeding 250 mm only in the eastern areas.

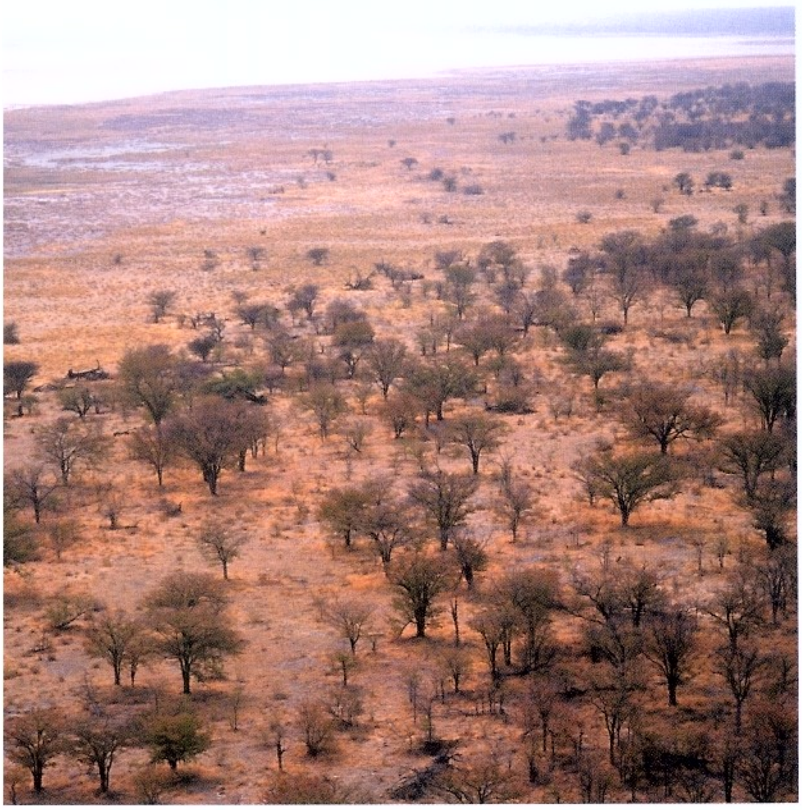
As the name suggests, the Succulent Karoo biome with its single vegetation type is characterised by succulents, both as shrubs and as dwarf shrubs. The great diversity of plants found here makes this one of the most important botanical areas in Namibia. Since many plants are also endemic to the biome, the number of specially protected species in it is extremely high. The high diversity is due to the variety of habitats, which, in turn, is the result of varied geology and land forms ranging from coastal, gravel, gypsum and sand plains to localised dune fields, impressive inselbergs and escarpments. Much of the biome receives some winter rainfall, and fog is common near the coast. The Namib Desert biome is, to some degree, a westerly, more arid sub-biome of the Succulent Karoo.

Very few plants grow on the Etosha Pan or the other, smaller saline pans which together form the Lakes and Salt Pans biome and vegetation type. The grass and dwarf-shrubland plains surrounding the Etosha Pan are underlain by limestone, and the shallow covering of relatively saline soils limits the growth of trees. The plains are favoured by grazing antelope. This biome includes other pans and lakes elsewhere in Africa, such as Lake Victoria, Lake Chad and the Makgadikgadi Salt Pan.

4.3 A variety of vegetation in place and form

Figure 4.1 presents a continental perspective on vegetation biomes, while Figure 4.2 goes on to give a more detailed perspective on how biomes are divided into vegetation types. However, the 29 broad vegetation types are themselves mosaics of smaller units, as shown by the five vegetation units within the Cuvelai Drainage vegetation type. In this example, the kind of vegetation present depends largely on soil conditions, which, in turn, are influenced by flooding patterns. Grasses and shrubs dominate in areas where the soils are flooded more often, and these soils are relatively shallow, clayey and salty. Taller woodlands grow on deeper sands that are less saline and that have not been affected by flooding.





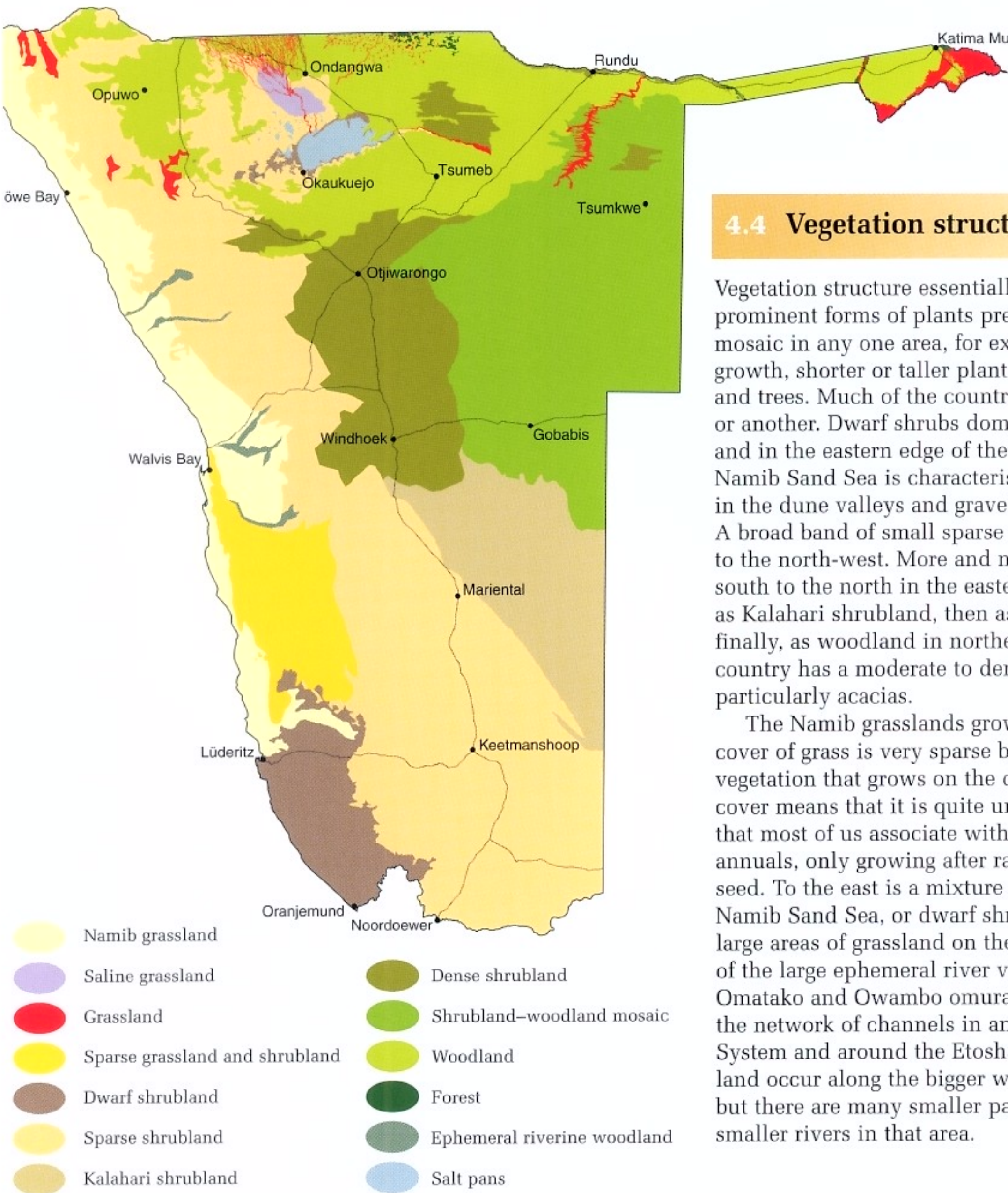
Plant life in transition areas between vegetation types is often diverse. This is the zone between woodlands in the foreground and the Etosha Pan in the distance. The trees grow on relatively deep soils, while only grasses and small shrubs and herbs can grow on the saltier soils close to the edge of the pan. The pan itself is so saline that only a few, very specialised plants grow there.

Vegetation structure and production

Anyone driving from one part of Namibia to another will be immediately aware of how the nature of plant life changes: from woodland to grassland to shrubland, for example. Changes are often apparent over small distances, but there are also broader structural variations, most of which are due to the effects of climate, soil types and topography. Thus, woodlands are only present where rainfall is high and soils are deep, for example in the north-east, or where trees use water trapped along river courses. Trees are largely absent from very saline soils and from very arid environments, where grasses and shrubs replace them. Only small shrubs or grasses grow in the most arid areas, and most grasses grow only after it has rained.

In addition to geographic variation in vegetation structure, there are also many changes from year to year. Most of this variation is due to rainfall, such that there is an abundance of growth after good rains but rather little in dry years or those with more sporadic falls. The greatest variation occurs in areas where grasses dominate the vegetation because their growth is dependent on rain. Most trees in woodland areas, by contrast, grow and produce leaves fairly independently of recent rainfall.

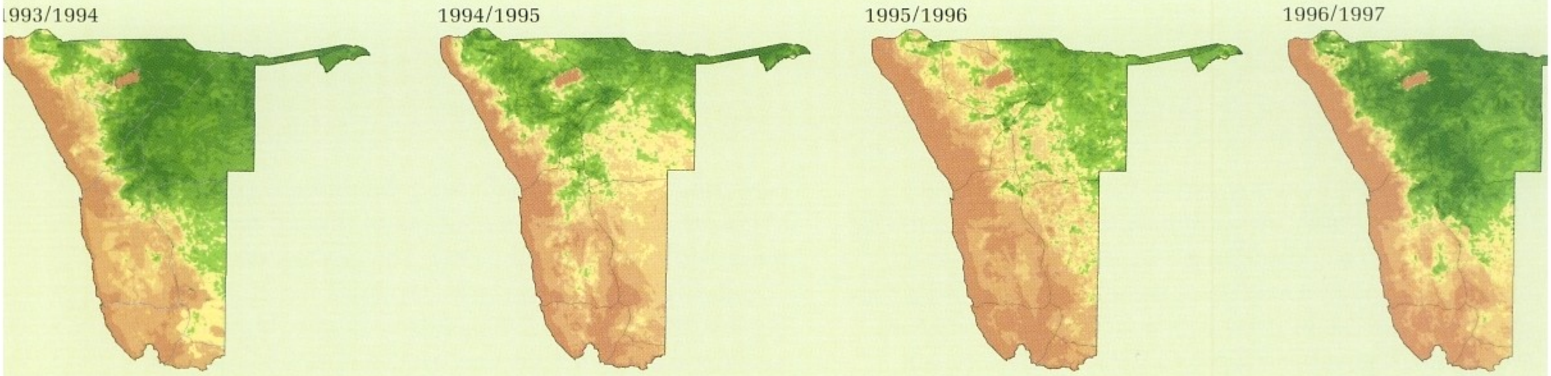
All of this variation in vegetation structure and growth has enormous implications for the use of plant resources, especially by farmers and other rural people. Some areas may have an abundance of grazing in one year, while others have more permanent supplies of wood that can be used for various purposes. Yet other areas may have very little to offer, and people who depend on plant resources often struggle.



4.4 Vegetation structure

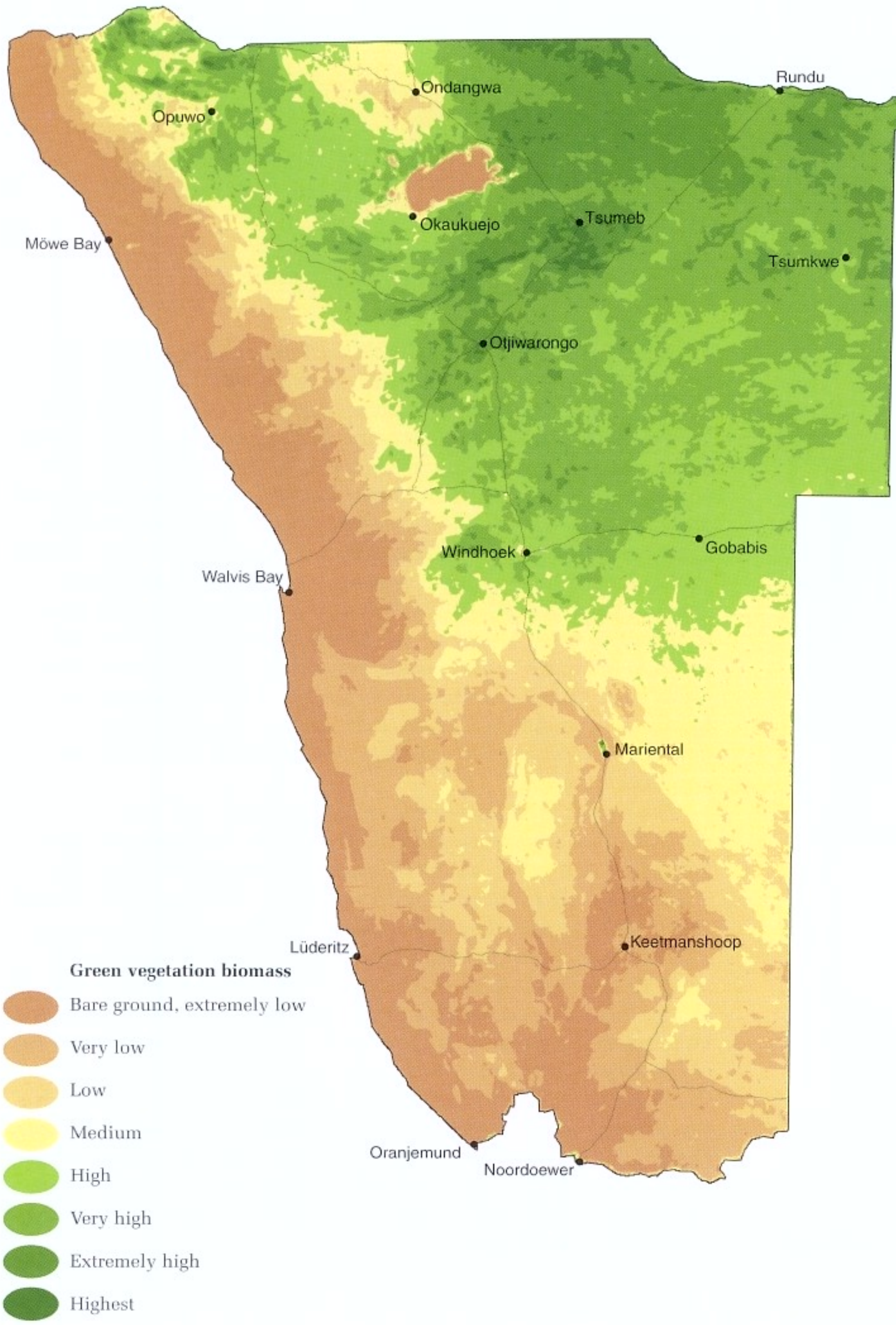
Vegetation structure essentially reflects the dominant and most prominent forms of plants present, even though there is often a mosaic in any one area, for example patches of denser or sparser growth, shorter or taller plants, or a varying mix of grasses, shrubs and trees. Much of the country consists of shrubland in one form or another. Dwarf shrubs dominate areas in the extreme south-west and in the eastern edge of the central Namib, while much of the Namib Sand Sea is characterised by a combination of dwarf shrubs in the dune valleys and gravel plains and grasses on the dunes. A broad band of small sparse shrubs stretches from the south-east to the north-west. More and more trees replace shrubs from the south to the north in the eastern zone of the Kalahari sands, first as Kalahari shrubland, then as shrubland–woodland mosaic and, finally, as woodland in northern Namibia. The centre of the country has a moderate to dense cover of shrubs and small trees, particularly acacias.

The Namib grasslands grow in an extremely arid area. The cover of grass is very sparse but nevertheless dominates the little vegetation that grows on the dunes and gravel plains. The thin cover means that it is quite unlike the more uniform layers of grass that most of us associate with grasslands. Many of the grasses are annuals, only growing after rain and then dying after producing seed. To the east is a mixture of grassland and shrubland in the Namib Sand Sea, or dwarf shrubland further north. There are also large areas of grassland on the Caprivi Floodplains and along some of the large ephemeral river valleys, for example those of the Omatako and Owambo omurambas. Saline grasslands characterise the network of channels in and to the south of the Cuvelai Drainage System and around the Etosha Pan. Larger areas of riverine woodland occur along the bigger west-flowing rivers in the north-west, but there are many smaller patches of similar woodland along the smaller rivers in that area.



4.5 Maximum plant growth and production from season to season[2]

There is an enormous amount of variation in plant growth from season to season, as shown by the indices of how much new plant growth was produced in each of seven seasons. Each season, taken from October in one year to April in the next, differs from the one before or after it. Plant production was substantial in the north-eastern half of the country during three of the seven seasons: 1993/94, 1996/97 and 1999/2000, but only in the 1999/2000 season did good growth extend to cover much of southern Namibia, for example. The categories in the legend are intended to show the range of variation within the country. An area rated 'highest', for example, has quite different growth from that in a tropical rain forest.

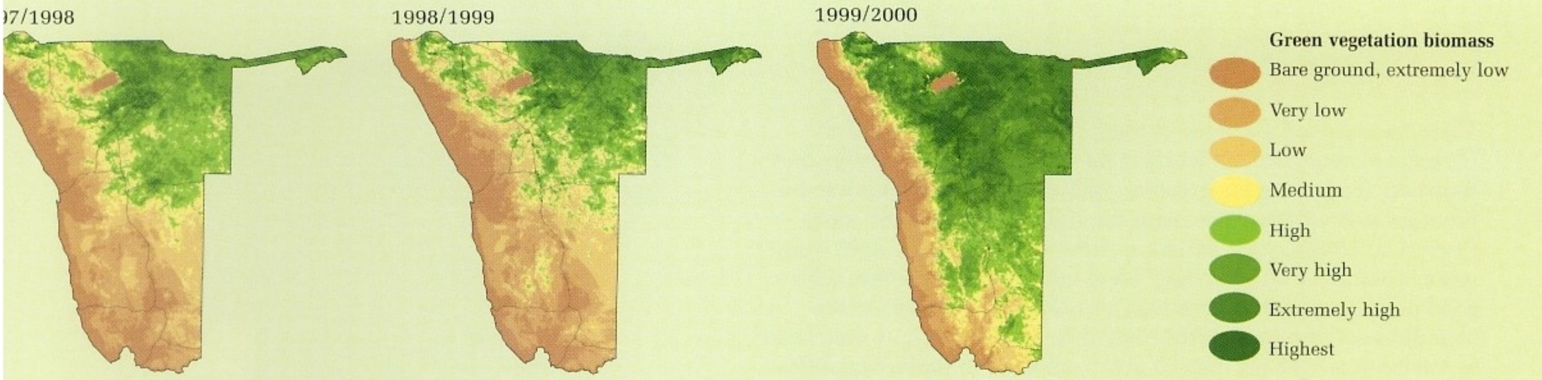


4.6 Average plant production

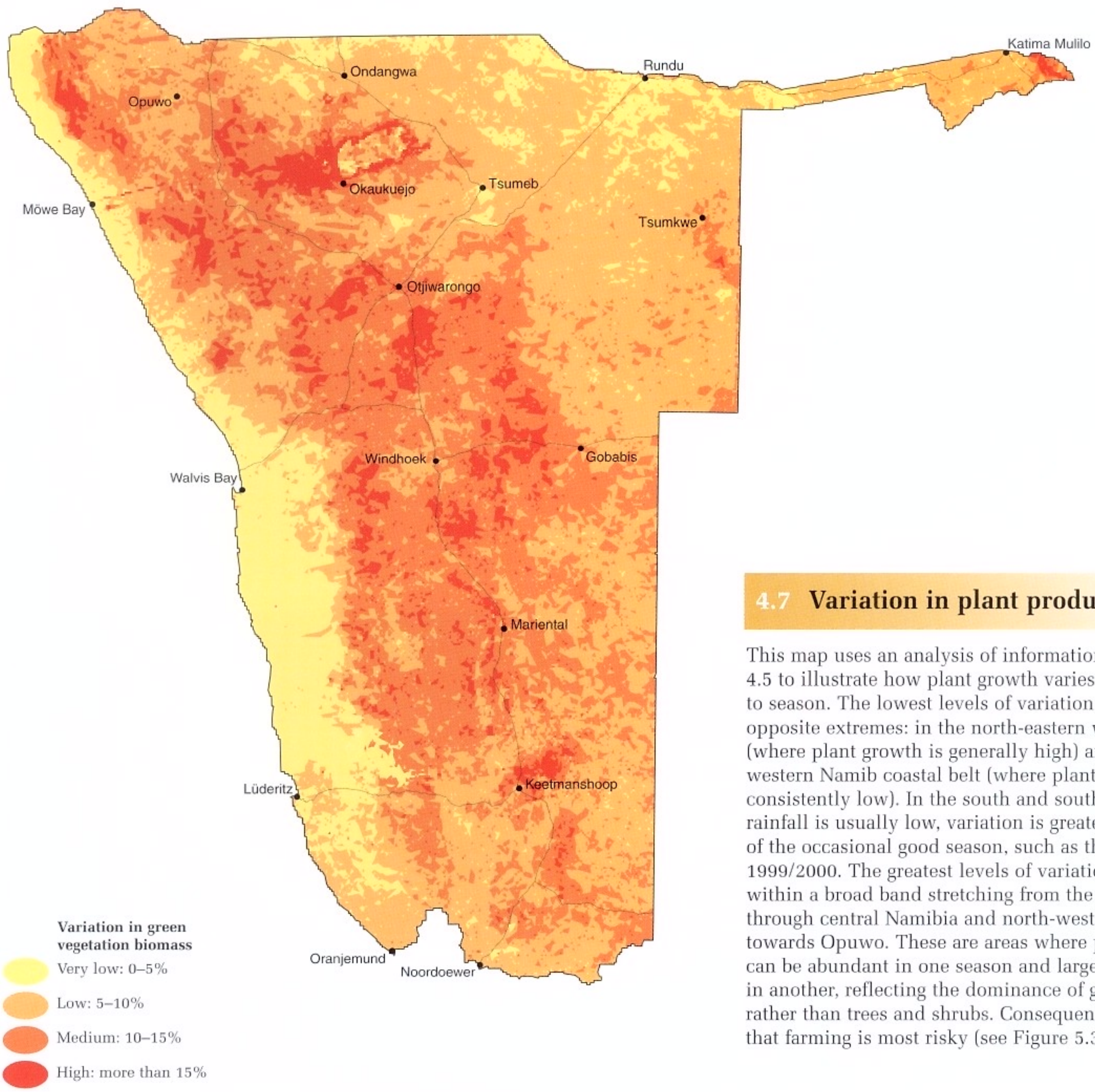
This is the average maximum production of plant biomass over the seven seasons shown in Figure 4.5. The greatest production is in the north-east, especially in dense woodland in Caprivi, Kavango and Ohangwena. Woodlands on and around the dolomite hills near Tsumeb, Grootfontein and Otavi and extending south-westwards beyond Outjo also produce considerable growth. Reed-beds growing in the eastern Caprivi Floodplains likewise produce large amounts of plant matter.

The least growth is in the western coastal belt in the Namib and the southernmost areas of the country as a result of low rainfall. Very little grows in the saline soils in Etosha Pan. Areas in and around the Cuvelai System to the north of Etosha Pan also stand out as producing very little plant biomass. Much of this area consists of saline grass-lands on which few woody plants grow and where grass cover is generally sparse. In other parts of the Cuvelai, however, there is a low level of production because high numbers of livestock keep the grass cropped at low levels and because vegetation has been cleared for mahangu fields, timber and firewood. This extensive clearing is due to the great number of people and livestock living in this small area (see Figure 6.1). The same effect is apparent in the narrow, densely populated band along the Okavango River.

There are also distinct boundaries where vegetation types change, for example between the Southern Kalahari and Karas Dwarf Shrubland (see Figure 4.2).



The maps also reveal much variation from place to place, even on a very small scale. Some small patches that differ from surrounding areas reflect changes in vegetation types. Good examples of this include Caprivi Floodplains in eastern Caprivi compared with adjacent woodlands; the bare Etosha Pan in contrast to the surrounding woodlands; or the small areas of dense teak forests in Ohangwena which produce more plant matter than surrounding woodlands. The Weissrand Plateau south-east of Mariental has much less plant growth than the sandy areas further east. Other patchiness is due to management practices and deforestation, the best example being in the Cuvelai System, as described in Figure 4.6. However, much of the small-scale variation is due to the sporadic and patchy nature of rainfall: one farm receives good soaking rain at just the right time in the season, while neighbours may wait for weeks before they receive rain.



4.7 Variation in plant production[3]

This map uses an analysis of information in Figure 4.5 to illustrate how plant growth varies from season to season. The lowest levels of variation are at opposite extremes: in the north-eastern woodlands (where plant growth is generally high) and in the western Namib coastal belt (where plant growth is consistently low). In the south and south-east, where rainfall is usually low, variation is greater as a result of the occasional good season, such as the one in 1999/2000. The greatest levels of variation occur within a broad band stretching from the south-east through central Namibia and north-westwards towards Opuwo. These are areas where plant growth can be abundant in one season and largely absent in another, reflecting the dominance of grass cover rather than trees and shrubs. Consequently, it is here that farming is most risky (see Figure 5.30).

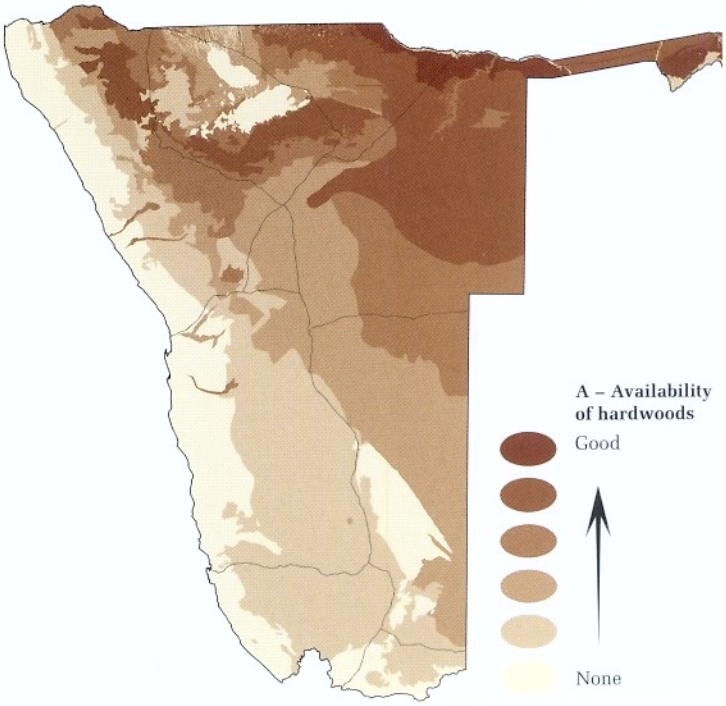
4.8 Ratings of the value of plant resources

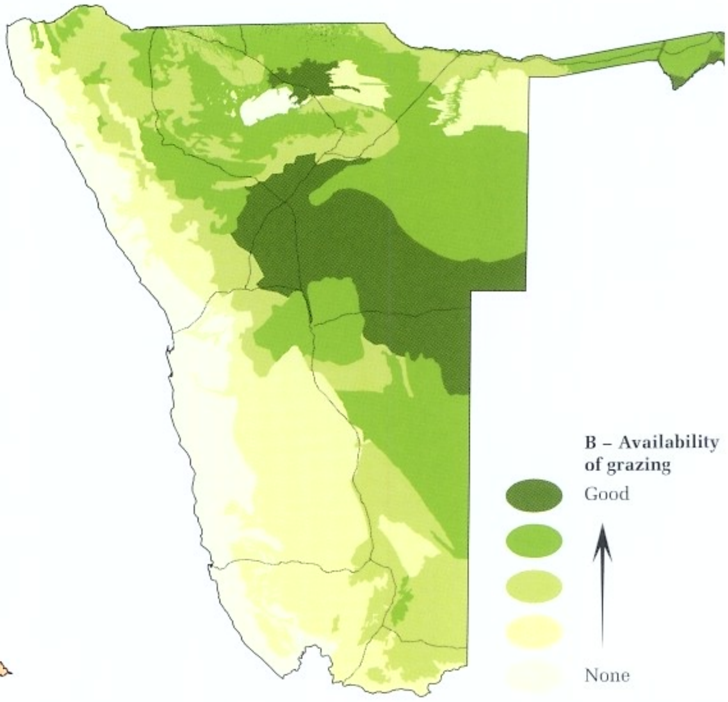
Three measures of the value of plant resources are shown here: (A) relative abundance of hardwoods typically used for timber and firewood, (B) grazing for livestock and wildlife, and (C) browse for livestock and wildlife. The maps provide approximations, since there is much fine-scale variation within each mapping unit. Thus, some broad areas rated as 'low' often include small patches with good plant resources. The ratings are also scaled relative to the abundance of resources within Namibia. For example, an area rated as having good grazing may be poor compared to pasture qualities in another country. The quality of information available for different units varies[4] and there are of course other values, such as medicinal uses and the value of fruits and nuts for human consumption that are not shown here.

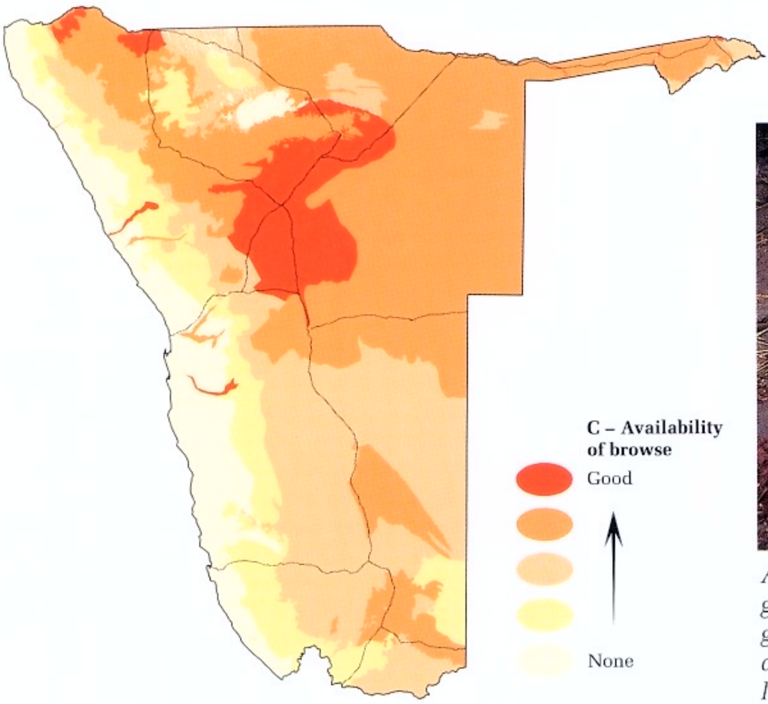
Hardwood suitable for timber and firewood is generally much more abundant in the north and north-east of Namibia. Much of the woodland there is broad-leaved, including a few small areas with valuable stocks of teak and kiaat. Other useful species are *Burkea africana*, mopane, *Terminalia prunioides* and *Terminalia sericea*. Further south in central Namibia, acacias are the most useful hardwoods because of their use for charcoal production and firewood.

Grazing resources consist of a wide variety of grass species. However, these vary widely in their palatability to grazing animals and in their abundance. Some central areas that have good grazing potential because of the presence of palatable and nutritious species cannot support many grazing animals as a result of severe overgrazing or bush encroachment (see Figure 4.11). The most important grass species for grazers are *Schmidtia kalahariensis* and *Cynodon dactylon*, and various species of *Brachiaria*, *Digitaria*, *Anthephora*, *Eragrostis*, *Enneapogon* and *Panicum*.

Elephant, as well as many wild ungulates (hoofed animals) such as kudu and giraffe, obtain most of their food by browsing the leaves of trees and shrubs. Browse is also important to goats, cattle and sheep. The best browse is available in the central areas of the country, while the southern and western desert areas have less to offer browsers. Various *Acacia* species are browsed regularly, and the seeds of these plants are often also important sources of energy and nutrients. Since acacias are often common along the ephemeral rivers that flow through the Namib to the coast, these corridors typically provide an abundance of browse and are the lifeline for many wild species and people living in the arid west.







A large tree felled and then hollowed out for use as a dugout has great value: for safe passage across wide rivers and to reach fishing grounds. But what steps can be taken to ensure that younger trees are kept free of bush fires (see Figure 4.9) so that they too can grow large one day?

4.9 A selection of important plant species[5]

Many plant species are of special interest because of their known economic, resource and conservation values, and these maps show the distributions of some better-known species. There are certainly many others among the over 4,000 plant species and subspecies in Namibia that are valuable and many may still be found to have important medicinal properties.

The welwitschia (*Welwitschia mirabilis*) is perhaps Namibia's most famous plant. It is also a botanical curiosity because of its position as a kind of 'missing link' between the cone-bearing and flowering plants. Each plant produces only two leaves during its lifetime. These are leathery to minimise water loss, and grow continuously from one woody stem, which carbon-dating tests of large individuals have shown can be over 1,000 years old. There are several separate populations, ranging from the well-known ones east of Swakopmund to others in southern Angola. The species is confined to gravel plains, hillside slopes and river valleys, and is legally protected in Namibia.

Large quiver trees (*Aloe dichotoma*) are a well-known sight in southern Namibia, especially in rocky habitats (see pages 2 and 3). As succulents, they can store water quickly in their leaves and trunks, and thus often grow in arid areas where few other trees survive. Their range extends north along the escarpment where they are less abundant than further south. The tree's branches divide in pairs, making the species easy to recognise. The yellow flowers that appear in June and July contain a large supply of nectar, which is relished by numerous insects and other animals. Like all aloes in Namibia, it is protected.

Kiaat (*Pterocarpus angolensis*) is a valuable timber tree because of the durability and attractive grain of the wood. These qualities make it useful for furniture, building material for rural homes and decorative carvings. The tree is confined to the woodlands on Kalahari Sandveld in the higher rainfall areas in the north-east. The high frequency of fires (see Figure 4.10) threatens populations of kiaat, the fires stunting growth, killing trees, and preventing seeds from germinating and young plants surviving to maturity. The species has also suffered from excessive logging and is thus listed in the World List of Threatened Trees.

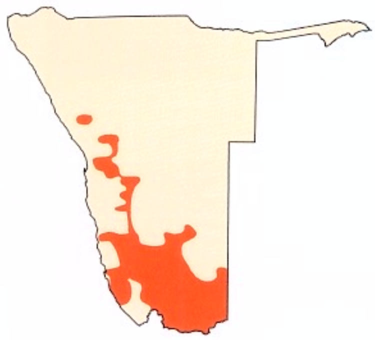
Mopane (*Colophospermum mopane*) is the most used, versatile and possibly over-utilised woody resource in the country. Tens of thousands of households in rural central-northern and north-west Namibia as well as in eastern Caprivi make great use of the tree for firewood, fencing and building material, and sometimes for implements. In the past, its roots were exported to decorate aquariums. Mopane prefers clayey soils and is sensitive to frost. The broad area of Kalahari Sandveld separates the two zones in which it occurs in Namibia. Mopane grows as tall trees in Caprivi and as scrub and trees of moderate height in the west. The Omusati Region takes its name from the word for mopane in Oshindonga, Otjiherero and several other languages.

Devil's claw (*Harpagophytum procumbens* subsp. *procumbens*) is presently the only commercially harvested medicinal plant in Namibia. The species is also legally protected because of its commercial value and the potential for over-exploitation. The tubers contain a compound that may alleviate a number of ailments including arthritis. Its predominant distribution in central and eastern Namibia reflects its preference for sandy habitats. The plant is exported in bulk, mainly to Europe, but it now contributes relatively little to the economy because hardly any value is added to the product within Namibia.

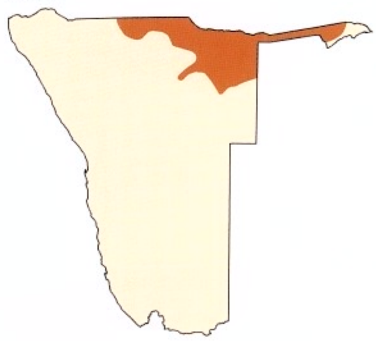
The tsamma melon (*Citrullus lanatus*) occurs widely and is usually associated with sandy habitats. It is the direct 'ancestor' of the cultivated watermelon, and its genetic resources could prove useful for developing commercial varieties that are tolerant of drought and pests. The melons are cultivated in northern Namibia where they are eaten fresh, cooked or used to provide oil extracted from the seeds.

Welwitschia

Quiver tree

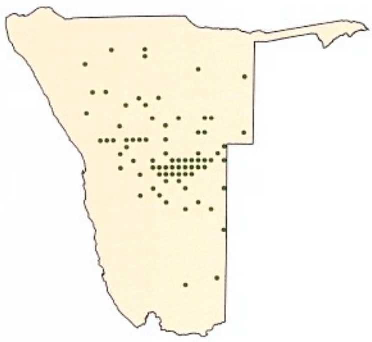


Kiaat

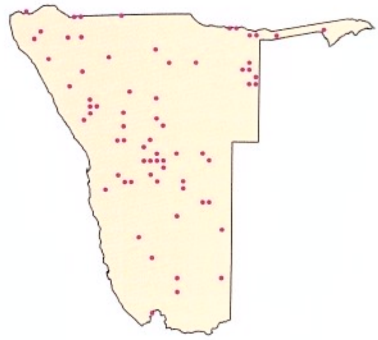


Mopane

Devil's claw



Tsamma melon



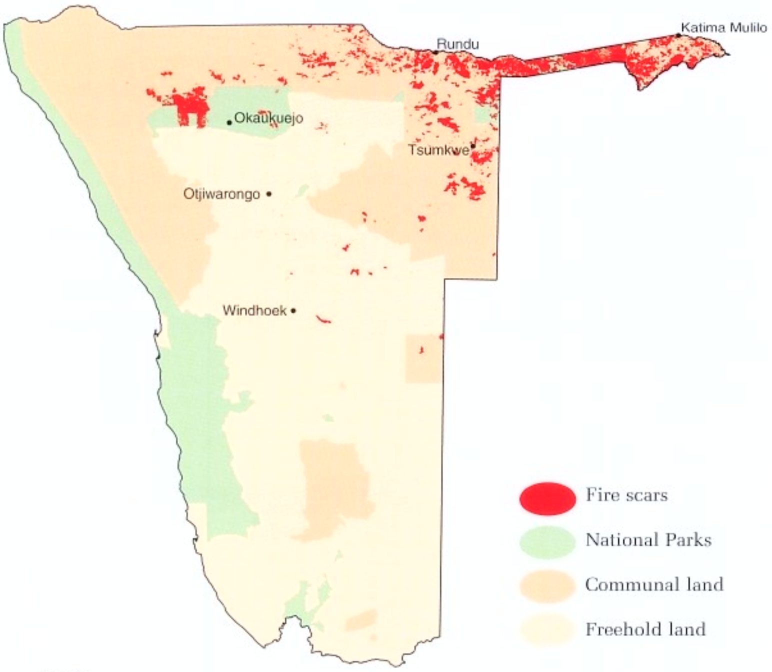
4.10 Bush fires

Each year, large areas burn in north-eastern Namibia, as shown in these maps of fire scars recorded between 1996 and 2000.[6] Substantial areas further south and west may burn in years when good rains have fallen and there is an abundance of dry grass in the winter months. This happened following good rains in 2000, when there were many more fires than in 1997, a relatively dry year.

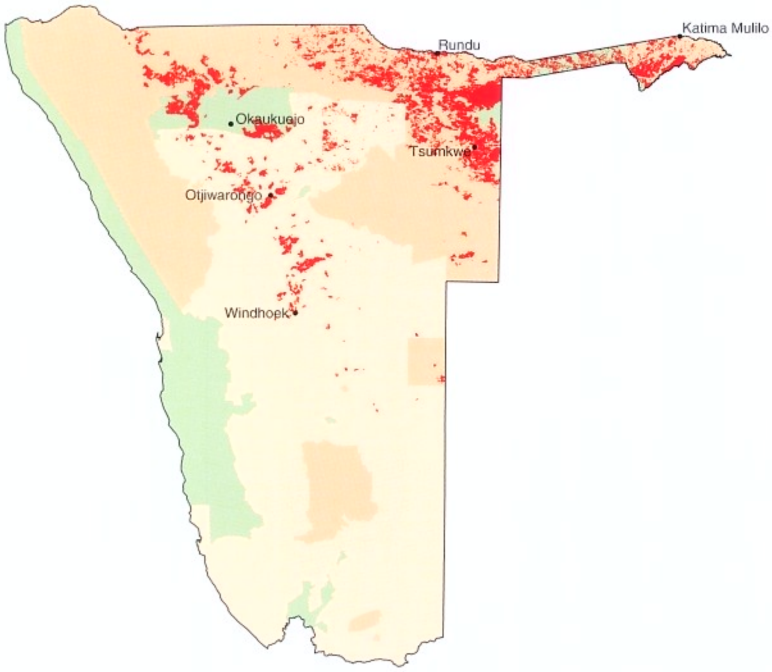
Most bush fires occur between June and October. The great majority are started deliberately, for example to clear fields or to clear away old grass so as to encourage new growth for livestock or to attract wild animals. However, many fires run out of control, and a single fire may end up burning hundreds of square kilometres of woodland and pasture. Although bush fires also occur naturally, the fact that many areas are burnt year after year has several very undesirable consequences. Many mature trees, including valuable timber trees, are killed. Saplings are also destroyed, with the result that the older trees that have died are not replaced, and some areas have been deforested completely. Bush fires and the clearing of land for cultivation (see Figure 5.24) are by far the most important causes of deforestation in Namibia. Bush fires also lead to valuable grazing areas being lost – either because of the direct effects of burning or because of bush encroachment caused by invasive shrubs that can withstand the effects of frequent burning (see Figure 4.11). Wild animals, livestock and people are often killed in bush fires as well.

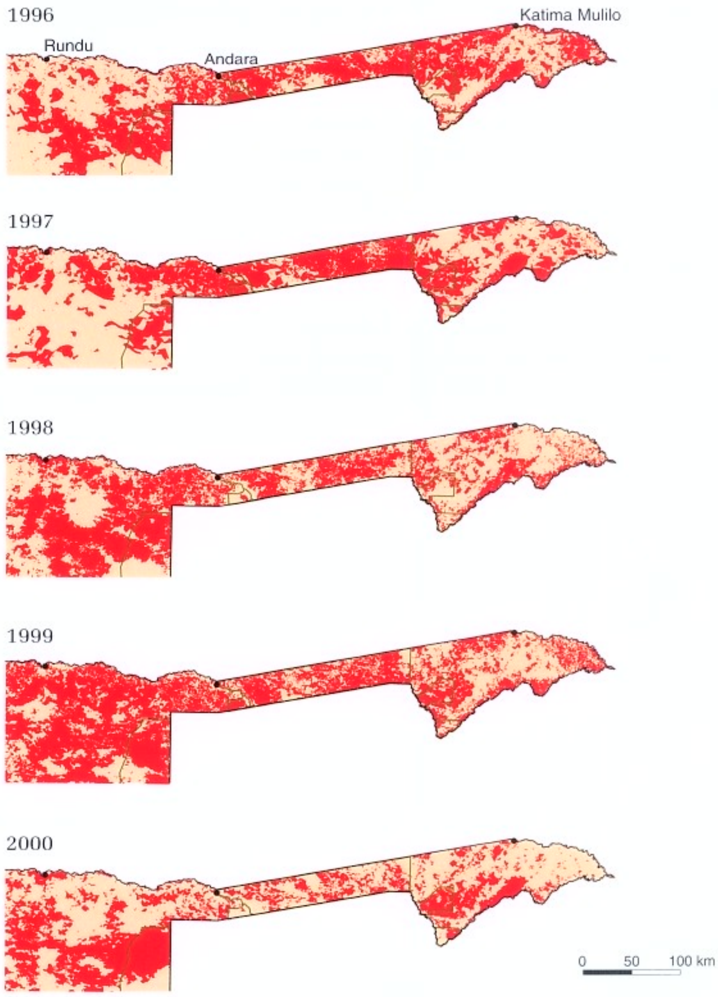
The areas burnt each year are notable. The zone shown in the five maps covers some 40,246 km² of north-eastern Namibia. The total area of the block that burnt each year varied between between 41% in 2000 and 62% in 1999, with an average of 51% for the five years. The graph below shows the extent of areas that were burnt during one or more years over the five-year period. Relatively small proportions burnt only once or in all five years, whereas substantial areas burnt during three or four of the five years.

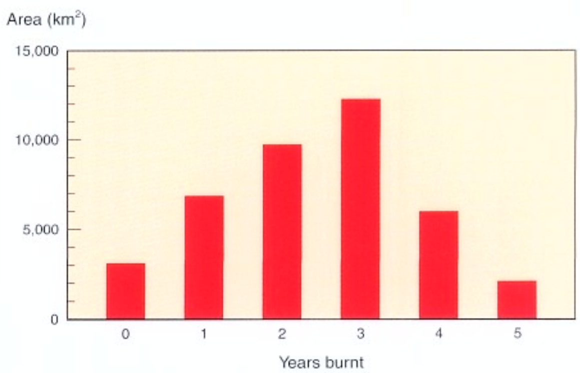
1997



2000







4.11 Bush encroachment[7]

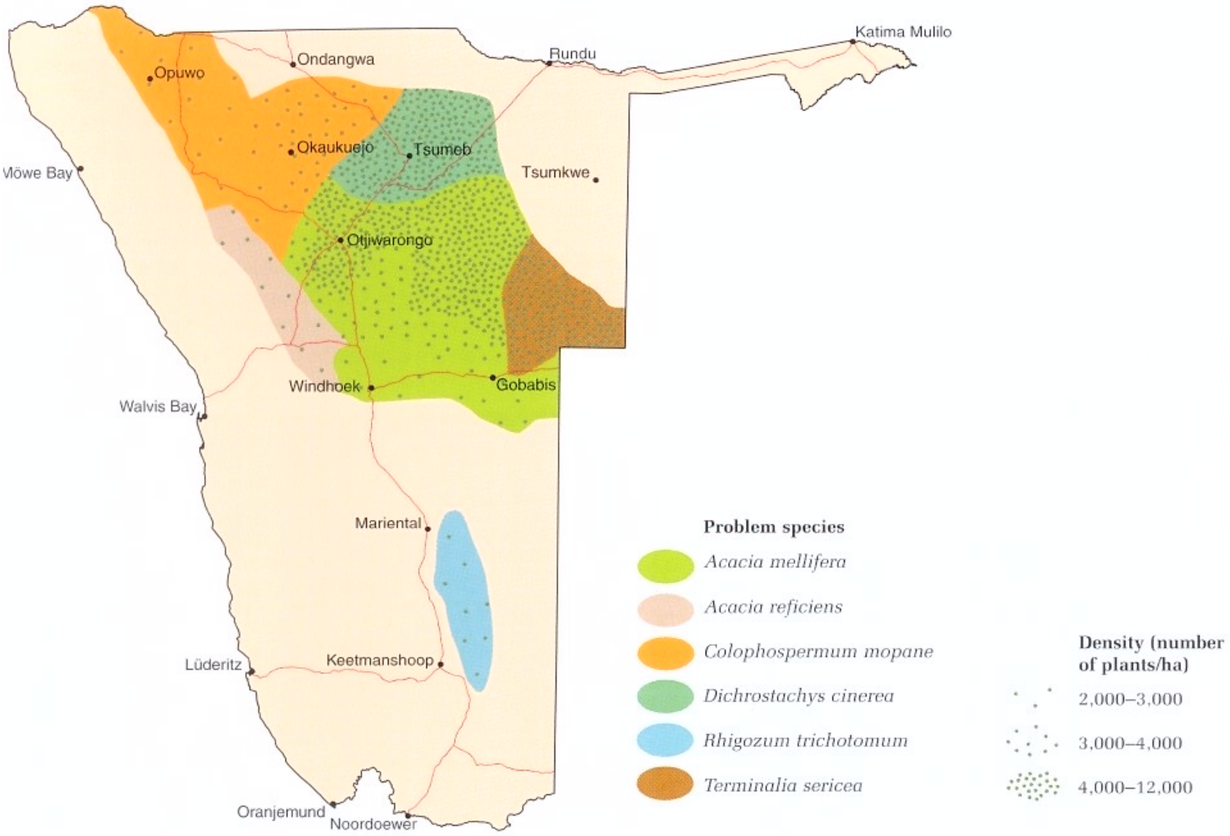
Bush encroachment occurs when relatively open areas become covered by dense layers of woody plants, the number of individual plants often totalling several thousand per hectare. This map provides an assessment of the large areas that have been encroached upon by bush in recent decades.

There are two ways in which bush encroachment reduces the availability of pastures for grazing animals. The first is a loss of grass cover because most grasses cannot grow under thick bush. The second problem is that grazing animals are unable to penetrate dense bush to get at the grasses that remain in small spaces between the woody plants. Areas that are very heavily encroached have often lost more than half their grazing capacity, thus limiting their potential for agricultural production and reducing the economic value of farmland.

Several factors are thought to cause invasive growth of shrubs or bush, but little work has been done to discover which have the most impact. Some factors are also certain to play more of a role than others, depending on the type of vegetation and use of land. For example, overgrazing due to inappropriate farming practices and an absence of bush fires is generally thought to cause encroachment in areas used for commercial farming. On the other hand, the high frequency of bush fires causes bush encroachment in some communal farming areas (see Figure 4.10). Moreover, many areas that were abandoned after being cleared for cultivation or other purposes are now covered with dense bush. In addition, some species are invasive in certain areas but not in other parts of Namibia.

The map below was compiled in 1996. Since then, the numbers of bushes and shrubs have probably decreased in some areas because of bushes dying after repeated years of low rainfall. Bush can be cleared by cutting it away or applying chemicals. Both methods are expensive, however, so only small areas have been cleared so far.

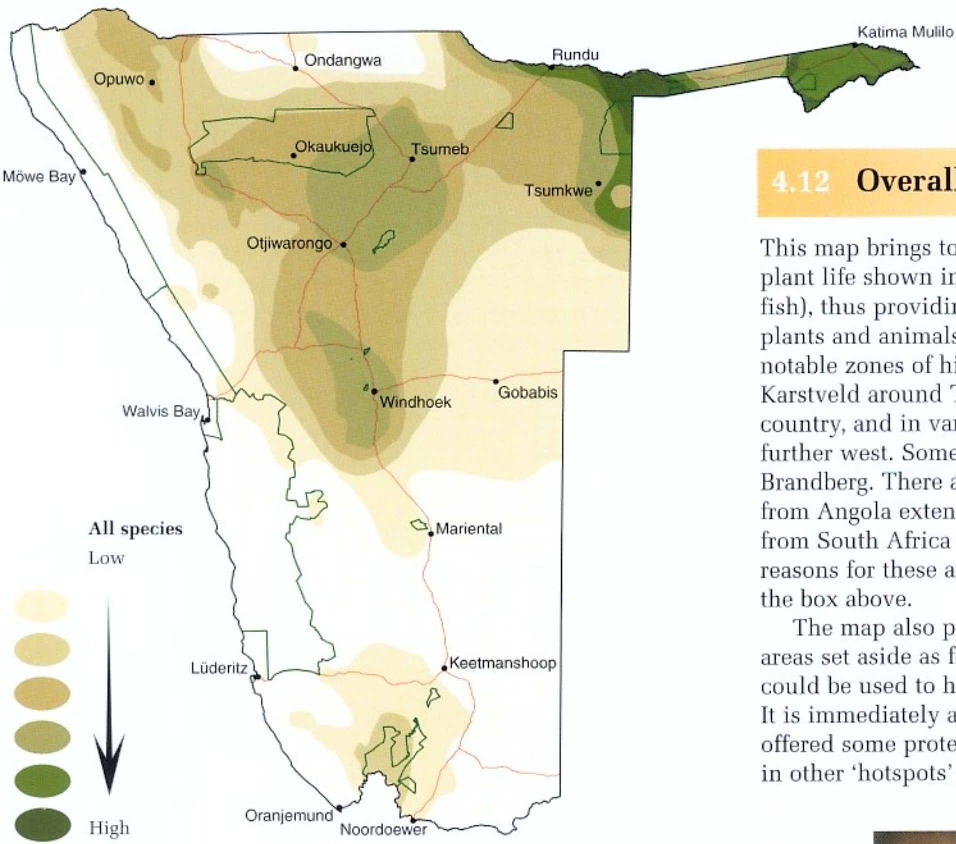
This wood is being burnt to make charcoal, a fuel produced these days by harvesting encroaching bush in the hope that useful revenues can be earned from this environmental problem. However, bush-clearing for charcoal has been limited to small areas because the markets remain too meagre to justify producing more charcoal. Bush cut for charcoal production also grows again unless additional (and expensive) steps are taken to kill or remove the roots.



Patterns of diversity

There has been a growing interest in the overall diversity of living organisms in recent years. What is known as the study of biodiversity now embraces a range of efforts to document, map and analyse patterns of the distribution and abundance of living organisms. The results of this work allow us to identify areas with higher or lower numbers of species, to assess needs and possibilities of applying conservation measures in relation to diversity, and to ask questions about the causes of different patterns of diversity. The maps shown here were assembled for plants and groups of animals for which adequate information is available for us to assess diversity.[8]

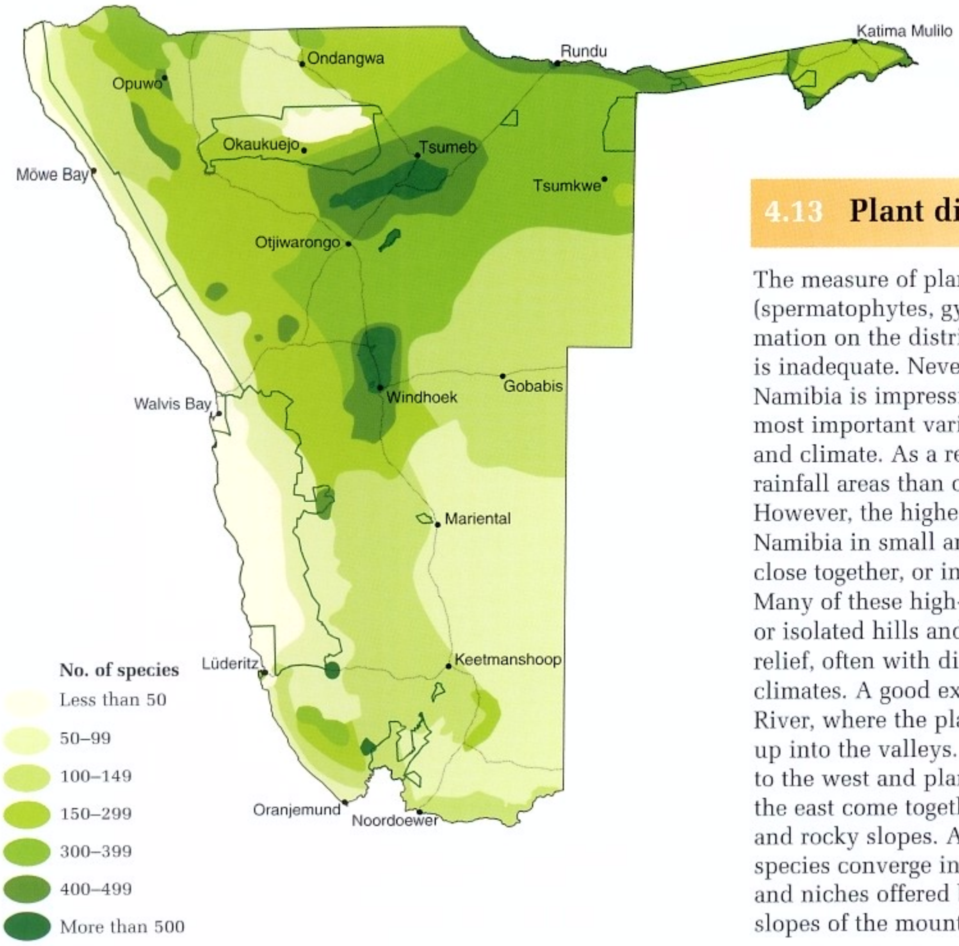
Levels of diversity in most of these groups vary in a similar way. Thus, north-eastern areas generally have the greatest numbers of species because of the higher rainfall and the presence of wetland and forest habitats that are not found elsewhere in Namibia. Many species in the north-east and extreme north and north-west are also more tropical, their ranges extending south into Namibia from neighbouring countries. There are also places of high diversity in central Namibia, chiefly in highland areas where many species with different habitat requirements converge because of the mix of rocky areas, woodlands and other habitats found here. Smaller highland areas in the west and south support very high numbers of plant species for similar reasons. Scorpions, a group most abundant in deserts and arid areas, stand out as having rather different patterns of diversity, with the highest numbers of species being found in southern and west-central Namibia.



4.12 Overall terrestrial diversity [9]

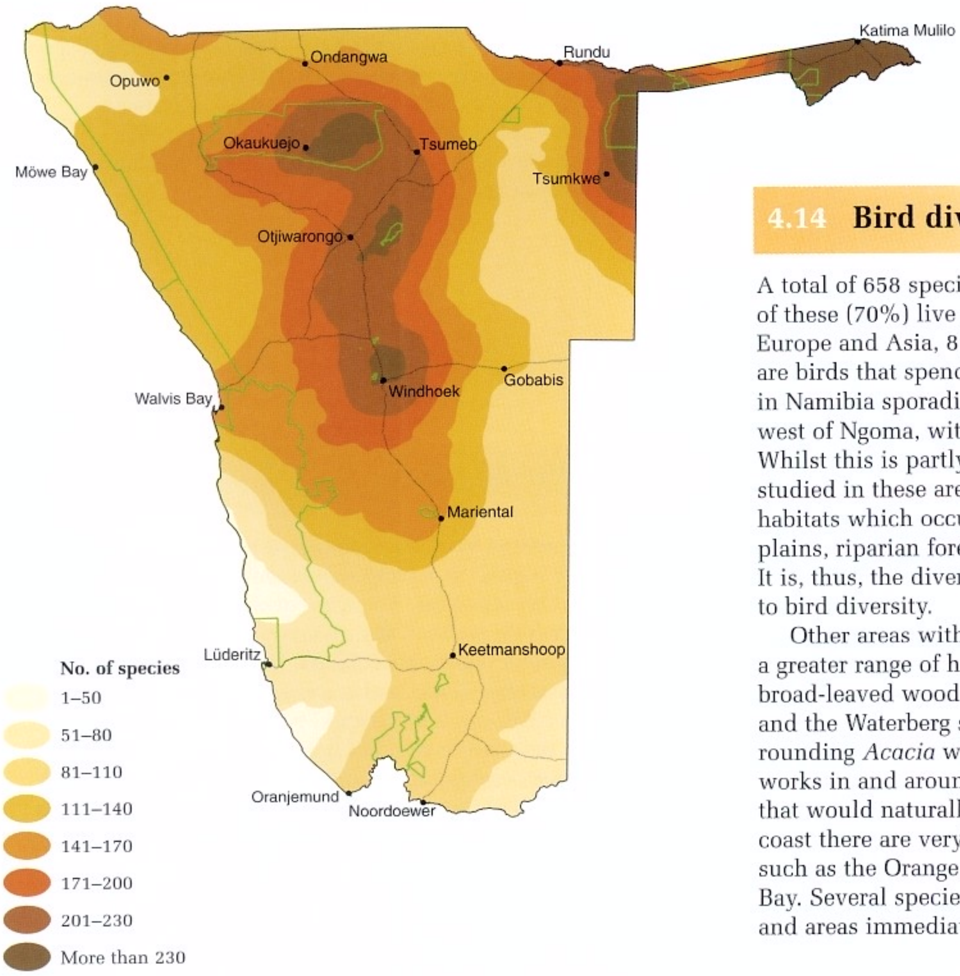
This map brings together the patterns of diversity of animal and plant life shown in the subsequent maps (excluding freshwater fish), thus providing a synthesis of overall diversity of terrestrial plants and animals (those living on or in the ground). The most notable zones of high diversity occur in the north-east, in the Karstveld around Tsumeb, in highland areas in the centre of the country, and in various other scattered areas of higher ground further west. Some of these are isolated mountains, such as the Brandberg. There are also areas of greater diversity where species from Angola extend southwards across the Kunene River, and from South Africa to the north of the Orange River. The principal reasons for these areas having more species are discussed in the box above.

The map also provides perspectives on the relationship between areas set aside as formal conservation areas and diversity, and could be used to help prioritise areas for new conservation efforts. It is immediately apparent that while many tropical species are offered some protection in parks in north-eastern Namibia, species in other 'hotspots' of high diversity are poorly protected.



4.13 Plant diversity

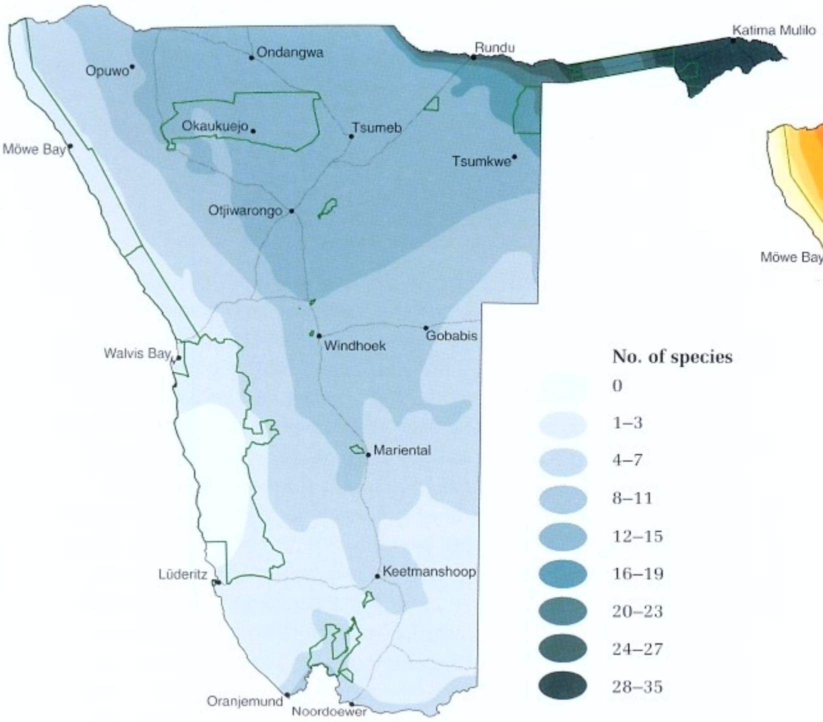
The measure of plant diversity is limited to so-called higher plants (spermatophytes, gymnosperms and angiosperms) because information on the distribution of mosses, ferns and other lower plants is inadequate. Nevertheless, the number of higher plants found in Namibia is impressive: almost 4,000 species and subspecies. The most important variables affecting the diversity of plants are habitat and climate. As a result, diversity is generally greater in higher rainfall areas than on the arid plains and dunes of the Namib. However, the highest pockets of diversity are dispersed throughout Namibia in small areas where several different habitats are found close together, or in areas of transition between major habitats. Many of these high-diversity areas are associated with highlands or isolated hills and mountains because of the varied slopes and relief, often with different kinds of rocks and numerous microclimates. A good example is the Namusberge, north of the Orange River, where the plains lead into mountains, and fog penetrates up into the valleys. Succulents common to the winter rainfall area to the west and plants typical of the summer rainfall region to the east come together there, as do species that prefer sandy plains and rocky slopes. Another example is the Waterberg, where many species converge in a small area in which there are several habitats and niches offered by the sandy plateau, the plains below and the slopes of the mountain.



4.14 Bird diversity

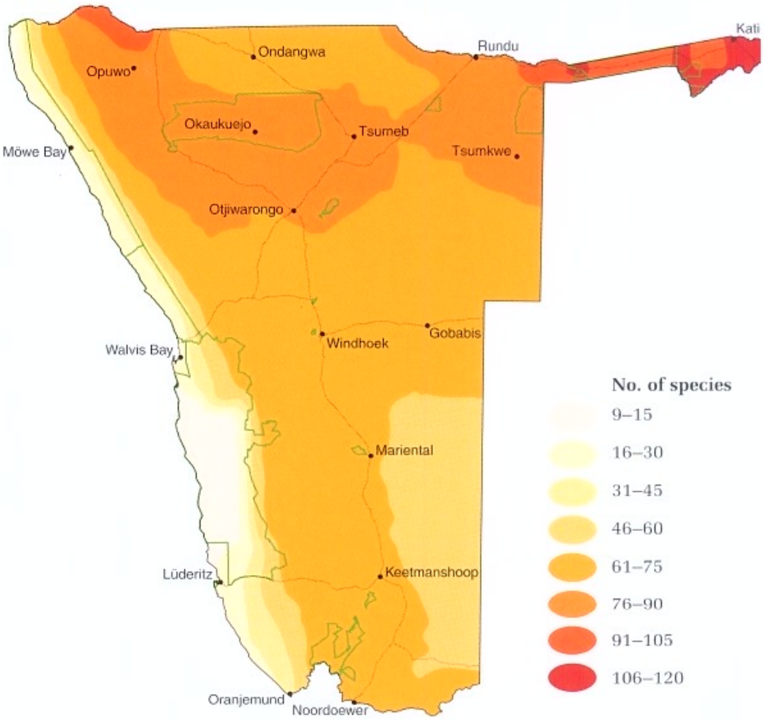
A total of 658 species of birds have been recorded in Namibia. Most of these (70%) live and breed in Namibia, 11% migrate here from Europe and Asia, 8% are migrants from elsewhere in Africa, 5% are birds that spend their lives at sea, and 7% are vagrants recorded in Namibia sporadically. The Mahango Game Reserve and an area west of Ngoma, with 419 species, have the highest known diversity. Whilst this is partly due to the fact that bird life has been well studied in these areas, it is also due to the rich combination of habitats which occur in the north-east, including open water, floodplains, riparian forest, woodlands, savanna and open grasslands. It is, thus, the diversity of habitats that is important in contributing to bird diversity.

Other areas with high bird diversity also reflect the presence of a greater range of habitats compared with surrounding areas. Thus, broad-leaved woodlands on the Tsumeb–Grootfontein–Otavi hills and the Waterberg support many birds that are absent from surrounding *Acacia* woodlands. Likewise, artificial dams and sewage works in and around towns provide habitats for aquatic species that would naturally occur only far to the north or east. Along the coast there are very rich concentrations of birds at key wetlands, such as the Orange River mouth, Sandwich Harbour and Walvis Bay. Several species occur only in the upper Kunene River valley and areas immediately south and west of Ruacana.



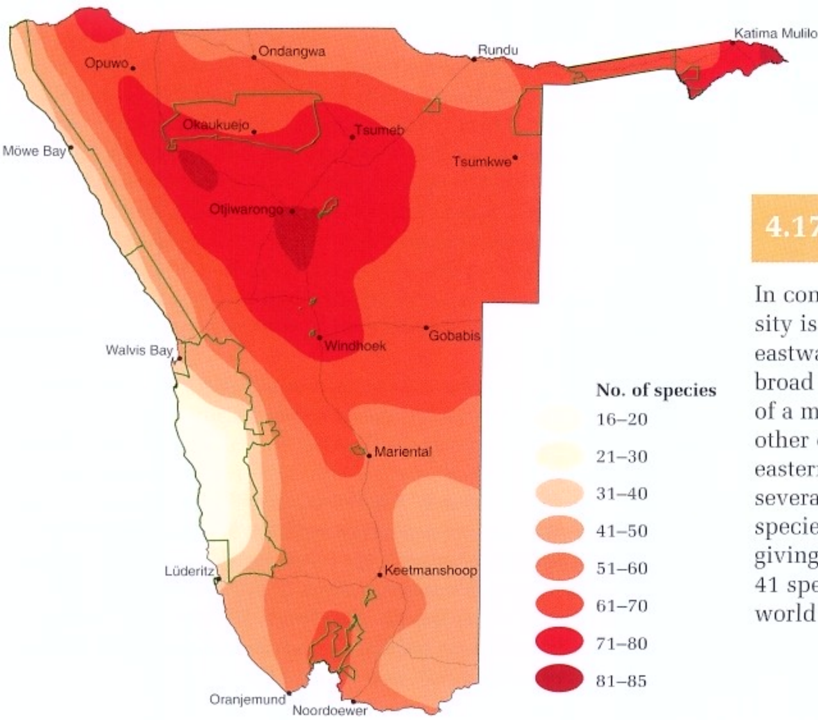
4.15 Frog diversity

The diversity of frogs closely follows patterns of average rainfall (see Figure 3.18), with the lowest number of species in the dry south-west, and highest number of 35 species in the wet north-east. This trend largely reflects the dependence of frogs on standing water for breeding and their general reliance on moist habitats in order to live. It is, thus, not surprising that there is a slightly higher diversity in the Orange River valley than in surrounding areas. Wetlands in eastern Caprivi have the highest diversity, providing habitats for three-quarters of the 50 species of frogs recorded in Namibia. Thirty different species have been recorded along the Okavango River alone. At least eight species occur in most areas of the country.



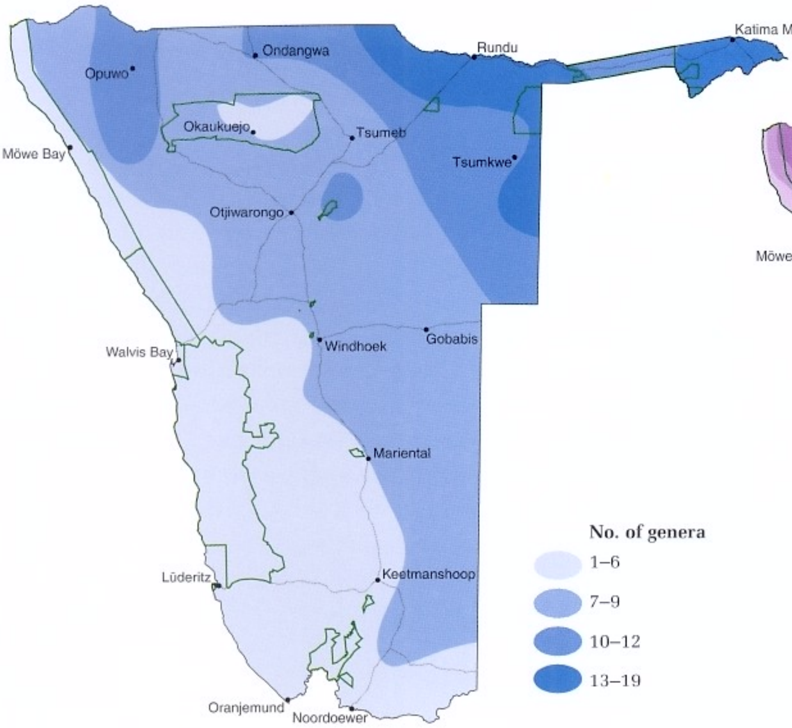
4.16 Mammal diversity

The diversity of mammals shows some similarities with the pattern for birds. Many tropical species which are abundant north and east of Namibia, and which are associated with wetlands and forests, have the southern edges of their ranges just within Namibia, especially in the north-east and in the Kunene River valley. Much of the country has over 60 species, while areas with the lowest diversity in the Namib dune fields have about a tenth of the species in the richest parts in the north-east. Of 217 species of mammals recorded in Namibia, the biggest groups consist of rodents (53 species), bats (43 species) and carnivores (35 species). Figure 4.36 provides a perspective on the diversity of large, herbivorous mammals.



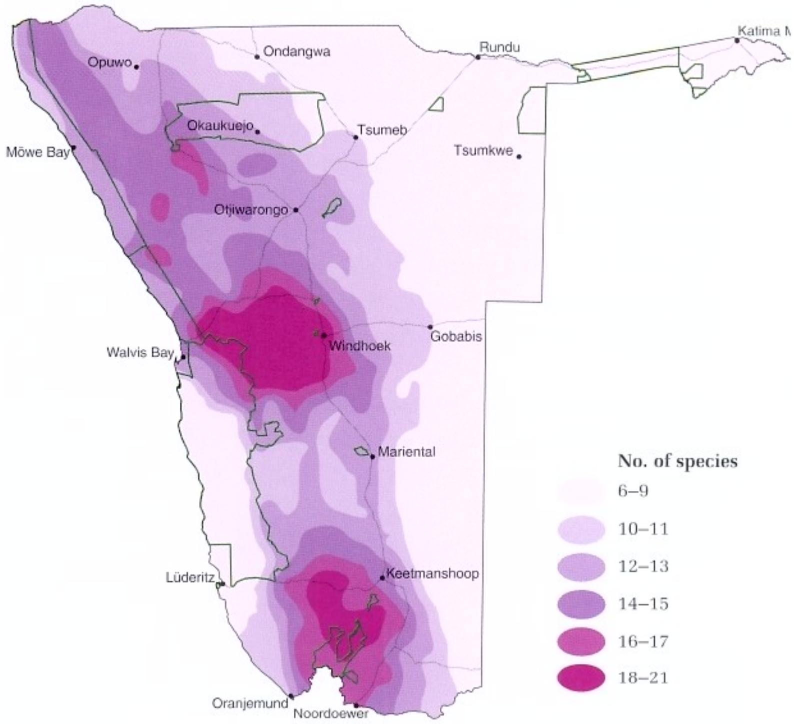
4.17 Reptile diversity

In contrast to patterns of bird and mammal diversity, reptile diversity is generally highest in a band that extends from the north-west eastwards into Otjozondjupa. There are over 60 species in this broad zone, in which much of the diversity is due to the presence of a mosaic of gravel plains, shrublands, inselbergs, mountains and other distinct habitats. There is also a concentration of diversity in eastern Caprivi (with up to 85 species) because of the occurrence of several species that live in wetland habitats. A total of 258 reptile species have been recorded in Namibia. Of these, 125 are lizards, giving Namibia one of the richest lizard faunas in Africa. Of the 41 species of tortoise in the world, Namibia has 6 – second in the world only to South Africa, which has 12 species.



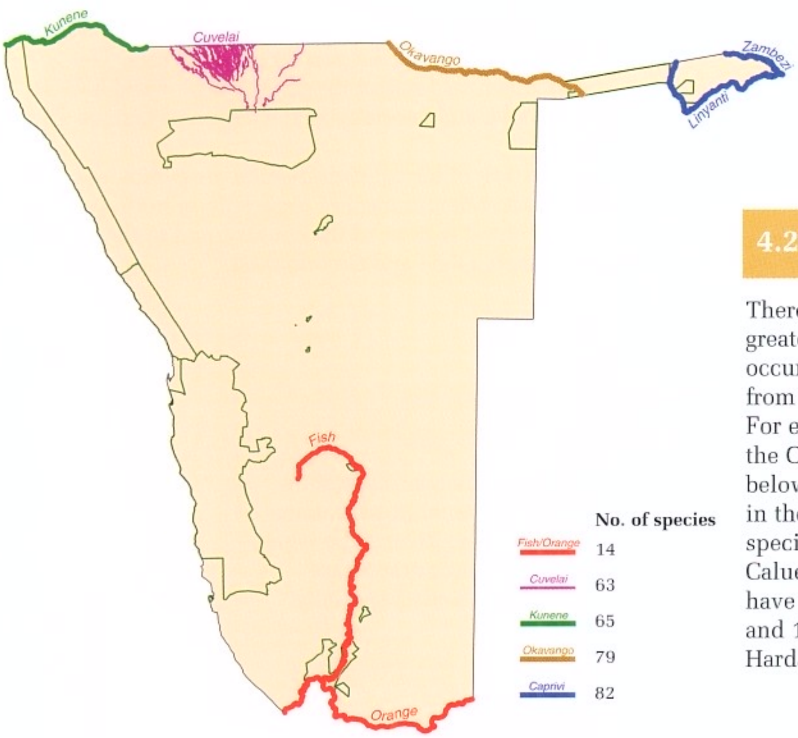
4.18 Termite diversity

Only the number of genera is available to provide a measure of diversity among termites, but a close relationship between numbers of species and genera can be expected. Eastern Caprivi and areas surrounding the Okavango River valley have the greatest diversity, with numbers tailing off towards the south-west, indicative of an association between rainfall and diversity. Pockets of higher diversity are present in the highlands in the Kunene Region and around Waterberg.



4.19 Scorpion diversity

The pattern of diversity for scorpions is quite different from that of the other animal groups in the previous maps. Many species of scorpion are adapted to arid areas, and this is where most species have their origins. The greatest diversity of up to 21 species occurs, therefore, in southern and western Namibia, especially in rocky areas where rainfall is relatively low. By contrast, there are very few species in the predominantly sandy areas of the eastern half of the country and in the Namib dune fields. At least 56 species of scorpions are now known to occur in Namibia, and several more species are being newly described.



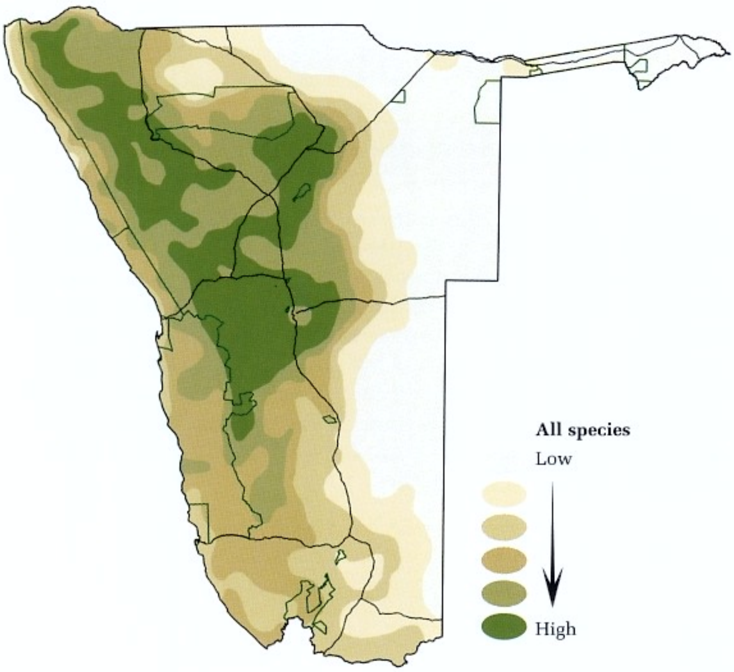
4.20 Freshwater fish diversity

There are 115 species of freshwater fish in Namibia, with by far the greatest numbers in the northern river systems. Many of the species occur in more than one river system but not all the species reported from a river system are present along the whole course of the river. For example, there are about 40–50 species above the confluence of the Okavango and Cuito rivers, compared with about 60 species below. Seventeen species have been recorded as occurring naturally in the oshanas of the Cuvelai Drainage System, while another 46 species were introduced to the oshanas via the canal from the Calueque Dam (see Figure 6.37) on the Kunene River. Six species have been recorded in the ephemeral rivers that flow to the coast, and 11 species occur in man-made dams, such as Von Bach, Hardap and Omatako.

Patterns of endemism

Some species are widely distributed across one or more continents, while others may be restricted to very small areas, some even to a single mountain or river. One way of identifying species with limited ranges is to select those that only occur in a particular area, habitat, biome or country. Such species are called endemics. The distributions of several groups of species endemic to Namibia are mapped here to illustrate distribution patterns and geographic areas of importance.

For some groups, only those species that occur wholly (100%) within Namibia are considered to be endemic, while others are treated as endemic to Namibia if over 75% or 90% of their range falls within the country. This discrepancy arises because various scientists treat the concept of endemism slightly differently. If one uses these kinds of classifications, there are 14 species of endemic birds (with 90% or more of their range in Namibia), 66 reptiles (75% or more), 15 mammals (75% or more), 14 scorpions (100% of their range), and 604 plants (100%). There are also 5 species of freshwater fish that occur only in Namibia. Since either these species occur nowhere else or the greatest part of their ranges is within this country, Namibia has a particular responsibility to protect these special plants and animals and the areas they occupy. As with diversity, adequate information on endemism is currently only available for certain groups, and much more needs to be discovered about the distribution of other endemic organisms.[10]

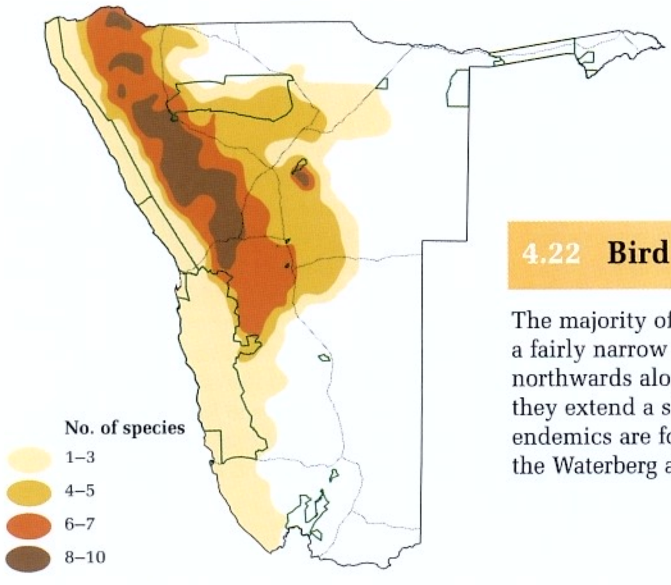


4.21 Overall terrestrial endemism[11]

Distributions of endemic plants and animals illustrated in the subsequent maps are synthesised here, and show that the overall patterns of endemism in Namibia are quite different from those of overall diversity (Figure 4.12). Unlike the concentration of diversity in the north-east, the great majority of endemics are found in the dry western and north-western regions of Namibia. Within these arid areas, endemic species are concentrated in three landscapes: the Namib lowland, the escarpment, and the highlands. The Namib lowland endemics are associated with the diversity of substrates, such as sandy and gravel plains, dunes, rocky inselbergs and hills. The rugged escarpment supports many endemic birds, mammals and reptiles. The highlands, including the Waterberg, the Khomas Hochland, the Karas Mountains, inselbergs in the Sperrgebiet, the Brandberg, and the Karstveld hills around Tsumeb, Otavi and Grootfontein, are particularly important for many endemic plants.

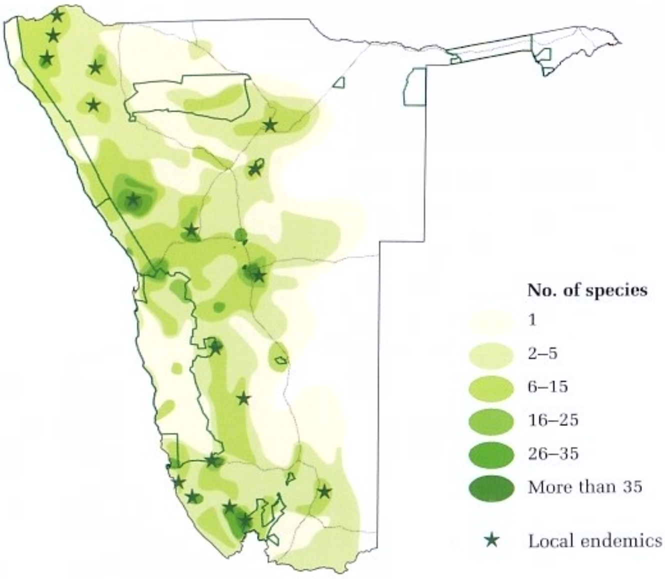
The fact that so many endemics are concentrated in the arid and often hilly western areas suggests that most of these species evolved there, perhaps as a result of climatic changes such as alternating wet and dry cycles over the past 20 million years. The patterns of endemism also reflect the importance of arid habitats in supporting unique and specially adapted species that are found nowhere else.

Namibia's network of formal conservation areas provides little protection for most endemic species, especially in north-western Namibia, in the central regions of the country, and in the Karstveld hills around Tsumeb, Otavi and Grootfontein.



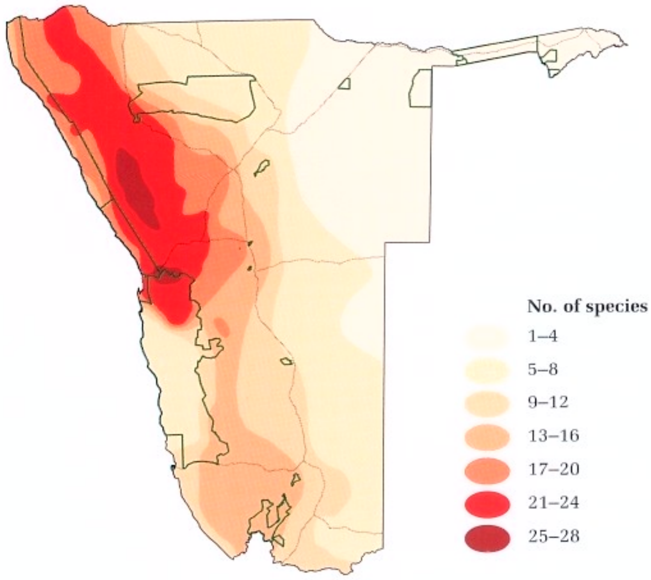
4.22 Bird endemism

The majority of the 14 endemic bird species are concentrated in a fairly narrow zone running from about the Naukluft Mountains northwards along the escarpment to the Kunene River, from where they extend a short way into Angola. Other concentrations of endemics are found on and around other highlands, especially the Waterberg and the Otavi Mountains.



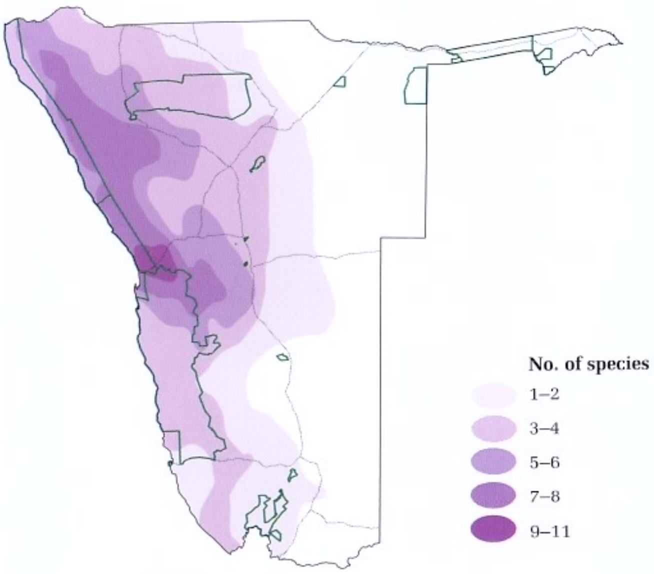
4.23 Plant endemism

Two levels or kinds of endemism are illustrated here. The underlying shaded areas show the number of widely distributed endemics within Namibia, while the stars show areas where significant numbers of highly localised endemics occur. Highland areas of importance for endemics include the Waterberg, the Khomas Hochland, the Karas Mountains and numerous inselbergs in the Sperrgebiet. Many endemic plants are also associated with a particular or isolated substrate, for example the granites of the Brandberg or the limestones of the Otavi–Grootfontein–Tsumeb hills. In addition, there are concentrations of endemics in the mountains of the south-west and north-west, and numerous plants extend just over the borders into adjacent and localised areas in South Africa and Angola. In addition to the 604 truly endemic species and subspecies of plants, over 90 plants extend just over the Kunene River, including the welwitschia and !nara, and about 250 plants have ranges that extend just south of the Orange River.



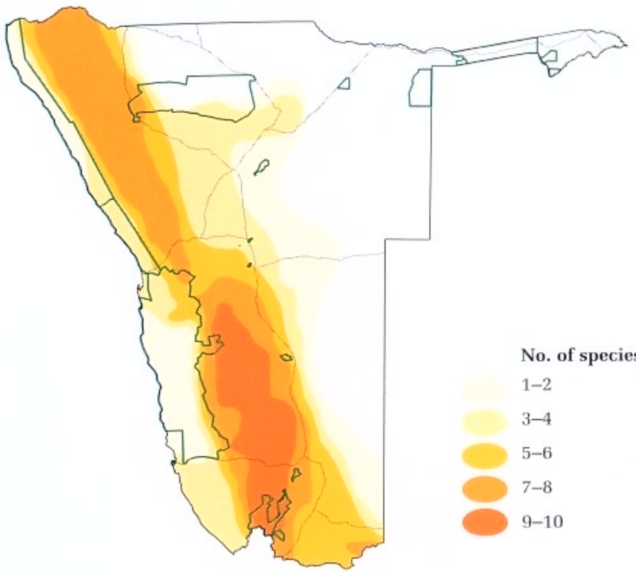
4.24 Reptile endemism

The overall areas in which the 66 endemic reptiles are found are similar to, but broader than, those for endemic birds and mammals. Most endemic reptiles are found in and around the escarpment zone, particularly north of the Namib Sand Sea and Kuiseb River. Unlike birds and mammals, there are also many endemic species in the Namib lowlands, where most reptiles are associated with rocky and gravel surfaces.



4.25 Scorpion endemism

Most of the 14 endemic scorpion species occur in north-western Namibia, and they show a rather similar pattern of distribution to that of reptiles and birds. The greatest concentration, however, is in the central Namib to the east of Swakopmund.



4.26 Mammal endemism

The distribution of the 15 endemic mammal species is similar to that of birds, with most species being broadly associated with the escarpment belt separating the Namib from higher elevations to the east. However, the majority of endemic mammals are in southern Namibia, and some species have ranges that extend into similar habitats in north-western South Africa.

Some important marine species

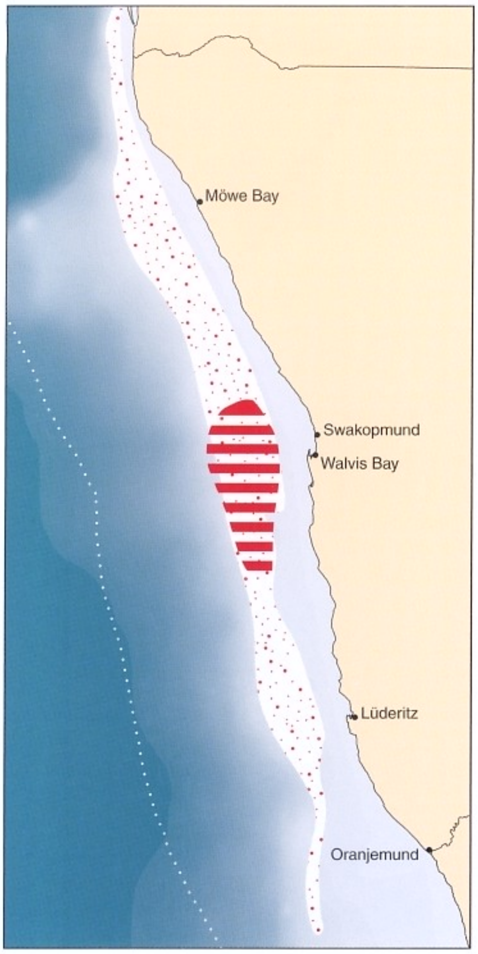
Several species of marine fish and other marine organisms are particularly abundant on or off the Namibian coast, where their profusion is the direct result of the nutrient-rich Benguela Current (see Figure 3.4). Deep water, rich in nutrients, is forced up to the surface in a number of upwelling cells, the most important being just north of Lüderitz. From there, the northward-flowing Benguela distributes the nutrients up the coast. Huge assemblages of drifting microscopic plants are the first organisms to use these nutrients once they reach the sunlit surface. These plants, called phytoplankton, are the primary producers of food in the Benguela Current, and they make the nutrients available to a wide range of animals. Some of these are minute animals, called zooplankton, while others are much larger, including fish, birds and mammals.

The value of the fish resource has varied a good deal over the years. For example, the population of pilchards (sardines) was estimated at over 10 million tonnes in the mid-1960s, but only a few hundred tonnes remained in the 1990s. There is widespread agreement that some major declines in fish stocks were due to overfishing, often by fishing vessels from other countries. Changes in the structure, composition and abundance of plankton populations also had an impact. Namibia now has an exclusive economic zone, extending 200 nautical miles (approximately 370 km) off the coast, which includes most of its valuable fish resources. Since fish populations move north, south and westwards out of Namibian waters, international cooperation is also required to ensure sustainable harvesting.

It is clear, however, that environmental conditions also have a great impact on fish numbers, sometimes leading to substantial declines that take years to recover. A drop in levels of oxygen in the water can cause some of the biggest changes. Other changes are caused by the intrusion of warm water from Angola, which leads to less upwelling and lower quantities of nutrients being available (see Figure 3.5). Huge losses of fish occurred in 1994 when oxygen levels in the sea were lower than normal and, then again, in 1995 when much warmer water was pushed southwards from the Angola Current. In both years, massive changes in the distribution and abundance of fish occurred because the fish either moved away from their normal feeding and spawning grounds or failed to breed. This resulted in a major setback to the Namibian fishing industry. Species that feed on fish, such as seals, were also affected, with the starvation and death of an estimated 300,000 seals. Similar effects on fish populations were caused by warm water events in 1963 and 1984.

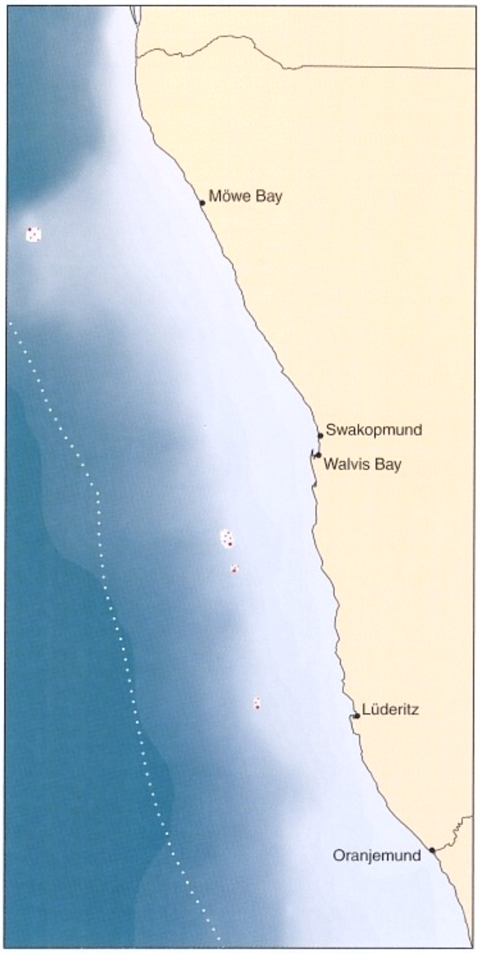
Maps of the distributions of economicaly important fish and other marine species shown here are grouped as follows: demersal or deep-water species, generally found at the sea bottom far off the coast (hake, orange roughy and monkfish); those that are pelagic and usually closer to the surface and shore (horse mackerel, pilchard and anchovy); and species associated with the coastline (rock lobster, seals and various birds).[12] Spawning areas are also indicated, since they represent the crucial areas from where fish stocks are replenished.

Several species of fish form the backbone of Namibia's fishing industry, which generated about N$1,469 million in 2000,[13] mainly through processing and exports. This amount represented about 10% of Namibia's GDP, and about 6% of all formal jobs are in the marine fishing sector.



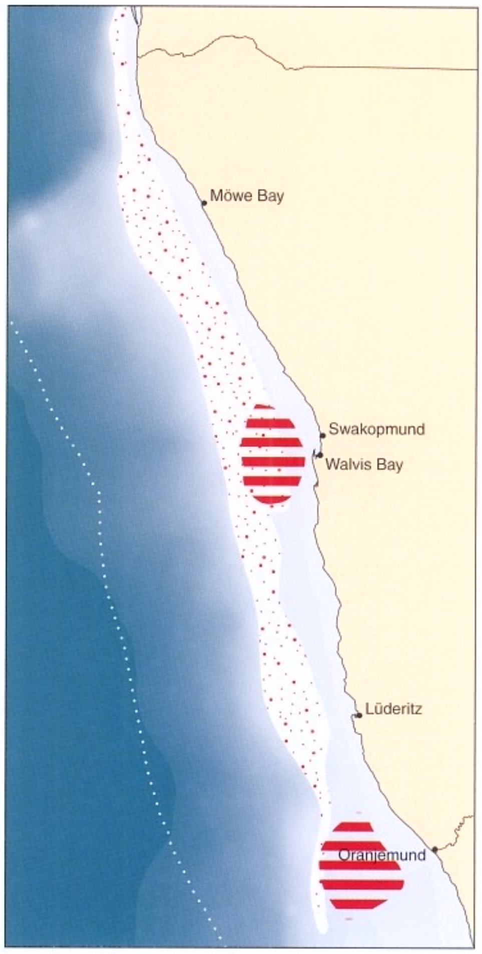
4.27 Hake

There are two species of hake, the Cape hake and the deep-water hake, which are now Namibia's most valuable commercial fish. Exploitation of Namibia's hake started in the 1960s. Severe overfishing followed, with over 500,000 tonnes being caught per year in the mid-1970s. By the end of the 1980s, annual catches had declined to less than 100,000 tonnes. The total population of hake now amounts to about 1 million tonnes, of which less than 200,000 tonnes per year have been harvested in recent years. Most of the harvest is marketed in Europe. Spawning takes place off the central Namibian coast, while adult fish are harvested along the entire coast between about 50 and 150 km offshore, where the sea depth is between 300 and 450 m.



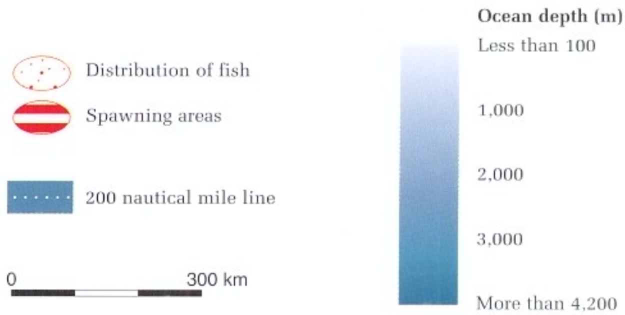
4.28 Orange roughy

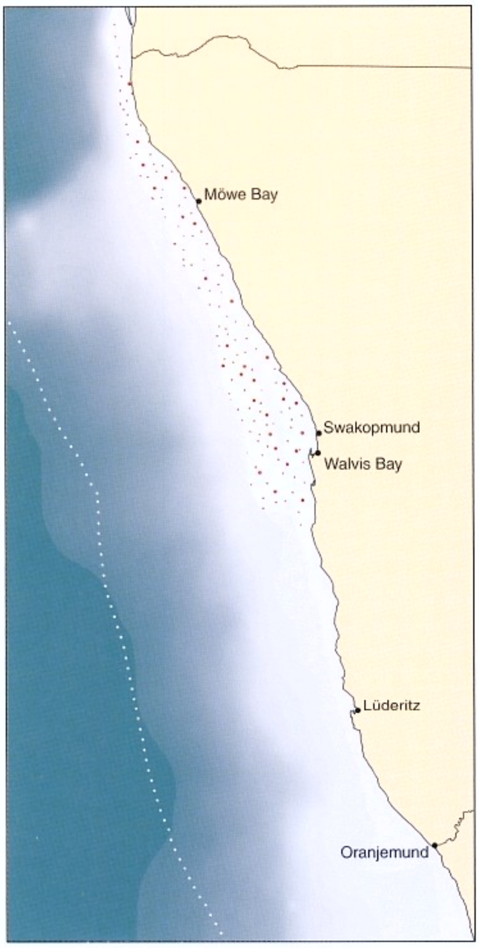
Experimental commercial fishing of orange roughy started in 1994. About 15,000 tonnes were landed in 1997, but catches have since declined. These fish live in water between 500 and 1,200 m below the surface, and are concentrated in just a few rocky, mountainous areas. Those off Namibia are thought to be only capable of breeding at an age of 24, and their life span may exceed 100 years! It is extremely difficult to establish sustainable harvesting quotas for such long-lived and slow-reproducing species, and conservative quotas are required to avoid depleting the populations.

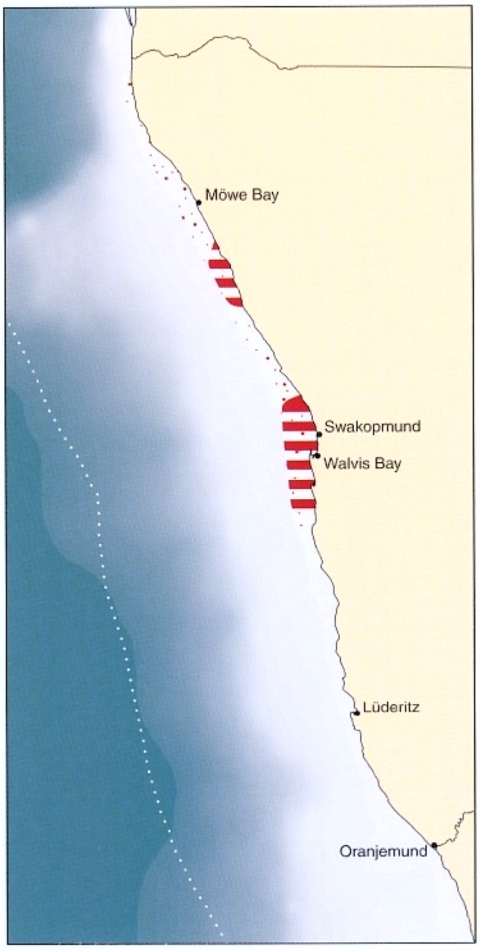


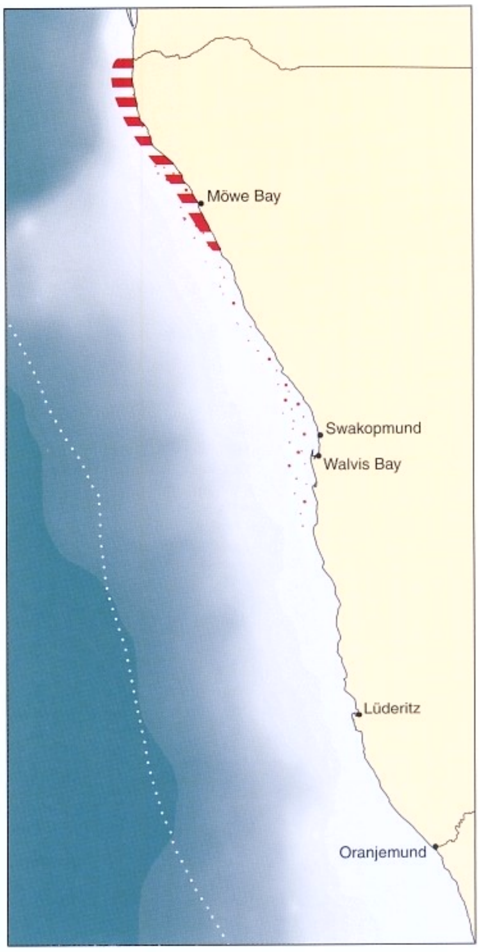
4.29 Monkfish

Catches of monkfish have risen in recent years from about 1,500 tonnes in 1990 to about 17,000 tonnes in 1998. The fish live at depths of around 200–800 m, where they are caught in bottom-trawled nets with sole and hake. Monkfish have an extension to the spine on their back which is dangled like a lure to attract their prey. There are two spawning grounds, one off the Orange River mouth and the other west of Walvis Bay.









4.30 Horse mackerel

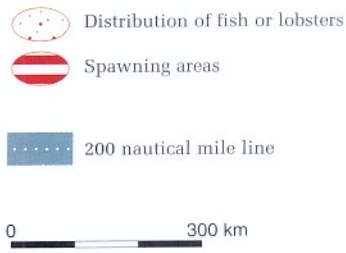
Horse mackerel has the highest estimated total biomass of all commercially fished species in Namibia, at 1.5–2.0 million tonnes. While catches have declined by about 50% over the past 20 years, largely owing to reduced fishing effort, they are still caught in very large numbers, with about 300,000 tonnes being harvested per year during the late 1990s. The young fish are generally found inshore near the surface, but the adults are found offshore and migrate between the surface and deeper waters each day.

4.31 Pilchard

Pilchards are generally found in shallow water within 50 km of the coast. Their spawning grounds are restricted to two areas: one around Walvis Bay, and the other further north off the Skeleton Coast. Adults occur along the coast from about Meob Bay northwards to warm water at the Angola–Benguela Front (see Figure 3.4). The Namibian stock remains at a very low level compared with the very great resource that existed up until the late 1960s. A rapid recovery of the stock is unlikely because of high rates of natural mortality.

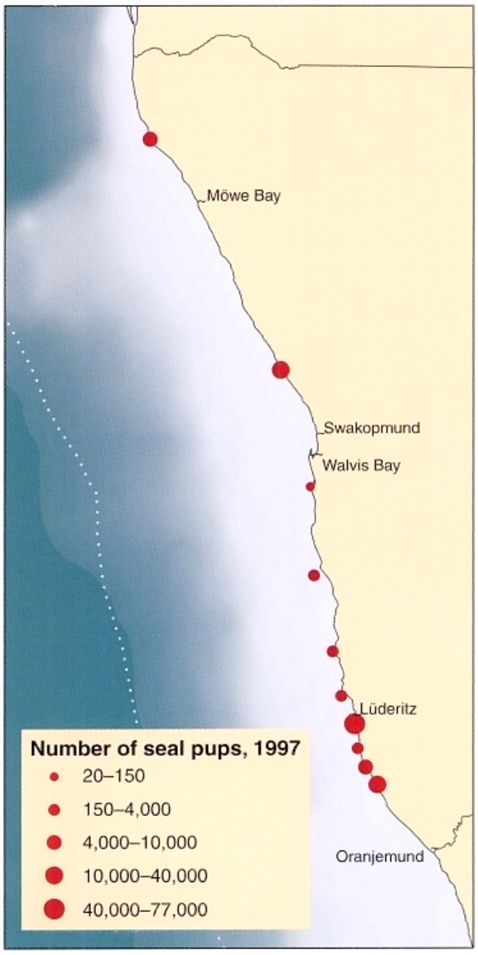
4.32 Anchovy

Anchovy catches have declined greatly in recent years: from an average of 100,000 tonnes in the 1970s, 130,000 tonnes in the 1980s, and over 60,000 tonnes in 1993 to about 2,000 tonnes in 1997. Most adult fish are found within 50 km offshore from about Meob Bay northwards. The spawning grounds are close inshore along the northern Namibian coast.



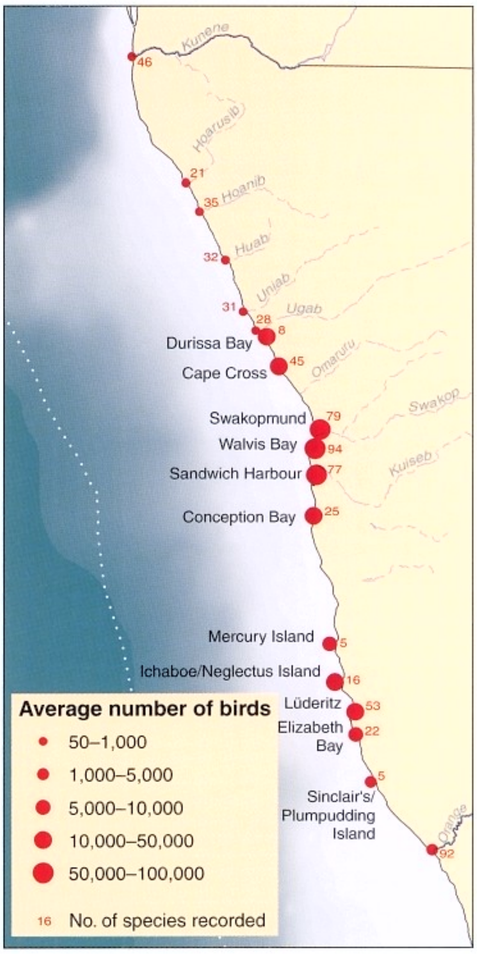
4.33 Rock lobster

Rock lobsters are restricted to several areas with rocky surfaces close to the shore, most of which are in southern Namibia. The animals migrate seasonally from shallow to deeper water in accordance with changing levels of oxygen. During the 1980s total catches amounted to about 1,500–2,000 tonnes each year, but this was followed by a drastic decline in the late 1980s and early 1990s. Between 100 and 300 tonnes have been caught annually in recent years.



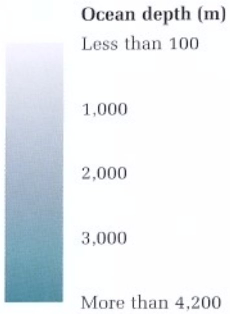
4.34 Cape fur seal [14]

The Cape fur seal is an abundant, well-known animal that occurs all along the Namibian coast. Many colonies are on islands just off the coast, such as Mercury, Ichaboe and Possession islands near Lüderitz, but there are large colonies on the mainland at Wolf Bay, Atlas Bay and Cape Cross. Seal numbers crashed during 1994, when oxygen levels were unusually low, and 1995, when warm water from the Angola Current pushed south (see Figure 3.4). In 1994 about 300,000 adult seals were estimated to have died, and the number of pups born was halved from over 200,000 to less than 100,000. The drop in numbers was due to the great mortality of fish during those two years. About 20,000 pups and 4,000 adult males have been harvested annually in recent years.



4.35 Coastal birds [15]

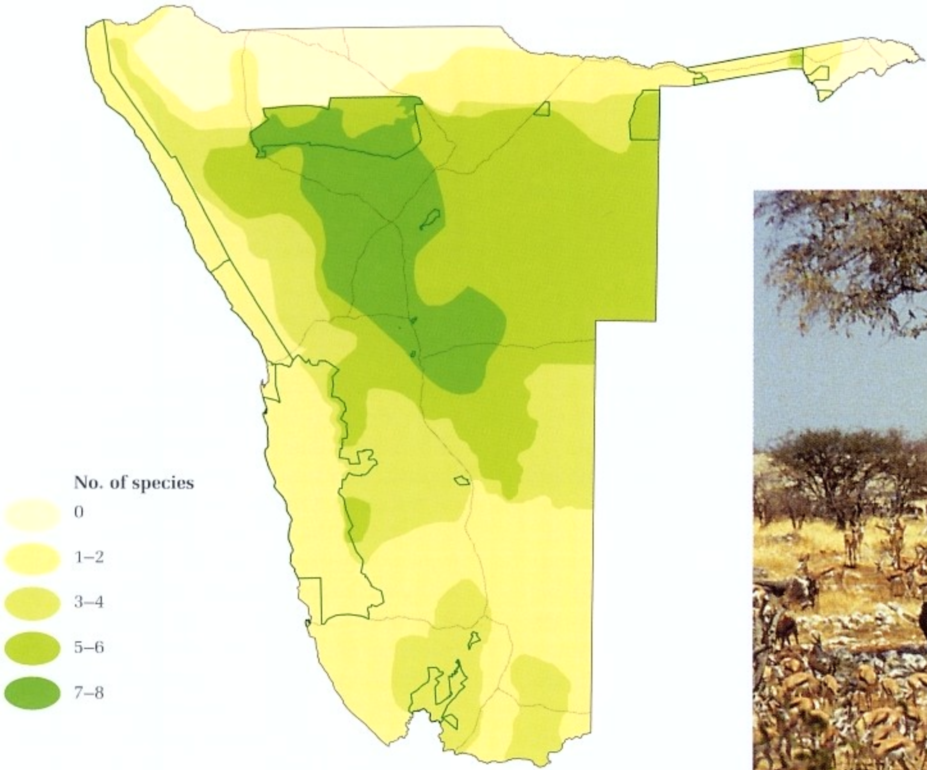
The Namibian coast provides a rich habitat for many birds because of the abundance of fish and other food. Some birds are resident and most of these breed on islands off the coast. Others are migrants from high latitudes in the northern hemisphere or from sub-Antarctic islands in the south. Many of the migrants are pelagic (they feed at or near the surface of the water) and travel up and down the coast. The map shows the position of islands on which birds such as cormorants, penguins, gannets and gulls breed, and the important estuaries and bays which provide good feeding grounds to terns and wading birds, such as flamingos, plovers and sandpipers. The greatest concentrations occur from near Conception Bay northwards to Cape Cross. Walvis Bay (with over 90,000 birds on average), Sandwich Harbour (over 75,000) and the wetlands around Swakopmund (over 65,000) are the most important onshore sites. Roosting and breeding sites for substantial numbers of cormorants, penguins and gannets are Ichaboe Island (about 22,000), Mercury Island (over 8,500) and Possession Island near Elizabeth Bay (over 5,000 birds).



Large herbivores

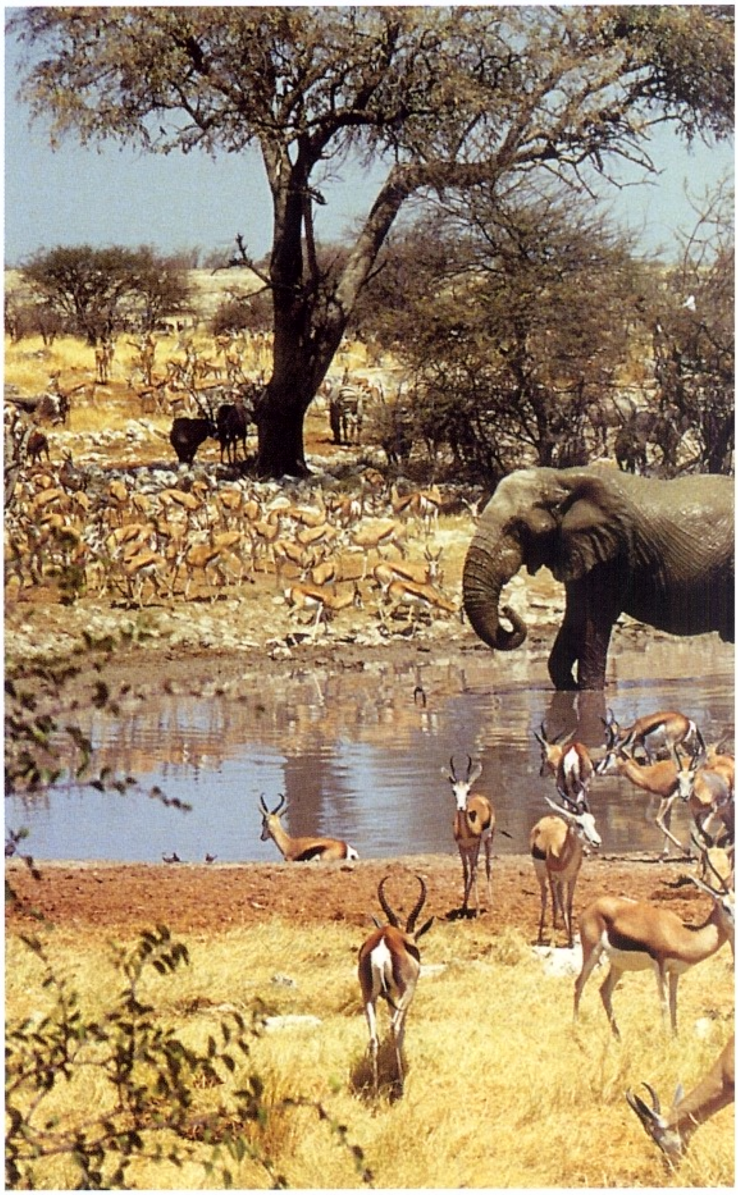
The large, mammalian herbivores presented here are important 'big game', attractions for tourists to Namibia, and the majority of them are hunted at times to provide income as trophy animals or as meat. All of this gives these species considerable economic value, and the tourist industry would be much smaller in the absence of these animals. On a smaller scale – but one with great impact – the sale of hunting concession fees earns approximately N$1 million each year for the small community of San people living in the Nyae Nyae Conservancy near Tsumkwe in north-eastern Otjozondjupa. It is, of course, also true that large mammals have considerable intrinsic appeal and value, and these are qualities that many people recognise in the efforts made to conserve wildlife. However, it is also sad that others see little worth in these wild animals.

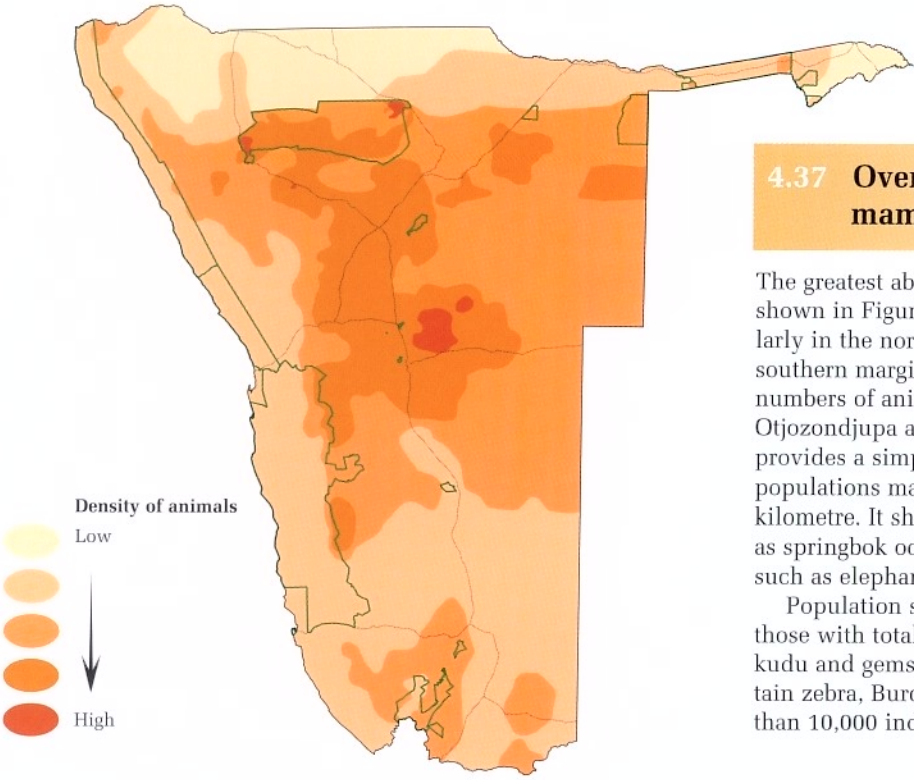
Many of these large herbivores are concentrated in nature reserves but others occur much more widely, as shown in the following maps. The maps show the distributions and relative abundances for a selection of species for which reliable information is available based on analyses of extensive aerial counts during 1998 and 2000 and from figures reported by farmers on freehold land during a survey in 1998.[16]



4.36 Overall diversity of large herbivorous mammals

The distributions of many of the eight large herbivorous animals shown in Figures 4.38–4.45 overlap, while other species have more separate ranges. The greatest number of herbivores is in the south of Etosha National Park, where seven or eight species occur. The number of species diminishes in a broad zone stretching east and south, so that there are between five and six species in a broad area covering Otjozondjupa, northern Omaheke and eastern Kunene. The lowest numbers of species are in the densely populated northern regions, as well as in the far west and south, where there is relatively little vegetation.

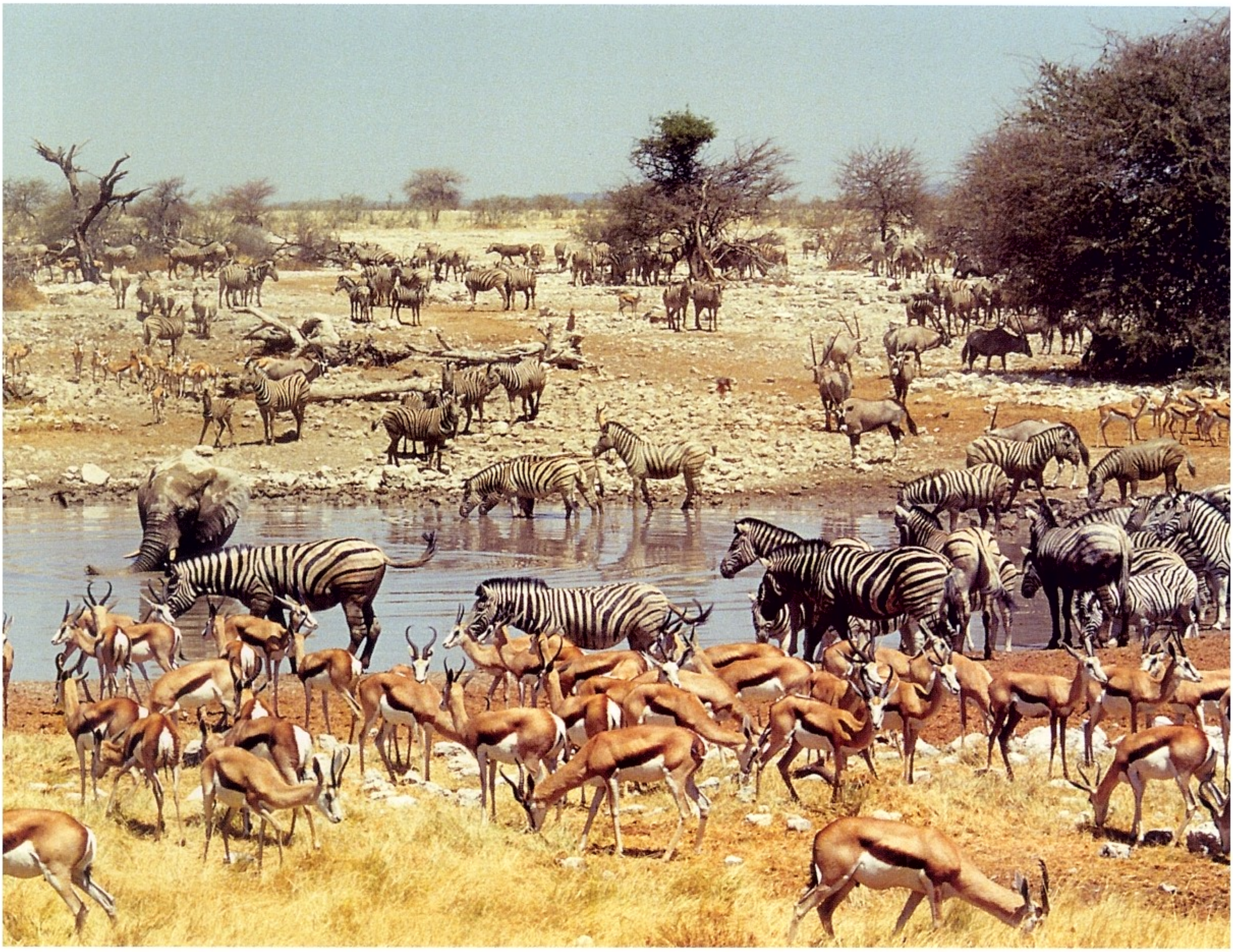


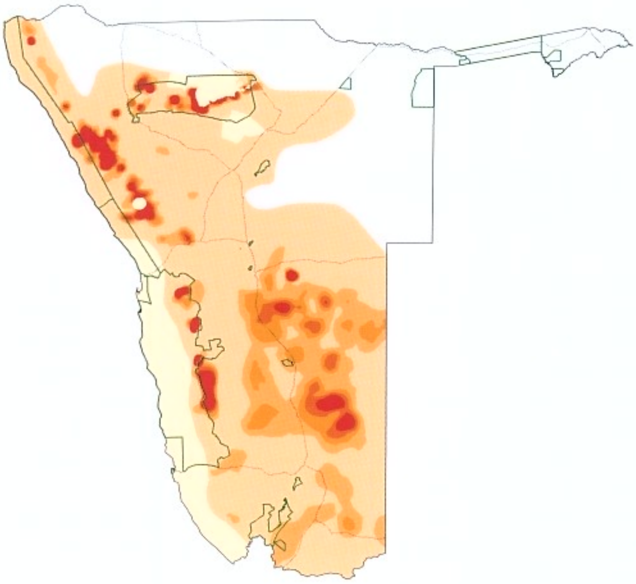


4.37 Overall abundance of large herbivorous mammals[17]

The greatest abundance of the eight large herbivorous mammals shown in Figures 4.38–4.45 is in the Etosha National Park, particularly in the north-eastern and south-western corners, and along the southern margins of the Etosha Pan itself. Other areas with large numbers of animals are the Khomas Hochland, north-eastern Otjozondjupa and south of the Naukluft Mountains. The map provides a simple ranking of relative abundance. Areas with large populations may support up to 70 or more animals per square kilometre. It should also be borne in mind that certain species such as springbok occur naturally at much higher densities than others, such as elephants.

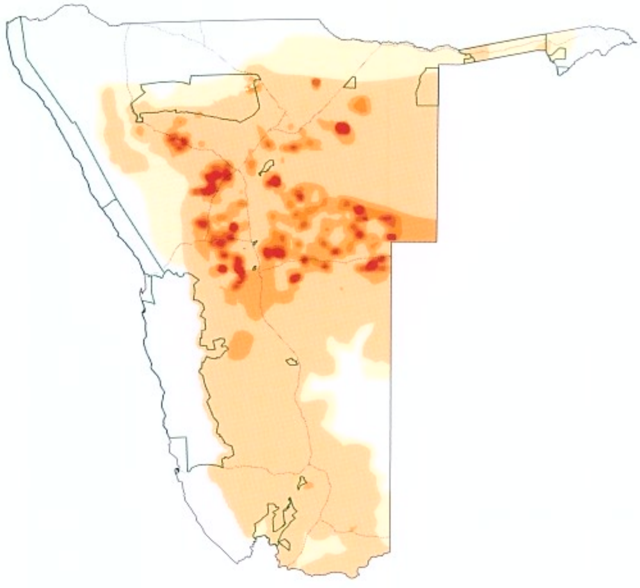
Population sizes of the eight species fall into three categories: those with total numbers of several hundred thousand (springbok, kudu and gemsbok), those with less than 100,000 animals (mountain zebra, Burchell's zebra and hartebeest) and those having less than 10,000 individuals (elephant and giraffe).





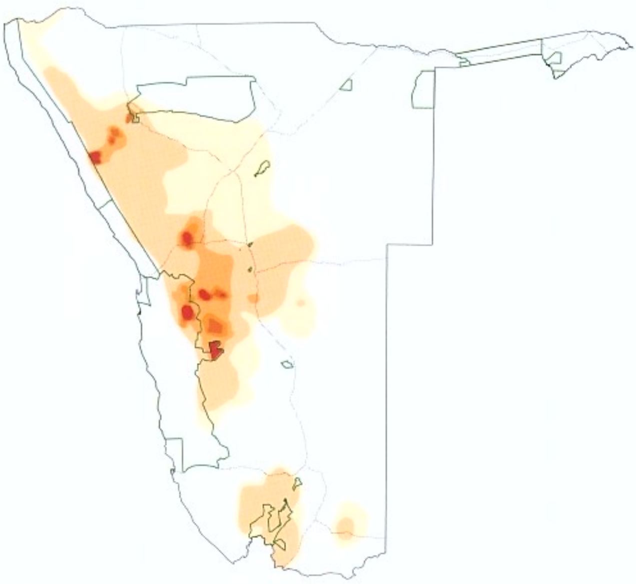
4.38 Springbok

Springbok are widely distributed in Namibia but are most abundant in open habitats with a sparse cover of trees. The highest densities are on the eastern plains of the Namib, in shrubland surrounding Etosha Pan, and in the south-eastern regions of the country. They occurred historically in the Nyae Nyae area of eastern Otjozondjupa, where they have been recently reintroduced.



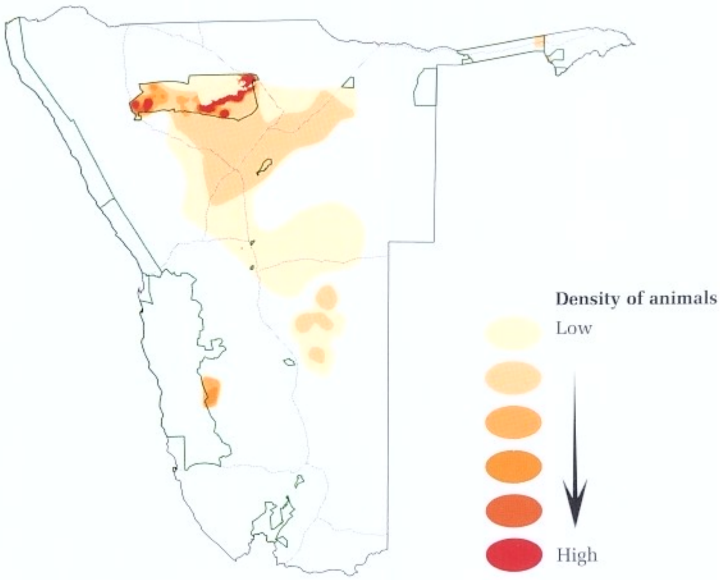
4.39 Kudu

Although kudu are found in most parts of Namibia, the majority of these handsome animals occur in a broad zone of *Acacia* woodlands stretching across the central regions. The highest densities are found in small areas in the western parts of the zone. Most kudu are on freehold farms and in other areas not proclaimed as nature reserves, especially in areas of thick bush where densities are particularly high.



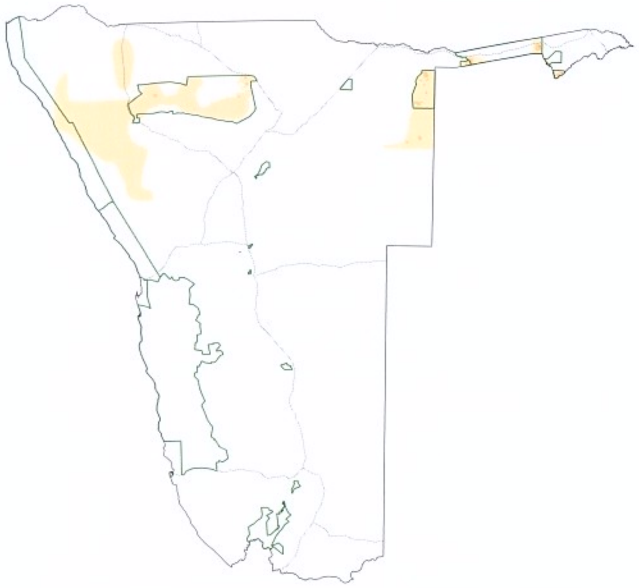
4.40 Mountain zebra

As their name suggests, mountain zebra are confined to hilly country in the western and central areas. The population just north of the Orange River in southern Namibia is apparently isolated from the one in the northern parts of the country. The majority of mountain zebra are outside proclaimed nature reserves although the Naukluft Mountains and adjacent areas of the Namib-Naukluft Park and the Daan Viljoen Game Park do support significant numbers.



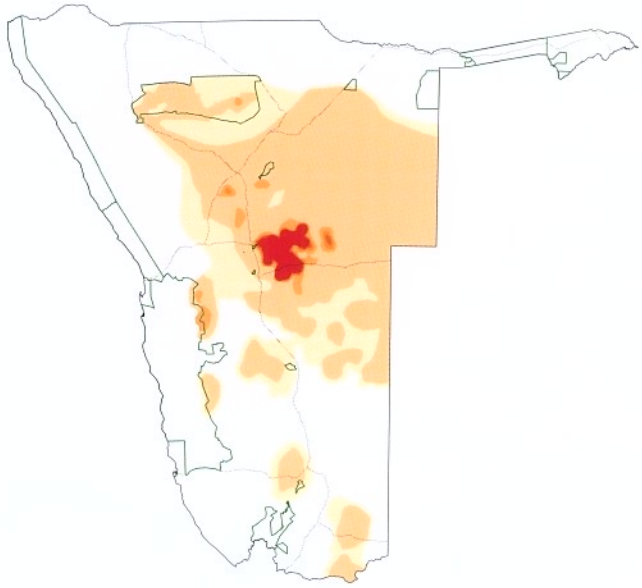
4.41 Burchell's zebra

Most of the Burchell's zebra in Namibia are in Etosha National Park, especially along the edges of the pan. Small populations in the south have been reintroduced onto private farms and nature reserves.



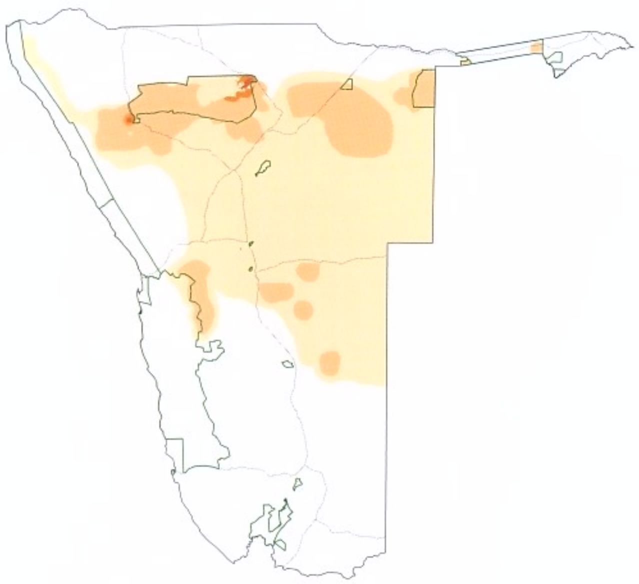
4.42 Elephant

Elephant occur in three distinct populations: the so-called desert elephants in Kunene, the Etosha elephants, and those in the north-east. Movements within these areas are substantial, and some individuals move between Etosha and the population to the west (see Figure 4.56). There are probably about 9,000 elephants in Namibia at any one time. However, numbers may increase or decrease considerably as animals move in or out of neighbouring countries. There were probably fewer than 1,000 elephants at the turn of the twentieth century as a result of hunting for the ivory trade. Etosha National Park had fewer than 50 elephants in the early 1950s but today there are often over 2,000.



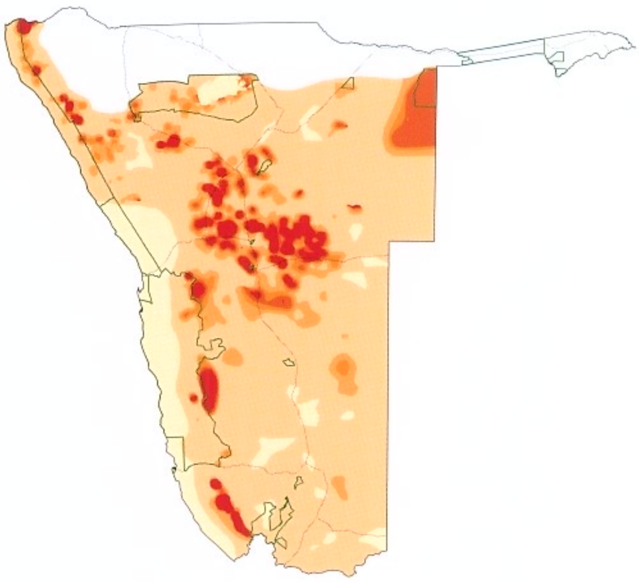
4.43 Hartebeest

There is a concentration of hartebeest to the east of Windhoek and Okahandja, with much lower densities in woodland areas further east and north. Most of these antelope are outside proclaimed nature reserves.



4.44 Giraffe

Giraffe are widely and thinly spread across a broad zone in the northern half of the country. There are small and relatively isolated populations in Caprivi and on various game farms. The greatest concentration is along the eastern edge of the Etosha Pan.

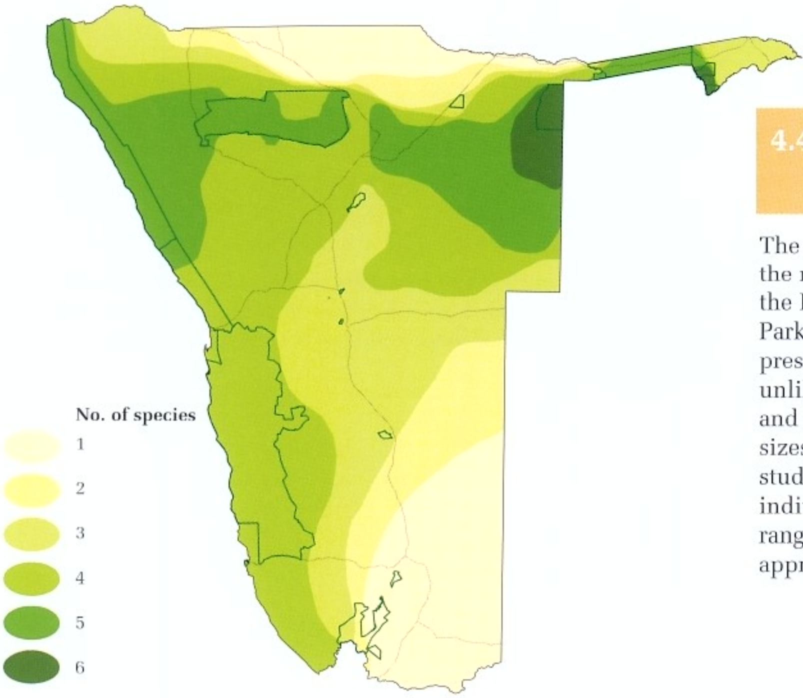


4.45 Gemsbok

Gemsbok are one of the most abundant large mammals in Namibia, occurring throughout Namibia with the exception of the northern regions. The greatest concentrations are on farms in the central areas and along the south-eastern and north-eastern edges of the Namib. Along with kudu, they are very popular animals among trophy hunters. Gemsbok meat is also sold by many butchers and in restaurants.

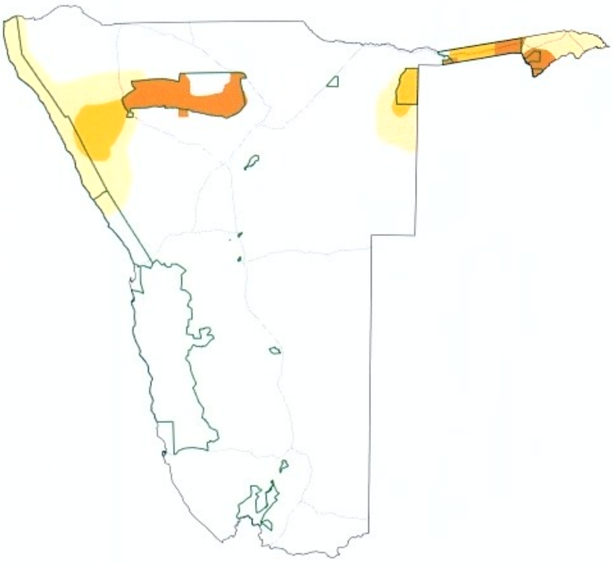
Large carnivores

Few animals fascinate us more than the large mammalian carnivores. One reason that these animals are so thrilling is that they are generally rare, and people are much more excited by sightings of unusual animals than common ones. Their rarity stems largely from the fact that large carnivores occur naturally at low densities and only in areas where their prey is comparatively abundant. But these animals have also suffered from decades of persecution, mainly by farmers who often consider any large carnivore as a threat to their livestock. Another factor making these animals difficult to see is that they are often secretive and more active at night than during the daylight hours. Maps of distributions and estimates of densities were derived from analyses of sightings and studies in certain areas.[18]



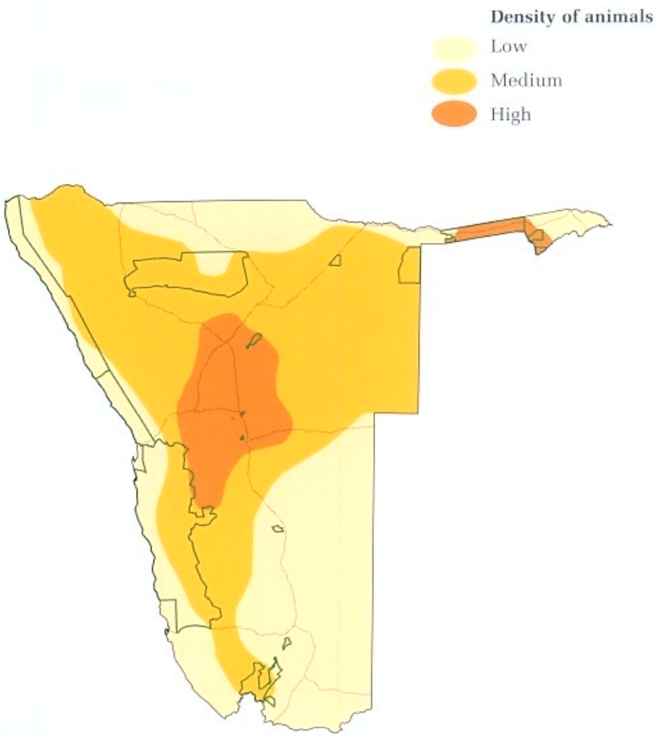
4.46 Overall diversity of large carnivorous mammals

The greatest number of species of the six large carnivores shown in the next maps are in north-eastern Otjozondjupa, in the vicinity of the Khaudum Game Park in Kavango, and in the Mamili National Park in Caprivi. Note that the number of species that are potentially present in an area is shown on the map, but most people are unlikely to encounter these animals because they are all secretive and occur in very low densities. Estimates of the population sizes of these species in Table 4.2 on page 123 were derived from studies of known individuals in a number of areas, where the individuals were tracked to provide measurements of their home ranges. Estimates of densities were then extrapolated to provide approximate numbers for the whole country.



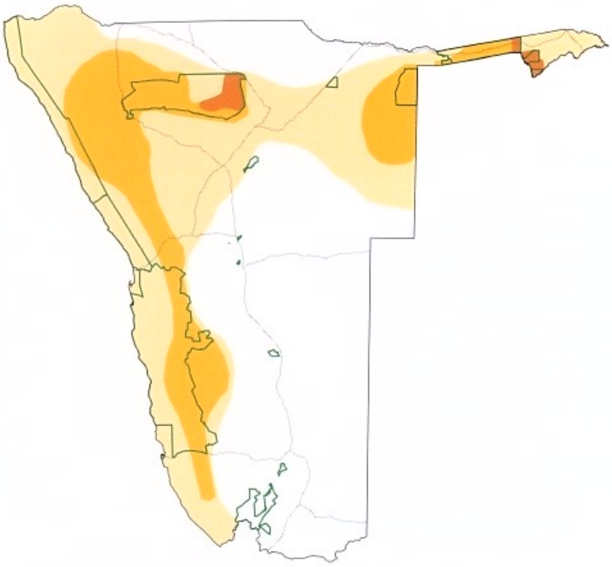
4.47 Lion

Most lion are concentrated in three separate populations: in the central Kunene Region and Etosha, in eastern Otjozondjupa and Kavango, and in eastern Caprivi. However, lions may move over large areas (see Figure 4.56) and some individuals move from one population to another. The biggest number of Namibian lions is in Etosha National Park. Unfortunately, many young males leave the Park when they mature and become a nuisance to livestock owners farming nearby.



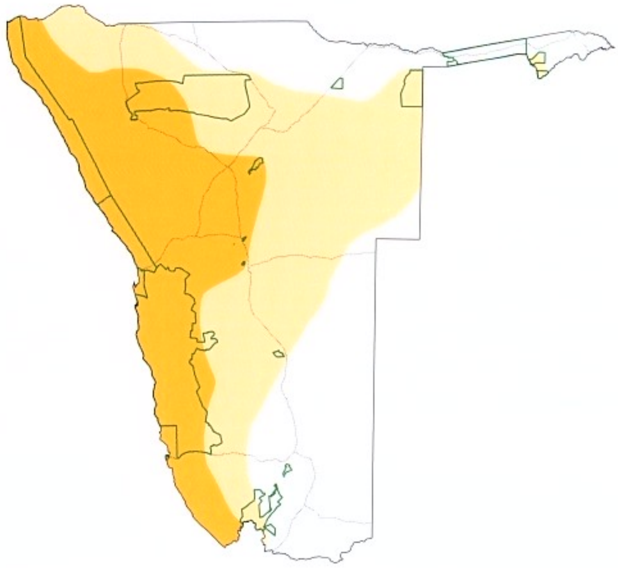
4.48 Leopard

Leopard are widely distributed and fairly abundant in Namibia, especially in the north-western third of the country and in eastern Otjozondjupa and Caprivi. Leopards are secretive, and it is hard to estimate the approximate number in Namibia.



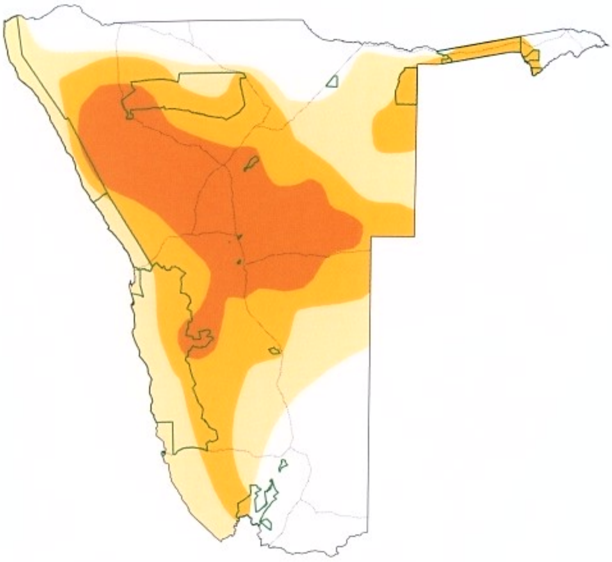
4.49 Spotted hyena

Most spotted hyena are concentrated in Etosha and adjacent parts of Kunene, in eastern Otjozondjupa, and along the eastern edge of the Namib and the adjacent escarpment. They, like brown hyena, are usually active at night and are, thus, seldom seen.



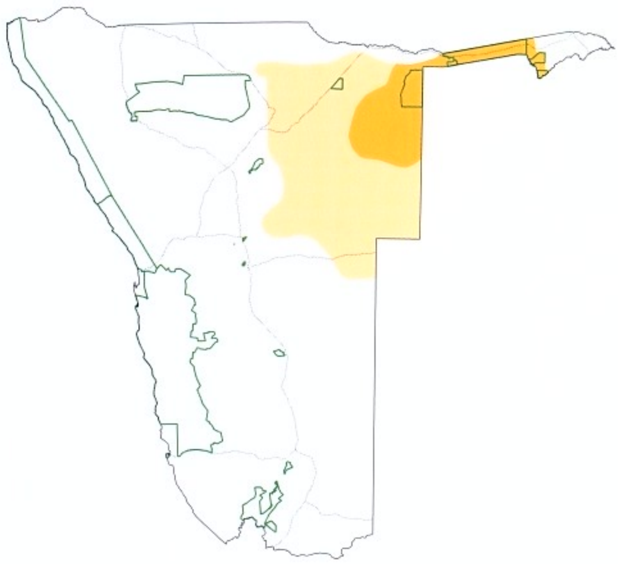
4.50 Brown hyena

Most brown hyena occur in open country in the western half of Namibia, especially along the coast, where they feed on dead seals, sea birds and other animals that wash up on the beach.



4.51 Cheetah

Most cheetah occur in the central and north-western areas of Namibia, living in a range of habitats from thick woodland to mountains and deserts. Many cheetahs are to be found on privately owned farm land; some farmers see them as a threat to their livestock while other farmers are proud to have these uncommon and attractive animals. The Namibian population of several thousand animals represents a substantial proportion of the total population of cheetah in the world, giving Namibia a special responsibility for their protection.



4.52 Wild dog

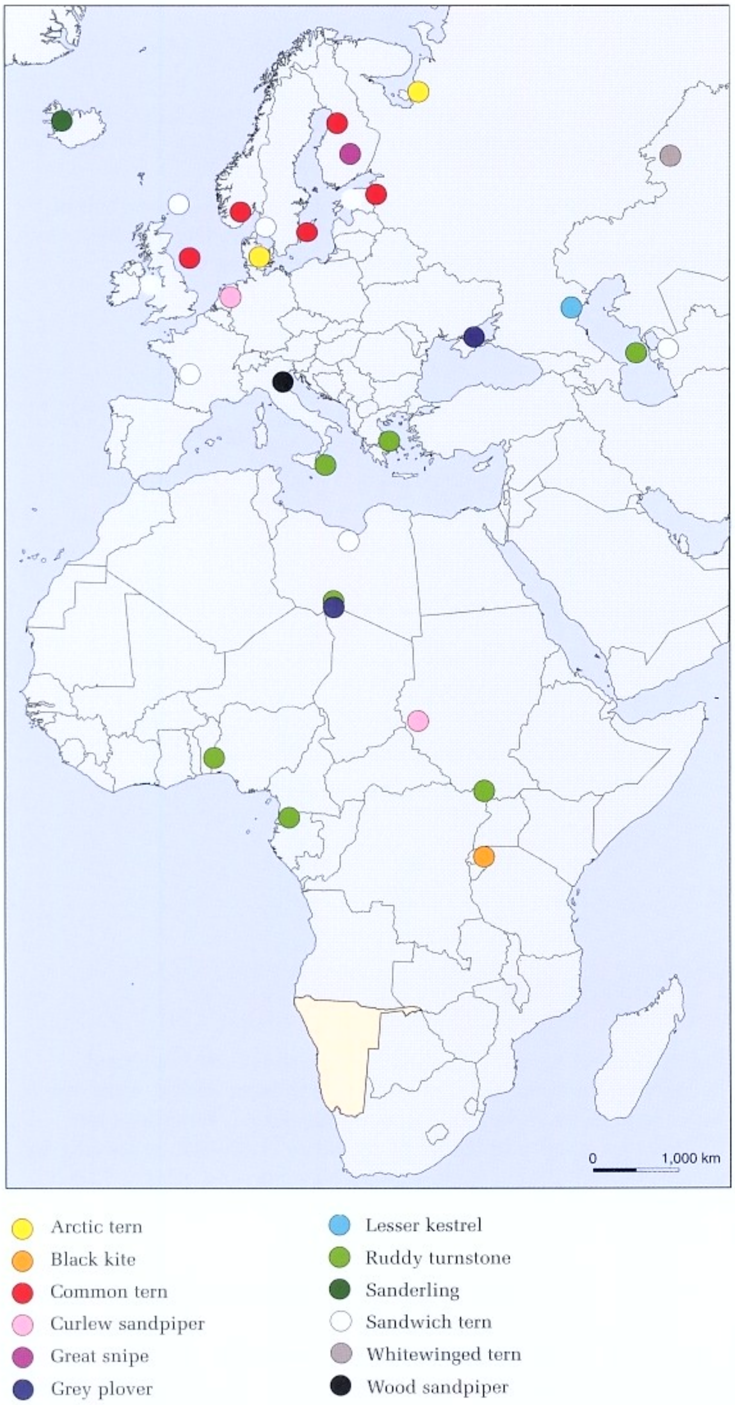
Populations of wild dog have decreased drastically in recent decades in Namibia and elsewhere in southern Africa. They are now listed as an endangered species for Africa. Wild dogs are limited to a small number of packs in the north-east, especially in eastern Otjozondjupa, south-eastern Kavango and eastern Caprivi.

Table 4.2 Estimated populations of carnivores

Species	Estimated number of animals in Namibia
Lion	500–1,000
Leopard	3,000–9,000
Spotted hyena	300–3,000
Brown hyena	500–700
Cheetah	2,500–8,000
Wild dog	200–1,200

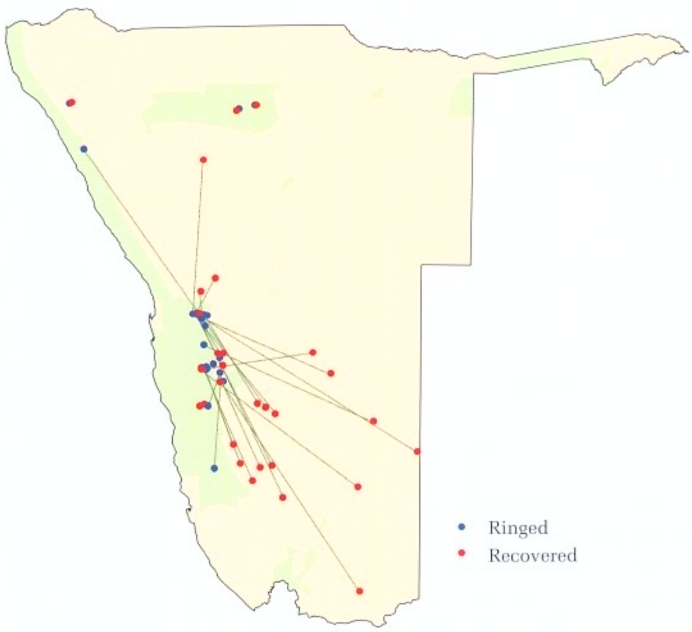
Long-distance movements

Animals make three kinds of long-distance movements: migrations, nomadic wanderings and dispersals. Migrations are regular movements twice a year between a summer and winter range. The best-known migrations are those made by the many birds that journey between the northern and southern hemispheres. Nomadic wanderings are an important strategy for many animals in arid and semi-arid environments where food only becomes available sporadically after rain. Many birds are nomadic in Namibia, and tens of thousands of springbok, blue wildebeest and Burchell's zebra used to move nomadically across the region. Their movements have now been severely restricted by the erection of fences. Dispersals by young animals generally occur when they move away from the area in which they were born, in search of new places to live as adults.



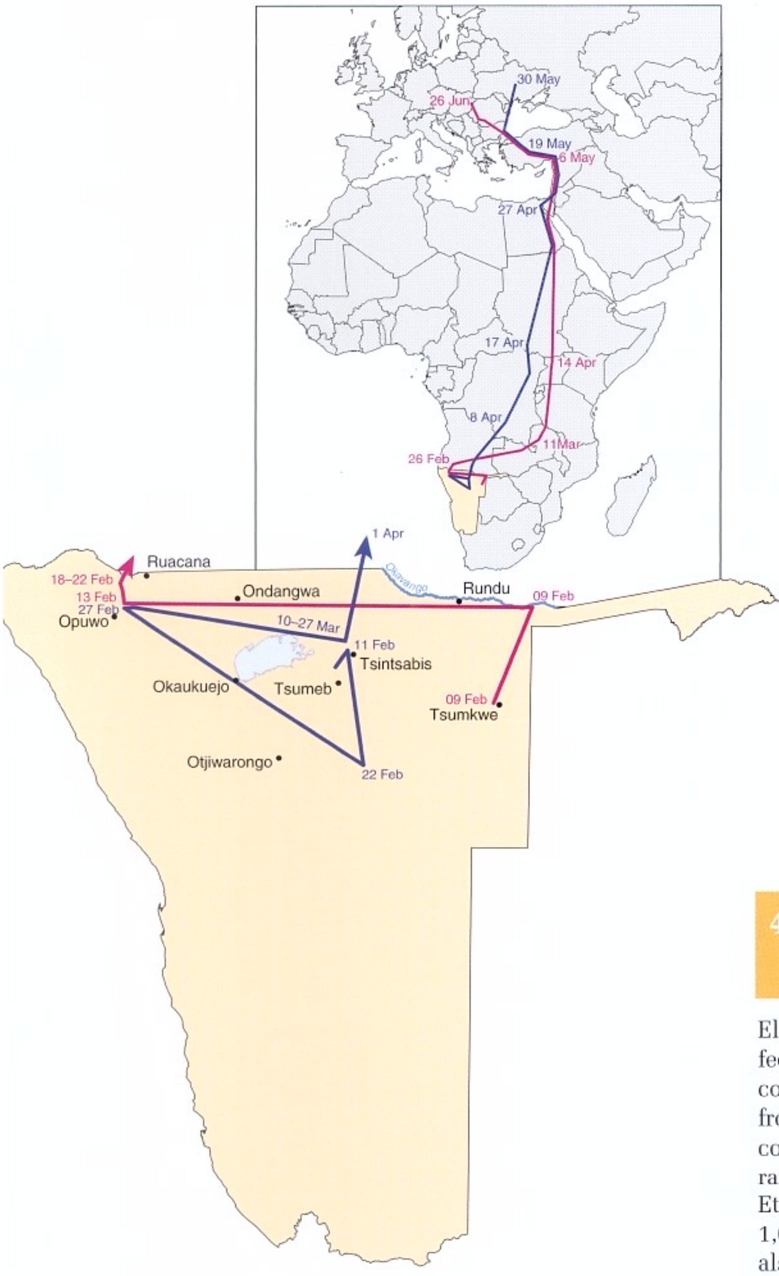
4.53 Long-distance migrations by birds [19]

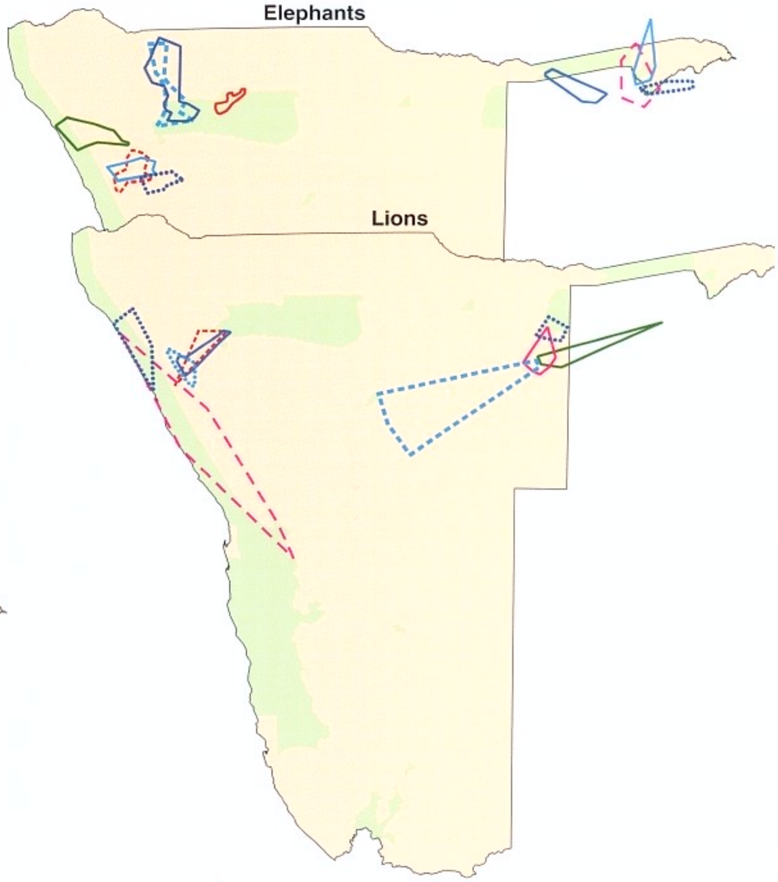
Namibia serves as a summer haven for millions of individual birds from Europe and Asia as well as from elsewhere in Africa or the sub-Antarctic. This map shows representative points for birds that were either ringed elsewhere and then recovered in Namibia, or ringed in Namibia and then later found elsewhere. Amongst the most spectacular movements are those by a sanderling from Iceland, an Arctic tern from the Russian coast of the Arctic Ocean, and a whitewinged tern found in northern Kazakhstan. Some migrants journey across the continent directly while others fly along the west coast of Africa, and several points on the map show places where birds were recovered en route to more distant destinations.



4.54 Dispersals and nomadic movements of lappetfaced vultures [20]

Some of the movements shown here by lappetfaced vultures that were ringed and later recovered are nomadic wanderings while others are dispersals in search of new home ranges. There are many nesting pairs in the eastern central Namib, and a good number of chicks ringed there were later found elsewhere in Namibia, many at distances greater than 300 km.





4.55 Movements by two lesser spotted eagles in Namibia, and their flight to Europe [21]

The movement of two lesser spotted eagles within Namibia in February and March 1994 illustrates how rapid and wide-ranging some nomadic wanderings can be. Both birds were carrying radio transmitters, which allowed their movements to be tracked. Lines on the map show their movements over a few weeks to several widely separated places where rain had fallen in northern Namibia. They then left for their breeding grounds in Europe, flying up through Africa, around the Mediterranean and into Europe.

4.56 Areas covered by elephants and lions fitted with radio collars [22]

Elephants regularly cover large distances, moving between different feeding grounds and water sources. They use low-frequency calls to communicate over distances of more than 50 km, and information from these calls probably influences their movements. The areas covered by the 11 individuals shown here provide an idea of the ranges occupied by different populations in north-western Namibia, Etosha and Caprivi. All 11 elephants covered ranges of more than 1,000 km^2, and four of them covered over 4,000 km^2. Many of them also moved in and out of protected nature reserves.

Most young male lions leave the prides in which they were reared, and some of the movements shown here were by young males seeking new prides and places where they could settle. The nine different lions shown in this map covered ranges larger than 1,000 km^2, with two of them covering more than 24,000 km^2.

A radio transmitter fitted to the collar worn by this lioness allows scientists to track her movements, which may cover hundreds of square kilometres. Such large open spaces are an important resource, allowing many species to move from one source of food or water to another. This is most important in arid environments where water and food tend to be available only sporadically.

CHAPTER 5: *The land*

Namibia depends to a great extent on resources derived directly from the land, especially through such activities as farming, mining and tourism. These are formal economic activities. But land also provides less formal benefits to the approximately 71% of people that live in rural areas, assets such as security and capital, a place to live, wood and other resources to harvest. If land is such a crucial resource, many key questions can be asked:

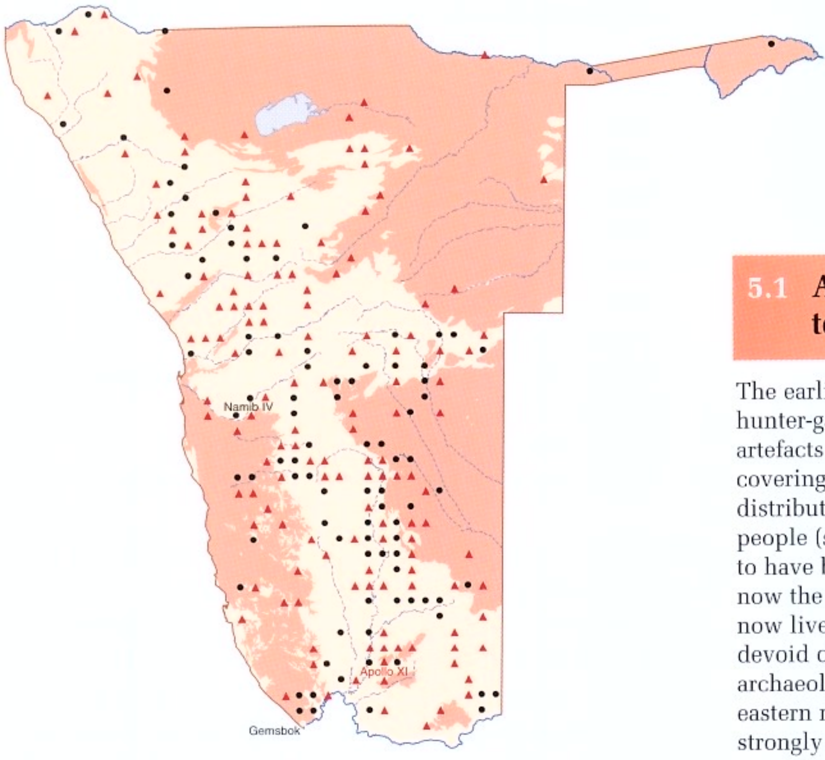
- who owns the land, who uses it, and for what purposes?
- how did land come to be allocated in the way that it is?
- how is land governed?
- how much land is allocated for communal purposes?
- which areas are used for farming and what types of farming are practised?
- which areas are privately owned?
- what is the market value of freehold or commercial farmland?
- which areas are important for tourism?
- which areas are allocated for conservation?

Many of the patterns observable today are best understood by looking at historical changes in the occupation and use of land. Some changes either happened so long ago or were so short-lived that they had little impact in shaping the Namibia of today. Other changes had far-reaching effects; for example, historical patterns of migration, settlement, occupation, segregation and land allocation have largely determined how land is now used and managed. Land issues also assumed huge political dimensions, to such an extent that local wars were waged over access to land. Furthermore, disparities in the distribution of resources largely ensured which individuals were best placed to exploit the market potential of land, and which people lacked such opportunities. Land is, therefore, not only a key resource for Namibia and its people but also a highly political issue.

Ancient history and land uses [1]

Humans and their predecessors have been present in Namibia for a long time. The remains of a pre-human, *Otavipithecus namibiensis*, have been found at Berg Aukas, near Grootfontein. This animal lived there about 13 million years ago, and was related to the line of primates that eventually evolved into humans.

Archaeological sites provide snapshots of the past, showing where people lived at particular times. Artefacts and environmental evidence found at these sites also provide clues as to how people once lived. Evidence collected worldwide suggests that hunting and gathering was the predominant lifestyle for much of human history, and that pastoral nomads and crop farmers emerged only quite recently during the last few thousand years. Many people believe that the occupants of archaeological sites in Namibia were San people.[2] However, there are no clues as to what languages were spoken and, more importantly, there is no reason to assume that these ancient predecessors belonged to any single ethnic group anyway.



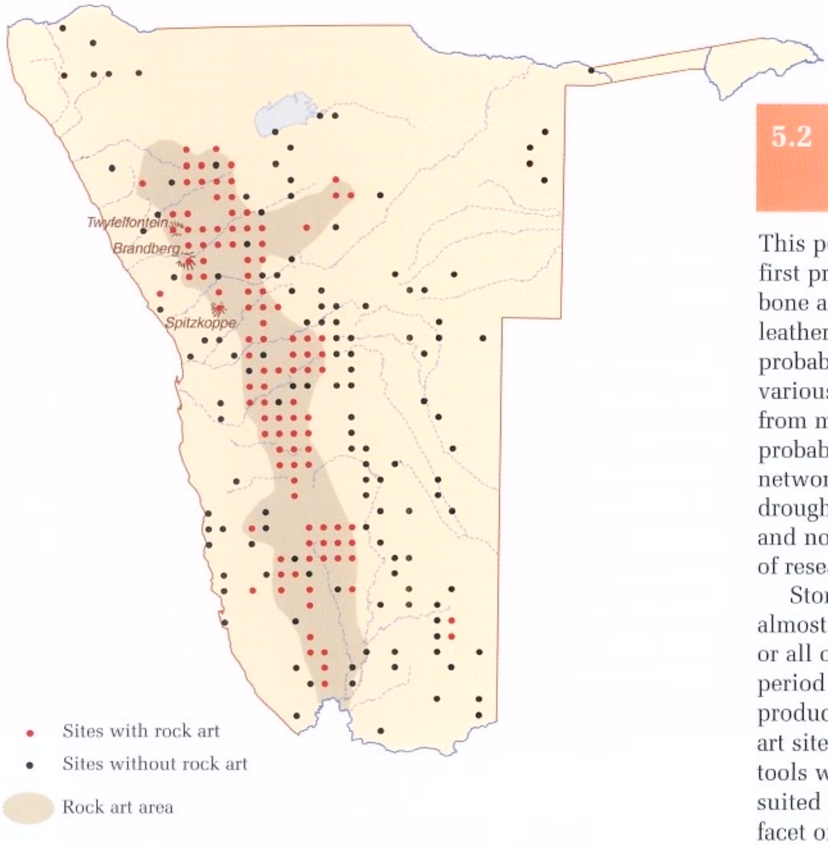
5.1 Archaeological records from 1.8 million to 10,000 years ago

The earliest stone tools found in Namibia were produced by hunter-gatherers about 1.8 million years ago. Most sites containing artefacts from this long period have been found in a broad band covering the southern and western two-thirds of the country. This distribution stands in stark contrast to the present distribution of people (see Figure 6.1). Almost exactly the same area that appears to have been most occupied over hundreds of thousands of years is now the most sparsely populated, while areas where most people now live – in the northern regions – seem to have been largely devoid of people. It must be remembered, however, that little archaeological research has been done in the northern and north-eastern regions, and the distribution of archaeological sites is strongly influenced by geology and landscape features. Many sites, for instance, have been covered by sand with the result that relatively few have been found in the Kalahari Sandveld and Namib Dunes. Moreover, artefacts such as stone tools are easier to find in rocky and flat areas where erosion has removed soil that might otherwise have concealed them.

The sites shown here were not occupied continuously. Rather, people came and went, selecting places where they could hunt, gather and scavenge food, and where drinking water was available. They would move on when these vital resources ran out. Most of their movements depended on where rain had fallen. Since Namibia's climate has been generally arid for millions of years (see Chapter 3) and rainfall sporadic and unpredictable, people moved frequently and covered large distances, leaving remains at each site that archaeologists could later discover. Perhaps this is the reason that so many sites are widely distributed in the more arid areas of the country.

Among the sites shown on the map is that at Gemsbok near the Orange River, which yielded the oldest stone tools to be reliably dated in Namibia. These are estimated to be 800,000 years old, while those at another site (Namib IV) are dated at 500,000 years ago. The Apollo XI cave in the Huns Mountains is another significant site where amongst the earliest rock art to have been dated was found. It is estimated that the images were painted between 19,000 and 26,000 years ago.

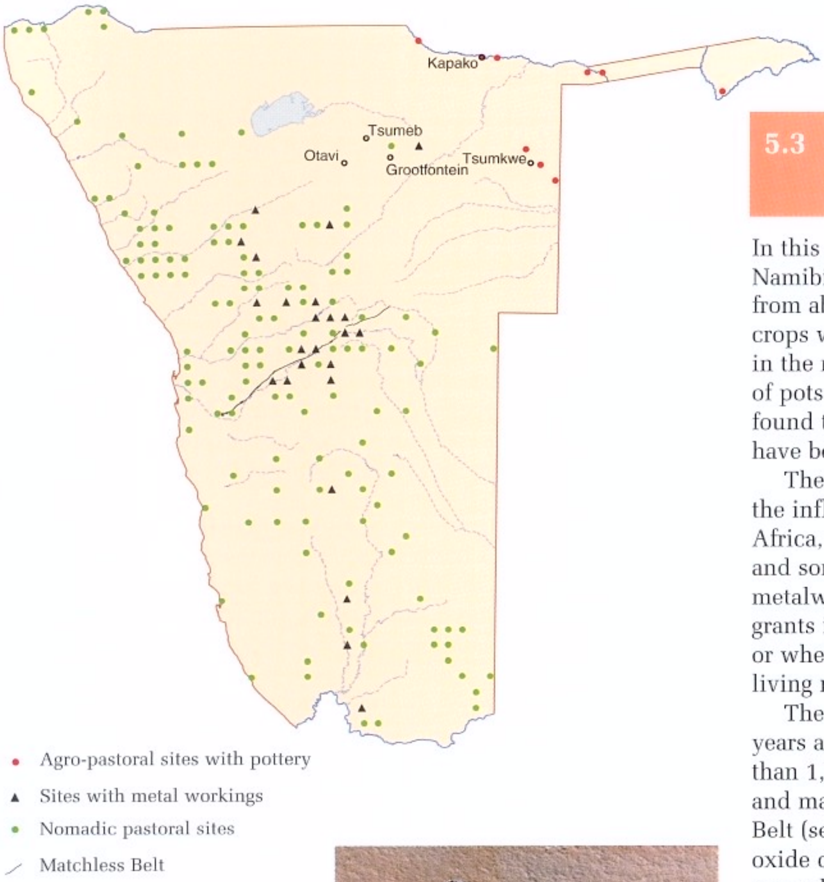
Of many wonderful rock art murals the most outstanding are at the Brandberg, where about a thousand rock art sites have been recorded on the mountain's granite surfaces. There are many rock paintings on other granite outcrops in this area.



5.2 Archaeological records from 10,000 to 2,000 years ago

This period starts when more specialised and complex tools were first produced. Many of the tools, such as arrows made of wood, bone and stone, were used for hunting, while others were used for leatherwork and woodwork. People were still hunter-gatherers but probably placed more emphasis on a range of methods to hunt various animals than on gathering. The use of vegetable foods from many plants remained important. During this period, people probably also moved around more, relying on complex kinship networks to provide access to resources in times of need like drought. Again, the absence of archaeological sites in northern and north-eastern Namibia is partly due to the limited amount of research conducted there.

Stone tools from this 8,000-year time span have been found almost everywhere surveys have been done, suggesting that much or all of the country was inhabited at one time or another. This period covers the time when most of Namibia's rock art was produced, either as paintings on rock faces or as engravings. Rock art sites have a much more restricted distribution than those where tools were discovered, being limited to areas with rock surfaces suited to painting and engraving. Rock art was probably just one facet of a rich ritual tradition that included aspects such as dance and folklore.



5.3 Archaeological records from the last 2,000 years

In this period food production probably became established in Namibia, though the earliest firm evidence for crop cultivation is from about 1,100 years ago at Kapako on the Okavango River. Most crops were probably produced along the banks of permanent rivers in the northern and north-eastern regions. Sites containing pieces of pots normally associated with crop production have also been found to the south in eastern Otjozondjupa, but these artefacts may have been used for the storage of honey and other foods.

The introduction of crop cultivation is generally attributed to the influx of people from further north, in central and western Africa, who spoke Bantu languages. They brought with them millet and sorghum crops, and were the first to introduce pottery and metalwork in Namibia. It remains unclear whether these immigrants introduced such crops and techniques directly to Namibia, or whether people in Namibia adopted them from people who were living nearby.

The oldest sites containing pottery date from about 2,200–2,000 years ago, while the oldest indications of metalworking are less than 1,000 years old. Copper smelting was one form of metalwork, and many smelting sites have been found close to the Matchless Belt (see Figure 2.4) where there are abundant workable copper oxide deposits near the surface. Copper was extracted in the hills around Tsumeb and Otavi as well.

This period also saw the introduction of domestic stock to Namibia by African migrants from further north: sheep at first, and then goats and cattle. The earliest evidence of domestic stock in Namibia is from about 1,000 years ago. Whereas crop cultivation was largely limited to northern Namibia, livestock farming was much more widespread. As pastoral nomads, people moved their herds and sometimes their homes to areas where pastures and water were available, and even the most arid parts in the central Namib were used for stock farming.

Clay pots were often used to store grain, and so their presence at archaeological sites provides clues to where and when crop cultivation first started.

Land occupation over the past 500 years[3]

Much of Namibia's history over the last 500 years reflects changes in the use and occupation of land by different groups of people. Each group of newcomers had an impact, bringing ongoing change to land that was unoccupied or displacing people that were already there. These events were repeated many times over the centuries.

The most recent immigrations are remembered most vividly: those resulting from colonial occupation by Germany in 1884 and then by South Africa in 1915. These occupations set in motion two major processes of change to the size and shape of land set aside for communal use, areas formerly known as 'native reserves' or 'homelands'. The first change occurred largely in southern and central Namibia, where large areas under the control of various indigenous communities shrank or disappeared as more and more land was sold to private, commercial farmers mainly from Germany and South Africa. Many people were therefore relocated or they had to find their own way to new homes, often far away, at places they had never seen and where the land had little capacity to support them.

The second major change occurred in northern Namibia. For a long period, much of northern Namibia was treated as state or crown land or even as 'no man's land'. Successive administrations later recognised the existence of different communities living there, and agreed that land should be demarcated for their use. Many old official maps show only those communities and communal areas that were acknowledged by the government in power at the time, while other communal areas were left blank, their communities unrecognised and anonymous.

5.4 Communities in the 1500s and migrations into Namibia

This map presents a perspective on areas settled by various communities in the 1500s, as well as on some of the major migrations into Namibia during subsequent centuries. The borders and routes on the map are approximate because much of the information is based on oral tradition. The map also shows only those migrations that are better documented. Most importantly, no information is available on what was happening in the gaps on the map: these spaces should not be interpreted as suggesting that the areas were unoccupied.

Most Damara communities were reported in rather localised areas in western and central Namibia, whereas most San communities were apparently more widespread, probably moving over larger areas in a nomadic fashion. It is believed that the predecessors of the Damara people may have originated in parts of Zambia and Zimbabwe, where they probably developed and shared the Khoekhoe language with the Khoe people, and perhaps also first became stock farmers. Damara communities then moved west into Namibia, while the Khoe moved further south into South Africa. Nama descendants of the Khoe in South Africa moved into Namibia very much later, first in the 1740s and then in the 1800s as a second wave of so-called Oorlam groups. These immigrants reintroduced Khoekhoegowab (also known as Damara Khoekhoe or Nama Khoekhoe) to Namibia; the language most likely had its origins far from where it is now commonly spoken (see Figure 6.7).

Oshiwambo-speaking and Otjiherero-speaking settlers probably arrived in Namibia during the 1500s. The first Oshiwambo-speakers settled at Oshamba, north-east of what is now Ondangwa. The earliest Owambo kingdoms (see Figure 5.7) were established by 1600, probably on the proceeds of the Angolan slave trade. Herero people first settled in northern Kunene before moving further south and east, probably reaching the Swakop River by the mid-18th century.

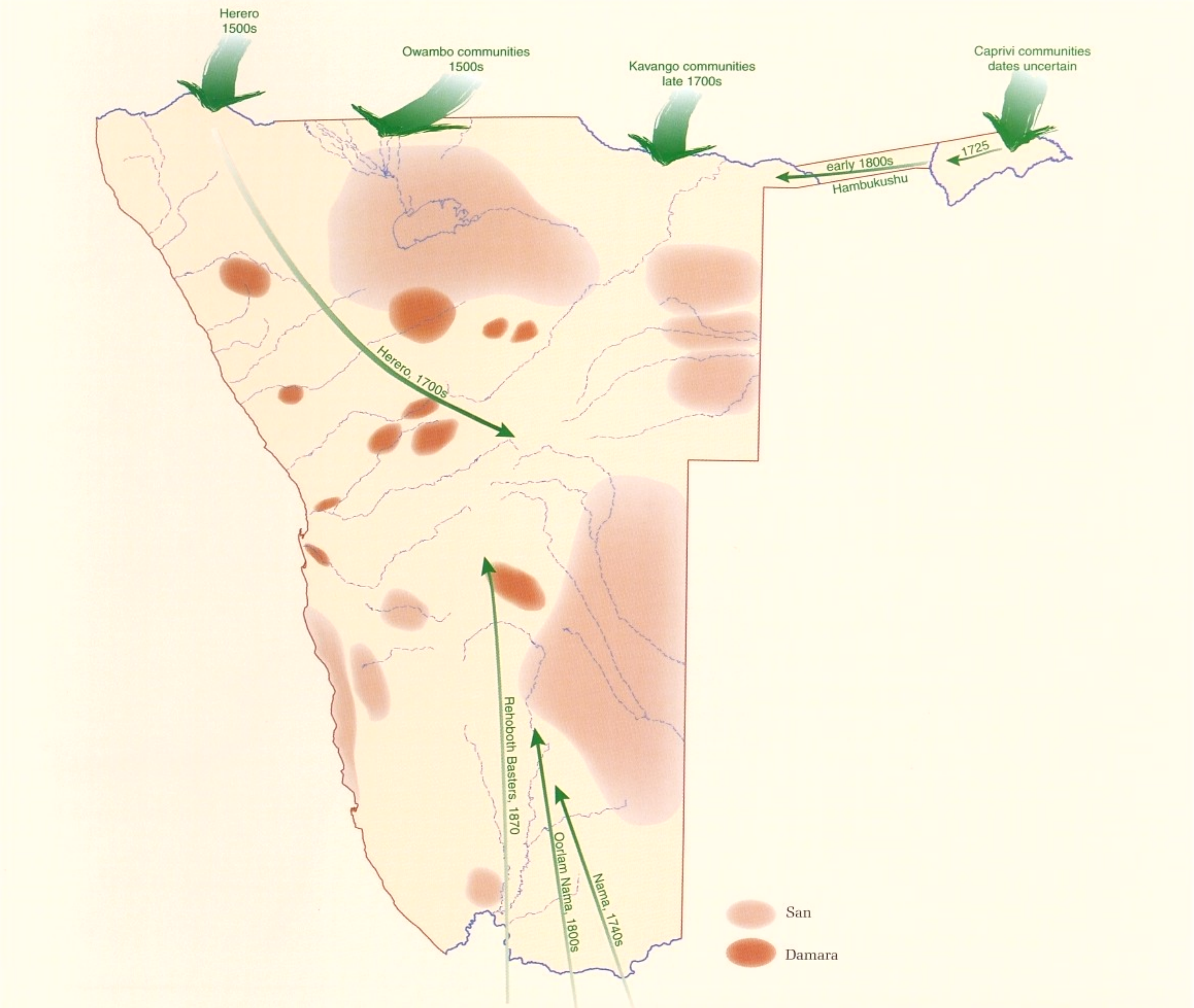
The date at which the communities who now live in the Caprivi arrived in Namibia has been the subject of intense historical and political debate. Oral traditions amongst the Masubiya and the Mafwe people on that early history remain contradictory.

The communities that came to settle in the Kavango Region moved from the Mashi area along the Kwando River before turning further south in the late 18th century to settle along the Okavango River. Hambukushu people first settled near Katima Mulilo and then moved to the Kwando River floodplain in about 1725. Much of the community later moved away and settled around Andara in the early 1800s.

There were also significant migrations in more recent years. In 1870, the Rehoboth Basters moved from the Cape, South Africa, to settle at Rehoboth. In 1907, the German Schutztruppe's defeat of Herero and Nama forces encouraged, and was followed by, a significant influx of German settlers and demobilised German soldiers who acquired land. Whilst poor white farmers from the northern Cape had moved up into Namibia prior to 1915, many more came in 1915 to acquire farms once the South Africans had defeated the German forces. Also in 1915, some 25,000 members of the Kwanyama nation moved from Angola into northern Namibia following the Portuguese victory over the Kwanyama king, Mandume ya Ndemufayo, at Pembe in Angola.[4] This movement increased the number of Oshiwambo-speakers by about 30% in the area that is now Namibia, and must have played a major role in contributing to the high population density in the central northern regions (see Figure 6.1).

Table 5.1 Major events related to the colonial occupation of Namibia[5]

Year	Event
1793	Dutch authorities in the Cape take possession of Walvis Bay.
1866	With South Africa under British rule, islands off the Namib coast are declared British territory.
1878	Walvis Bay is annexed by Britain as part of the Cape Colony.
1884	Germany declares Namibia a German protectorate.
1890	Namibia becomes a German colony, and the Caprivi is added to Namibia.
1915	German forces surrender to troops from the new Union of South Africa, which had become part of the British Empire in 1910.
1920	The League of Nations grants South Africa a mandate to govern Namibia.
1946	The United Nations rejects South Africa's attempt to turn Namibia into a fifth province of South Africa.
1959	Formation of South West African National Union, the first nationalist movement in Namibia.
1960	The South West Africa People's Organisation (SWAPO), which was to lead the struggle for independence, was formally established.
1961	South Africa becomes a republic and the United Nations starts to recognise the need for independence for Namibia.
1966	Following increasing discontent, the armed liberation struggle begins at Ongulumbashe.
1968	The United Nations declares South Africa's occupation of Namibia illegal.
1990	Namibia becomes independent on 21 March.
1994	Walvis Bay is reintegrated into Namibia.




KARTE DES
HERERO=(DAMARA=)
UND NAMAQUA=LANDES
AN DER WESTKÜSTE SÜD=AFRIKA'S
nach den im Besitze der Rhein. Missionsgesellschaft
befindlichen Original=Aufnahmen
entworfen von H. Wackernagel.
Maasstab 1:3,000,000.
Britisches Territorium
Freies Land
Rhein. Missions Stationen
Kupfer Minen
Süd=Grenze des Herero Landes
Durch den Krieg verlassene Missions Stationen
Die Höhen=Angaben sind nach Metern
Schnalzlaute der Namaqua-Sprache:
Dentalis
Palatalis
Cerebralis
Lateralis
ATLANTISCHER OCEAN
HERERO=(DAMARA=) LAND
GROSS=NAMAQUA LAND
Kl. Namaqua Land
Etosa Salz-Pfanne
Wendekreis des Steinbocks
Otavi
Omburo
Okahandya
Otyimbingue
Jonker'sche
Windhoek
Gobabis
Anwaal'sche
Topnar
Walfisch B.
Scheppmannsdorf
Rehoboth
Rothe=Volk
Gross-Todte
Witbooi
Gibeon
Franzmann
Goliat
Bersebu
Bethanien
Keetmanshoop
Zeib
Angra Pequena
Bondelschwarz
Orange Fl.
Steinkopf
Concordia
Kommaggas
Verlag v. R. L. Friderichs in Elberfeld.

5.5 Southern and central Namibia in the mid-1800s[6]

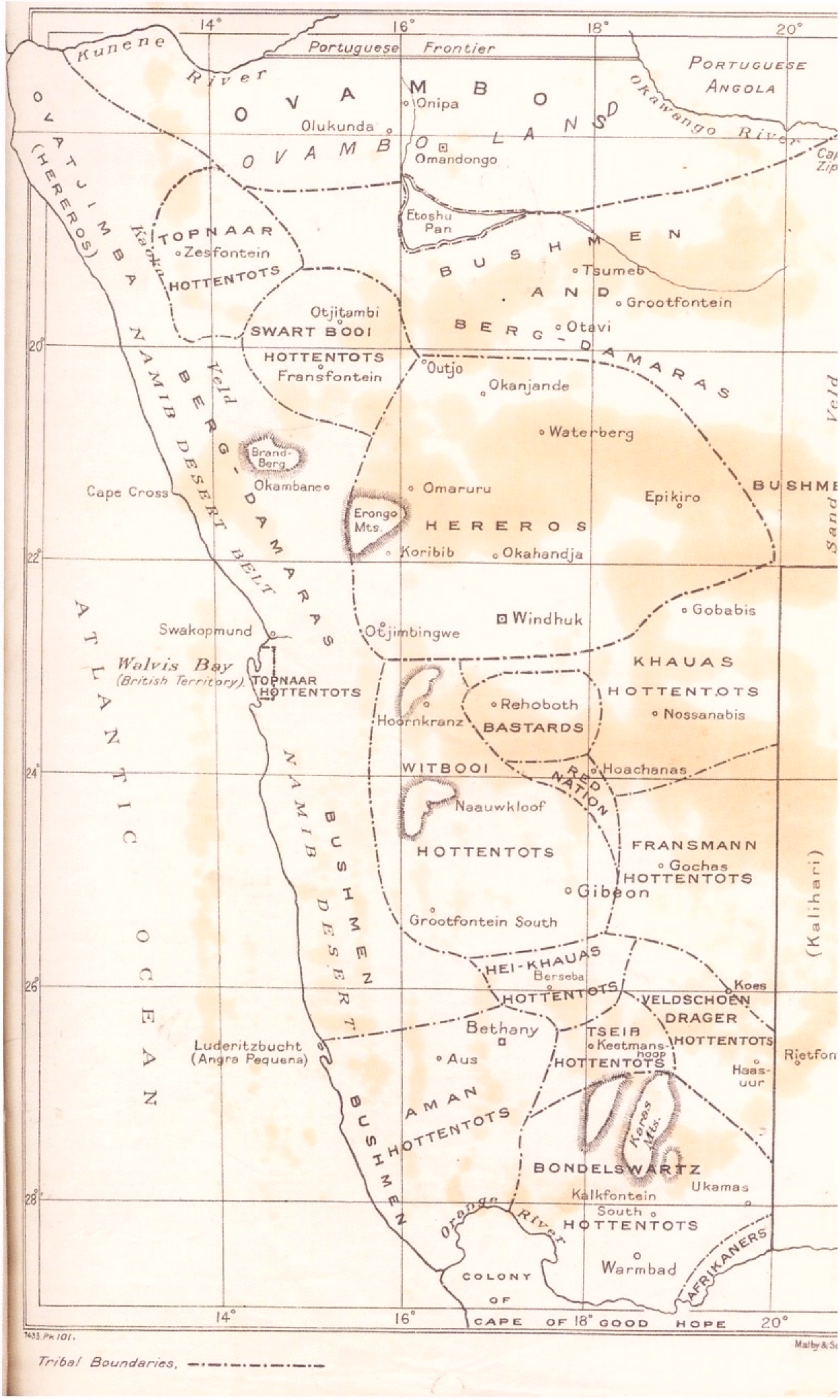
The maps on this and the facing page provide perspectives on the distribution of various groups during the mid-1800s, before the first land acquisitions by the German administration. At that time most European explorers, missionaries and colonial authorities tended to focus their attention on southern and central Namibia, and their maps provide much more detail about those areas than they do about the north, reflecting the substantial interests that colonists had in land in southern and central Namibia.

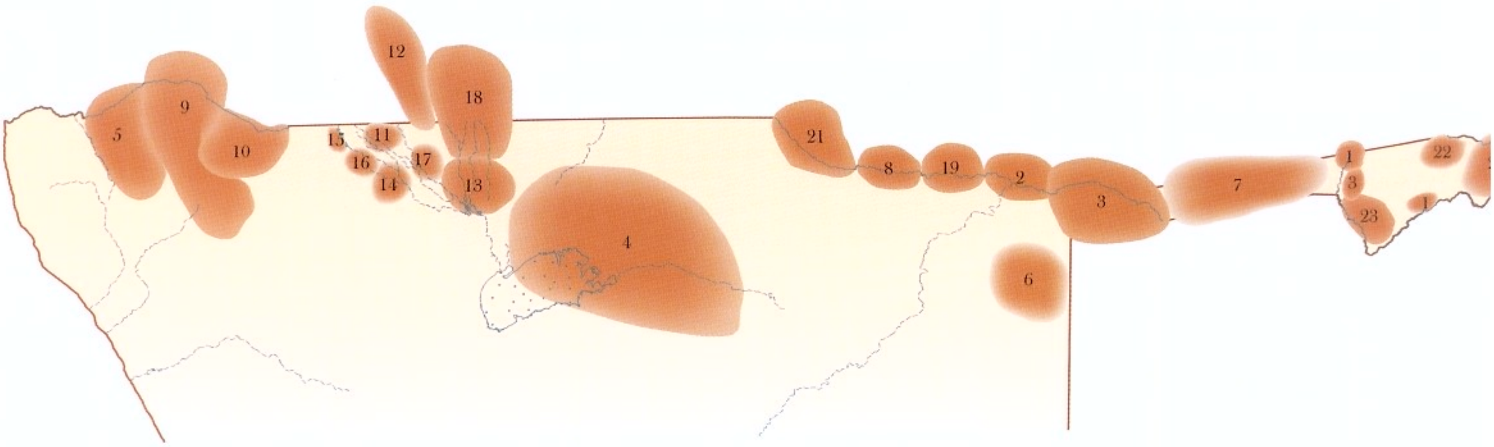
Johannes Olpp, a Rhenish missionary, published the map on page 132 in 1884. His map separates the country into two areas: 'Hereroland' (also 'Damaraland') in the north and 'Gross Namaqualand' (Great Namaqualand) in the south. The map is interesting since it was only in December 1894 that the German authorities first attempted to officially delimit the southern boundary of Hereroland. This boundary was then drawn to follow the White Nossob River in the east as a result of negotiations between Samuel Maharero, the Herero leader, and Theodor Leutwein, the German Governor. The boundary would play an important role in leading to later conflicts between the German authorities and Herero communities because it excluded Herero farmers from important grazing areas to the south.

Samuel Maharero was probably born in 1856. He rose to prominence as a leader of the Herero people during the German colonial period when he and Hendrik Witbooi led resistance to the foreign administration and its forces. Samuel Maharero died in Botswana on 14 March 1923.

5.6 More of Namibia in the mid-1800s[7]

The map below provides a more complete idea of how and where various groups of people were settled in the country around 1890. The map makes no mention of separate communities in Kunene and Kavango, and simply indicates most of the north-eastern area as being occupied by the Owambo. It is also interesting that the map shows San people as supposedly living in large areas of the central and southern Namib Desert.



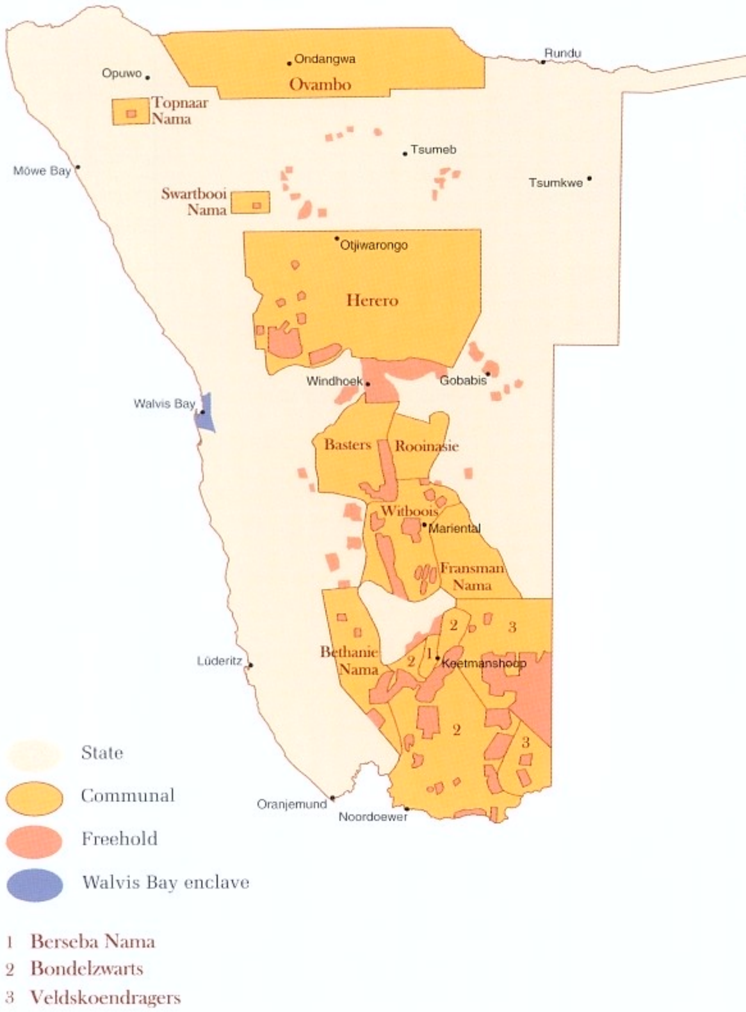


1 Fwe
2 Gciriku
3 Hambukushu
4 Hei//om
5 Kakurukouye
6 Ju/'hoansi
7 Kxoe
8 Mbunza
9 Mbwanandja
10 Muhonakatiti
11 Ombalantu
12 Ombadja
13 Ondonga
14 Ongandjera
15 Oukolonkadhi
16 Oukwaluudhi
17 Oukwambi
18 Oukwanyama
19 Sambyu
20 Subiya
21 Ukwangali
22 Totela
23 Yeyi

5.7 Northern Namibia in the late 1800s and early 1900s

Most early maps either simply left northern Namibia blank (see Figure 5.5) or attributed large areas to a vaguely defined Owambo group (see Figure 5.6). It is clear, however, that many quite separate kingdoms, communities and language groups existed in the northern parts of the country. A good deal of that diversity remains today in the many languages and dialects spoken in northern Namibia (see Figure 6.7).

This map, compiled from a variety of sources,[8] shows where distinct communities are known to have existed. There were probably others that remain unknown. Moreover, boundaries changed from time to time as the kingdoms and territories controlled by communities moved, expanded or retracted as a result of conflicts, climatic changes, and changing farming and trading practices. Again, gaps on the map should not be regarded as suggesting that no one lived there.



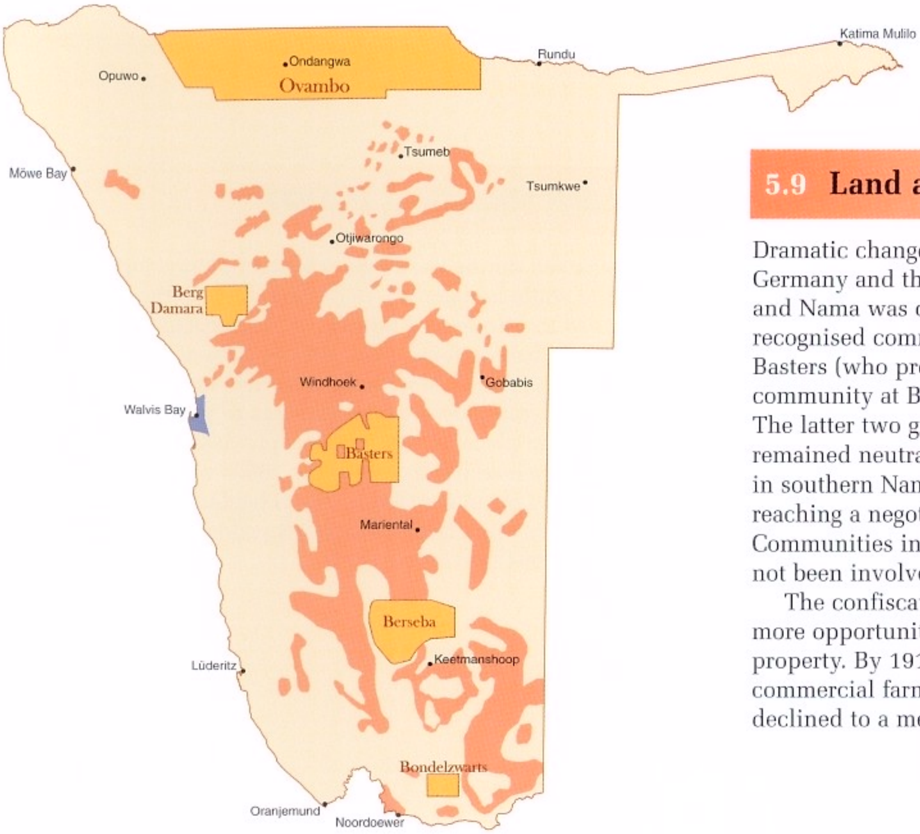
5.8 Land allocations in 1902[9]

Land acquisition by the Germans started in 1883, when an area around the town of Lüderitz and a wide strip of land from the Orange River north to 26° South was purchased from the Nama chief, Josef Fredericks, of Bethanie. Allocations became more formalised after Germany declared Namibia a protectorate in 1884, and many more land purchases followed. Protection treaties were also negotiated with local leaders to give the German government and German companies rights to the use of land. Many of these agreements were speculative in the hope that earlier discoveries of gold and diamonds in South Africa would be repeated in Namibia.

At the same time as settlers bought or leased land allocated for commercial farming, the areas occupied by indigenous communities began to be formally defined. Owing to the rinderpest epidemic which in 1897 had killed most cattle in Namibia, many Herero cattle farmers and their families were forced to seek the charity of missions. They also gave up their land more readily to German settlers or companies. By 1902, freehold farmland accounted for 6% of Namibia's total land surface area, and 30% was formally recognised communal land. This and the next four maps show how land use and allocation subsequently changed. Three broad categories of land use are shown:

- freehold areas used for commercial farming by individuals or companies,
- areas that the government of the time recognised and allocated for communal use, and
- land either used by the government or not yet allocated.

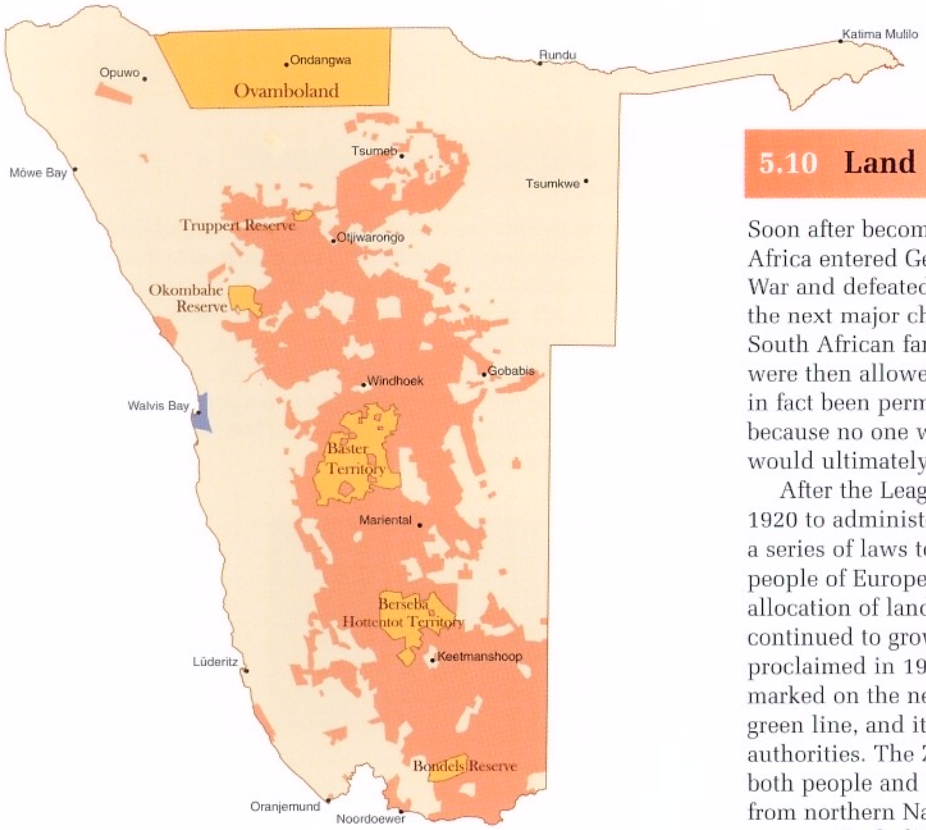
The names given for the communal areas are those found on the original maps, reflecting the terms in use at the time.



5.9 Land allocations in 1911 [10]

Dramatic changes followed the end of the 1904–1907 war between Germany and the Herero and Nama forces. The land of the Herero and Nama was confiscated by proclamation in 1907, and the only recognised communal land that remained was that of the Rehoboth Basters (who provided the Germans with troops), the Gai-//khauan community at Berseba, and the Damara community at Okombahe. The latter two groups were allowed to keep their land as they had remained neutral during the war. The Bondelzwarts community in southern Namibia was also able to keep a small area after reaching a negotiated settlement with the German Administration. Communities in northern Namibia were not affected since they had not been involved in the war.

The confiscation of land by the 1907 proclamation opened up more opportunities for white farmers and companies to acquire property. By 1911, some 21% of the country had been allocated to commercial farmers, while areas of recognised communal land had declined to a mere 9%.

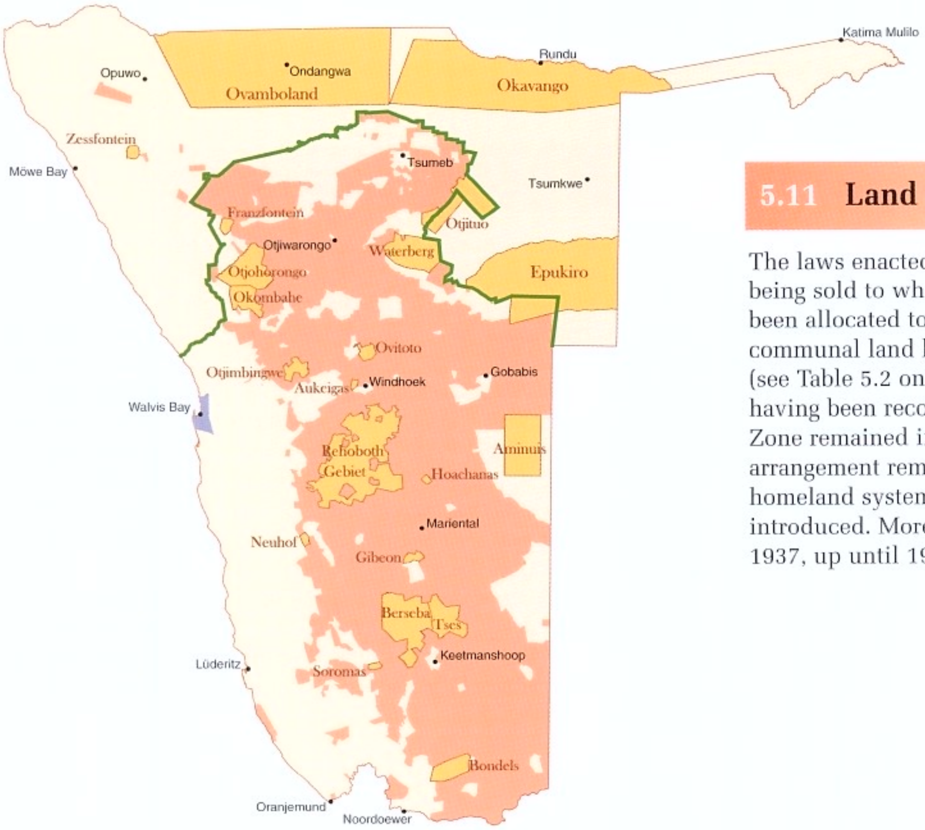


State
Communal
Freehold
Walvis Bay enclave

5.10 Land allocations in 1921 [11]

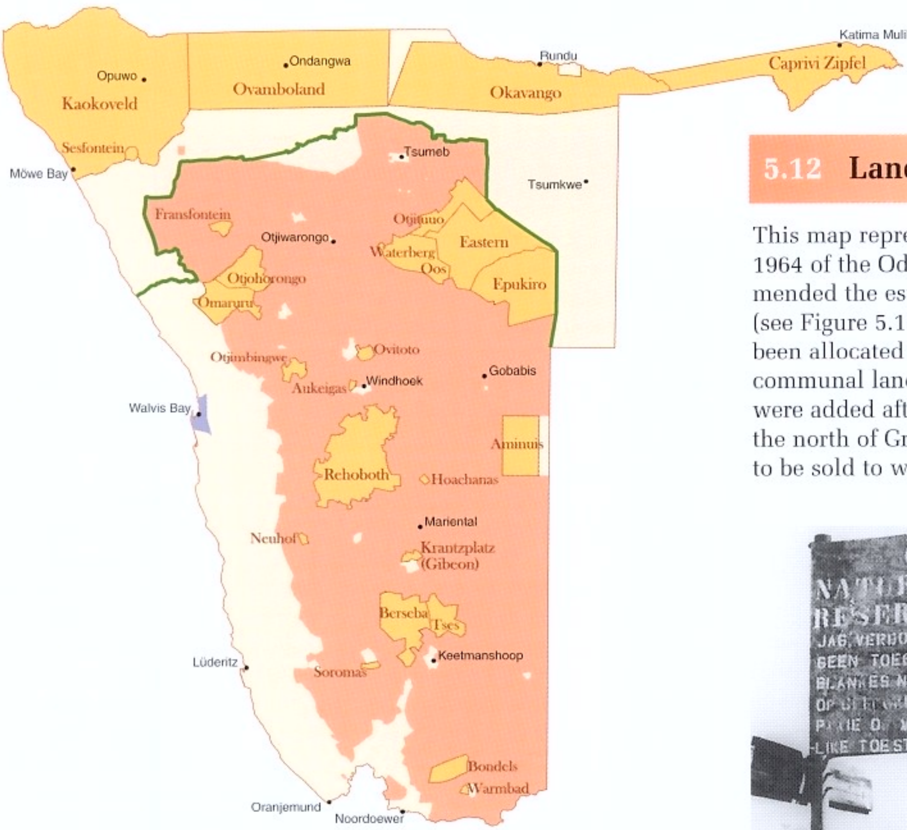
Soon after becoming a Union within the British Empire, South Africa entered German South West Africa during the First World War and defeated the German forces. Their victory set in motion the next major change in land allocations. In 1915 many white South African farmers moved onto Namibian farms, which they were then allowed to lease for five years. Some black farmers had in fact been permitted to lease farms before the end of the war because no one was then sure whether Germany or the Allies would ultimately win.

After the League of Nations gave South Africa a mandate in 1920 to administer Namibia, South African authorities promulgated a series of laws to govern land allocations. Some laws encouraged people of European descent to buy farms while others governed the allocation of land to indigenous communities. Freehold farmland continued to grow as a result. The so-called Police Zone was proclaimed in 1919. Its position was probably similar to that marked on the next map (for 1937) as the area south of the thick green line, and it was administered directly by the South African authorities. The Zone served to restrict and contain the mobility of both people and animals, as well as the spread of cattle diseases from northern Namibia to the central and southern parts of the country. Each district in the Police Zone was controlled by a magistrate, whilst reserve boards and advisory boards provided a link between the authorities and the residents of the rural 'native reserves' and their urban counterparts, the 'locations'. To the north of the Zone, the administration of day-to-day affairs was left to the traditional authorities under the supervision of officials from the Native Affairs Department. The administration would, however, intervene if leaders were seen to be uncooperative. For example, King Mandume ya Ndemufayo of the Oukwanyama and King Iipumbu ya Tshilongo of the Oukwambi were removed by force from office in 1917 and 1932, respectively.



5.11 Land allocations in 1937 [12]

The laws enacted during the 1920s resulted in more and more land being sold to white farmers. By 1937 about 36% of the country had been allocated to commercial farmers, while recognised areas of communal land had doubled since 1921 to 17% of the country (see Table 5.2 on page 137), with the area then known as Okavango having been recognised as a communal area as well. The Police Zone remained in place; indeed, various provisions of this arrangement remained in force until the 1960s when the so-called homeland system recommended by the Odendaal Commission was introduced. More white farmland was also added in the years after 1937, up until 1964 (see Figure 5.13).

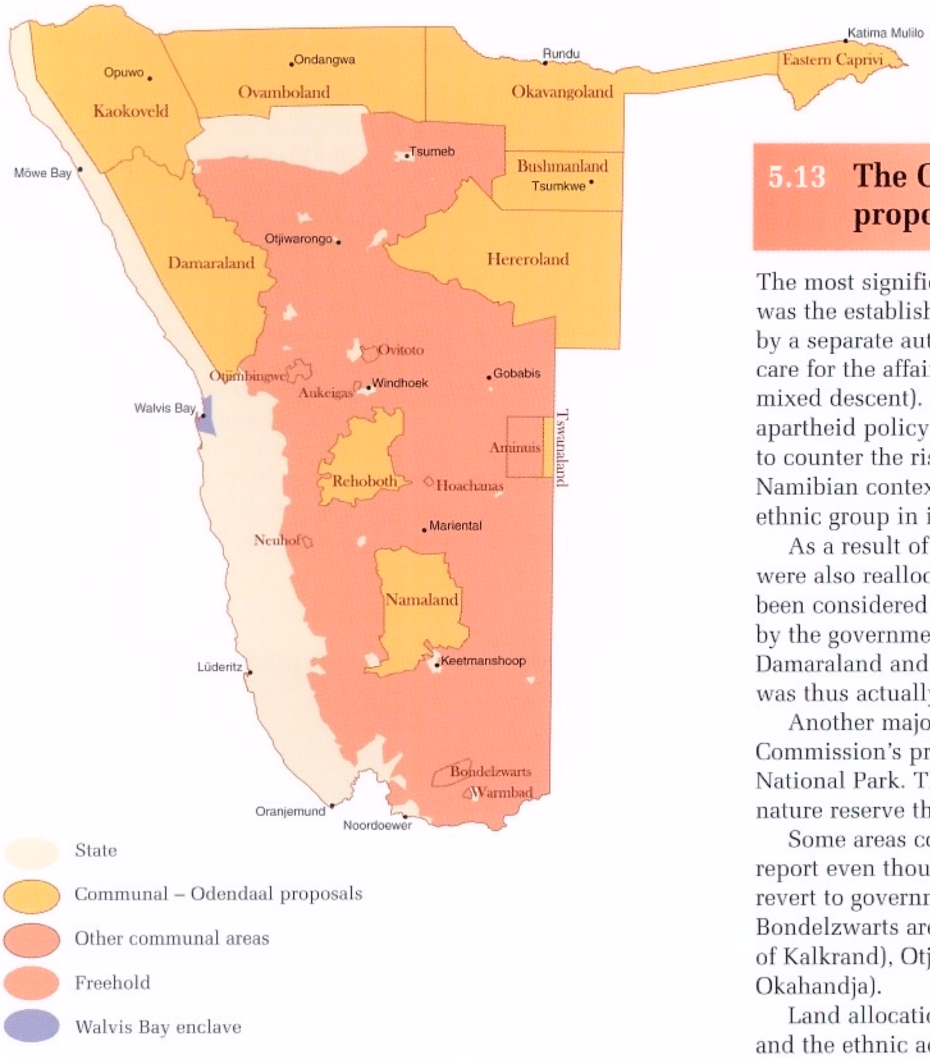


State
Communal
Freehold
Walvis Bay enclave
Police Zone border

5.12 Land allocations in 1955 [13]

This map represents the situation just before the publication in 1964 of the Odendaal Commission's proposals, which recommended the establishment of new boundaries for communal lands (see Figure 5.13). By this stage, about 47% of the country had been allocated for commercial farming, leaving 27% as recognised communal land and 26% as government land. A few freehold farms were added after 1955, mainly along the border with Kavango to the north of Grootfontein. These were the last new freehold farms to be sold to white farmers.

A grim reminder of a segregated society. The warnings given here proclaim that only whites were allowed to travel through the Otjohorongo Reserve along proclaimed roads and that dealings with the 'natives' were strictly prohibited. Hunting was also forbidden.



5.13 The Odendaal Commission's 1964 proposals

The most significant aspect of the Commission's proposals in 1964 was the establishment of ten ethnic areas, each to be administered by a separate authority, while one central administration was to care for the affairs of whites and so-called coloureds (people of mixed descent). The recommendations followed the South African apartheid policy of fostering ethnic identity and divisions, in part to counter the rise of black nationalism during the 1960s. In the Namibian context these aimed at consolidating each indigenous ethnic group in its own separate area, known as a homeland.

As a result of the Commission's proposals, many freehold farms were also reallocated for communal use. These farms, which had been considered unsuitable for commercial farming, were bought by the government and incorporated into the new homelands of Damaraland and Namaland. The area allocated for freehold farming was thus actually reduced to about 44% of the country.

Another major change implemented in response to the Odendaal Commission's proposals was the reduction in size of the Etosha National Park. The Park was previously part of a much larger nature reserve that stretched west to the coast.

Some areas continued to exist as communal areas after the 1964 report even though the Commission had recommended that they revert to government land. These included the Aminuis block, the Bondelzwarts area, Neuhof (west of Maltahöhe), Hoachanas (east of Kalkrand), Otjimbingwe (south of Karibib) and Ovitoto (east of Okahandja).

Land allocations based on the Odendaal Commission's proposals and the ethnic administrations remained in place until Namibia's independence in 1990. While the expansion of the area of land for freehold use by white farmers came to a halt by the 1960s, the process of allocating or claiming large, new farms *per se* did not end (see Figure 5.22).

5.14 Percentages of land allocations between 1902 and 2001[14]

The proportions given here were derived from the previous six maps, while those for 2001 were taken from the map of areas controlled by different bodies (Figure 5.22).

Most of Namibia was not clearly allocated in the early years of the twentieth century, and thus fell broadly under the control of the government. More and more land was then set aside for freehold farming and as recognised communal land. The substantial decline in communal land between 1902 and 1911 was due to the confiscation of land during the 1904–1908 war (see Figure 5.8 & 5.9). The increase in government or state land after the Odendaal Commission's 1964 report was largely the result of the establishment of several national parks and the purchase of many freehold farms for resettlement and other purposes.

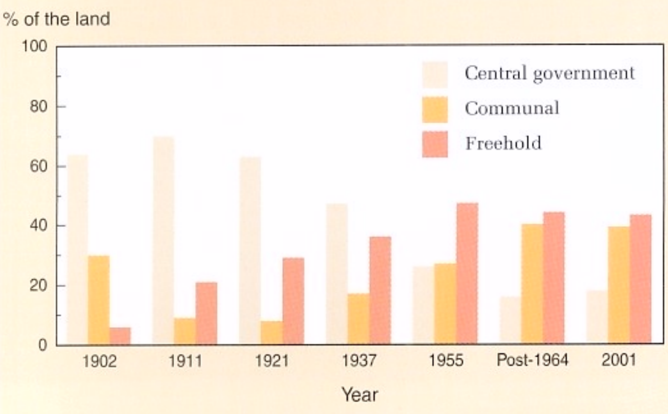
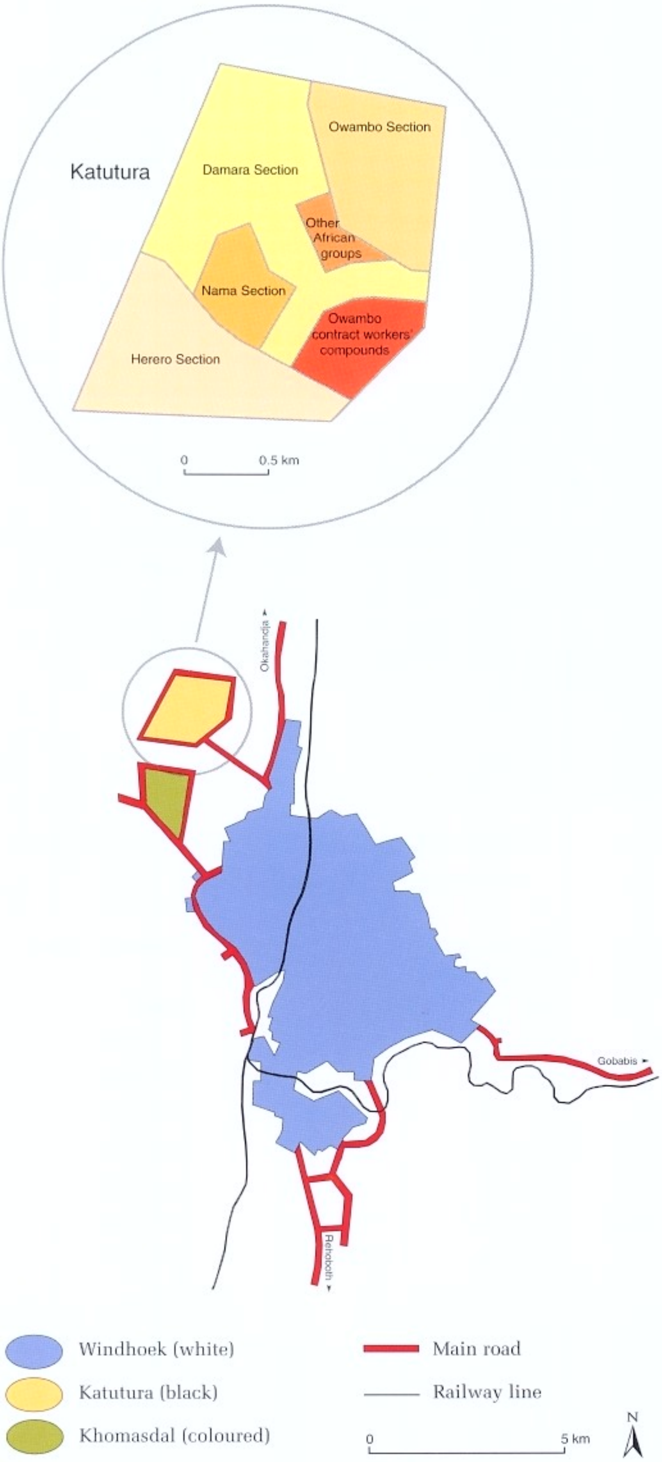


Table 5.2 Estimated areas of land allocations between 1902 and 2001[15]

Year	Government or state land (km²)	Recognised communal land (km²)	Freehold land (km²)
1902	526,800	249,100	48,100
1911	575,200	77,400	171,400
1921	515,300	67,100	241,600
1937	385,600	143,500	294,900
1955	219,100	221,400	383,500
Post-1964	128,800	332,500	362,700
2001	169,100	298,200	356,700

5.15 The segregation of people and land in urban areas

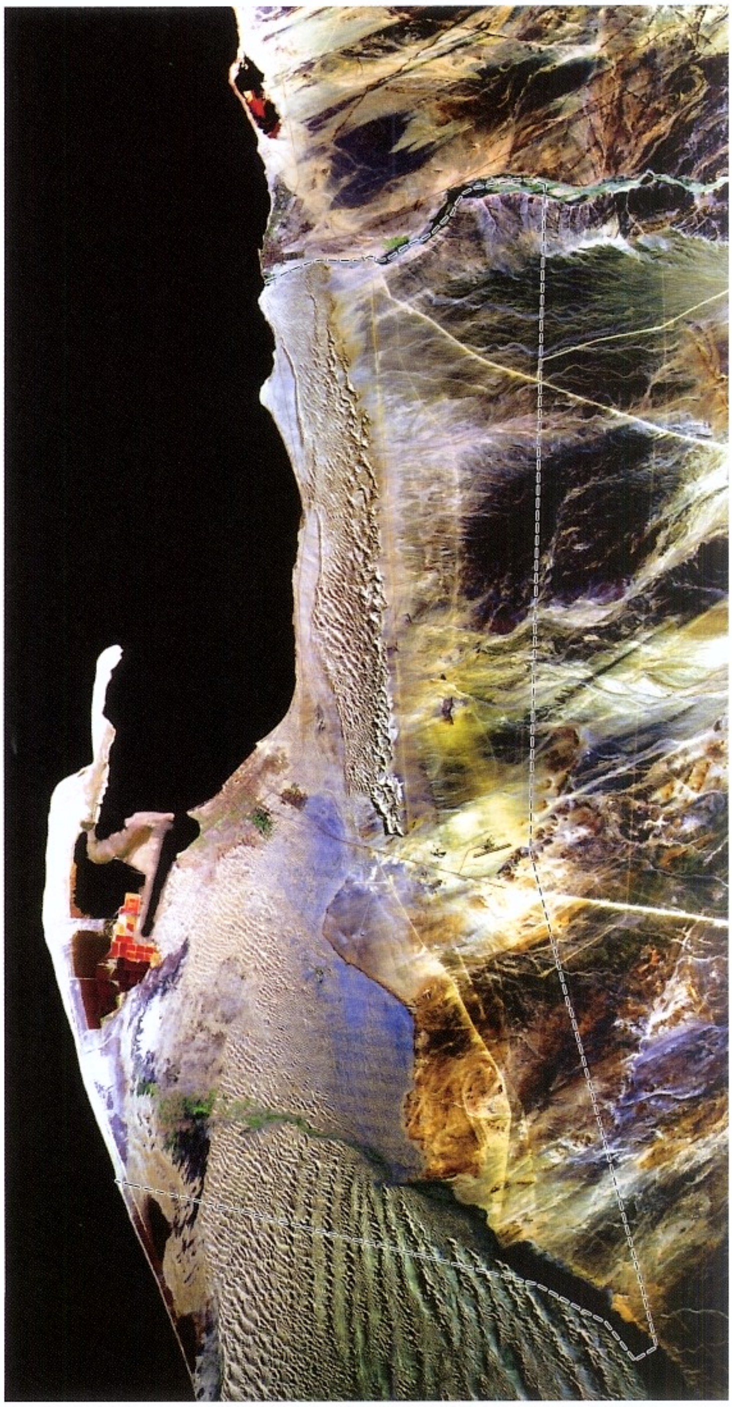
This sketch of residential land in Windhoek in the 1970s gives an example of how the policy of dividing the country along ethnic lines was instituted in many towns. Completely separate areas were allocated to white, coloured and black people. Those for coloureds and blacks were generally quite some distance from the main services and commercial areas in the centre of each town. Some black townships, such as Katutura, were also divided into blocks for separate language or tribal groups.



5.16 The history of Walvis Bay

As the most protected and natural harbour along the Namibian coast, Walvis Bay has long been prize property. The first to take possession of it were the Dutch authorities in the Cape in 1793. In 1884 Britain annexed the enclave and formally declared it part of the Cape Colony following the establishment of responsible self-government there in 1872. Walvis Bay thus remained in British hands in 1890 when Namibia was declared a German protectorate.

Ironically, Walvis Bay was the first piece of the country to be claimed by a colonial government, and the last to be returned to the people of Namibia. This was because Walvis Bay's incorporation into the Cape Colony at the time allowed successive governments in South Africa to continue to treat the harbour as their own territory and not as part of South West Africa or, even, independent Namibia. Only in 1994, after negotiations during the early 1990s, was Walvis Bay finally reintegrated into Namibia as part of its sovereign territory. The dotted line shows the border of the enclave.



Regional and local government

Namibia's Constitution makes provision for central, regional and local levels of government. The central government consists of the legislature or parliament (the National Assembly and National Council), the judiciary (Supreme, High and lower courts) and the executive (the President, Cabinet and 19 ministries).

At a regional level, there are 13 political regions, comprising 102 constituencies. These were first demarcated in 1993 for purposes of regional representation. Local governments or authorities are provided for by the proclamation of settled areas as municipalities, towns and villages.

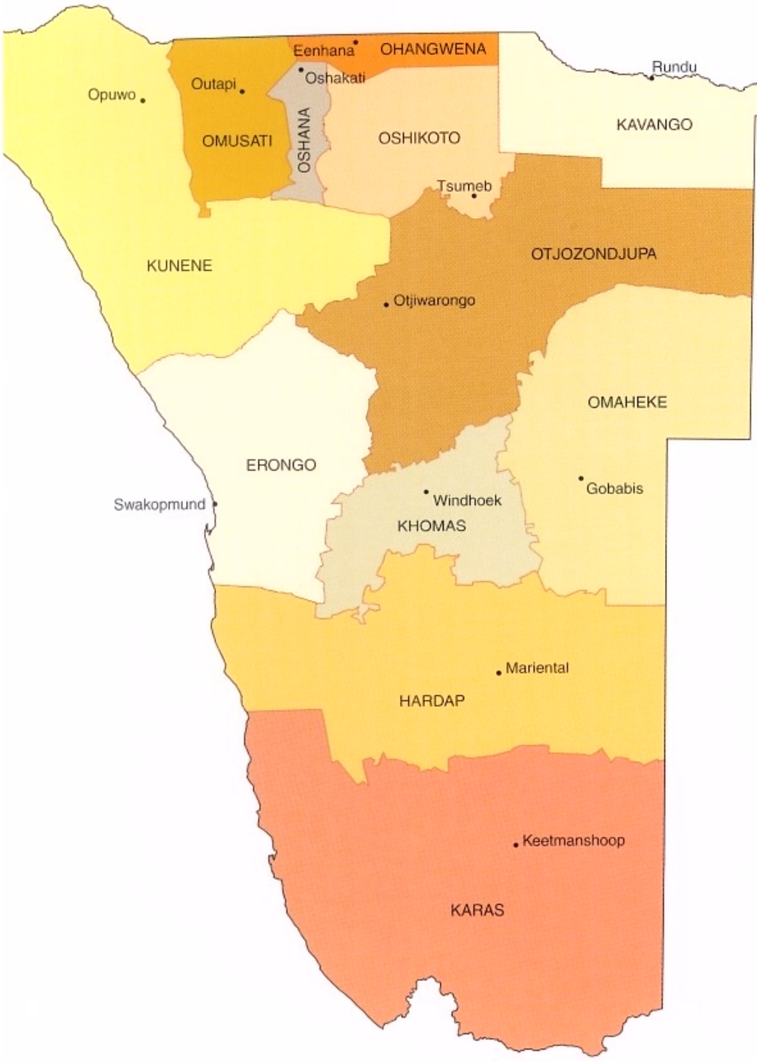
There are also long-established systems of traditional leadership or administration in communal areas. Although systems vary among the communities, most operate within some kind of hierarchical order. While ultimate power is vested in a king, chief or tribal council, the local representative is a headman or headwoman or a village committee. Traditional leaders are elected or may inherit a position of leadership from a family member. Certain traditional leaders are recognised in terms of the Traditional Authorities Act (No. 17 of 1995). The responsibilities of traditional leaders in relation to those of local or regional government are not always clear.

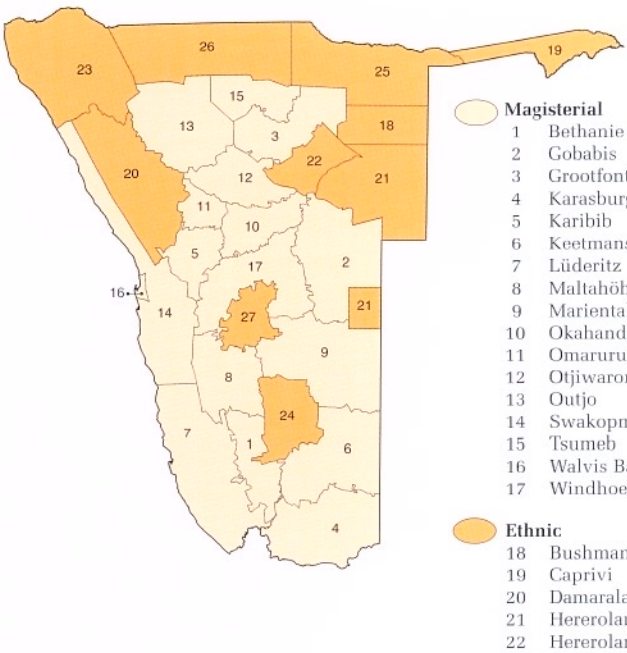
	Area (km²)
Caprivi	14,467
Erongo	63,586
Hardap	109,659
Karas	161,086
Kavango	48,483
Khomas	36,861
Kunene	115,154
Ohangwena	10,694
Omaheke	84,440
Omusati	26,558
Oshana	8,682
Oshikoto	38,669
Otjozondjupa	105,334

5.17 Regional government areas

Namibia is divided into 13 political regions. Each is headed by a Regional Governor, who chairs a Regional Council comprising the region's Councillors (see Figure 5.18). Each region also has administrative offices in the towns shown on the map.

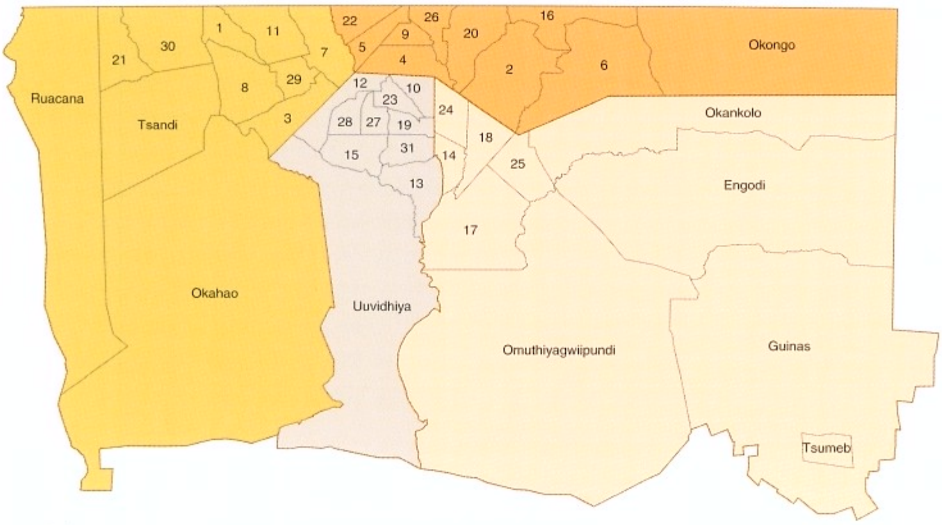
The boundaries given here were delimited in 1998. Some of these were adjusted from an earlier set of delimitations proclaimed in 1993, which had replaced the longstanding magisterial and homeland areas that were in existence before independence (as shown in the small map below; see also Figure 5.13). Magisterial districts are judicial areas (see Figure 6.35).





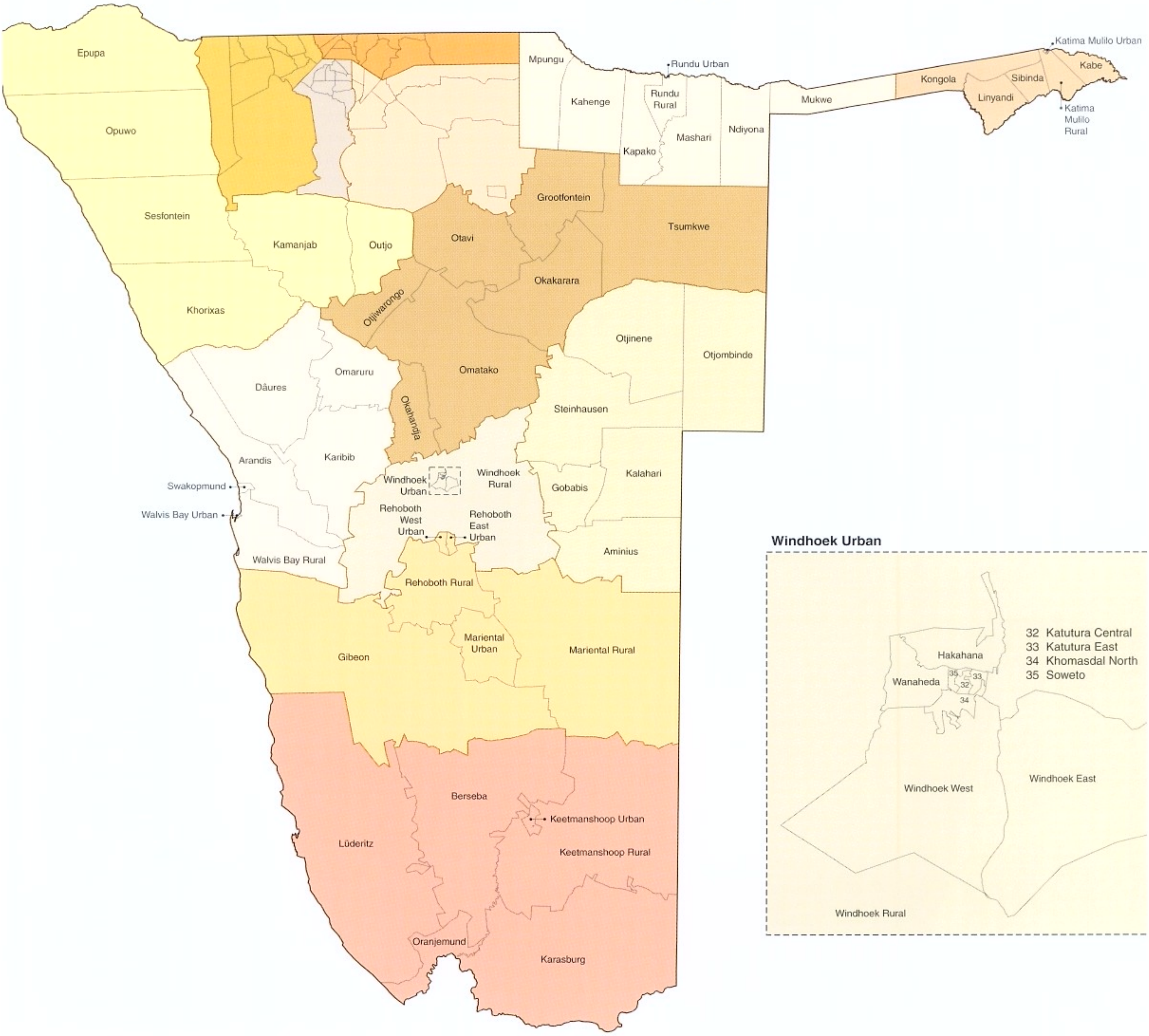
Magisterial
1 Bethanie
2 Gobabis
3 Grootfontein
4 Karasburg
5 Karibib
6 Keetmanshoop
7 Lüderitz
8 Maltahöhe
9 Mariental
10 Okahandja
11 Omaruru
12 Otjiwarongo
13 Outjo
14 Swakopmund
15 Tsumeb
16 Walvis Bay
17 Windhoek

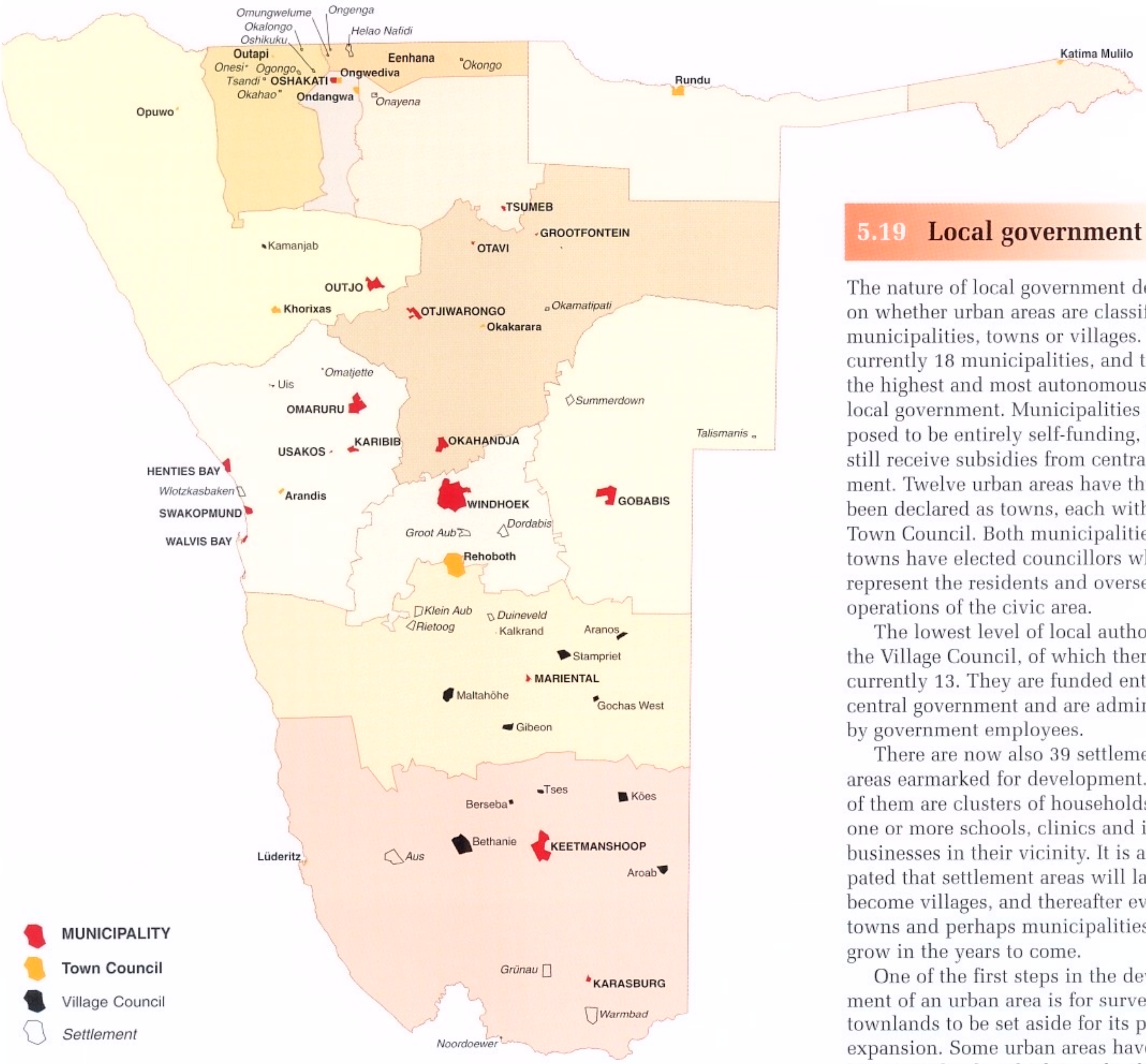
Ethnic
18 Bushmanland
19 Caprivi
20 Damaraland
21 Hereroland East
22 Hereroland West
23 Kaokoland
24 Namaland
25 Kavango
26 Owamboland
27 Rehoboth



5.18 Constituencies

The 13 political regions shown in the previous map are divided into 102 constituencies. An elected Regional Councillor represents each constituency on the Regional Council. Regional Councillors are responsible for the overall well-being of their constituents and should play a role in planning and promoting the development of their constituencies. Two Regional Councillors from each region also serve on the National Council, the second house of parliament in Windhoek. The National Council thus consists of 26 members. All legislation has to be approved by both the National Council and the National Assembly, which consists of 72 elected and 6 appointed members.





5.19 Local government areas[16]

The nature of local government depends on whether urban areas are classified as municipalities, towns or villages. There are currently 18 municipalities, and these are the highest and most autonomous forms of local government. Municipalities are supposed to be entirely self-funding, but they still receive subsidies from central government. Twelve urban areas have thus far been declared as towns, each with its own Town Council. Both municipalities and towns have elected councillors who represent the residents and oversee the operations of the civic area.

The lowest level of local authority is the Village Council, of which there are currently 13. They are funded entirely by central government and are administered by government employees.

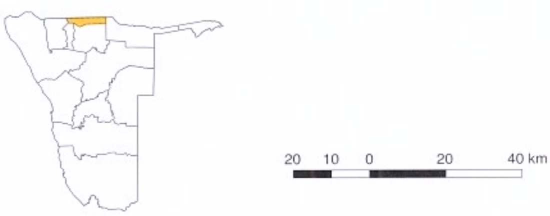
There are now also 39 settlement areas earmarked for development. Many of them are clusters of households with one or more schools, clinics and informal businesses in their vicinity. It is anticipated that settlement areas will later become villages, and thereafter evolve into towns and perhaps municipalities as they grow in the years to come.

One of the first steps in the development of an urban area is for surveyed townlands to be set aside for its potential expansion. Some urban areas have very large townlands, which are clearly visible on the maps of land ownership (see Figure 5.21).

5.20 Traditional authorities

Various systems of traditional leadership exist in the communal areas, where they play an important role in the allocation of land and grazing, and in settling disputes. This map gives an example of how areas are apportioned among the headmen in Ohangwena. The position of each headman's home was mapped so that the approximate area under his jurisdiction could be estimated.[17] On average, there were about 44 households and 360 people in each headman's area.

In the example of Ohangwena, there are three additional levels of leadership above headmen: senior headmen, a traditional council and a king. Senior headmen are responsible for districts within each communal area.



Ownership, control and use of land

The next three maps show how land is divided into different categories of ownership, control and use. Each piece of Namibia's surface area (about 823,680 km^2 in total) is owned privately or by a recognised authority, the ownership being legally registered in title deeds or legislation. The control of land is generally in the hands of the landowners, who determine what uses the land is put to and who has access to it. Control over much government-owned land is, however, vested directly or indirectly in someone else. Land is used for many different purposes, and most uses are related to ownership: commercial farmers use their land for farming, for example. But land is also used in ways that seem unrelated to what was intended by the owner or controlling authority.

After independence, Namibia chose to maintain the division of the country into communal and freehold areas, with quite different forms of tenure for the two land types. Freehold land may be bought and sold, and the owners hold full title to their land. Issues of ownership, control and use are quite clear on freehold land, therefore. This is not the case with communal land, where there is such a great mix of uses and levels of control that the term 'communal' is often inappropriate. There is also a good deal of commercial farming activity on communal land. Many communal farmers sell part of their produce and some of them have become wealthy by selling large numbers of cattle and goats. All the same, 'communal' is a fitting and valuable word because it emphasises that the land is intended for communal use, especially in providing resources for poor people who are unable to buy freehold land.

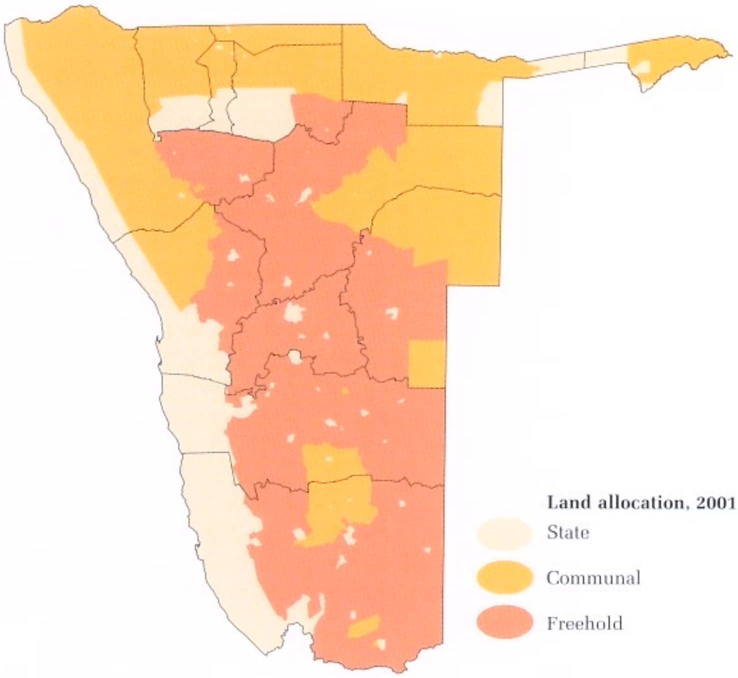
Communal areas are formally owned by the government: the land may be used – but not owned – by people living there. Much of this land is indeed communal in that people share access to common property resources in open areas. But the total area that is, by contrast, exclusive is also very large, consisting of thousands of small fenced farms around rural homes and the many farms, much larger in size, allocated for the exclusive use of certain people. Small areas of communal land may be allocated for special purposes by way of a permit, often called 'permission to occupy' (PTO). A variety of people and bodies exert control over communal land, ranging from individual families and farmers, traditional authorities, and regional and central government institutions.

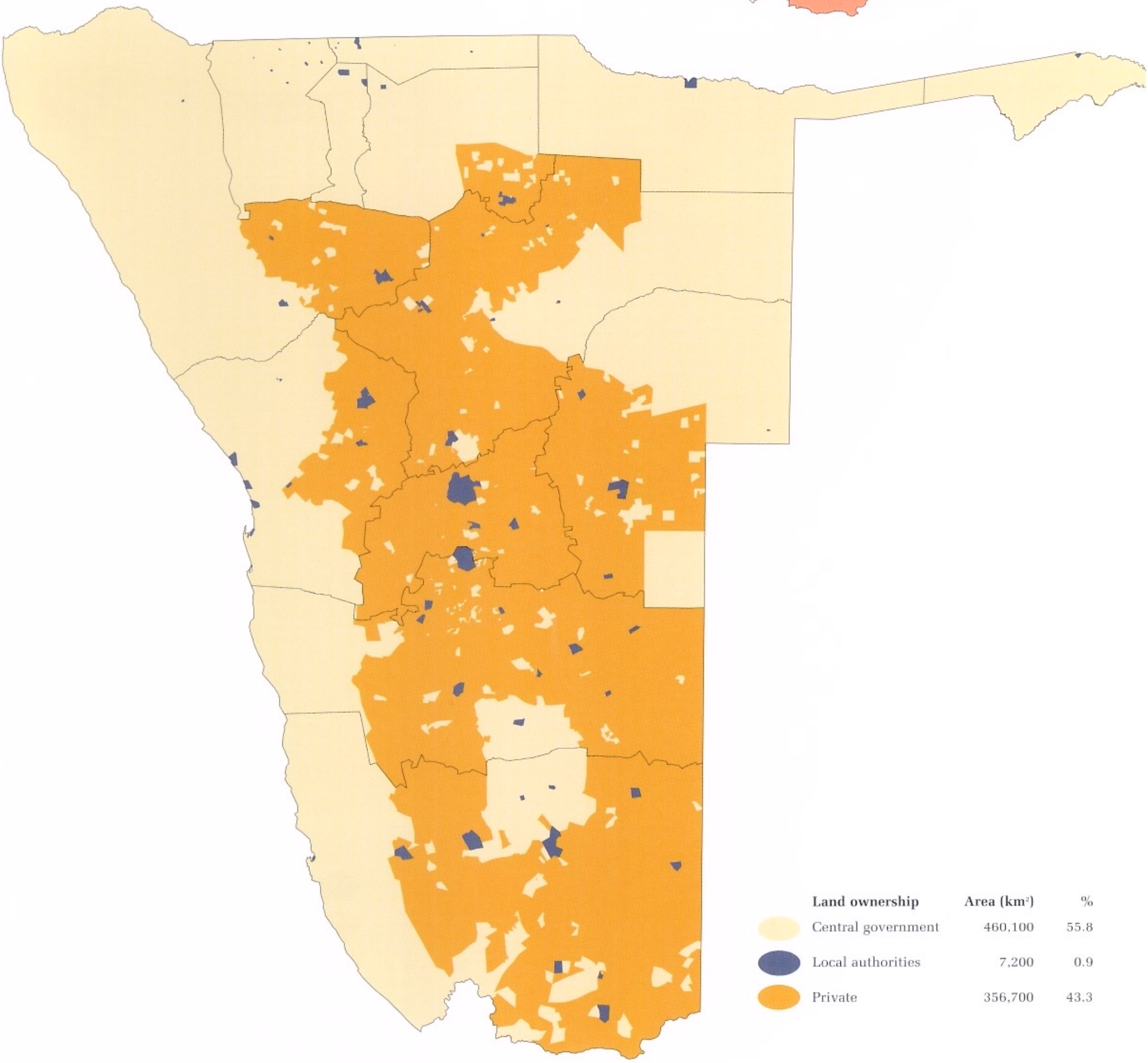
Water in shallow wells and comparatively fertile soils attracted people to settle here in central northern Namibia hundreds of years ago. The area now has a very dense population of people living on small-holdings, such as the ones shown here.

5.21 Land ownership

There are three major categories of landowners: central government (which owns 56% of the land surface area), local authorities (which own 0.9%), and private individuals or companies (who own the remaining 43.3%). Approximately 28% of the people or companies who owned private farms in 1992 had more than one farm.[18] The many small pockets of central government land comprise largely farms used for resettlement, agriculture and other purposes (see Figure 5.23). The smaller map alongside shows land owned by the government but declared as communal land, which makes up 37% of the total area of Namibia.

The popular idea that all farms were allocated to whites prior to independence in 1990 is not true. Hundreds of farms in the Rehoboth area were claimed for the exclusive use of Rehoboth Baster farmers in 1895.[19] As part of an attempt to encourage commercial farming, many black farmers were allocated large farms in the communal areas between the 1960s and 1980s, as shown in Figure 5.22.





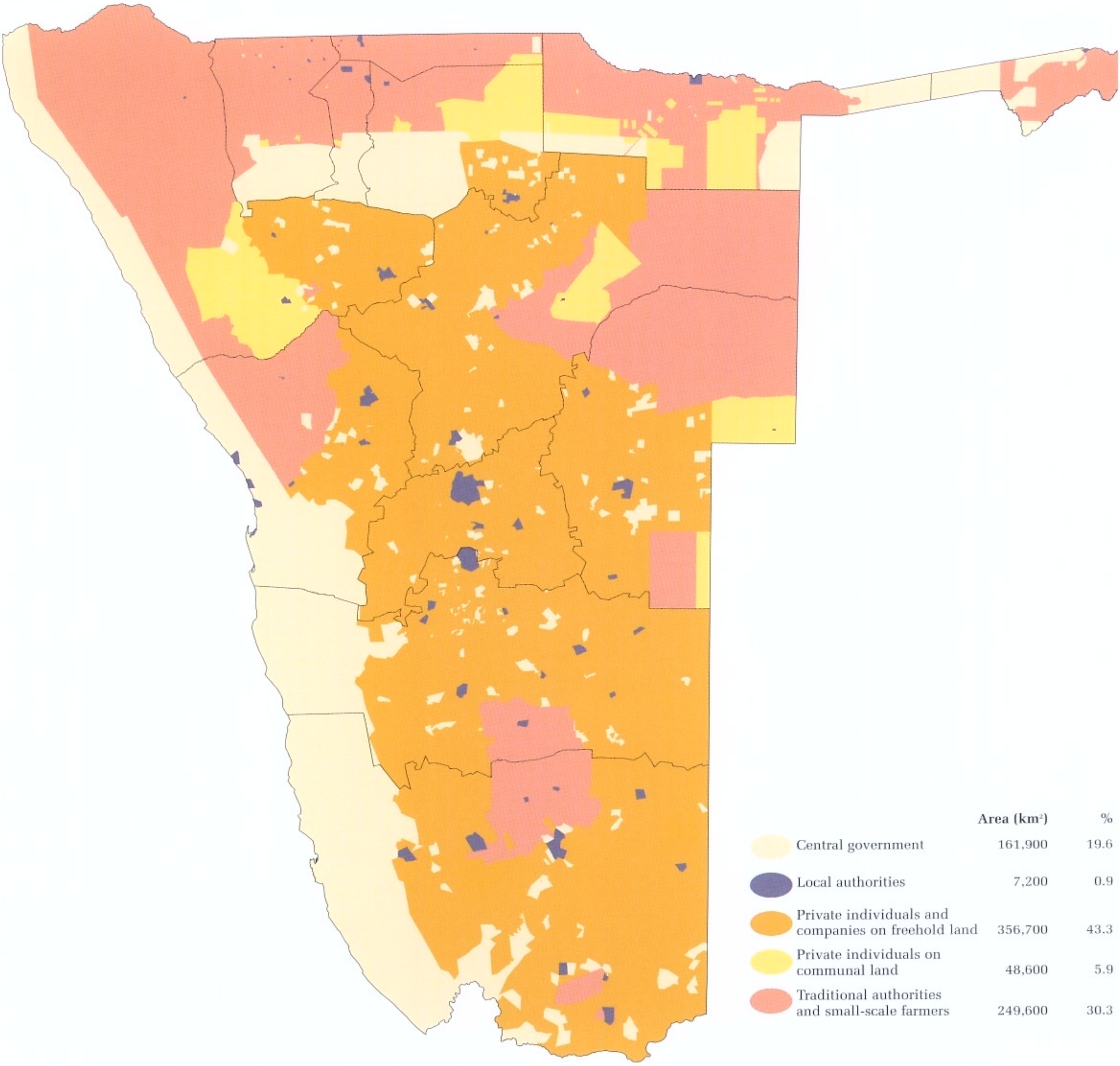
Land ownership	Area (km²)	%
Central government	460,100	55.8
Local authorities	7,200	0.9
Private	356,700	43.3

5.22 Control over land

Generally, the owners of freehold and urban land also have control over it, but land that is formally state-owned is controlled in a variety of ways. The government, through its ministries and parastatal bodies, directly manages the national parks as well as resettlement, agriculture, and other farms. The 13 regional authorities (see Figure 5.17) also exercise a certain degree of control over areas under their jurisdiction, and they are expected to play an increasingly important role in administering communal areas once the central government devolves more of its functions to them. Traditional authorities play varied roles in controlling access to land in communal areas, and communal farmers themselves have control over their individual farmlands.

The large areas of farmland shown as being controlled by 'private individuals on communal land' were established in two ways. Firstly, the previous government allocated or leased to individual farmers several hundred farms in five blocks during the 1960s, 1970s and 1980s.[20] Secondly, and more recently, private individuals have acquired many large farms by way of allocations made to them by traditional councils, or by claiming or acquiring the land informally. Some of the large farms in communal areas are indeed farmed actively and commercially, but others serve more as private ranches and investments. Most owners of these large farms are relatively wealthy and prominent people. What is significant is that the large farms limit free access to grazing, water and other natural resources in communal areas, which are meant to provide resources and a safety net for the rural poor.

The extent of this new kind of land acquisition, often known as 'illegal fencing', is substantial, and perhaps about 10% of Namibia is now held by individuals with large farms in communal areas. About a quarter of the area in what was previously the 'homeland' of Owamboland has been fenced off into large farms. There are also many other fenced farms that have not been mapped and are not shown here, especially in eastern Otjozondjupa and the Aminuis area.



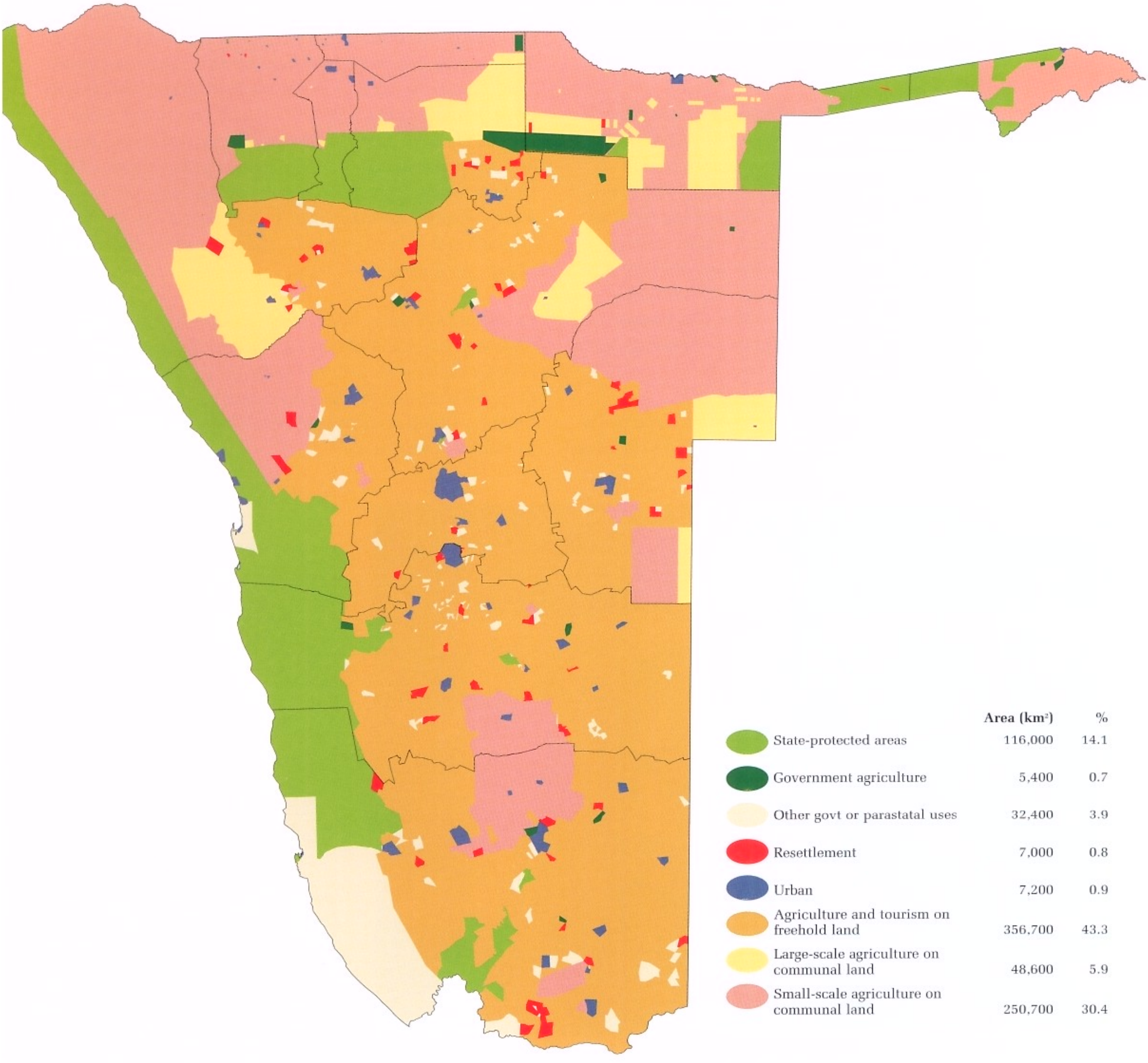
	Area (km^2)	%
Central government	161,900	19.6
Local authorities	7,200	0.9
Private individuals and companies on freehold land	356,700	43.3
Private individuals on communal land	48,600	5.9
Traditional authorities and small-scale farmers	249,600	30.3

5.23 Land uses

The predominant use of land in Namibia is agricultural. Farming is the main activity in most areas shown on the map as 'agriculture and tourism on freehold land' and 'small-scale agriculture on communal land'. Significant areas of these zones are also used for tourism and mining, while others are not really used for any particular purpose.

State-protected areas make up 14.1% of the country. Resettlement farms, which make up 0.8% of the country, consist of both farms purchased since independence for this purpose and farms that were acquired by the government long ago. Most resettlement farms were freehold farms, but there are also several such farms in the communal areas. Resettlement farms are usually divided into units, each unit theoretically being allocated to a family. The size of the units varies according to the capacity of the land to support livestock: units in the south are larger than in the northern areas where greater numbers of livestock can be supported per hectare. A further 0.7% of the land consists of farmlands that are government-owned and used to quarantine animals or for agricultural research.

The new wave of acquisition of exclusive large-scale farms on communal land represents the continuation of a long process that started late in the 19th century (see Figures 5.8–5.13). It was begun by German settlers, was continued by mainly South African immigrants, and has now been adopted by Namibians.



	Area (km²)	%
State-protected areas	116,000	14.1
Government agriculture	5,400	0.7
Other govt or parastatal uses	32,400	3.9
Resettlement	7,000	0.8
Urban	7,200	0.9
Agriculture and tourism on freehold land	356,700	43.3
Large-scale agriculture on communal land	48,600	5.9
Small-scale agriculture on communal land	250,700	30.4

Farming

Much of Namibia is used for farming (see Figure 5.23), largely for livestock and crop farming. About 71% of all Namibians live in rural areas where, to a greater or lesser degree, they practise subsistence farming. The majority of communal farms consist of small fields of mahangu (pearl millet), sorghum or maize, and herds of cattle and goats. In contrast with commercial agriculture, which aims simply to maximise production for sale, farm products in communal areas are used for a variety of purposes. Harvests may be consumed at home or sold at local markets; moreover, some of the harvest in good years will be stored for possible use in years when food is in short supply. Sorghum is grown in many areas to produce beer, while livestock are kept for more diverse reasons: as capital investments, for use as draught power, for meat and milk production, for social security and other cultural reasons, and for sale commercially.

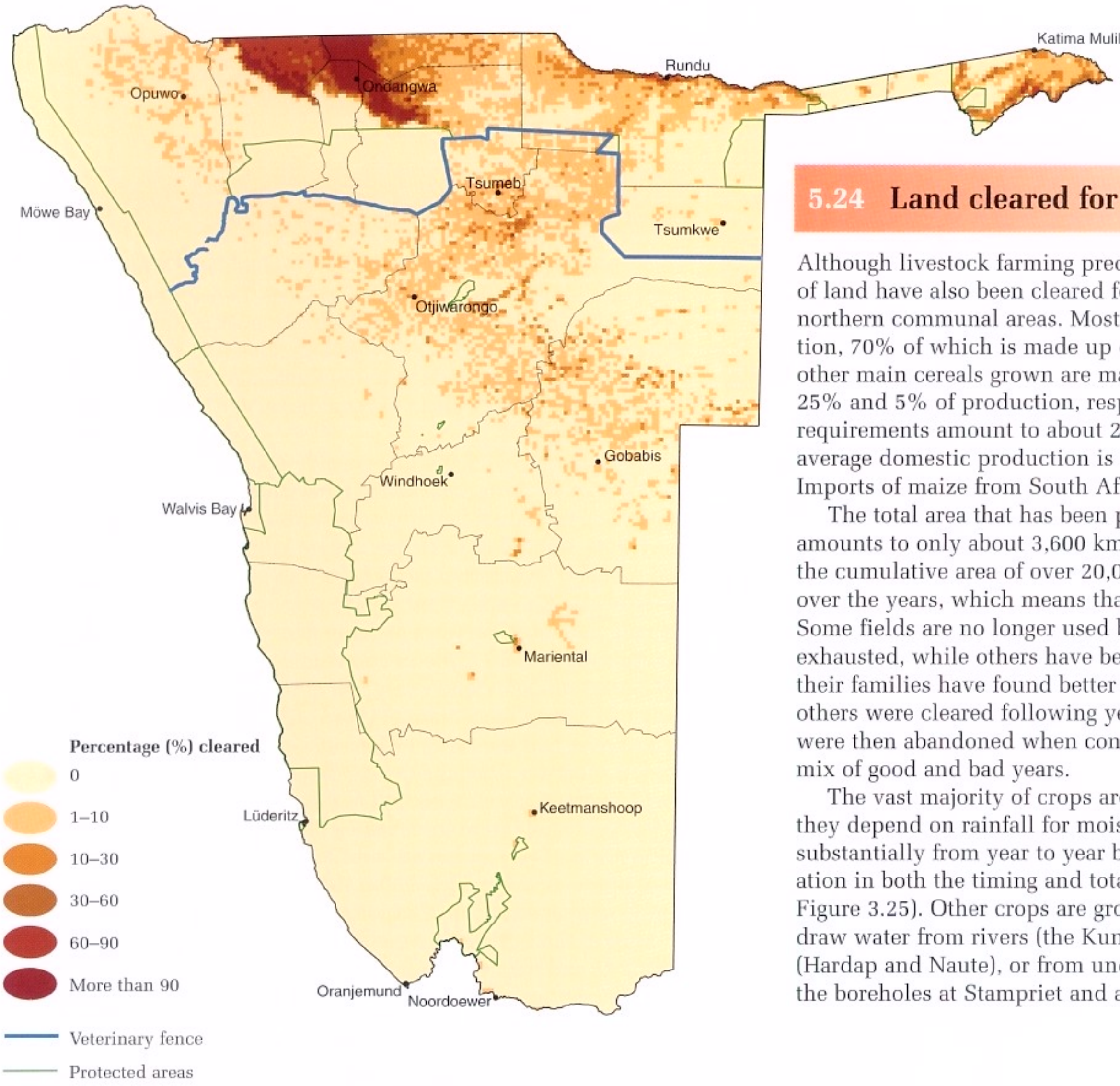
Communal farming is often characterised as 'low input – low output'. For example, relatively few inputs of equipment, fertilisers and high-yielding crop varieties and livestock breeds are used, and yields are generally low as a result. Labour is often the biggest input, in the form of ploughing, weeding and harvesting crops, and tending herds of animals. Many communal farming activities are adapted to the semi-arid environment in which they occur. Farming strategies have also evolved as measures to counter the terrible famines that have occurred in some areas during the past two centuries.

Commercial farming is dominated by livestock, especially cattle and sheep. Most of these animals are used to produce meat for the Namibian market and for export to South Africa and the European Union. Stocking rates (numbers of animals kept per unit area) are generally lower than in communal areas, and the majority of farms are big ranches, the animals grazing extensively and rotationally in large, fenced camps. Most of the limited area used for commercial rain-fed crop cultivation is in the Tsumeb–Otavi–Grootfontein triangle, where maize is the predominant crop. Small irrigation schemes elsewhere in the country are used to produce maize, wheat, vegetables and various fruits.

Livestock populations in communal and freehold farming areas have changed in substantial and opposite ways in recent years. On freehold farms, the number of cattle and goats dropped by between 20 and 25% between 1988 and 2000, while sheep bred for meat (lamb and mutton) declined by over 40% between the late 1980s and 2000. The number of karakul sheep totalled around 195,000 in 2000, being less than 10% of what it was in the early 1960s. These declines occurred throughout the country and are generally attributable to decreasing returns from livestock farming, poor rainfall, and perhaps increasing levels of bush encroachment (see Figure 4.11). Exports of animals and animal products make up 17% of Namibia's export production.

In communal areas, by contrast, cattle numbers almost doubled between 1988 and 2000, and the number of goats rose by about 40% over the same period. Much of this increase is due to the increased availability of surplus income, which could be invested in larger herds, usually as capital investments.

Farming is an important activity for many Namibians, and it dominates much of the day-to-day lives of poorer households. Having enough labour to plant, weed and harvest at exactly the right time in the season is often a major problem for such people.



5.24 Land cleared for cultivation [21]

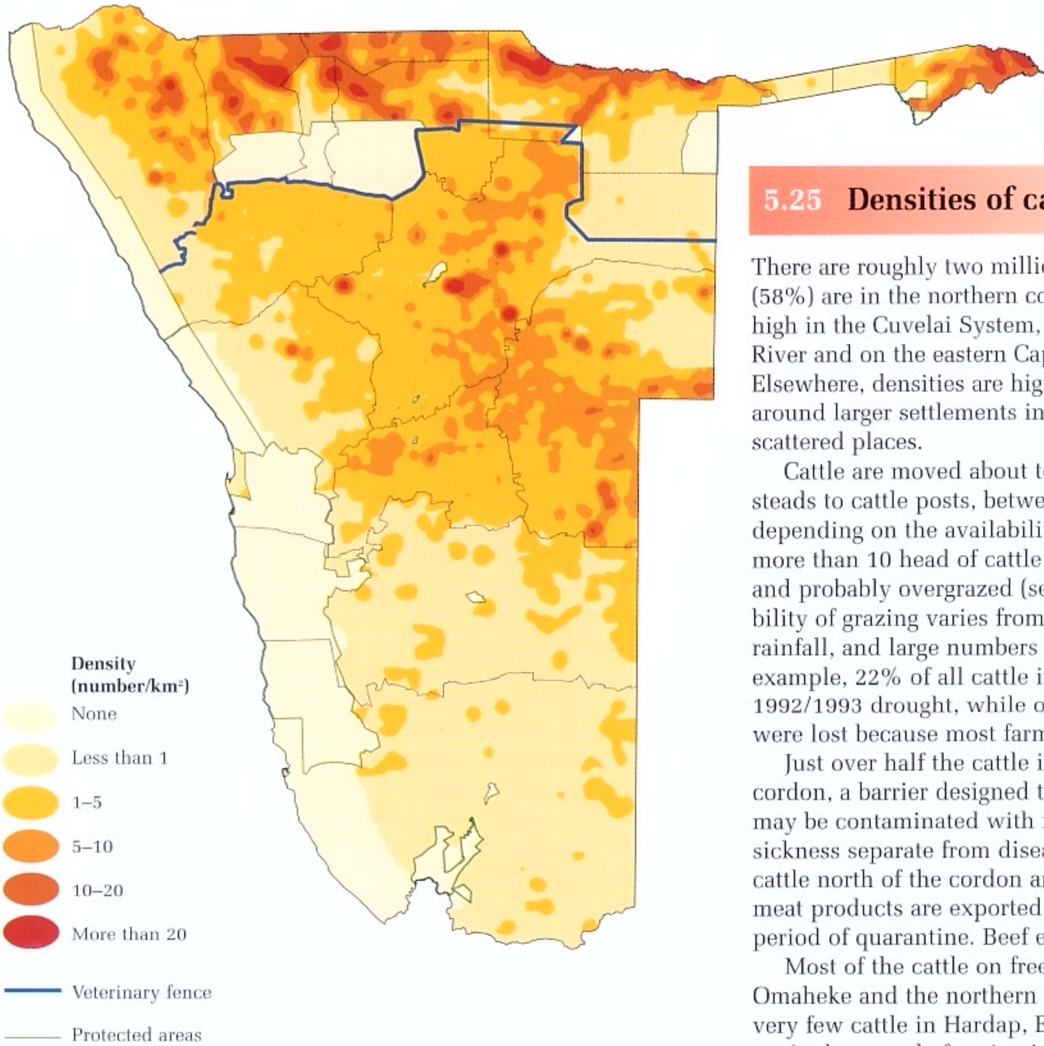
Although livestock farming predominates in most areas, large tracts of land have also been cleared for crop farming, especially in the northern communal areas. Most fields are used for cereal production, 70% of which is made up of mahangu and sorghum. The other main cereals grown are maize and wheat, which make up 25% and 5% of production, respectively. Namibia's total cereal requirements amount to about 270,000 tonnes per year, while average domestic production is seldom more than 150,000 tonnes. Imports of maize from South Africa make up most of the shortfall.

The total area that has been planted in the last few years amounts to only about 3,600 km^2. This is almost six times less than the cumulative area of over 20,000 km^2 cleared for crop production over the years, which means that most fields now lie abandoned. Some fields are no longer used because soil nutrients have been exhausted, while others have been deserted because farmers and their families have found better sources of income and food. Still others were cleared following years of unusually high rainfall but were then abandoned when conditions reverted to the more normal mix of good and bad years.

The vast majority of crops are grown on dryland fields where they depend on rainfall for moisture. Cereal production varies substantially from year to year because of the high degree of variation in both the timing and total amount of rain that falls (see Figure 3.25). Other crops are grown on irrigation schemes, which draw water from rivers (the Kunene, Okavango and Orange), dams (Hardap and Naute), or from underground sources (for example, the boreholes at Stampriet and artesian springs at Sesfontein).

Table 5.3 Areas cleared for cultivation and estimated numbers of livestock in Namibia in 2000 [22]

Region	Area cleared for crops (km^2)	No. of goats	No. of donkeys	No. of cattle	No. of karakul sheep	No. of Dorper sheep
Caprivi	1,320	6,800	100	110,200	0	100
Erongo	10	110,600	4,900	35,200	1,500	48,900
Hardap	40	151,600	3,400	36,900	50,800	565,400
Karas	20	189,500	3,100	23,700	101,800	651,900
Kavango	1,920	160,600	700	199,500	0	900
Khomas	40	42,900	2,100	124,400	8,900	111,000
Kunene	150	547,400	11,800	255,200	17,900	116,000
Ohangwena	3,250	228,900	9,000	111,500	0	8,100
Omaheke	710	110,100	6,000	340,400	11,500	221,900
Omusati	5,630	269,100	66,100	180,500	0	10,000
Oshana	1,880	102,300	16,800	30,200	100	4,700
Oshikoto	3,910	207,400	15,300	165,100	1,000	13,600
Otjozondjupa	1,350	96,500	4,000	382,200	1,100	104,200
North of veterinary cordon fence	17,900	1,446,500	116,900	1,007,600	800	110,000
South of veterinary cordon fence	2,330	777,200	26,300	987,400	193,800	1,746,700
Freehold farms	1,750	609,800	19,900	837,200	170,800	1,651,600
Communal areas	18,480	1,613,900	123,400	1,157,800	23,700	205,100
TOTAL	20,230	2,223,700	143,300	1,995,000	194,500	1,856,700



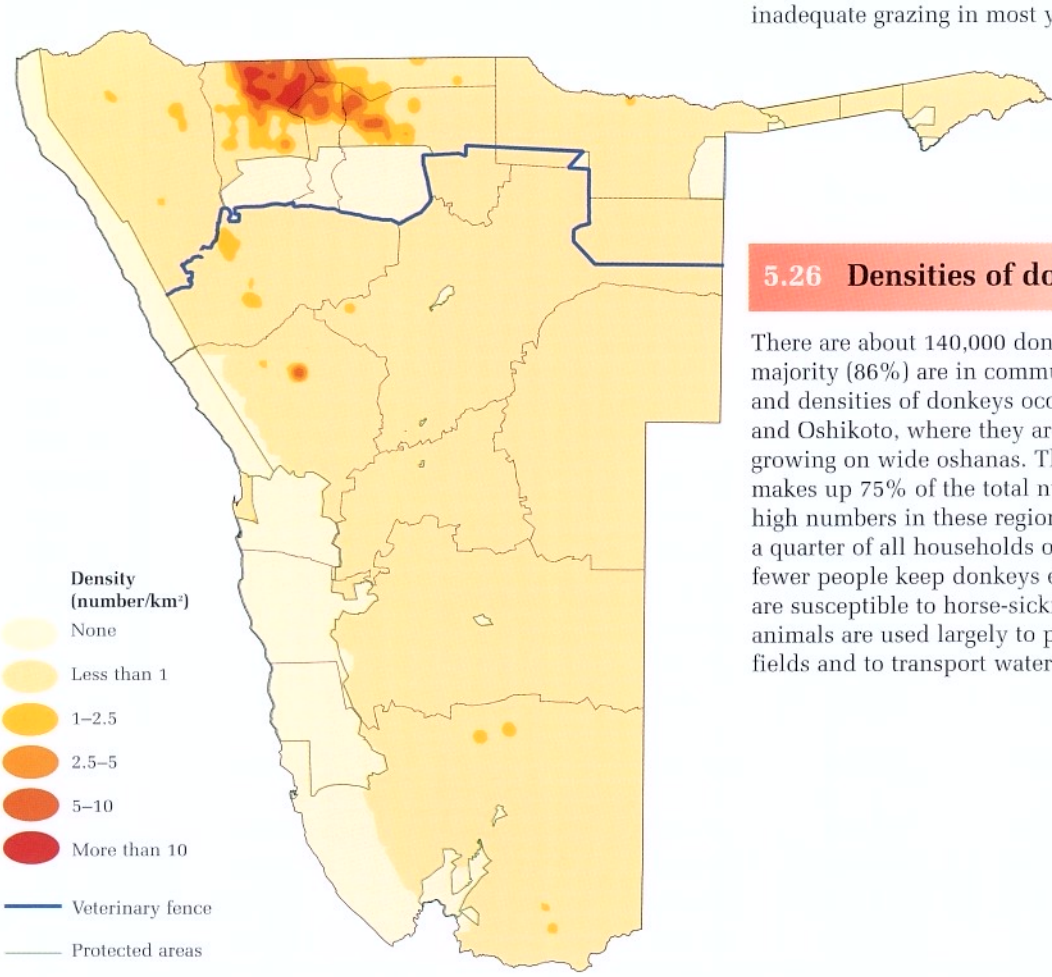
5.25 Densities of cattle [23]

There are roughly two million cattle in Namibia, of which over half (58%) are in the northern communal areas. Densities are particularly high in the Cuvelai System, along certain areas of the Okavango River and on the eastern Caprivi Floodplains (see Figure 1.4). Elsewhere, densities are high in the Rietfontein and Aminuis areas, around larger settlements in Otjozondjupa, and in various other, scattered places.

Cattle are moved about to a considerable extent, from homesteads to cattle posts, between grazing camps or from farm to farm, depending on the availability of pastures. However, any area with more than 10 head of cattle per square kilometre is heavily stocked and probably overgrazed (see Figure 5.29). Moreover, the availability of grazing varies from year to year in accordance with rainfall, and large numbers of cattle may die in drier years. For example, 22% of all cattle in communal areas died during the 1992/1993 drought, while only 2% of cattle on freehold farms were lost because most farmers sold off part of their herds.

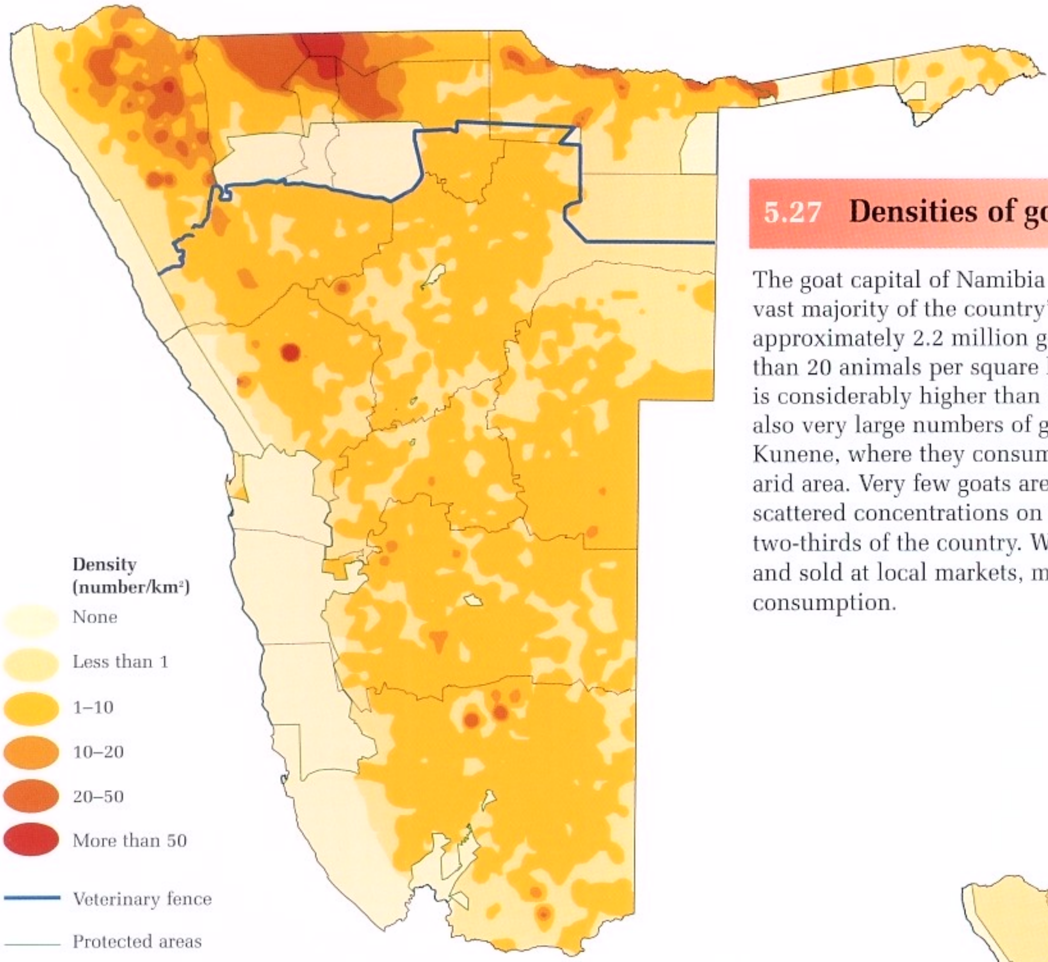
Just over half the cattle in Namibia are north of the veterinary cordon, a barrier designed to keep livestock and large game that may be contaminated with foot-and-mouth disease and lung-sickness separate from disease-free herds to the south.[24] Many cattle north of the cordon are sold for local consumption and some meat products are exported after the animals have been through a period of quarantine. Beef exports earned N$750 million in 1999.

Most of the cattle on freehold farms are in Otjozondjupa and Omaheke and the northern half of the Khomas Region. There are very few cattle in Hardap, Erongo and Karas (see Table 5.3 on page 147) where cattle farming is too risky because of low rainfall and inadequate grazing in most years.



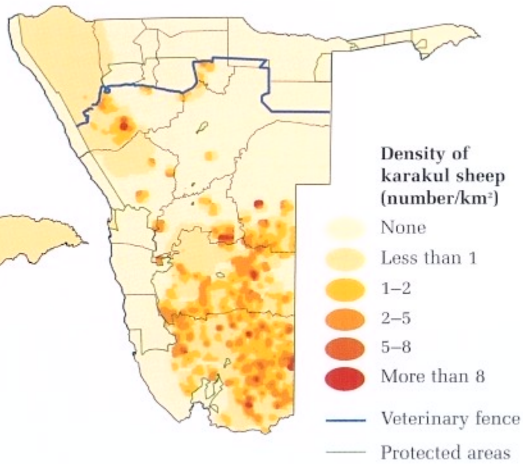
5.26 Densities of donkeys

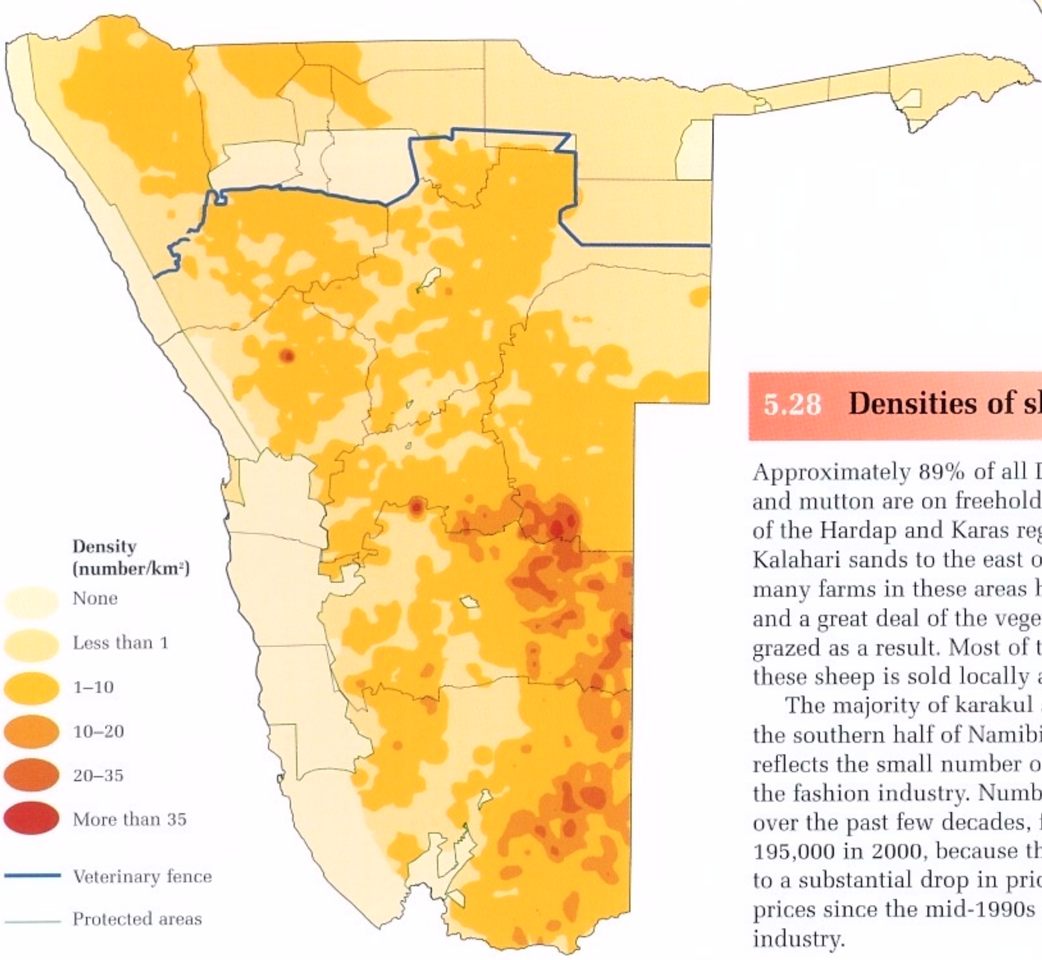
There are about 140,000 donkeys in Namibia, of which the great majority (86%) are in communal areas. By far the greatest numbers and densities of donkeys occur in Ohangwena, Omusati, Oshana and Oshikoto, where they are most abundant in open grasslands growing on wide oshanas. The population in these four regions makes up 75% of the total number of donkeys in Namibia. The high numbers in these regions are attributable to the fact that about a quarter of all households own two or three donkeys, whereas far fewer people keep donkeys elsewhere. Also, donkeys and horses are susceptible to horse-sickness in north-eastern Namibia. The animals are used largely to provide draught power to plough fields and to transport water containers.



5.27 Densities of goats

The goat capital of Namibia is in the Cuvelai System where the vast majority of the country's goats live, making up about 36% of approximately 2.2 million goats in Namibia. The density of more than 20 animals per square kilometre in and around the oshanas is considerably higher than in any other extensive area. There are also very large numbers of goats along the Okavango River and in Kunene, where they consume a good deal of the plant life in this arid area. Very few goats are kept in Caprivi, and there are only scattered concentrations on certain farms in the remaining southern two-thirds of the country. While some goats are slaughtered and sold at local markets, most goats are kept for domestic consumption.





5.28 Densities of sheep bred for meat

Approximately 89% of all Dorper and other sheep bred for lamb and mutton are on freehold farms, especially in the eastern areas of the Hardap and Karas regions, where they are concentrated on Kalahari sands to the east of the Weissrand Plateau. Densities on many farms in these areas have been very high over many years, and a great deal of the vegetation has reportedly been badly overgrazed as a result. Most of the lamb and mutton produced from these sheep is sold locally and to South Africa.

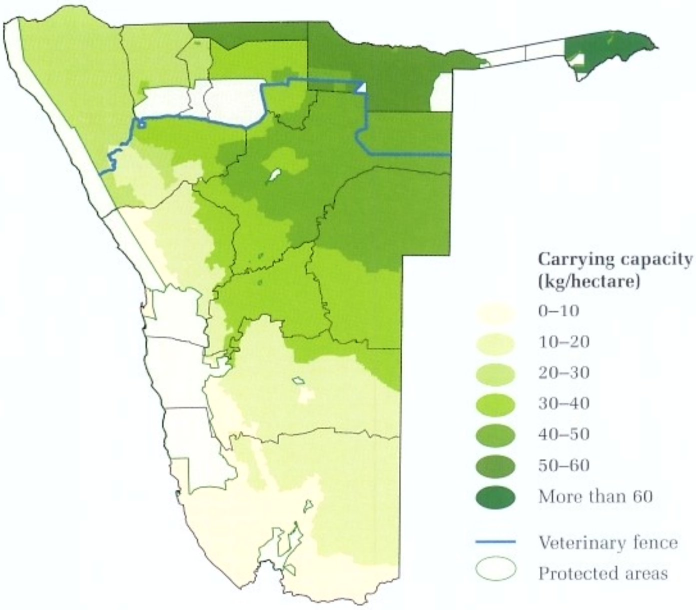
The majority of karakul sheep (see the small map above) are in the southern half of Namibia, where their scattered distribution reflects the small number of farmers who produce karakul pelts for the fashion industry. Numbers of karakul have declined drastically over the past few decades, from almost 3 million in 1974 to about 195,000 in 2000, because the reduced demand for karakul pelts led to a substantial drop in prices offered abroad. A slight increase in prices since the mid-1990s may lead to an upswing in the karakul industry.

5.29 Livestock densities and carrying capacity[25]

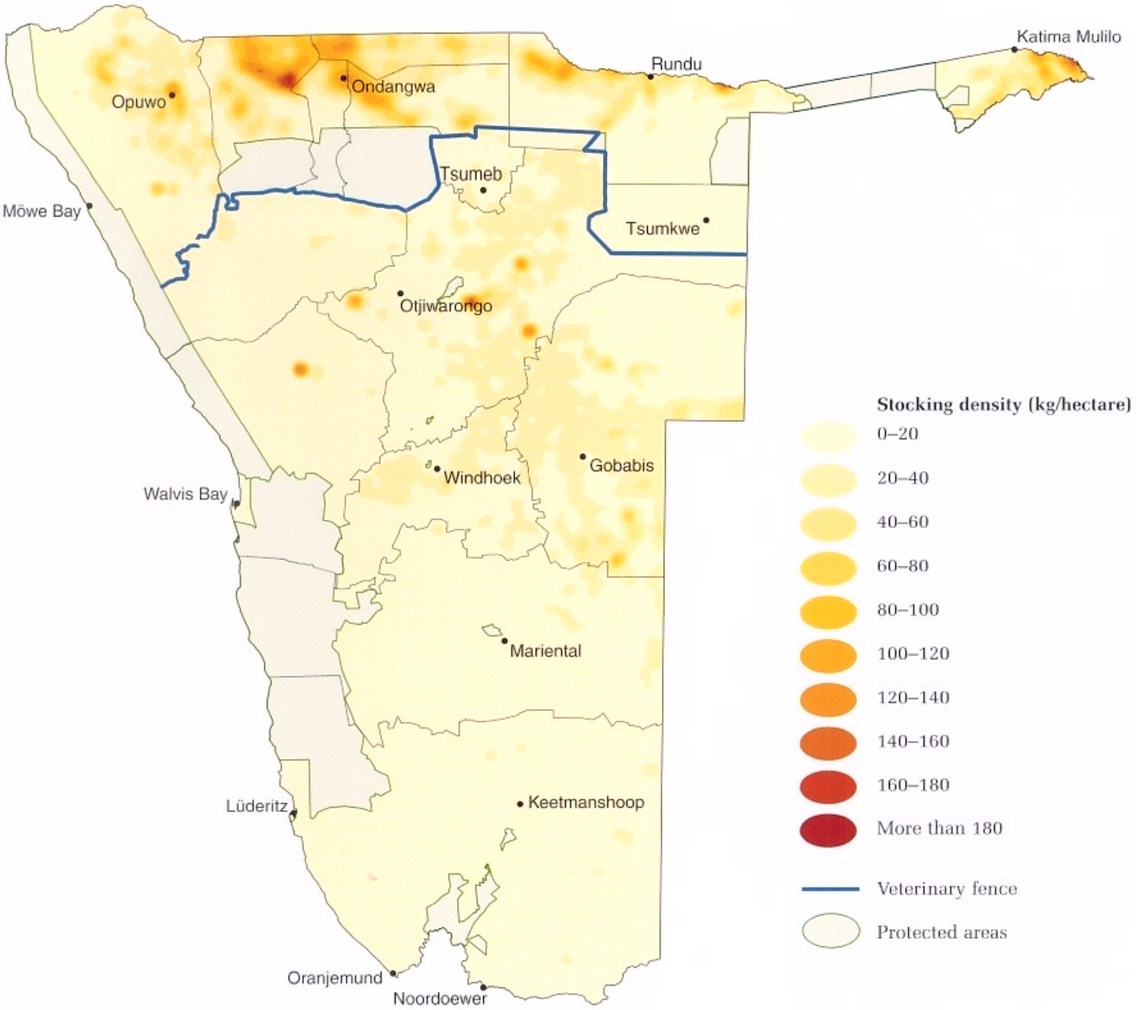
Densities of livestock shown in the previous maps have been combined to give the overall stocking rate shown in this series. The first map provides an estimate of carrying capacity – a measure of the maximum biomass of livestock that can be supported on a long-term, sustainable basis by the available grazing and browse. Both carrying capacity and livestock density use the number of kilograms of livestock per hectare. The third map compares actual and potential stocking rates to see what areas of the country are overstocked or understocked or where stocking rates are reasonably balanced. Natural pastures are likely to be damaged in overgrazed areas, and livestock will be less productive than in other areas where they will grow faster and produce more young.

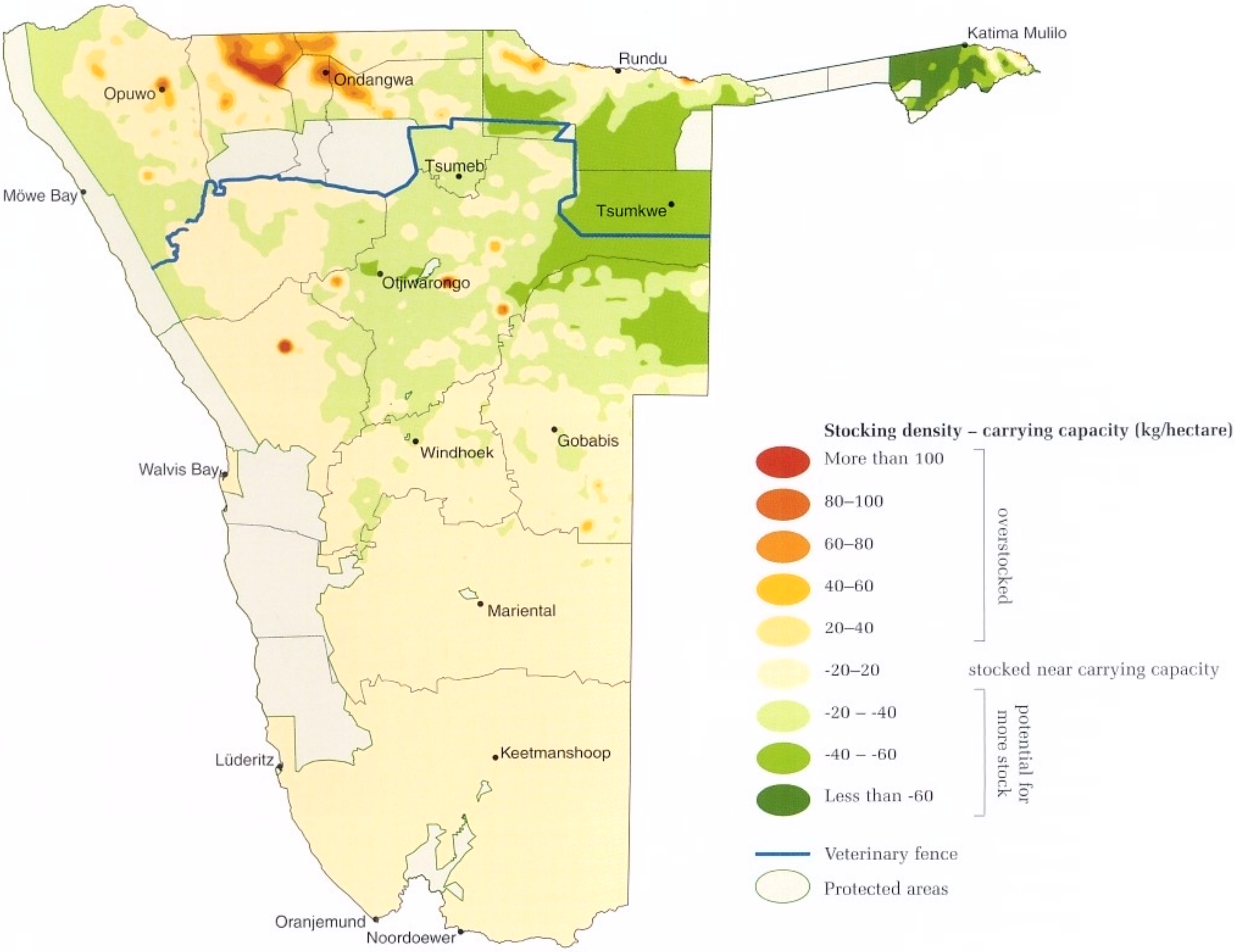
Areas that are most overstocked occur in central northern Namibia, along the Okavango River, on the eastern floodplains in Caprivi and in a variety of other scattered places, typically around large settlements. Overstocking in these areas is generally due to the presence of large numbers of cattle and goats. In total, about 3.7% of the land (excluding protected areas) is overstocked at levels that are roughly double the carrying capacity of the land or more. At the other extreme are large areas, especially in Otjozondjupa, where there are very few livestock in relation to the number of animals that could be supported.

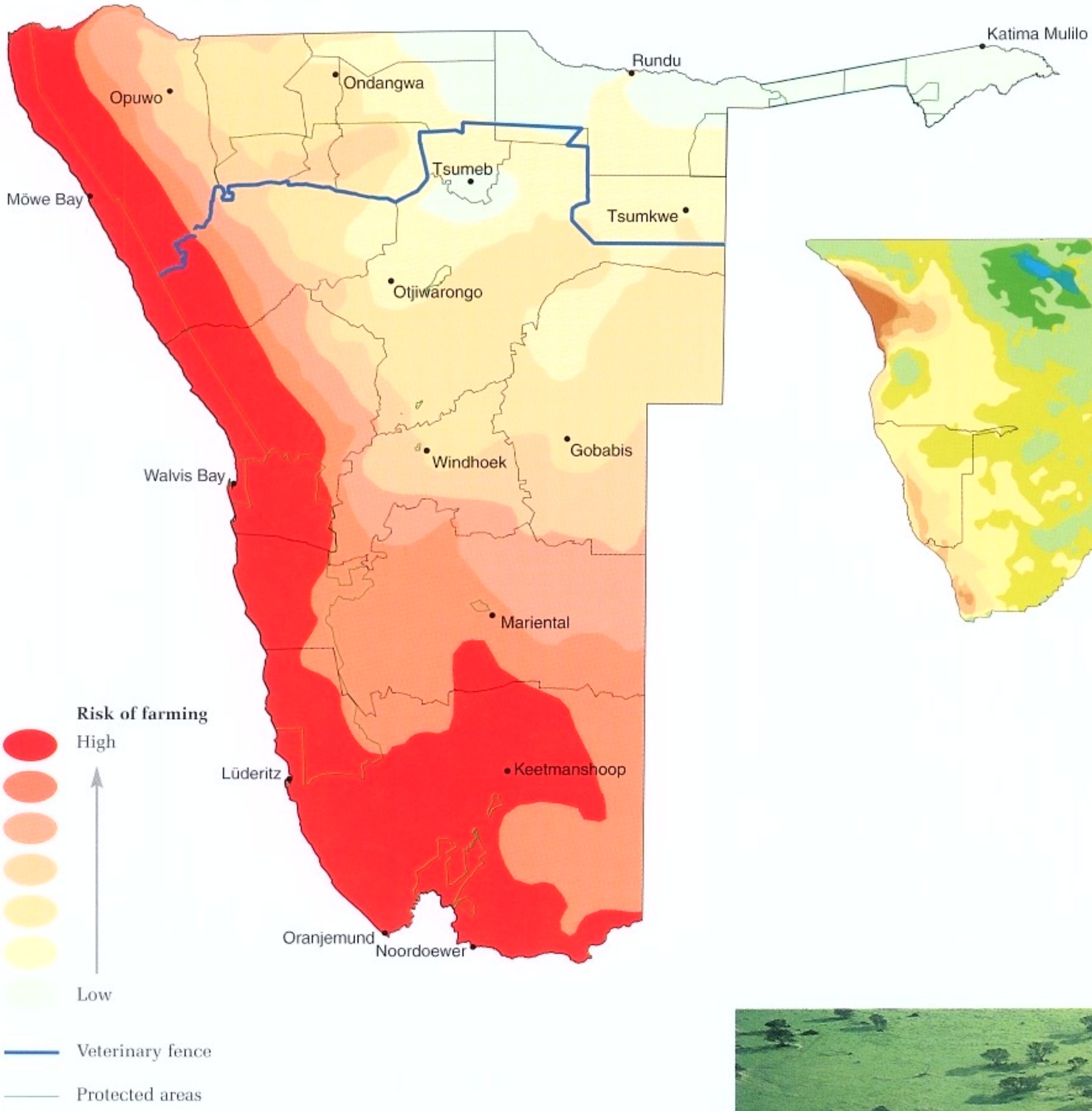
The usefulness of the concept of carrying capacity is sometimes hotly debated, especially in arid environments and communal areas where animals are assumed to be on the move, grazing one area and then moving on to another before the pastures are exhausted. Movements of this kind certainly occur in some places, but it is also true that grazing rights are strictly controlled in many communal areas, where livestock are not moved regularly.

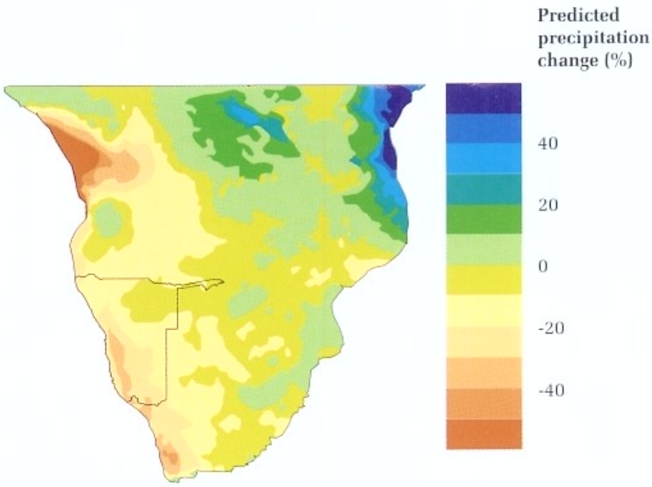


Few commodities are as important to Namibians as cattle: for meat and milk production, as capital assets and security, and simply as good food in many restaurants. Perhaps as a result of all this, many areas are badly overgrazed by cattle.


Katima Mulilo
Rundu
Opuwo
Ondangwa
Tsumeb
Möwe Bay
Tsumkwe
Otjiwarongo
Walvis Bay
Windhoek
Gobabis
Mariental
Lüderitz
Keetmanshoop
Oranjemund
Noordoewer
Stocking density (kg/hectare)
0–20
20–40
40–60
60–80
80–100
100–120
120–140
140–160
160–180
More than 180
Veterinary fence
Protected areas


Katima Mulilo
Rundu
Opuwo
Ondangwa
Tsumeb
Möwe Bay
Tsumkwe
Otjiwarongo
Walvis Bay
Windhoek
Gobabis
Mariental
Lüderitz
Keetmanshoop
Oranjemund
Noordoewer
Stocking density – carrying capacity (kg/hectare)
More than 100
80–100
60–80
40–60
20–40
overstocked
-20–20
stocked near carrying capacity
-20 – -40
-40 – -60
Less than -60
potential for more stock
Veterinary fence
Protected areas





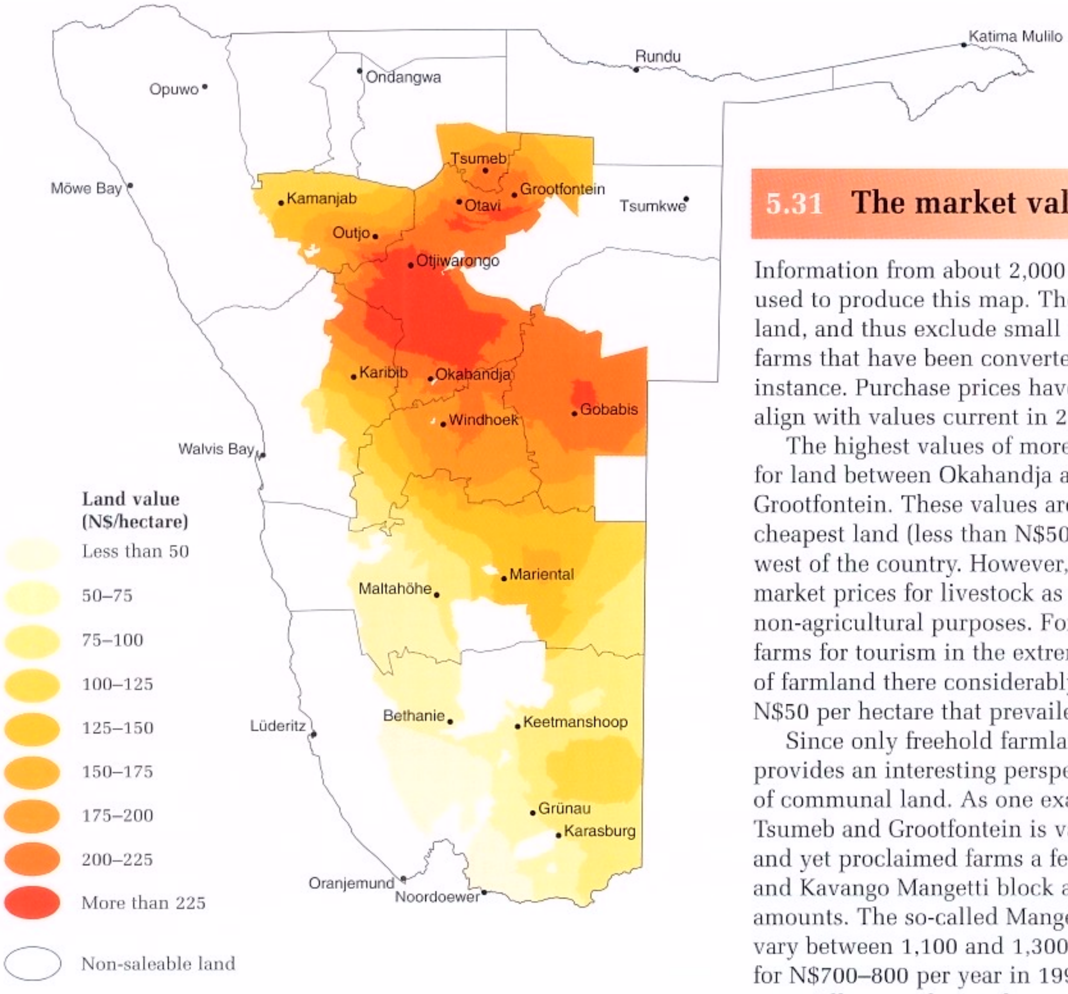
5.30 The risk of farming in different areas

Farming in Namibia is a risky business. In some areas it is much more risky than in others: areas with the greatest risks are those with short growing seasons, low rainfalls and high rainfall variability from year to year. The perspective on risk presented here is based on a synthesis of information on average rainfall (Figure 3.18), variation in rainfall (Figure 3.21), average plant production (Figure 4.6) and variation in plant production (Figure 4.7).[26] It therefore takes account of both actual levels of rainfall and plant production and the degree of variability in an area.

The most risky parts are in southern and western Namibia, as opposed to areas where rainfall and plant production are more reliable, particularly in Kavango and Caprivi, and parts of Ohangwena and Oshikoto. The lower risks in these areas do not mean that all land is suited to all kinds of farming. The soils in many parts of north-eastern Namibia are not fertile enough for crop growth (Figure 2.19), and livestock grazing in certain places may be limited because of bush encroachment (Figure 4.11), overgrazing (Figure 5.29) or poor quality grasses (Figure 4.8b).

It is widely agreed that climatic changes will occur as the earth's atmosphere gradually warms. While it is less certain exactly what kinds of changes will occur, the results of several analyses predict that rainfall over Namibia and most of southern Africa will drop, as shown in the small map.[27] Should these predictions prove correct, farming in Namibia is likely to become even more difficult and risky.

The rapid transformation of brown, parched and bare surfaces after good rains into areas of fresh, green and luxuriant growth is almost miraculous. However, the change is a miracle only because it happens so infrequently and unpredictably, and this is one reason farming is so difficult in many areas.

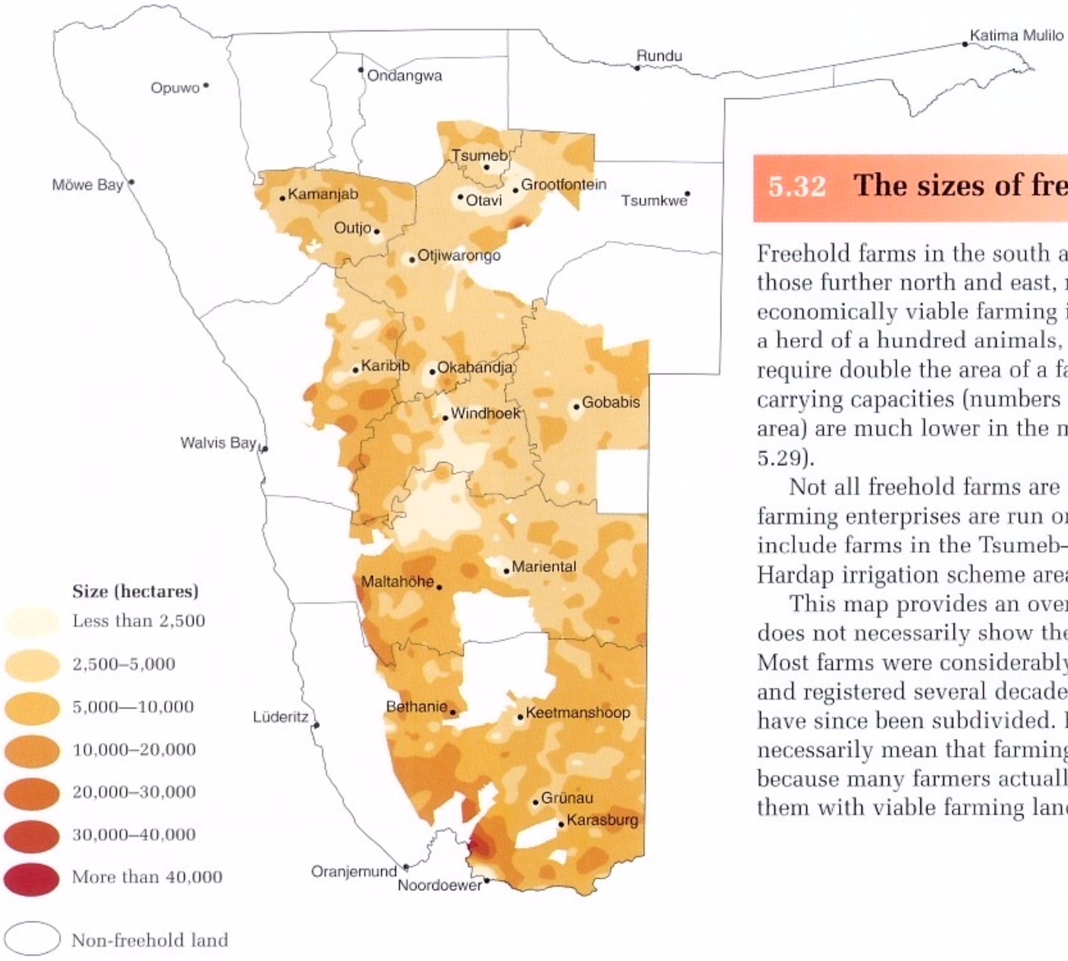


5.31 The market values of freehold farms [28]

Information from about 2,000 farm sales over the past 10 years was used to produce this map. The values are those of 'average' farmland, and thus exclude small farms used for irrigated crops or farms that have been converted into expensive tourist resorts, for instance. Purchase prices have also been adjusted for inflation to align with values current in 2000.

The highest values of more than N$200 per hectare were paid for land between Okahandja and Otjiwarongo and to the south of Grootfontein. These values are about four times greater than the cheapest land (less than N$50 per hectare) in the extreme southwest of the country. However, land prices fluctuate depending on market prices for livestock as well as the potential use of land for non-agricultural purposes. For instance, the recent interest in using farms for tourism in the extreme south-west has increased the price of farmland there considerably to more than the average of below N$50 per hectare that prevailed during the 1990s.

Since only freehold farmland can be bought and sold, this map provides an interesting perspective on the potential market value of communal land. As one example, freehold land to the north of Tsumeb and Grootfontein is valued at more than N$150 per hectare, and yet proclaimed farms a few kilometres away in the Oshikoto and Kavango Mangetti block are leased to farmers for minimal amounts. The so-called Mangetti farms in Oshikoto, which vary between 1,100 and 1,300 hectares in extent, were leased for N$700–800 per year in 1999. [29] These are modest costs, especially considering that many of the tenant farmers are extremely wealthy people.



5.32 The sizes of freehold farms

Freehold farms in the south and west are considerably larger than those further north and east, reflecting the large areas needed for economically viable farming in the more arid regions. To support a herd of a hundred animals, for example, a southern farmer may require double the area of a farmer up north. This is because carrying capacities (numbers of animals that can be kept per unit area) are much lower in the more arid southern areas (see Figure 5.29).

Not all freehold farms are large, however. Many intensive crop-farming enterprises are run on relatively small areas. Examples include farms in the Tsumeb–Grootfontein–Otavi triangle and the Hardap irrigation scheme area north of Mariental.

This map provides an overall approximation of farm sizes and does not necessarily show the average size of viable farming units. Most farms were considerably larger when they were first surveyed and registered several decades ago and, for various reasons, many have since been subdivided. However, these subdivisions do not necessarily mean that farming units are now smaller than before, because many farmers actually use more than one farm to provide them with viable farming land (see Figure 5.21).

Conservation and tourism

Namibia is fortunate in having large areas set aside for environmental conservation. Most of these areas consist of national parks and game reserves that were proclaimed several decades ago. The Ministry of Environment and Tourism today manages these formal conservation areas. Several sites of special significance have also been declared.

Although government ownership and management of such areas is customary around the world, a growing number of non-formal and multi-purpose conservation areas have been added in recent years. In Namibia, these consist of conservancies and private game or nature reserves and tourism concessions.

Tourism is currently the fastest-growing economic sector in the world. This trend holds true for the Namibian tourist industry as well; its value has increased by 8–10% each year over the past decade. There are several reasons why tourism is so important to Namibia. Firstly, tourists bring valuable income and foreign currency to the country. Secondly, it has the potential for generating many jobs. For example, the estimated 25,000 jobs in the tourism sector represented 15% of all private sector employment during 1998. Thirdly, Namibia's tourism sector is heavily dependent on the natural environment. Natural resources are now recognised as having real economic value, a worth that can increase and help ensure that the natural environment is protected and used wisely. A growing tourism sector should, therefore, derive even greater benefits from the unspoiled and open wilderness, the diversity of interesting wildlife and the country's majestic scenery.

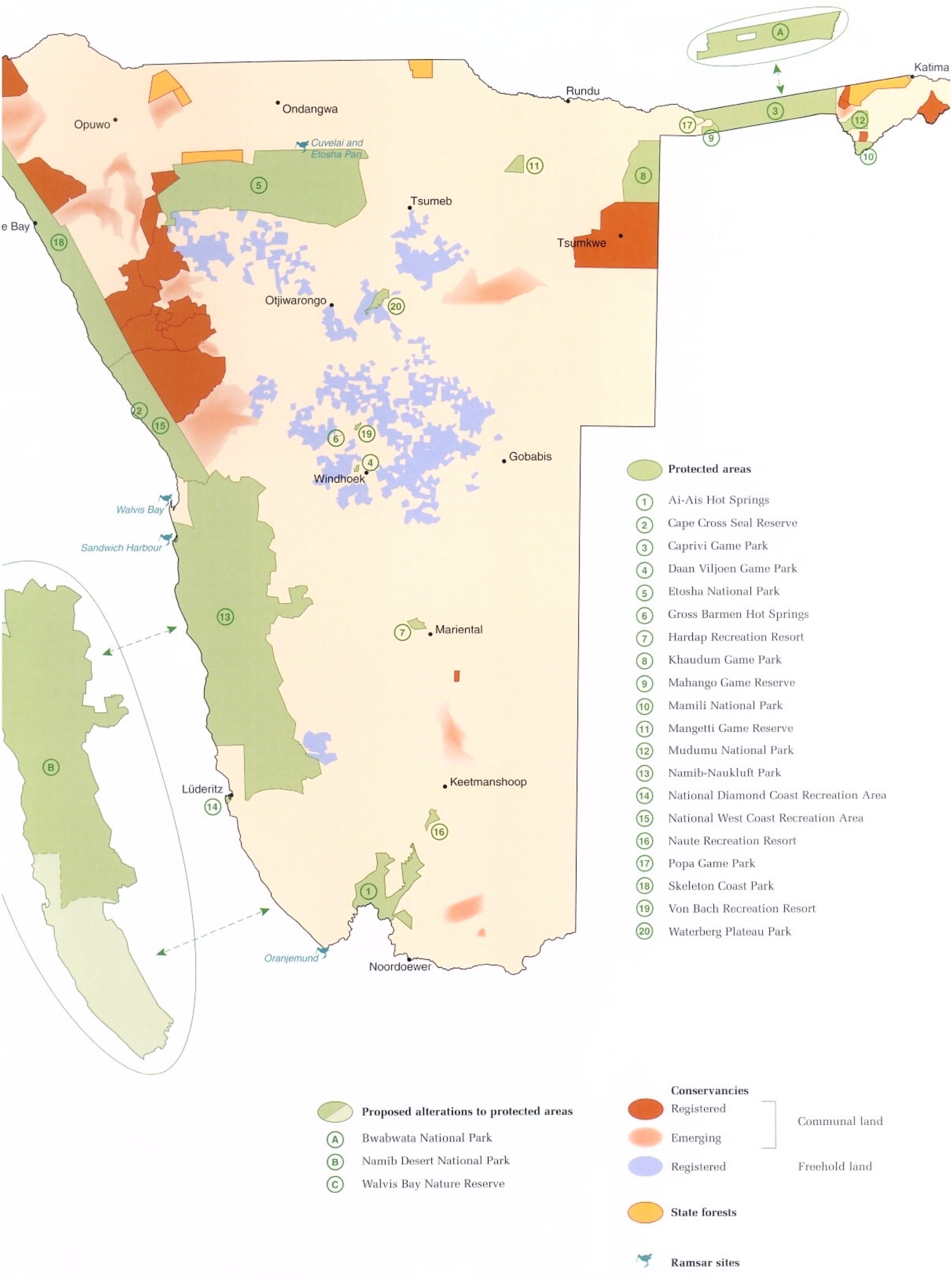
5.33 Areas allocated and proposed for conservation

There are a total of 20 proclaimed nature reserves or national parks, ranging from the huge Namib–Naukluft (50,700 km^2), Etosha (22,700 km^2) and Skeleton Coast (16,800 km^2) National Parks to the tiniest of them all, Popa Game Park. Together, these areas make up 14.1% of Namibia's surface area. This total is likely to be enlarged soon by the addition of the old Sperrgebiet diamond-mining concession, which will result in the largest national park in Africa covering some 72,600 km^2. Once the park is created there will be a continuous conservation area stretching over an area of about 100,500 km^2 from the Orange to the Kunene rivers. The borders of the Caprivi Game Park are also likely to change with the exclusion of some areas and the additions of others. Several government conservation areas have a slightly equivocal status, including various state forests that have not been formally proclaimed.[30] Sites declared in terms of the international Ramsar Convention have special importance as places where there are large numbers of water birds.

In addition to the state protected areas, large areas have been declared as conservancies in recent years. These consist of private farmland or communal land where natural resources are not only protected but also managed and used for the benefit of conservancy members living there. This is especially important in communal areas where conservancy members are able to generate valuable income through tourism and hunting. Communal conservancies earned about N$6 million for their members in 2001 alone, and members are encouraged by these benefits to protect natural resources. By 2000, some 40,600 km^2 and 38,200 km^2 had been declared as conservancies in communal and freehold areas, respectively. Many other emerging conservancy areas are being planned, amounting to tens of thousands of square kilometres.

Natural resources in large areas of privately owned farmland are also conserved in other forms. Many farms are now managed as nature reserves, some being used only for tourism, others generating incomes from the hunting of game or from selling game products. A great number of other farms make no direct use of wildlife but mix some of these conservation and tourism activities with livestock farming.

These camelthorn trees and dunes exemplify the overlay and mix of life and form, colour and shape, which are conserved for future generations.

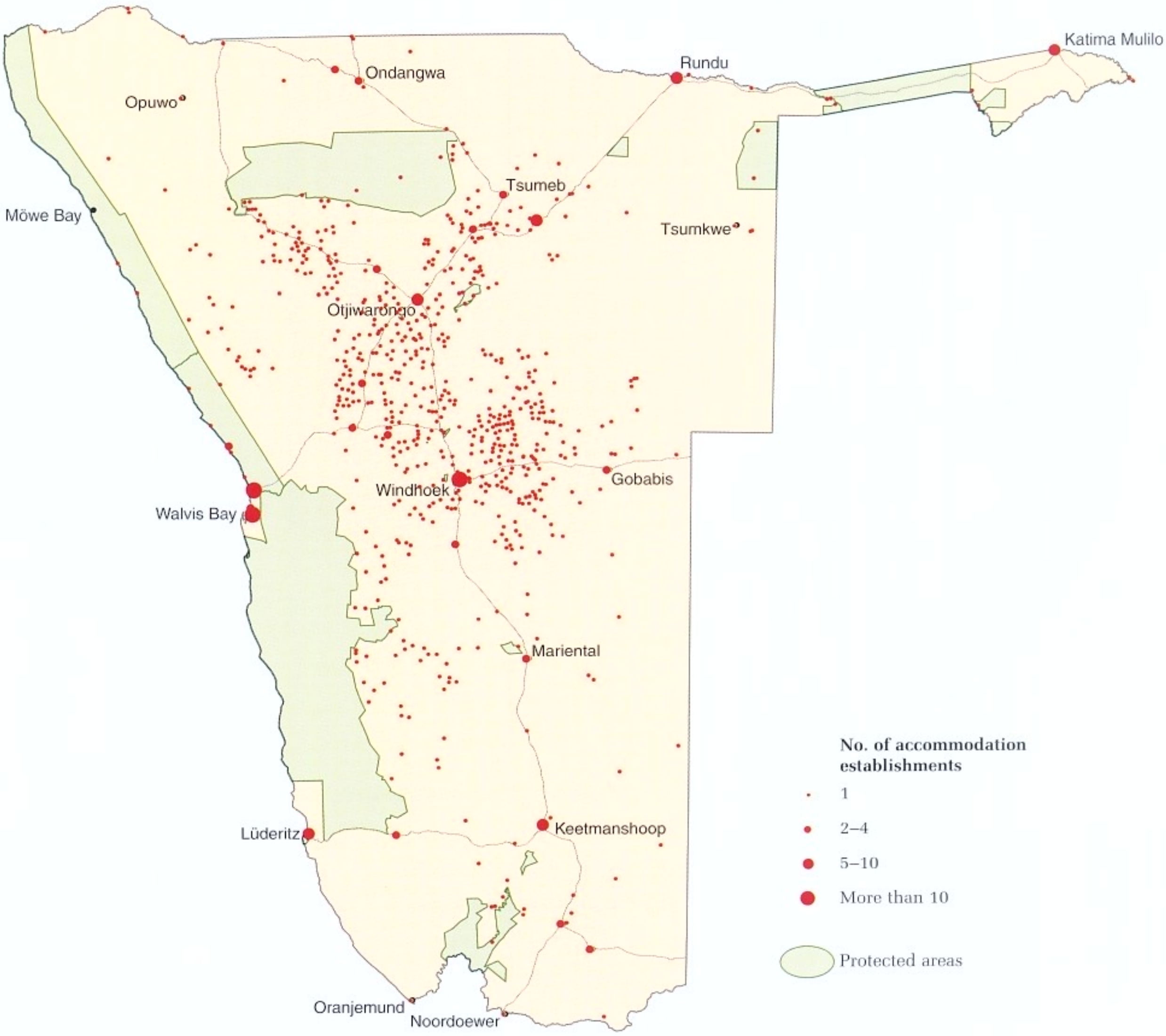

Katima
Rundu
Ondangwa
Opuwo
Cuvelai and Etosha Pan
Tsumeb
Tsumkwe
e Bay
Otjiwarongo
Gobabis
Windhoek
Walvis Bay
Sandwich Harbour
Mariental
Keetmanshoop
Lüderitz
Oranjemund
Noordoewer
Protected areas
1 Ai-Ais Hot Springs
2 Cape Cross Seal Reserve
3 Caprivi Game Park
4 Daan Viljoen Game Park
5 Etosha National Park
6 Gross Barmen Hot Springs
7 Hardap Recreation Resort
8 Khaudum Game Park
9 Mahango Game Reserve
10 Mamili National Park
11 Mangetti Game Reserve
12 Mudumu National Park
13 Namib-Naukluft Park
14 National Diamond Coast Recreation Area
15 National West Coast Recreation Area
16 Naute Recreation Resort
17 Popa Game Park
18 Skeleton Coast Park
19 Von Bach Recreation Resort
20 Waterberg Plateau Park
Proposed alterations to protected areas
A Bwabwata National Park
B Namib Desert National Park
C Walvis Bay Nature Reserve
Conservancies
Registered
Emerging
Communal land
Registered
Freehold land
State forests
Ramsar sites

5.34 Tourism accommodation

A great variety of accommodation is available to tourists, and this map shows the distribution of over 900 different hotels, guest and hunting farms, lodges, resorts in national parks, and campsites in Namibia. The majority of establishments are guest farms in the central regions.

Most tourists who come on holiday to Namibia are from South Africa and the European Union, especially Germany. There has been growing interest in tourism to north-western Namibia, and several new enterprises have developed there in recent years. These include tourism concessions and campsites established by local communities to generate income. Such initiatives improve the livelihoods of local communities and provide incentives to people to protect the natural resources that attract tourists. Despite these initiatives, it is clear from the map that much of Namibia remains poorly served with accommodation for tourists. It is also regrettable that there is so little accommodation for tourists in the many large and spectacular areas that are owned or controlled by the government. Some ideas about areas that hold potential for tourism are provided in the map on page 157.

Namibia offers a great variety of tourist accommodation across the country, ranging from exclusive lodges to simple campsites.

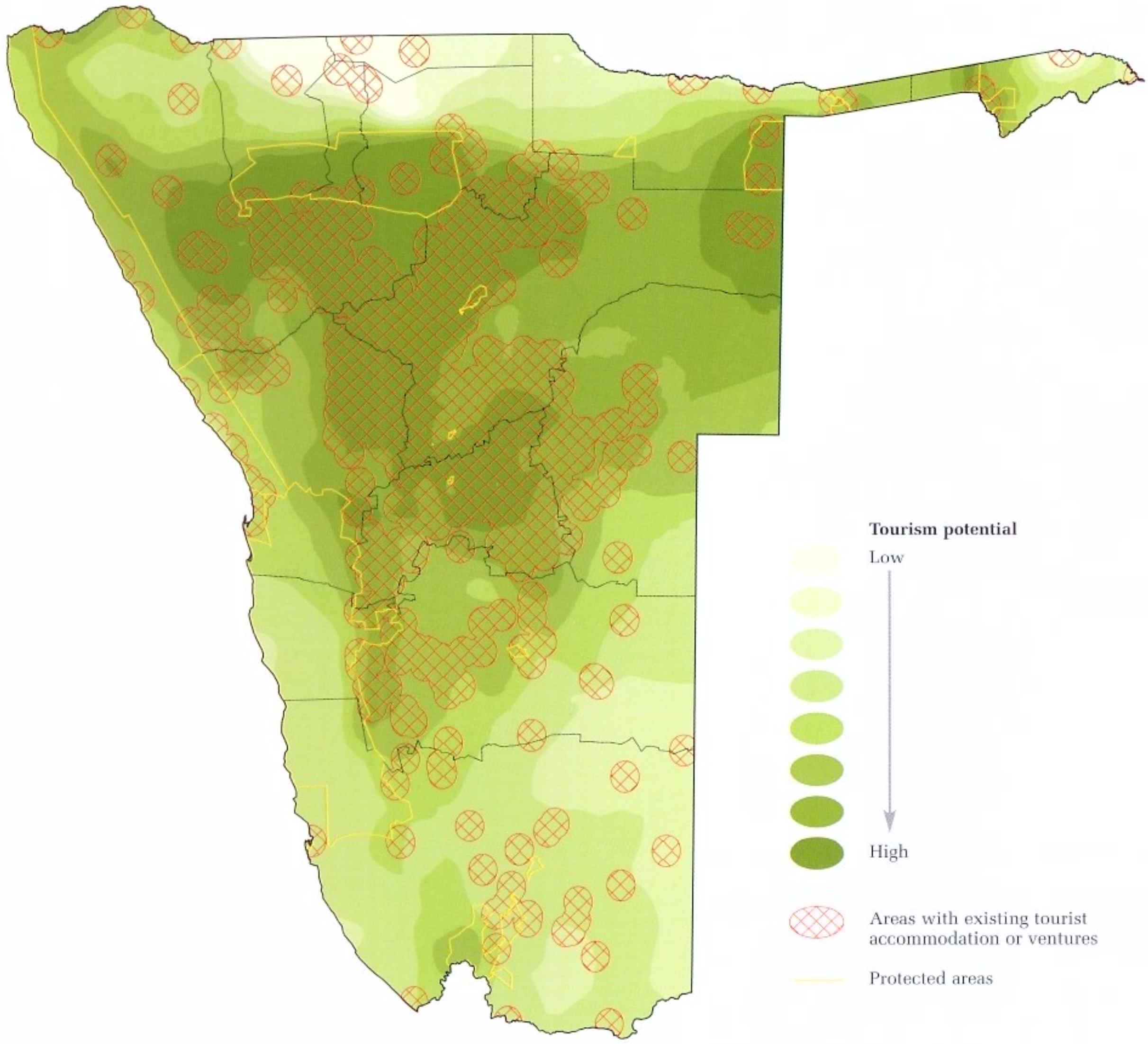


5.35 Potentials for tourism[31]

There are many factors that make an area or resort attractive to tourists. However, it is Namibia's scenery and wildlife and the solitude of many areas that attract most tourists. This map provides perspectives on which areas are perhaps most attractive. It brings together a measure of altitudinal relief with information on the diversity of large mammals (Figure 4.36), carnivores (Figure 4.46) and birds (Figure 4.14). It also adds information on the density of people (Figure 6.1), the assumptions being that areas with high numbers of people are less attractive to tourists while wildlife and undulating landscapes are more attractive. The resulting synthesis of these factors provides an index of areas that have greater potential for tourists than others. The map also shows an area of 20 km around existing accommodation establishments to reveal which parts of the country have good potential but are not yet served with resorts, hotels and other accommodation for tourists.

From this analysis it appears that the areas with the greatest potential for expanded tourism are in eastern Otjozondjupa, parts of Kunene and in Etosha National Park, where there are only three resorts to accommodate visitors.

Few countries in the world can offer such magnificent views of wildlife, an unspoilt environment and spectacular scenery, and good infrastructure. These are qualities that are special to Namibia, and give its tourism industry great value and potential.



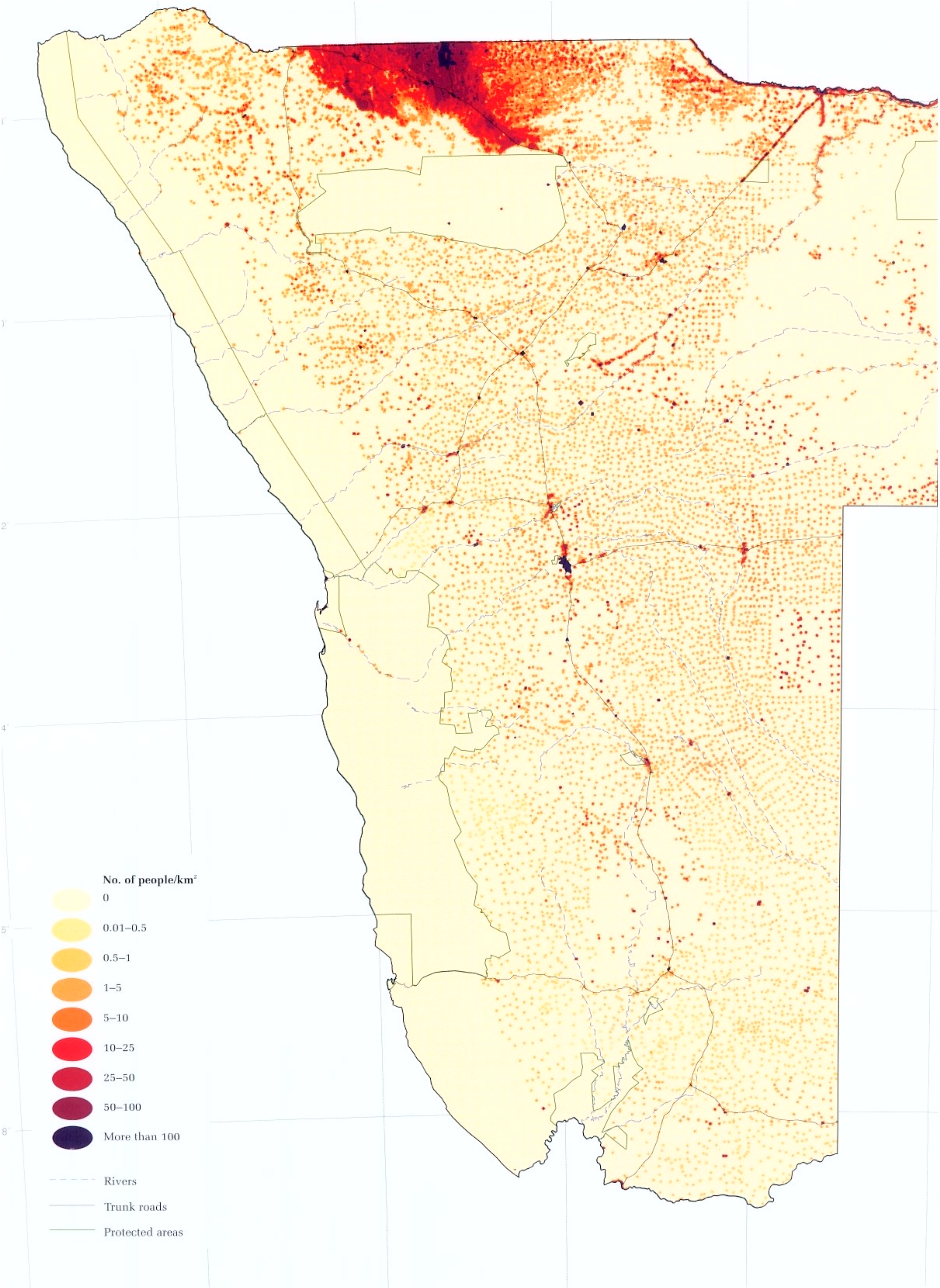

Oktoberfest

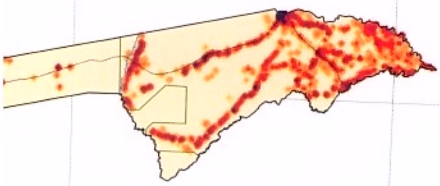
CHAPTER 6: *The people*

Namibia has a comparatively small human population, especially in relation to the large area of the country. The total population of about 1.83 million people in the year 2001 enjoyed an area of about 823,680 km^2: each square kilometre was thus occupied by just over two people on average. Few countries in the world are as thinly populated as this.

People are not, however, spread evenly across Namibia. This leads us to ask where are the greatest concentrations and what factors determine where people live. How, too, has the population expanded? What movements of people have taken place, and how do urban and rural areas compare demographically? At what rate are children born, how many die at an early age, and for how long can the average man and woman expect to live? What are the major diseases in Namibia, and what levels of education have people achieved? How do housing conditions and household economies vary from one part of the country to another? Where have public services and infrastructure been developed? These and many other questions are addressed in this chapter.

Answers to such questions can help to highlight areas where opportunities and needs for planning and development are greatest. They also provide an understanding of how the population has changed over the years and what changes may be expected in the future. This information is essential for purposes of good governance and the formulation of sound policies and planning at national, regional and local levels. For instance, Namibia's population is dominated by young people, with 53% of the whole population in 2000 being than less than 20 years of age. Almost all of these people still have to enter the job market, and much will have to be done to ensure that the country's economy makes this possible. From an environmental perspective, too, information on demographic features, household economies and housing conditions is essential for any assessment of likely demands on natural resources.


No. of people/km²
0
0.01–0.5
0.5–1
1–5
5–10
10–25
25–50
50–100
More than 100
Rivers
Trunk roads
Protected areas



Distribution of people

The maps and graphs that follow describe how numbers of people vary in different areas of Namibia: the distribution and density of people, the relative populations in urban and rural areas, and the way these have changed in recent years. The present distribution of people is the result of many historical events and processes (see Chapter 5), as well as the capacity of the land to support people, and the economic opportunities that have become available in urban areas. While some of these factors have been driven by formal planning by various governments, other settlement patterns have developed much more informally.

6.1 Population distribution [1]

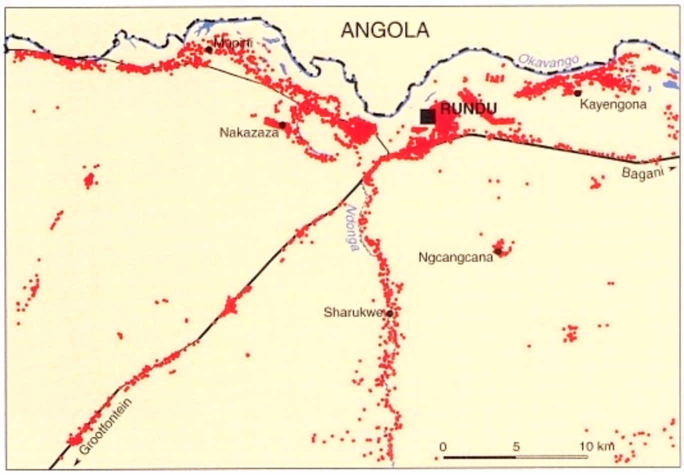
Namibia's population is very unevenly spread across the country. Large areas of land are uninhabited and many others are very sparsely populated. Indeed, most people are concentrated in towns and a few small rural areas, for three important reasons. The first is the availability of natural resources. These determine the distribution of most rural people, who are concentrated in areas where drinking water can be obtained, crops can grow because both rainfall and soil fertility are relatively high, and pastures are available for livestock. All these conditions broadly hold in the densely populated Cuvelai Drainage System in central northern Namibia, along the Okavango River and on the floodplains surrounding rivers in eastern Caprivi. While the great majority of rural Namibians are concentrated in these larger areas, many other rural homes are in places with similarly favourable environmental conditions at a more localised level. Examples of these are shown in the next maps.

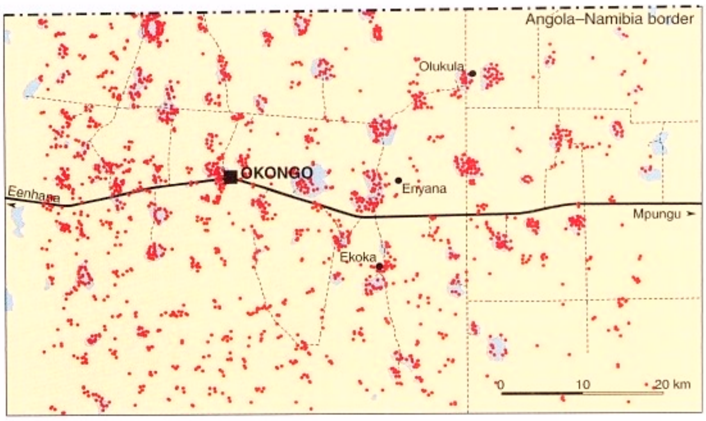
The availability of employment and business opportunities is the second major factor affecting the distribution of many people. About one in three people (see Figure 6.6) live in towns for this reason.

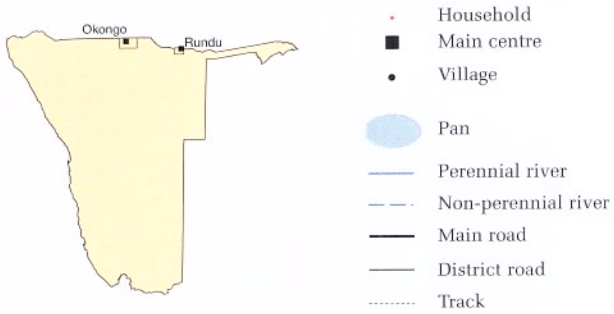
The third factor is the availability of transport, water and other services. While these services obviously contribute to the quality of life in towns, they also affect the distribution of rural populations. Many houses are clustered along main roads in Caprivi and Kavango, for example (see Figure 6.2). The provision of pumped underground water has also been a key factor in attracting people to settle in places where it would otherwise be difficult or impossible to live. Small settlements in southern Kunene and Erongo are thus concentrated around boreholes, while many commercial farmers would be unable to water their animals in the absence of water pumped from under the ground.

6.2 Localised distributions of households

These more detailed maps show clearly how people settle in areas where crops can be grown and where water is available along the dry rivers in Kavango or in and around old pan systems in eastern Ohangwena. Roads also affect settlement patterns, a good example being the presence of households along the main road from Grootfontein to Rundu.



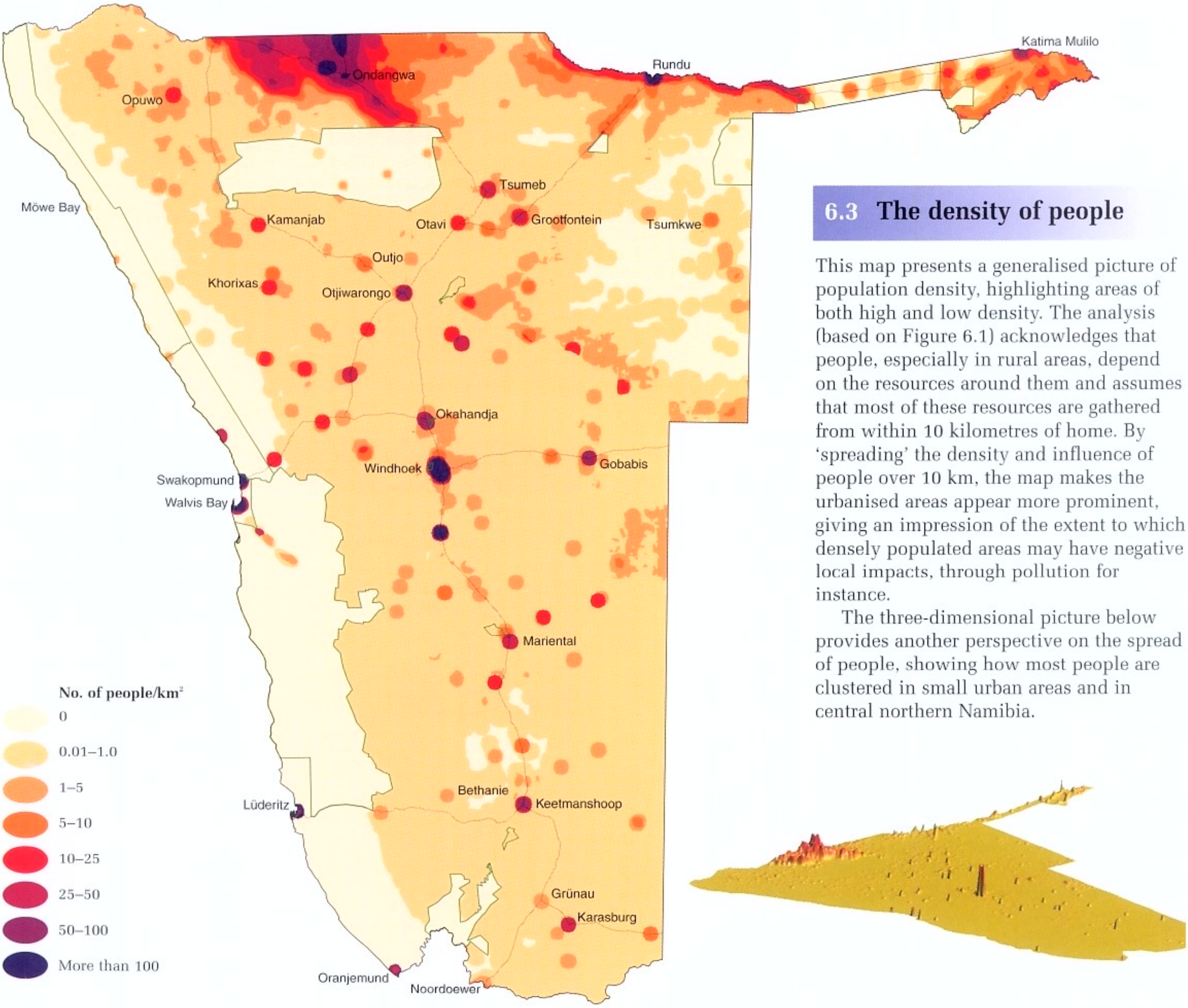


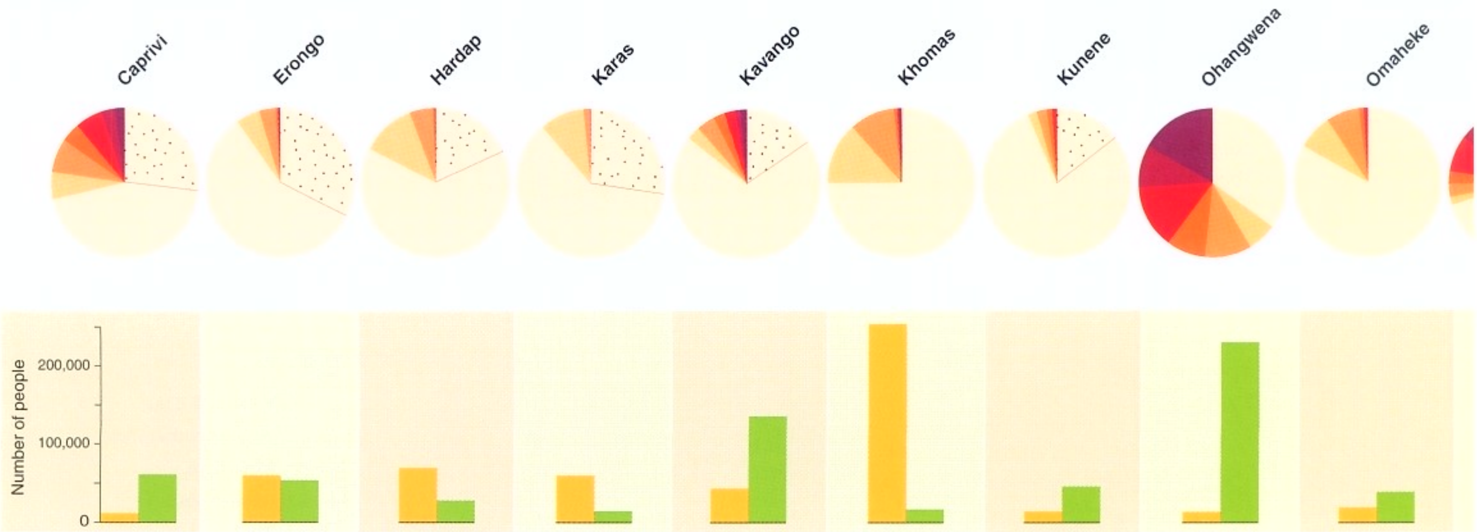


6.3 The density of people

This map presents a generalised picture of population density, highlighting areas of both high and low density. The analysis (based on Figure 6.1) acknowledges that people, especially in rural areas, depend on the resources around them and assumes that most of these resources are gathered from within 10 kilometres of home. By 'spreading' the density and influence of people over 10 km, the map makes the urbanised areas appear more prominent, giving an impression of the extent to which densely populated areas may have negative local impacts, through pollution for instance.

The three-dimensional picture below provides another perspective on the spread of people, showing how most people are clustered in small urban areas and in central northern Namibia.





6.4 Changing proportions of people living in urban and rural areas

The number of people living in urban areas has increased dramatically over the past 70 years. In 2001 about 39% of the total population (approximately 700,000 people) was settled in urban areas, compared with only 10% in 1936. Rates of urbanisation vary from town to town, but some of the highest include Ondangwa, Ongwediva, Rundu, Katima Mulilo and Windhoek. Almost 600 people moved into Windhoek each month between 1991 and 1995, and the city's population is expected to double every 12 to 13 years.[2] Overall rates of urban growth for the whole country have been between 5% and 6% over the past few decades. About 75–85% of Namibians will be living in towns by 2020 if these rates of urbanisation continue.

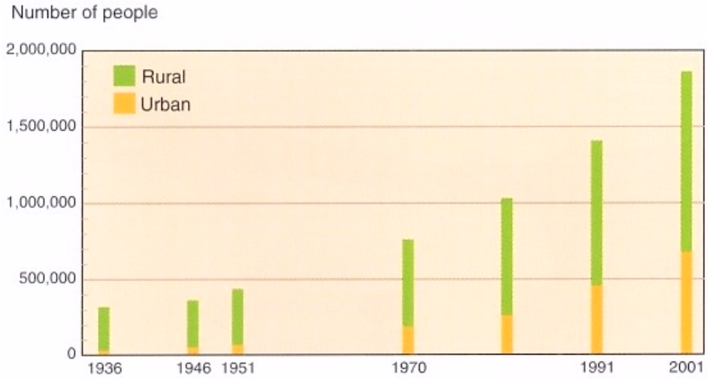
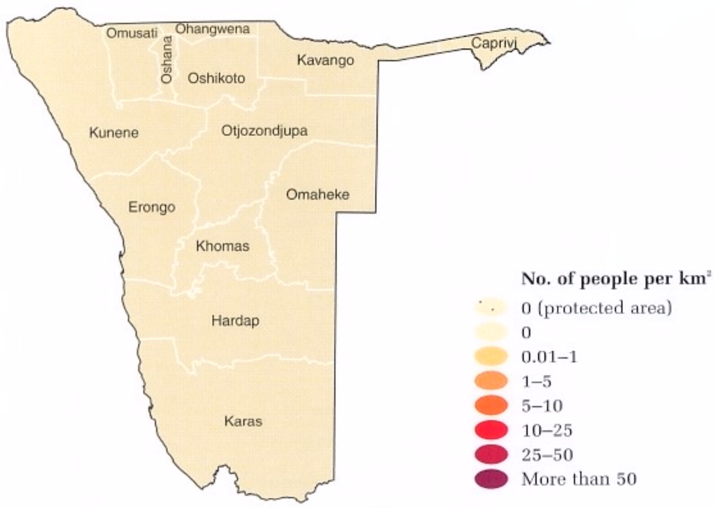
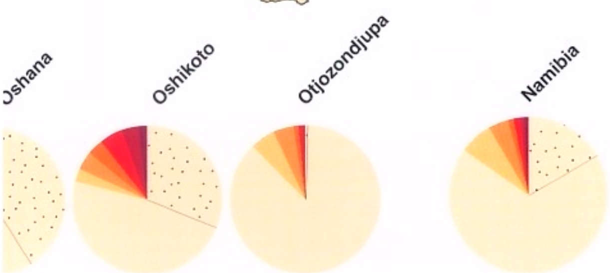


Table 6.1 Estimates of numbers of people in various regions and areas of Namibia in 2001[3]

Area	Number of people
Total country	1,826,854
Regions	
Caprivi	79,852
Erongo	107,629
Hardap	67,998
Karas	69,677
Kavango	201,093
Khomas	250,305
Kunene	68,224
Ohangwena	227,728
Omaheke	67,496
Omusati	228,364
Oshana	161,977
Oshikoto	160,788
Otjozondjupa	135,723
People within 5 km of Okavango River	124,200
People within 5 km of Caprivi Floodplains	22,600
Rural freehold farm areas	159,200
Rural communal areas	1,025,000
Cuvelai System	461,200

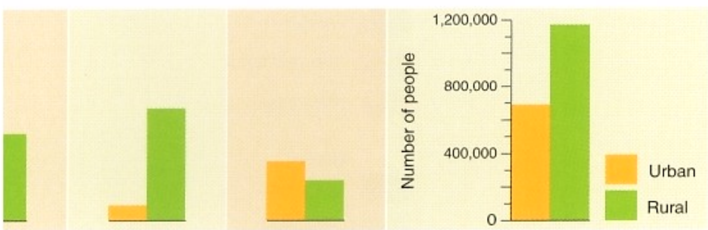




6.5 Densities of people in the 13 political regions[4]

The pie diagrams show the proportions of each region that are populated at different densities. Those with relatively large areas occupied by dense populations are the four central northern regions and Caprivi; Ohangwena is much more densely populated than any other region. Most regions have sizeable proportions of protected areas such as national parks, exceptions being Khomas, Ohangwena, Omaheke and Otjozondjupa.

Much of the land in Namibia is uninhabited. The surface area over which there are more than 10 people per km² amounts to only about 3% of the total. Most urban areas in Namibia have more than 500 people per km².



6.6 Urban and rural populations in the 13 political regions[5]

Urban populations dominate Khomas, Erongo, Hardap, Karas and Otjozondjupa. In the other regions most people live in rural areas, especially so in Ohangwena, Omusati and Oshikoto. Of all people living in urban areas in Namibia, most are to be found in Khomas (37%), Otjozondjupa (11%), Hardap (10%), Erongo (9%) and Karas (9%). The majority of the country's rural population, by contrast, is to be found in Ohangwena (20%), Omusati (20%), Oshikoto (12%), Kavango (11%) and Oshana (9%).

6.7 Distribution of language groups and major dialects[6]

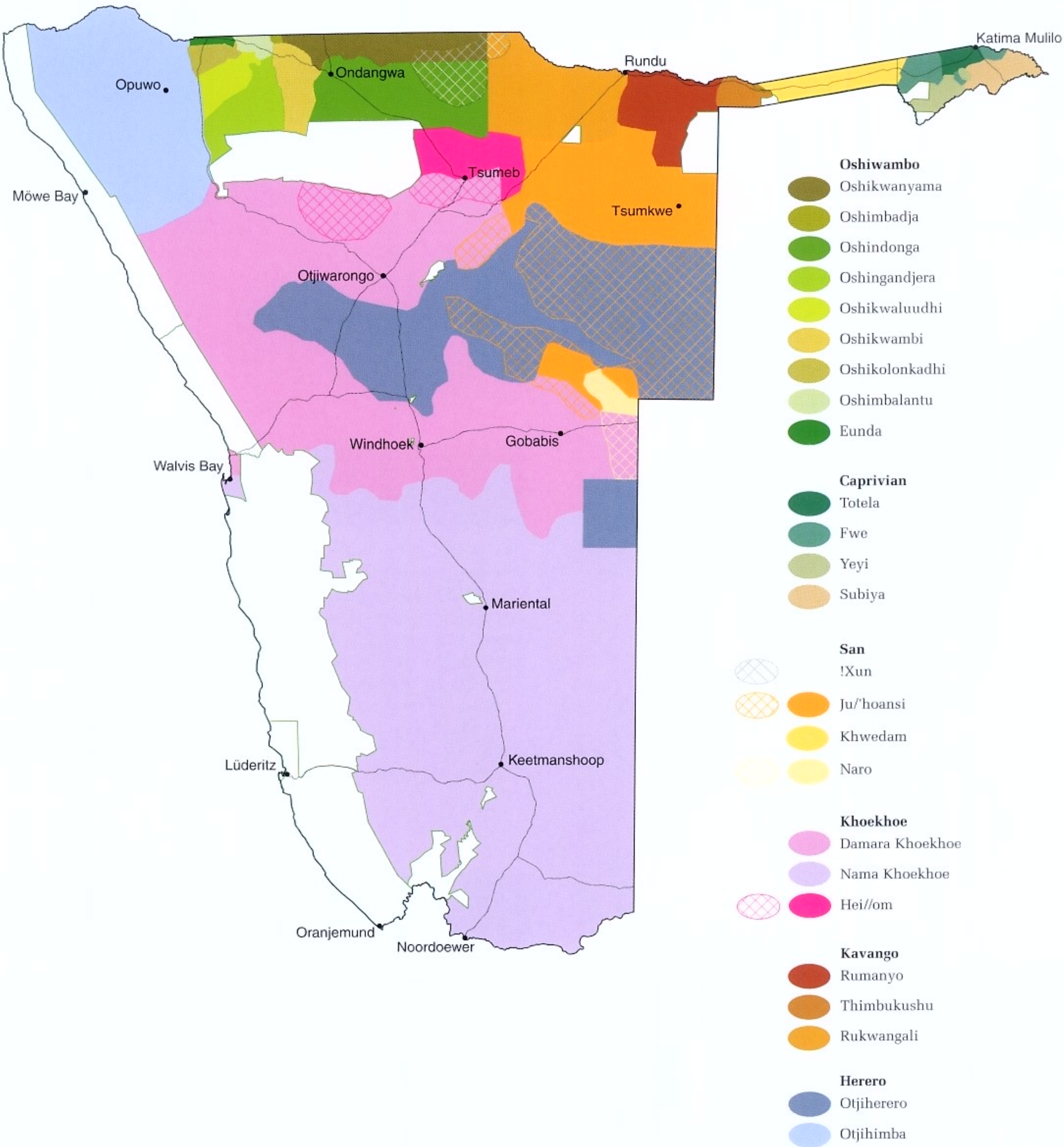
Despite having a relatively small population, Namibia has a rich diversity of languages. This map shows where different languages or major dialects are predominantly spoken.

There is a degree of mix to a greater or lesser extent everywhere, but the only overlapping language areas represented here are those for some of the so-called San and Hei//om languages or dialects.[7]

Whilst there are just three predominant languages or major dialects across the southern two-thirds of the country – Nama Khoekhoe, Damara Khoekhoe and Otjiherero – there are 21 distinct languages or major dialects in northern Namibia. This profusion reflects, to a large extent, patterns of historical settlement (see Figure 5.7), as well as the fact that communities that produce crops tend to be much more segmented than pastoral societies. Rumanyo is now the name adopted for the language embracing what many people call Rushambyu and Rugciriku.

People speaking so-called San languages predominate in parts of north-eastern Otjozondjupa; elsewhere they form smaller proportions of the population. There are at least four distinct major dialects: Khwedam in western Caprivi, Ju/'hoansi in north-eastern Otjozondjupa, Naro in Omaheke, and !Xun in eastern Ohangwena and Oshikoto. The Hei//om language around Grootfontein, Tsumeb and Otavi is part of the Khoekhoe family of languages, and not a San language, as many people believe.

As for languages of European origin, most Afrikaans speakers are to be found on farms, in towns and in the Rehoboth area; English-speaking people are generally in towns; while most German speakers are in the freehold farming areas and in towns.

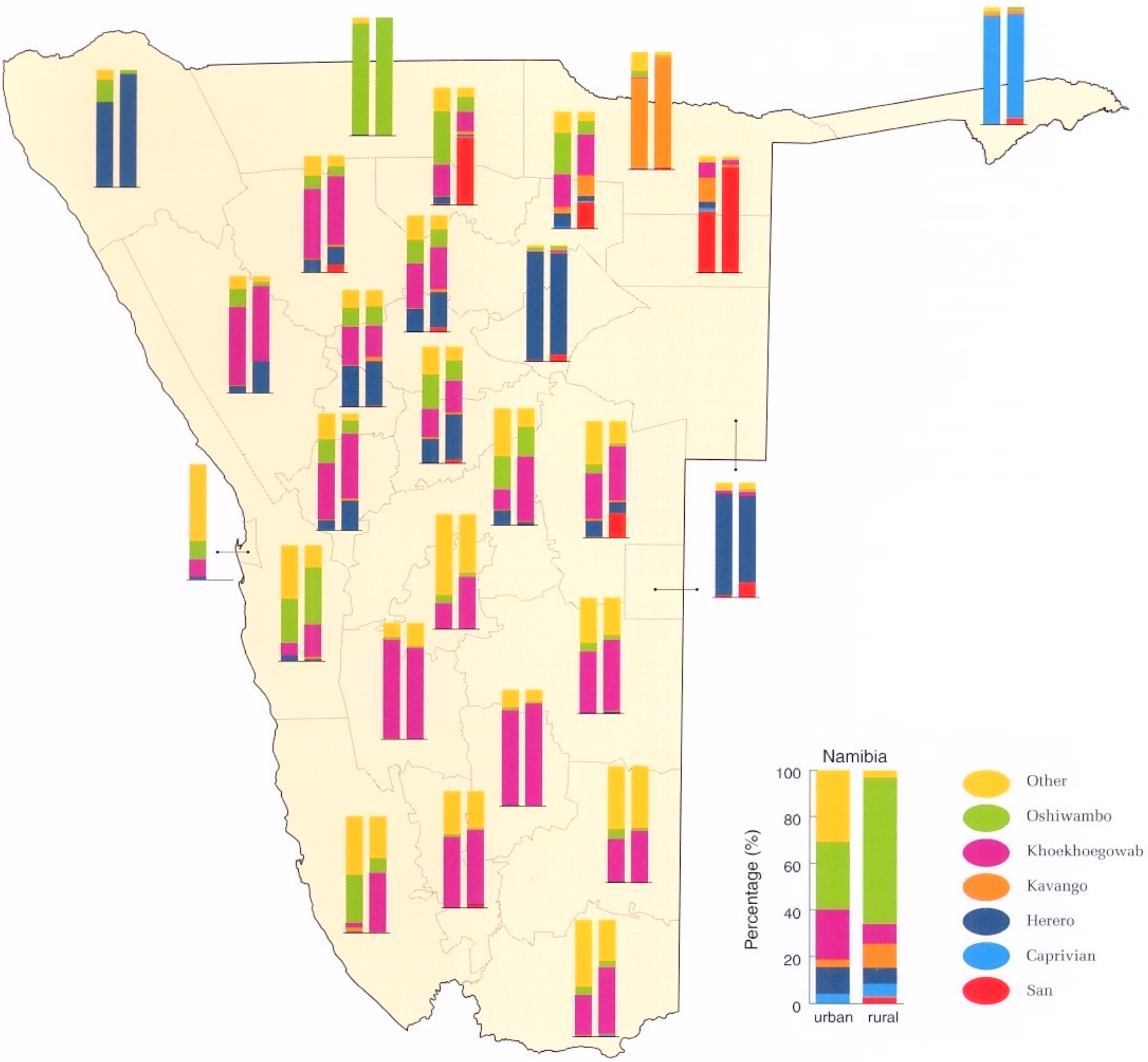


6.8 Distribution of major language groups in urban and rural areas

The histograms show the proportion of people in each major language group living in urban and rural areas in each of the old ethnic and magisterial districts,[8] and in Namibia as a whole. There are several reasons why people speaking different languages are so segregated, including historical patterns of settlement over hundreds of years (see Figure 5.7) and the enforced separation of people into distinct areas by colonial governments (see Figures 5.8–5.13). Moreover, people who speak the same language tend naturally to live close to one another. In contrast to the rural areas, urban areas have a much greater mix of people speaking different languages. This is true even of small towns in communal areas, such as Rundu and Opuwo. The greater mix of people in urban areas is of course largely due to migration and urbanisation: most people who live in towns were born elsewhere.

The degree to which people have moved out of the old ethnic districts differs from one language group to another. Very few speakers of Caprivian and Kavango languages have moved away from Caprivi and Kavango, whereas there are high proportions of speakers of Oshiwambo, Otjiherero, and Nama Khoekhoe and Damara Khoekhoe (these two dialects are collectively called Khoekhoegowab) in urban areas such as Windhoek, Swakopmund, Walvis Bay, Grootfontein and Gobabis.

Over half the people who moved into Windhoek in recent years were migrant Oshiwambo speakers from Oshikoto, Ohangwena, Omusati and Oshana.



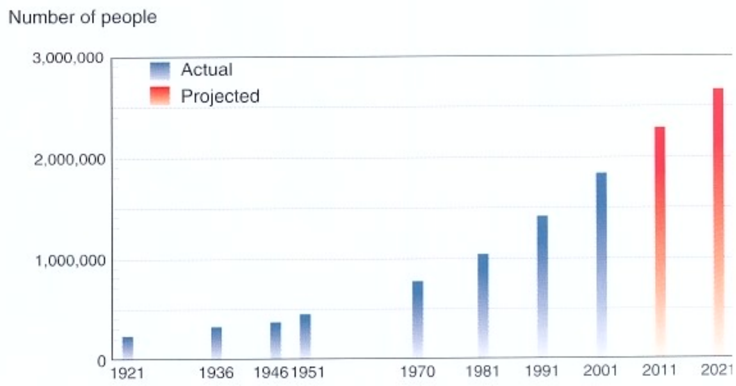
Growth and structure of the population

This section reflects on the total and changing numbers of Namibians, and what proportions of people are male and female and in different age groups. Three demographic characteristics determine these features: fertility (the rate at which children are born), mortality (the rate and ages at which people die) and migration (though very little good information is available on the numbers of people coming into or leaving Namibia). Whilst it is generally assumed that relatively few people have left Namibia in recent years, migration into Namibia has been, and continues to be, substantial. For example, more than 40,000 people returned to Namibia from exile just before Independence in 1991, adding about 3% to the population, while in 2001 there were at least 20,000 refugees in the country. In 1991 about 5% of the total population in Namibia had been born in Angola and over 2% in South Africa. Most immigrants live in urban areas: in Oshakati, for example, 13% of the residents in 1991 had been born in Angola, while in Windhoek about 9% of people in 1991 had been born in South Africa and about 2% in Angola.

6.9 The growth of Namibia's population [9]

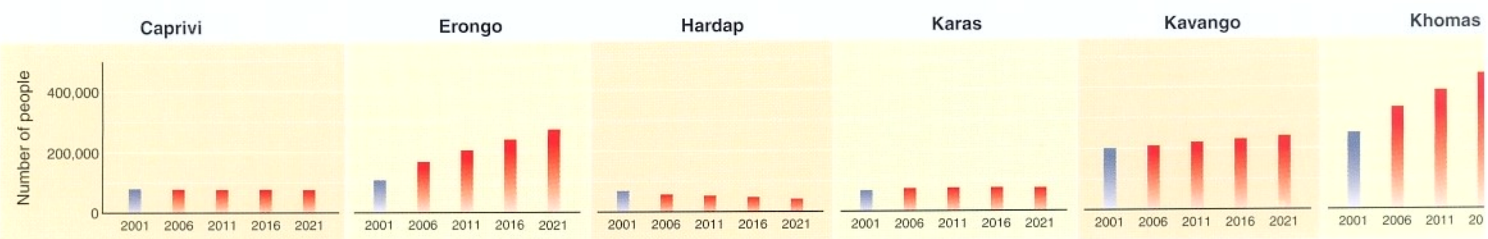
During the first population census in 1921 about 229,000 people were reported. The population has increased more than eight-fold since then, reaching about 1,827,000 people in 2001. Rates of growth increased from about 2% per year in the first half of the 20th century to 3% in the last few decades.

Projections suggest that the population will rise to about 2,250,000 in 2010 and 2,600,000 by the year 2020. Even though the total number of people will increase by about 800,000 over the next 20 years, the rate of growth is expected to drop steadily from the current 3% to about 1.5% in 2006. Much of that decline in growth will be due to the effects of AIDS (see Figure 6.25). It is also expected that higher levels of education among women, and involvement in the cash economy, will lead to lower birth rates and, therefore, lower growth rates. Note that the growth rate indicates how rapidly a population is increasing, while population growth measures the actual increase in numbers of people.



6.10 Population projections for each region [10]

While the total population of Namibia will rise over the next 20 years, different kinds of changes are expected. Some regions are likely to suffer much more severely from the impact of AIDS. At the same time, increasing rates of urbanisation will lead to losses in rural areas and increases in regions with growing towns. Erongo, Otjozondjupa and Khomas should experience the greatest population increases as a result of more and more people moving into Walvis Bay, Swakopmund, Windhoek, Okahandja, Otjiwarongo and Grootfontein. On the other hand, populations are expected to actually decline in Kunene, Caprivi and Hardap.

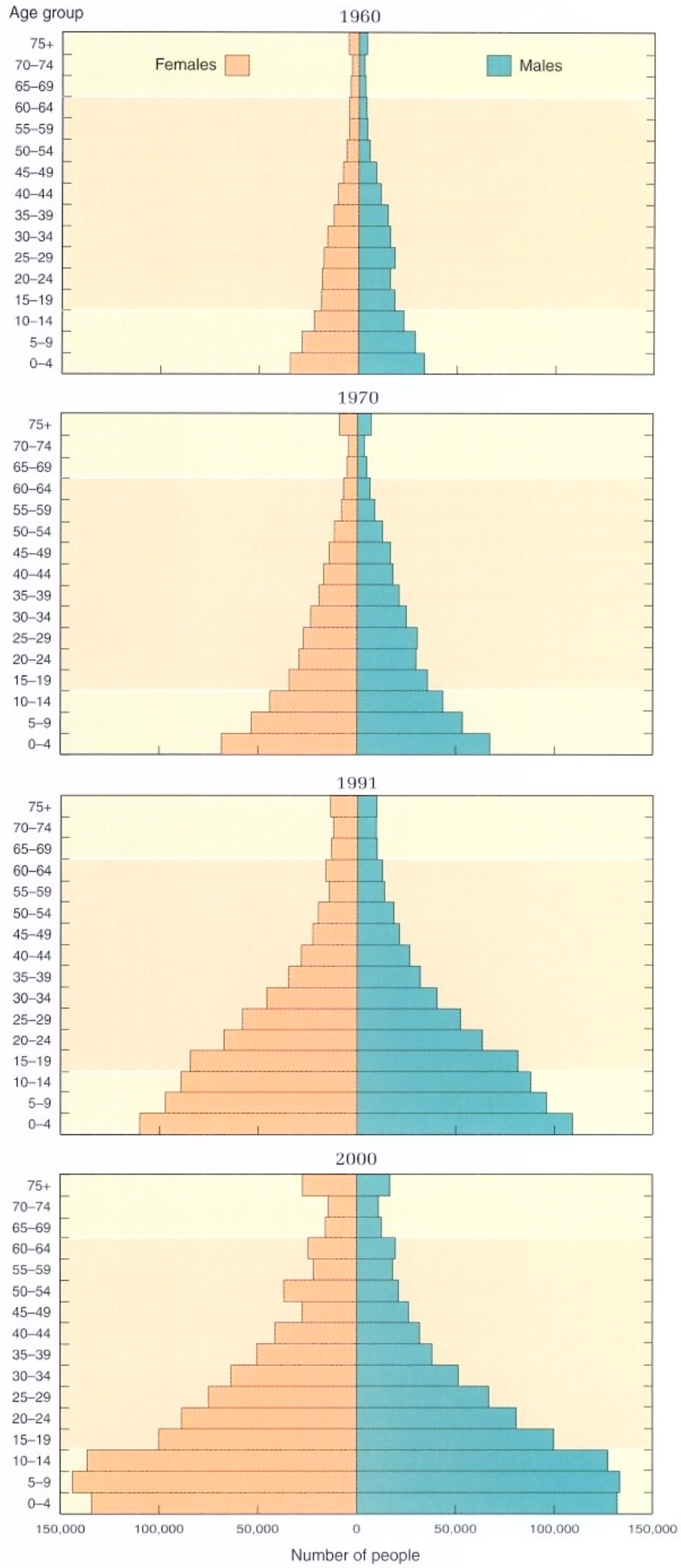


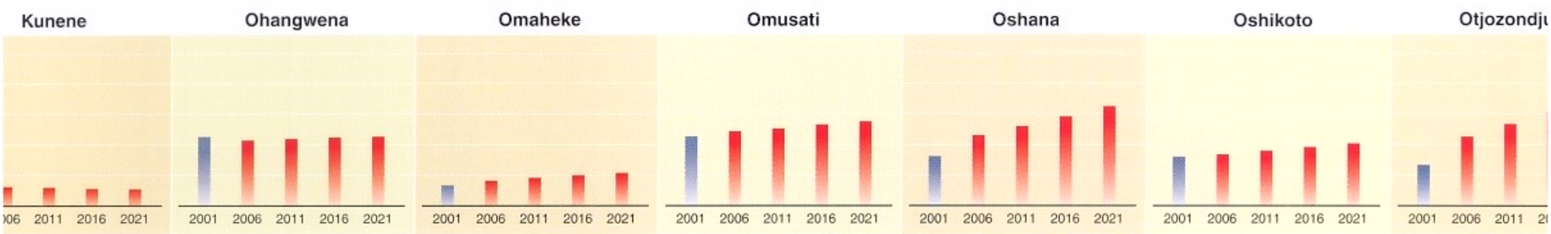
6.11 The structure of the population, 1960–2000

Changes in population size and growth rates seen in Figure 6.9 have not been accompanied by any major changes in the structure of the population. Thus the proportion of children under the age of 15 was 40% in 1960 and 43% in 2000. Similarly, the proportion of the population aged 65 or older was 5.4% in 1960 and 5.1% in 2000. Overall, there are roughly equal numbers of females and males, 52% being female and 48% male. It is amongst older people that women really outnumber men because women live longer on average.

Age pyramids of a growing population normally have the highest number of people in the lowest age group. Bars for 0–4-year-olds are therefore quite a bit wider than those for 5–9-year-olds. This pattern was true in 1960, 1970 and 1991, but in 2000 the number of children aged 0–4 years was less than those aged 5–9 years. This represents a significant change in the structure of the population, and is largely due to a substantial decline in fertility (see Figure 6.15). Further significant changes are also to be expected as a result of the impact of AIDS (see Figure 6.25).

Like many developing countries, Namibia's population is dominated by young people. Ample funds will have to be found to educate all these young people, and Namibia will have to develop an economic environment that will provide them with jobs.

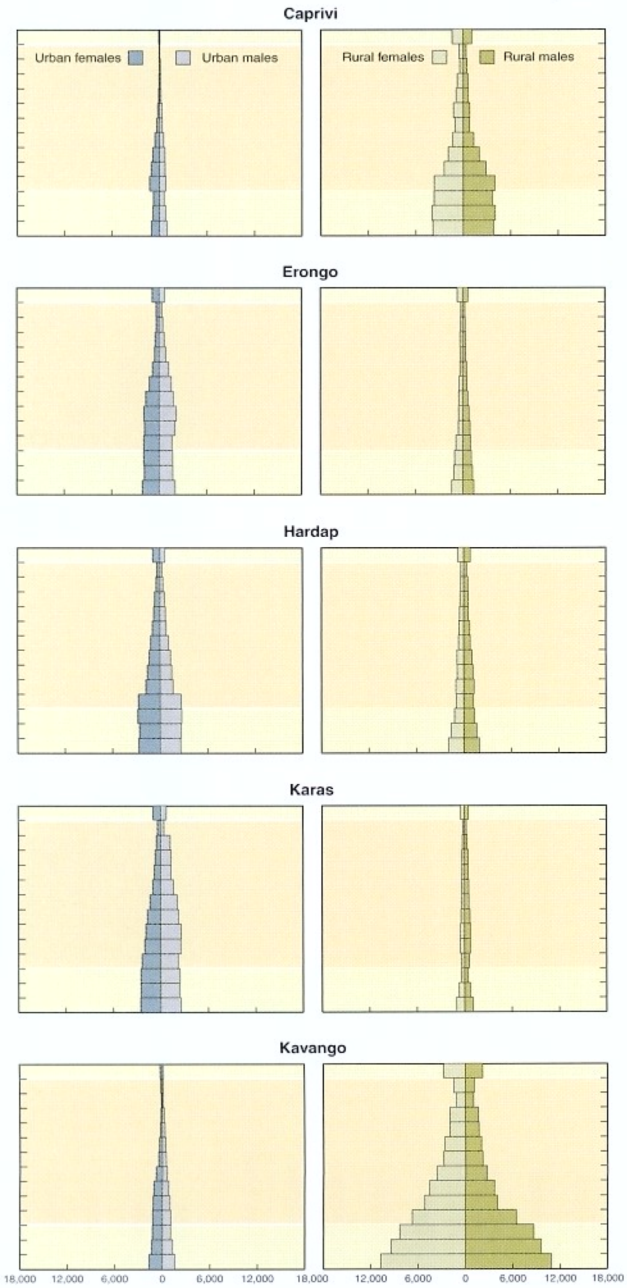


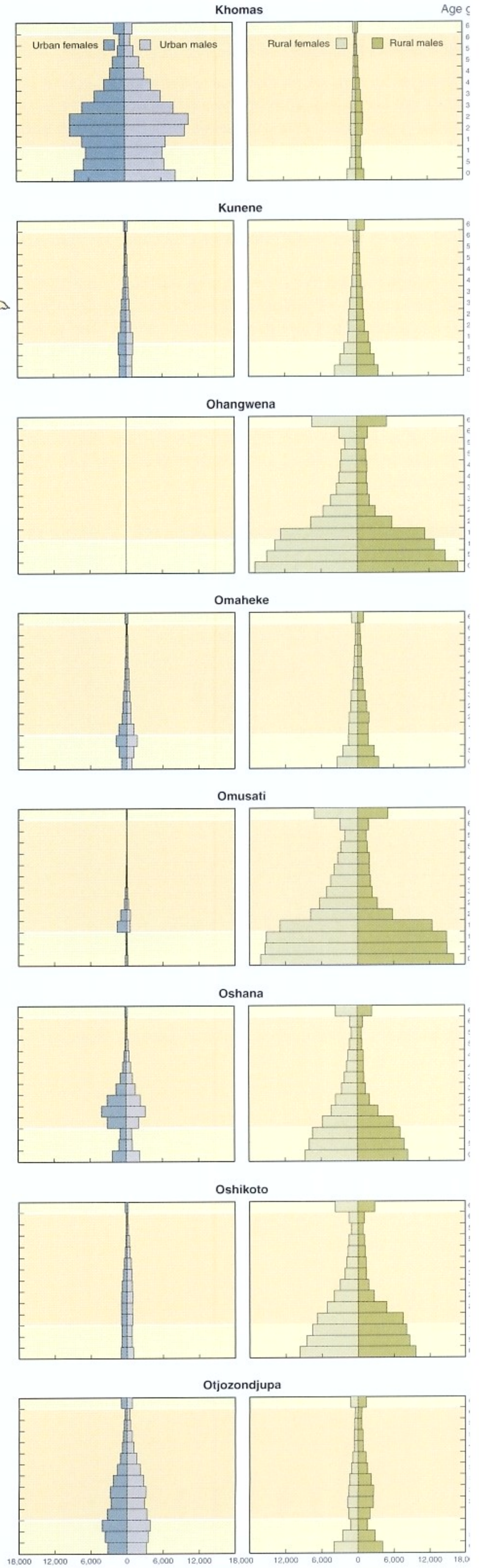


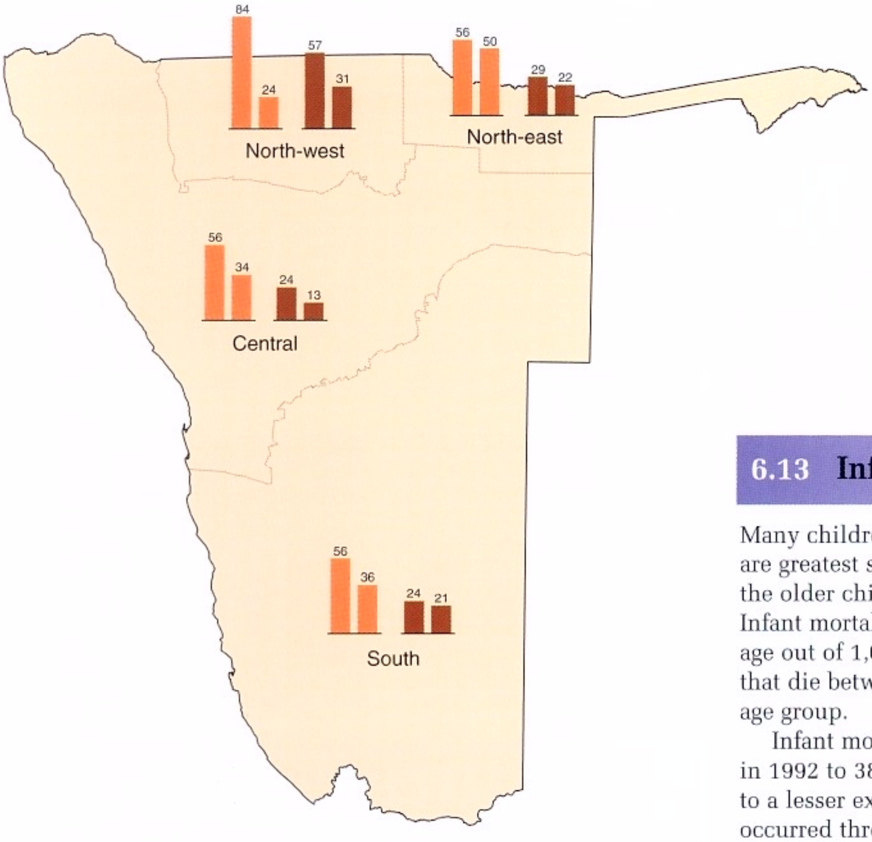
6.12 Age and sex structures in each region[11]

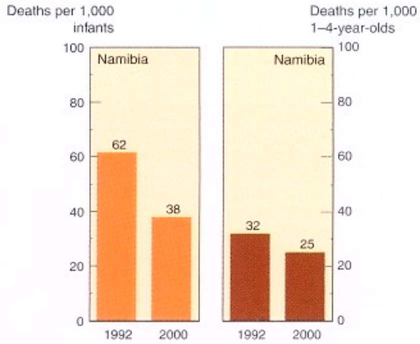
In contrast to the population as a whole, age pyramids for the regions show that numbers of males and females differ greatly in many areas. There are far fewer men than women in the northern regions of Omusati, Oshana, Oshikoto and Ohangwena, for instance, because so many men have moved away to work in towns in other regions. Men therefore outnumber women in many urban areas.

The age pyramids also show how the age structure of populations varies from area to area. Some are dominated by children, for example the rural areas in Ohangwena and Omusati, while others are dominated by older children and young adults, such as the towns in Khomas (i.e. Windhoek), Erongo (Usakos and Swakopmund) and Oshana (Ongwediva, Oshakati and Ondangwa). Many of the atypical shapes to the pyramids are the result of the migration of adults away from their rural homes to work in towns, while others, such as that for Otjozondjupa, result from children being sent to board at urban schools.







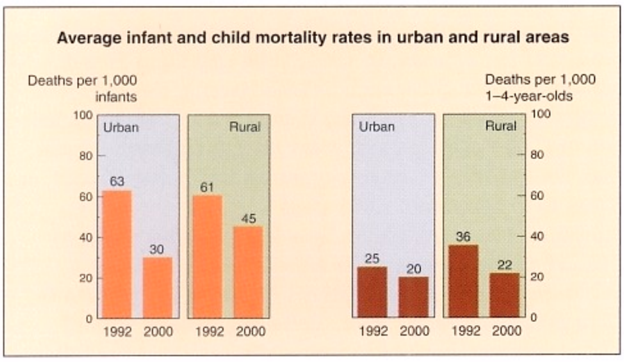


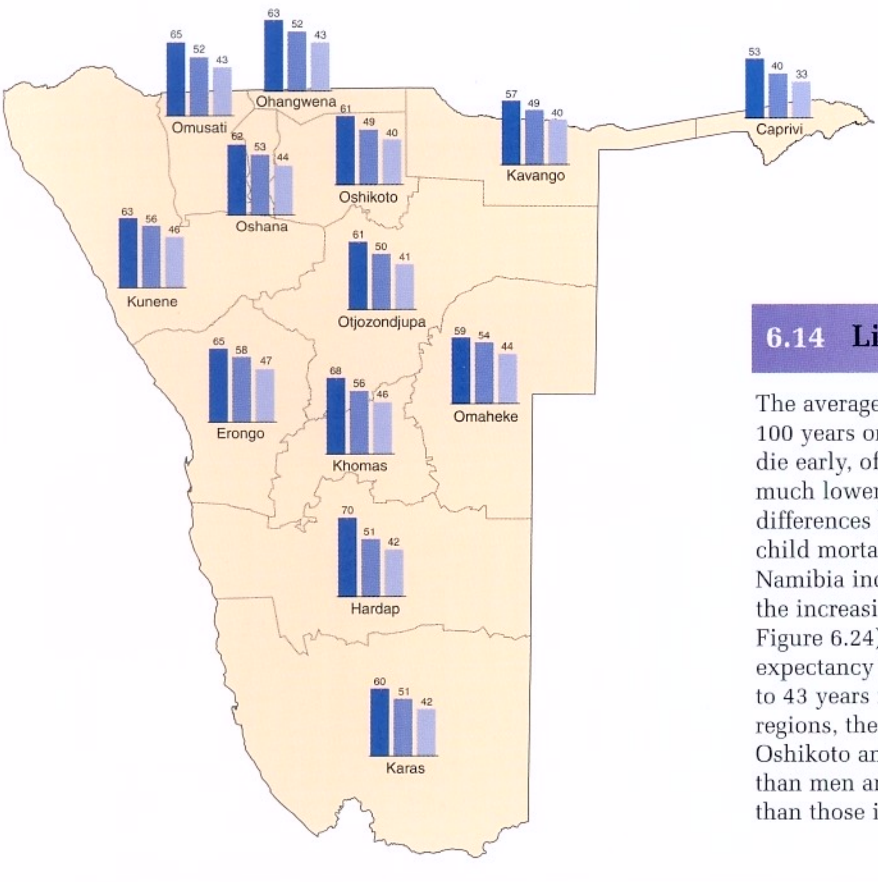
6.13 Infant and child mortality rates [12]

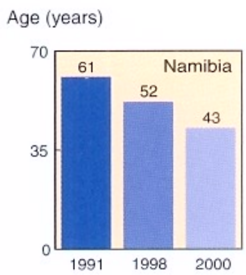
Many children die in their early years. Their chances of dying are greatest soon after birth, and so the odds of survival improve the older children get. Two measures of mortality are shown here. Infant mortality is the number of babies that die before 1 year of age out of 1,000 that are born, while child mortality is the number that die between the ages of 1 and 5 out of 1,000 children in this age group.

Infant mortality dropped dramatically from 62 deaths per 1,000 in 1992 to 38 deaths in 2000. Child mortality also declined but to a lesser extent, from 32 in 1992 to 25 in 2000. The reductions occurred throughout the country, as shown in the graphs, which groups the regions into four zones. Both infant and child mortality rates in rural communities are higher than in urban areas in 2000.

Infant and child mortality rates are generally higher in the northern regions, and areas with higher infant mortality rates usually also have more child deaths. This is probably due to greater poverty, poorer medical care and exposure to tropical diseases – such as malaria – in these regions. Infant mortality is also related to the mothers' level of education: women in these regions are generally less educated than those further south (see Figure 6.16).

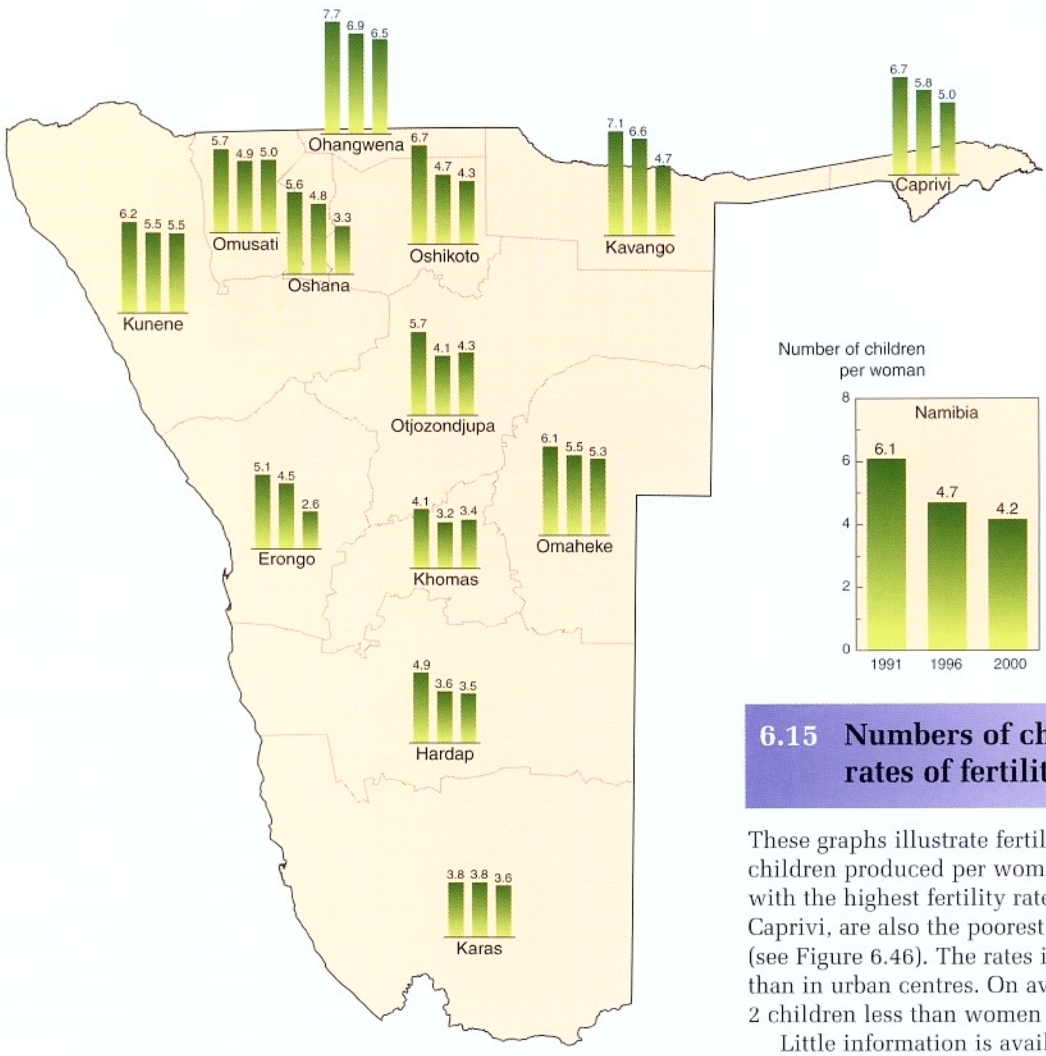


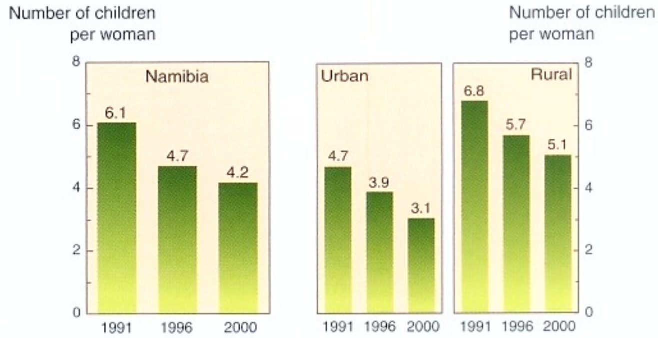




6.14 Life expectancy [13]

The average length of a life is much shorter than the exceptional 100 years or more that a few people reach, because many people die early, often as children (see Figure 6.13). Life expectancies are much lower in northern Namibia than in the south. Many of the differences between regions are due to higher or lower infant and child mortality rates. Over the last few decades, life expectancy in Namibia increased significantly as health care advanced. However, the increasing numbers of young adults dying from AIDS (see Figure 6.24) are now reversing this trend. In 1991 the overall life expectancy was 61 years. It then dropped to 52 years in 1998 and to 43 years in 2000. While there were significant declines in all regions, the biggest reductions have been in Hardap, Caprivi, Oshikoto and Omusati. Women generally live several years longer than men and, on average, people in urban areas live slightly longer than those in rural areas.





6.15 Numbers of children born: rates of fertility [14]

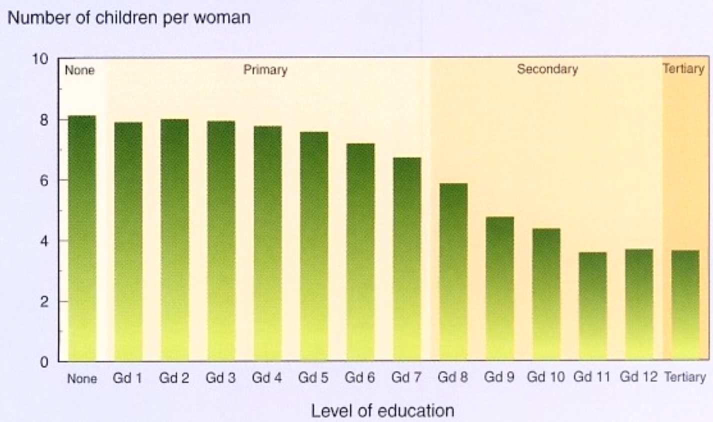
These graphs illustrate fertility rates, or the average number of children produced per woman, in 1991, 1996 and 2000. Regions with the highest fertility rates, such as Ohangwena, Kavango and Caprivi, are also the poorest and least developed in many respects (see Figure 6.46). The rates in rural areas are considerably higher than in urban centres. On average, women in towns have about 2 children less than women in rural areas.

Little information is available on how fertility rates changed prior to 1991. There has, however, been a dramatic decline in recent years, from a national figure of 6.1 children per woman in 1991 to 4.2 in 2000. The reasons for such a big decline are not clear. Fertility rates may have been unusually high in 1991 following the achievement of Independence. Alternatively, the rate in 1991 could indeed have been typical of that time and the subsequent decline may be the result of social changes as many more people entered the modern cash economy, moving to towns, getting jobs and starting businesses. Higher levels of education also lead to lower fertility (see Figure 6.16), and further declines are predicted because of improving levels of education and the effect of AIDS.

6.16 Numbers of children and a mother's education [15]

It is widely acknowledged that women with more education have fewer children than women with little or no schooling. This pattern holds in Namibia, but it is only when women have had some secondary schooling that the effect of education becomes significant. The graph shows the average number of children born to women who have completed different grades or levels of education.

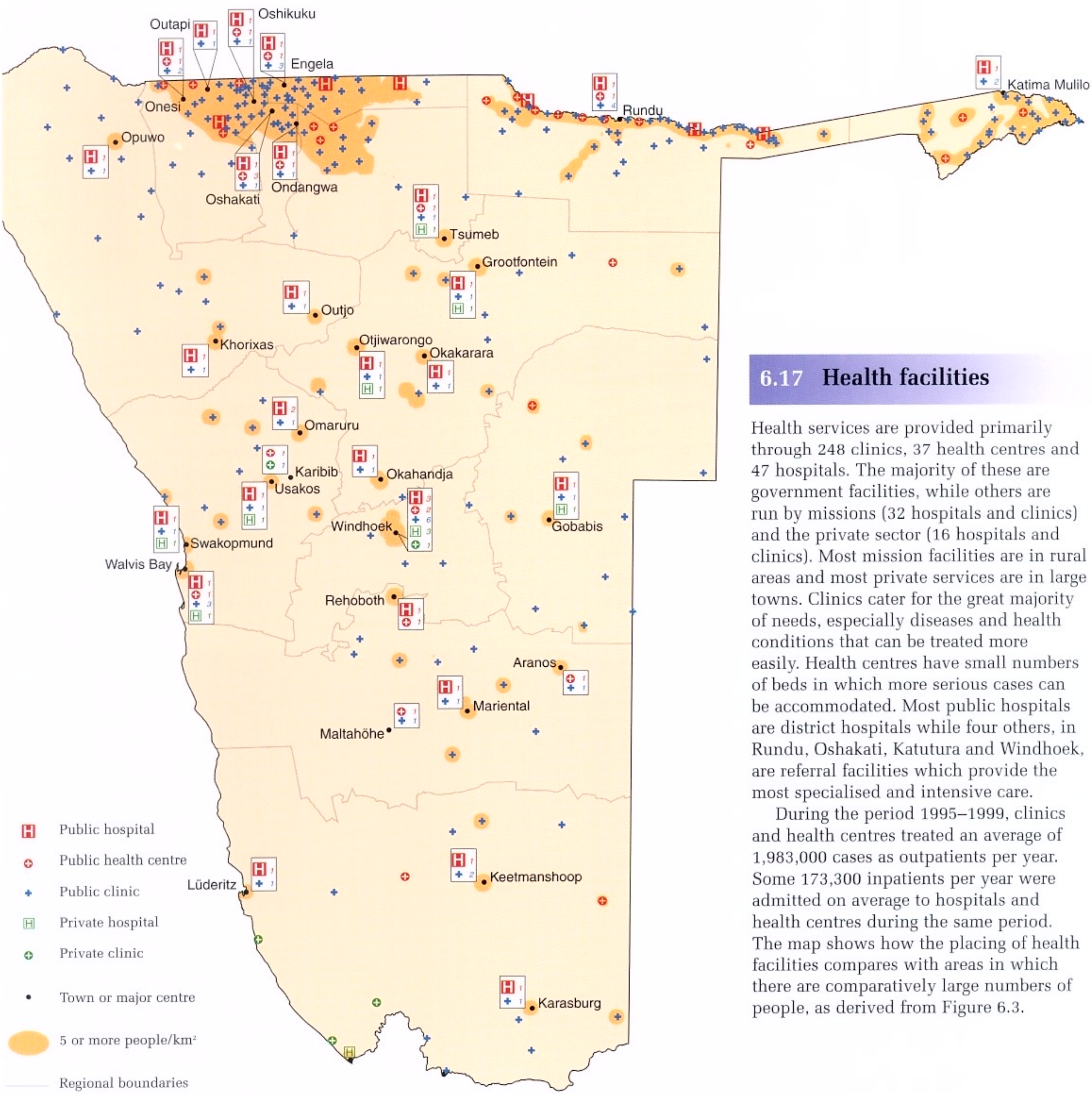
Women who have had no schooling have, on average, 1.4 more children than those who completed a full primary education (Grade 7). By contrast, women who have completed Grade 12 or received tertiary education have about 3 children less than those who completed only Grade 7 or less.



The health of people

Health matters are important because so many people suffer from the debilitating effects of diseases, making their lives uncomfortable, reducing their productivity and increasing their dependence. Poor health is costly to the country for two reasons: losses in productivity lead to economic costs, and large sums of money need to be spent on medical care. Health issues also have huge effects on the country's demography. On the one hand, improved health care over the past decades has led to people living longer and to growth in the population. On the other hand, the high incidence of HIV infection and the resulting deaths from AIDS – which is now the most prominent health issue in Namibia – are reducing life expectancy and slowing down the rate of population growth.

Several sets of information on HIV/AIDS are presented on pages 174 and 175, preceded by information on malaria, diarrhoea and malnutrition. Many people are affected by these health conditions, but their incidence varies across the country.[16]



6.17 Health facilities

Health services are provided primarily through 248 clinics, 37 health centres and 47 hospitals. The majority of these are government facilities, while others are run by missions (32 hospitals and clinics) and the private sector (16 hospitals and clinics). Most mission facilities are in rural areas and most private services are in large towns. Clinics cater for the great majority of needs, especially diseases and health conditions that can be treated more easily. Health centres have small numbers of beds in which more serious cases can be accommodated. Most public hospitals are district hospitals while four others, in Rundu, Oshakati, Katutura and Windhoek, are referral facilities which provide the most specialised and intensive care.

During the period 1995–1999, clinics and health centres treated an average of 1,983,000 cases as outpatients per year. Some 173,300 inpatients per year were admitted on average to hospitals and health centres during the same period. The map shows how the placing of health facilities compares with areas in which there are comparatively large numbers of people, as derived from Figure 6.3.

6.18 The provision of health services[17]

There are many aspects to the provision of health services: medicines, medical equipment, trained health workers, clinics and hospitals, for example. These graphs reflect on two features: the accessibility of medical services and the availability of hospital beds. Of all people in Namibia, about 80% or 1,510,000 people live within 10 km of a public health facility, a distance considered reasonable in providing adequate health services. This means that about 320,000 people do not have such ready access to health services. In some regions access is not as good as in others, especially in areas where there is a low density of people scattered over large areas. This is particularly true of Kunene and Omaheke, where only about half the population lives within 10 km of a health facility.

There is one hospital bed on average for every 271 people in Namibia. Ohangwena, Omusati, Caprivi and Omaheke have the lowest provision of beds with more than 350 people per bed, while Khomas, Oshana and Karas have ratios of less than 200 people per bed. The lower ratios in Khomas and Oshana reflect, to some extent, the presence of the Oshakati, Katutura and Windhoek hospitals to which people are referred from other regions.

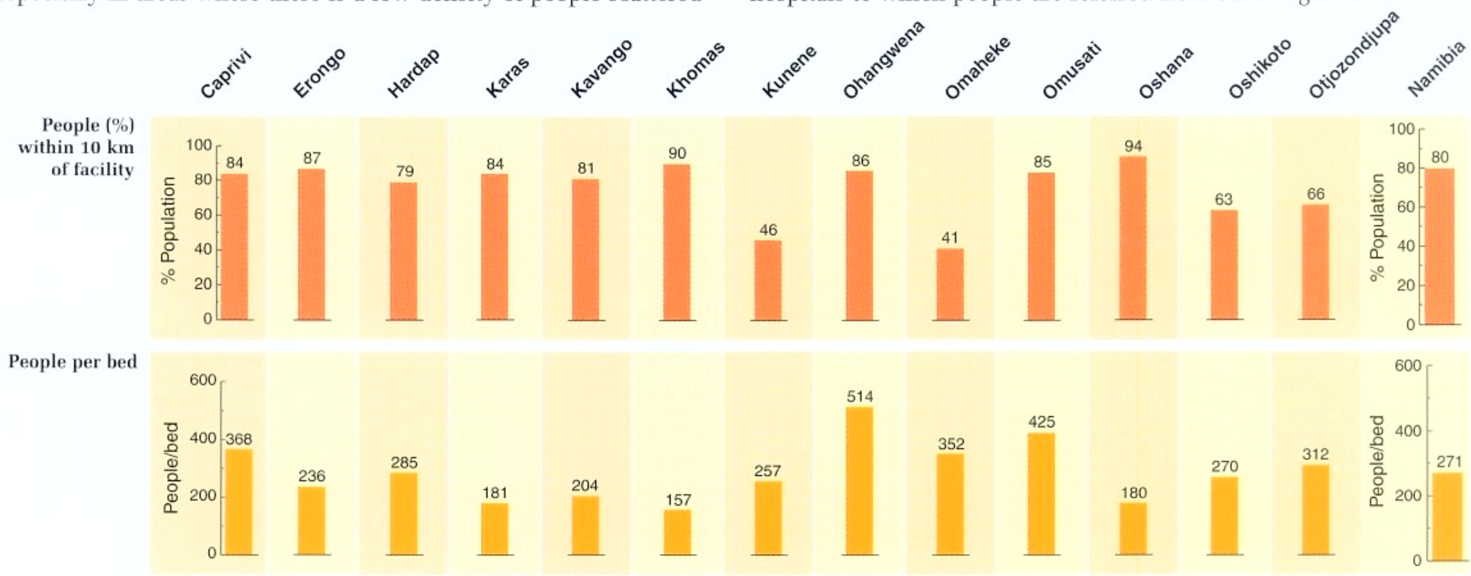


Table 6.2 The main causes of death, 1995–1999[18]

Five diseases accounted for 46% of all deaths in government hospitals over the five years between 1995 and 1999. Until 1996 malaria was the main cause of death among adults in Namibia, and it is only since then that AIDS has started to kill more people. Over half of all AIDS deaths were recorded in Oshana, Omusati, Kavango and Khomas, largely because of the high number of people in these regions.

Diseases such as tuberculosis and malaria have always been major causes of death in Namibia. However, many deaths now attributed to such diseases are associated with AIDS because the HIV virus reduces the body's ability to withstand infections, making people more susceptible to diseases which might previously not have been fatal.

Between 1995 and 1999 deaths as a result of acute respiratory infections, such as pneumonia, were especially prevalent in Oshana and Oshikoto, while the number of people killed by malaria was greatest in Kavango, Oshana, Omusati and Caprivi. Other important causes of death in Namibia are cancer, heart conditions, prematurity and malnutrition. Most deaths due to malnutrition are recorded among children between 1 and 3 years old. These are risky ages because children are usually in transition from a diet of breast milk to solid foods.

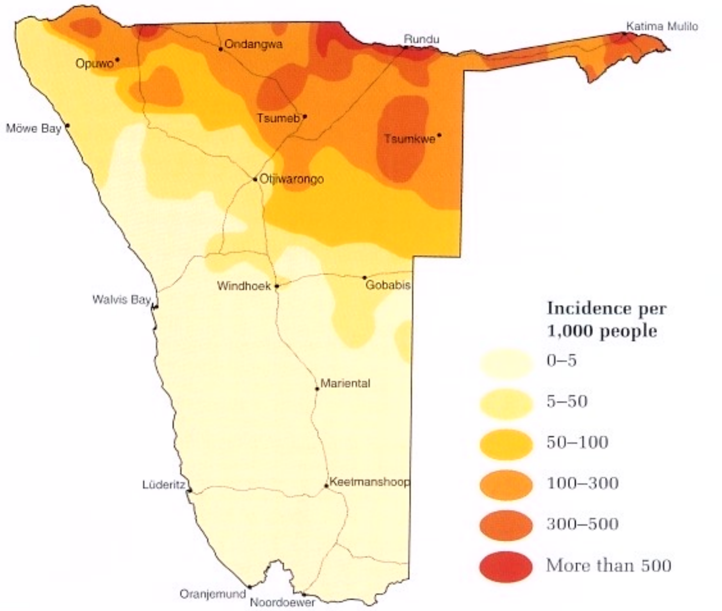
	AIDS	Tuberculosis	Acute respiratory infections	Gastroenteritis	Malaria	Total
Namibia	**6,934**	**3,630**	**3,603**	**2,869**	**2,588**	**19,624**
Caprivi	338	246	258	454	338	1,634
Erongo	258	151	103	64	6	582
Hardap	124	206	122	79	10	541
Karas	122	139	84	84	1	430
Kavango	905	303	393	522	627	2,750
Khomas	1,020	345	460	188	113	2,126
Kunene	54	67	68	62	43	294
Ohangwena	590	296	401	157	191	1,635
Omaheke	44	96	50	90	62	342
Omusati	1,022	367	232	120	351	2,092
Oshana	1,468	515	691	363	404	3,441
Oshikoto	709	681	543	529	286	2,748
Otjozondjupa	280	218	198	157	156	1,009

6.19 Rates of infection by malaria[19]

Many people contract malaria every year. The great majority of cases are in northern Namibia, where most people live and where mosquito vector numbers are highest. Most people recover from malaria within a few days, the main effect being severe sickness and fever during the period of infection. Many others, however, succumb to the disease, and until 1996 it was the main cause of mortality in Namibia, whereafter deaths from AIDS became more numerous. Malaria is difficult to control or eradicate since malaria parasites evolve to withstand many of the drugs used to treat the disease.

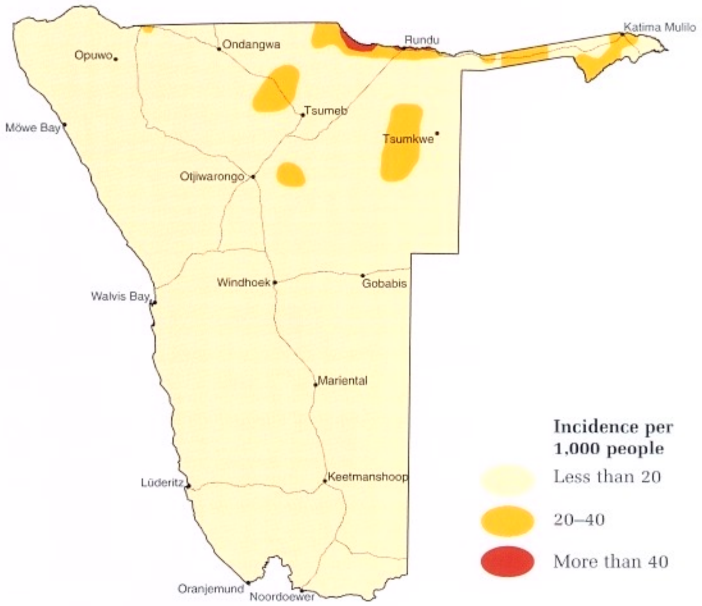
The figures on the map give the average incidence of malaria detected at government health facilities each year between 1995 and 1999. The highest rates of infection, more than 500 cases per 1,000 people, show that in some areas more than half the population may be treated for malaria each year.

Rates of infection vary from year to year and are especially high after good rains. Infections also vary during the year, starting earliest in Caprivi because that region receives rain before areas to the west and south (see Figure 3.24). The disease then spreads westwards and south from December onwards, so that rates of infection peak in March, April and May in regions such as Omusati and Kunene.



6.20 The incidence of diarrhoea[20]

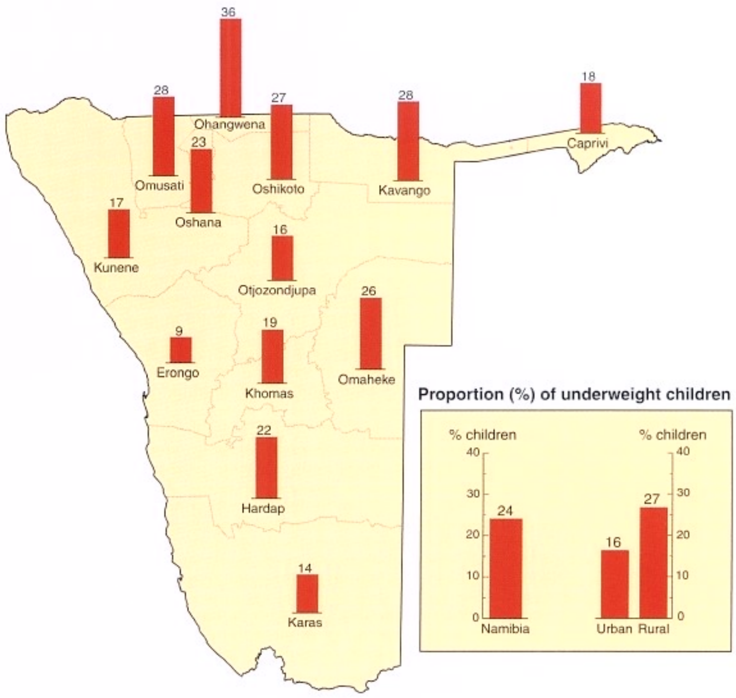
Many people suffer from diarrhoea each year, usually as a result of infections caused by parasites and bacteria carried in dirty water or contaminated food. The map shows the average number of cases of severe diarrhoea each year per 1,000 people, between 1995 and 1999. These severe cases are usually caused by intestinal infections and can lead to gastroenteritis and death. The highest incidence is along the Okavango River, in parts of eastern Caprivi, and among rural communities in eastern Otjozondjupa.



6.21 Malnutrition amongst children

While most Namibians are adequately fed, there are considerable numbers of people that live in poverty and do not get adequate nourishment. One effect of this is that children do not develop as they should.

A survey in 2000 found that 24% of all children aged 5 and younger in Namibia were underweight.[21] Greater proportions of children in rural areas (27%) were underweight than those in urban areas (16%). The highest proportions of underweight children were in Ohangwena (36%), Kavango and Omusati (both 28%) and Oshikoto (27%). Less than 10% of children were underweight in Erongo, by contrast.

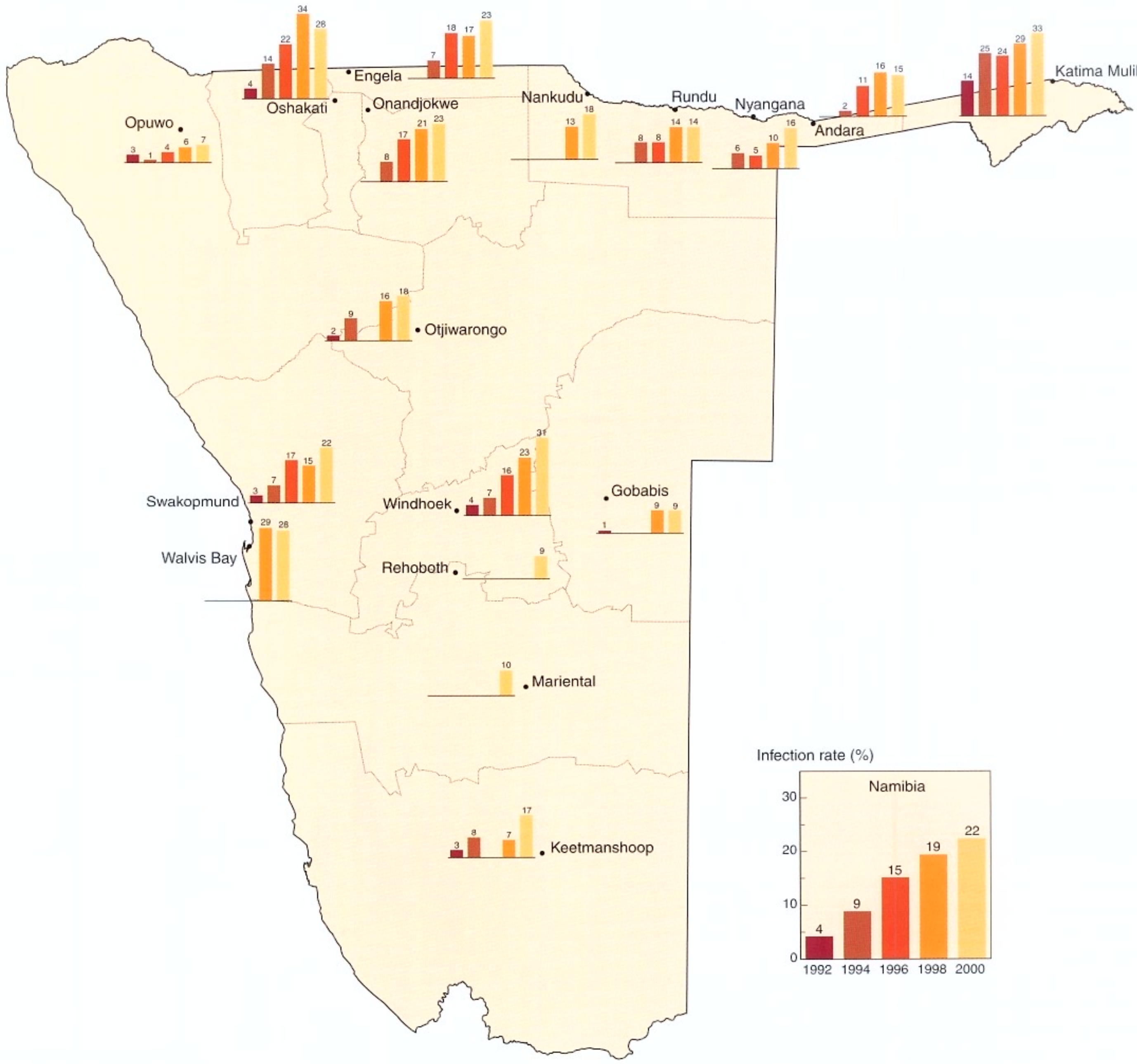


6.22 HIV infection rates[22]

Sample tests for HIV have been carried out at hospitals since 1992 on randomly selected pregnant women. Their rates of infection provide a good measure of infection rates among all people in age groups that are sexually active.

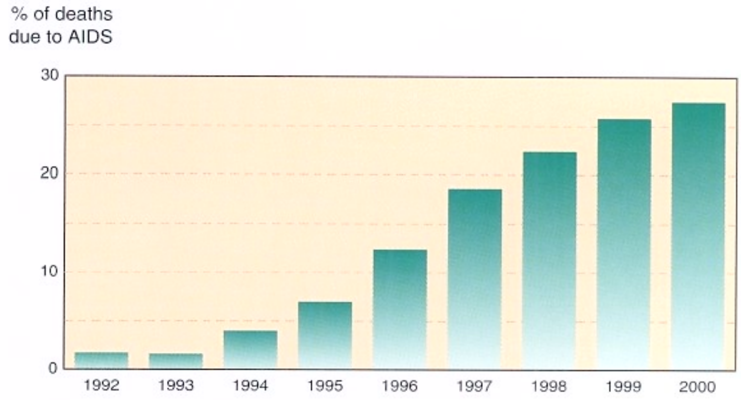
The overall rate of infection in Namibia has increased from 4% in 1992 to 22% in 2000. Several other interesting results have emerged:

- rates increased more rapidly at some places (e.g. Oshakati) than at others (e.g. Opuwo);
- rates of infection rose above 20% in Caprivi much earlier than elsewhere;
- infection rates in northern Namibia are generally higher than in the south, but the incidence of the disease is lower in Kavango than in the other densely populated northern regions of Caprivi, Ohangwena, Oshikoto, Oshana and Omusati;
- rates reported at most large urban hospitals (Oshakati, Windhoek and Walvis Bay) are higher than at those serving more rural communities; and
- 25% of all people with HIV are in the 25–29 age group.



6.23 The growing number of AIDS deaths

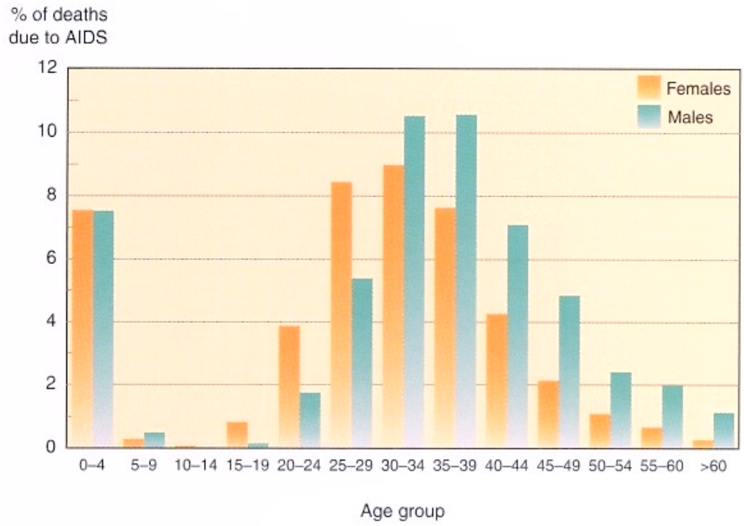
While information in Figure 6.22 records rates of HIV infection, data from 1992 onwards show the increasing proportions of all deaths caused by AIDS. Whereas the disease accounted for less than 2% of deaths in 1992, this rose to 28% in 2000. One out of every four deaths in 2000 was thus due to AIDS. The number of AIDS deaths in government hospitals rose from only 86 in 1992 to about 3,400 in 2000. Including people that died outside government hospitals, the total number of people who died of AIDS in 1999 is estimated to have been 18,000. About 67,000 children are also estimated to have become orphans by the end of 1999 as a result of AIDS deaths. Whilst this is a large number, it is small compared to the number of orphans that Namibia will have in the years ahead.



6.24 Who has died of AIDS? [23]

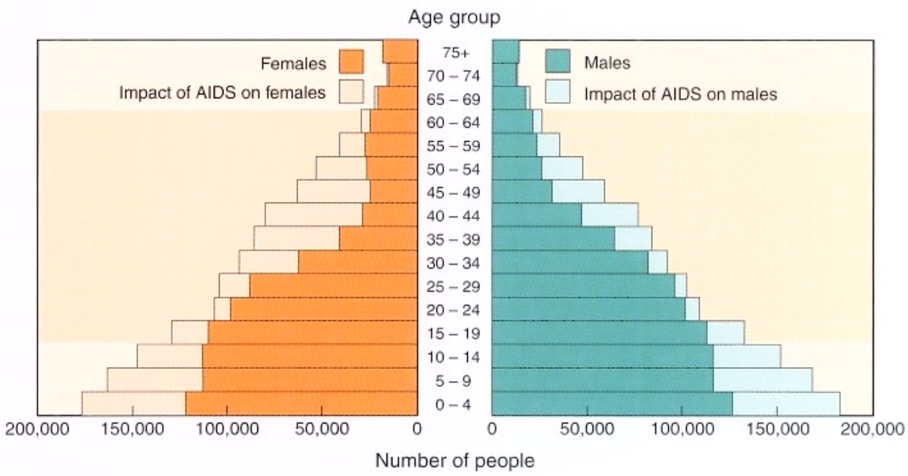
Of all people who died of AIDS between 1995 and 1999, 54% were males and 46% were females. About 8% were children under the age of 5 who contracted the HIV virus from their mothers. About 30% of infected mothers pass the virus to their children as foetuses; breast-fed children may also be infected through their mothers' milk.

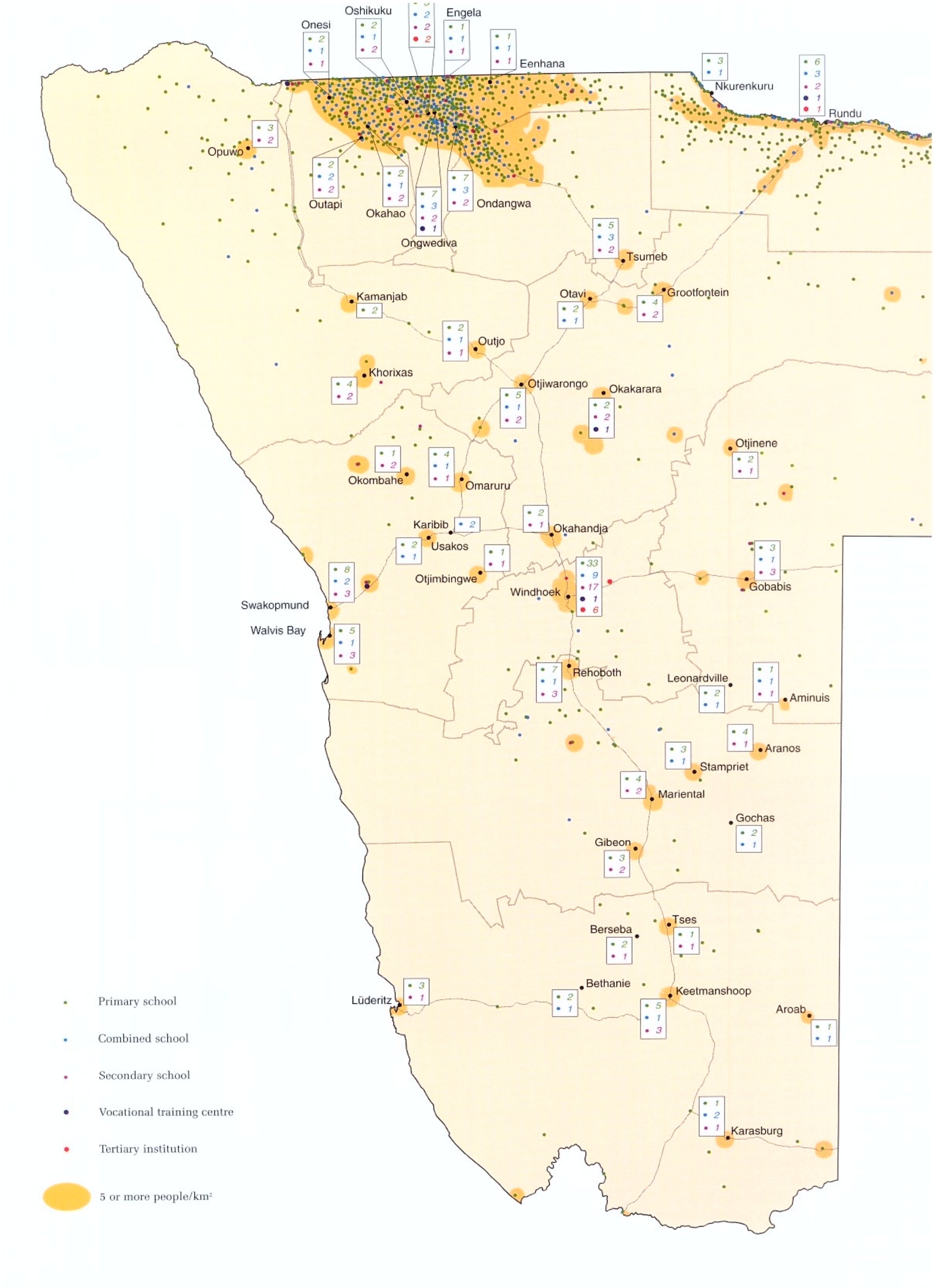
The majority of deaths occur among people between the ages of 25 and 45: almost 40% of all people who have died of AIDS were between 30 and 40 years old. These are amongst the most economically active people in the country. In addition to being of a productive age, most people in these age groups are also better educated. Men who contract the disease are generally older than women with AIDS because men usually remain promiscuous longer than women. Women are also often sexually active at younger ages than men.



6.25 Effect of AIDS on the structure of the population [24]

It is clear that AIDS is having, and will continue to have, a great impact on Namibia's population. This age pyramid shows one estimate of what the Namibian population may look like in 2016. The bars compare the expected numbers of people in the absence of AIDS with the numbers that are now predicted. Much of the change will be due to three effects that AIDS has on the population: increased death rate, reduced fertility, and the absence of children who would otherwise have been born to women that have died. Life expectancies will drop substantially (see Figure 6.14), and the structure of the population will change as a result of so many young adults being killed. The fertility rate could decline by 20–30% as a result of AIDS alone. With over 20% of Namibians aged 15 to 49 infected with the virus in 2000, at least one in five people in that age group will die from AIDS before 2010.




Oshikuku
Engela
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Rundu
Opuwo
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Ondangwa
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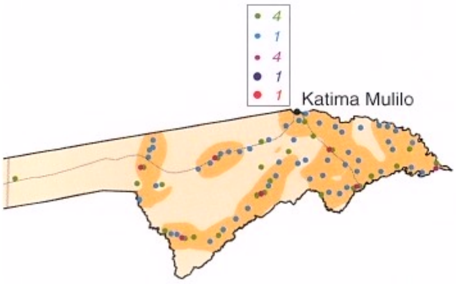
Otavi
Grootfontein
Outjo
Khorixas
Otjiwarongo
Okakarara
Otjinene
Okombahe
Omaruru
Karibib
Usakos
Okahandja
Otjimbingwe
Windhoek
Gobabis
Swakopmund
Walvis Bay
Rehoboth
Leonardville
Aminuis
Aranos
Stampriet
Mariental
Gochas
Gibeon
Tses
Berseba
Bethanie
Keetmanshoop
Lüderitz
Aroab
Karasburg
Primary school
Combined school
Secondary school
Vocational training centre
Tertiary institution
5 or more people/km²



The education of people [25]

The provision of schooling in Namibia has gradually increased over the past hundred years. While historically some groups of people have had little or no access to education, others have had a comparatively long history of good schooling. This has had a major impact on the levels of education among people of different ages, and different sexes, and in different areas. Information on school attendance rates and measures of performance of school pupils provide perspectives on how well the education sector is currently doing. Namibia's Constitution states that all children must attend school from the age of 6 until they complete primary school or reach the age of 16, whichever comes first. An estimated 94% of all 7–13-year-olds attended school in 2000. This is a very high percentage compared to school attendance in most other African countries.

6.26 Education facilities

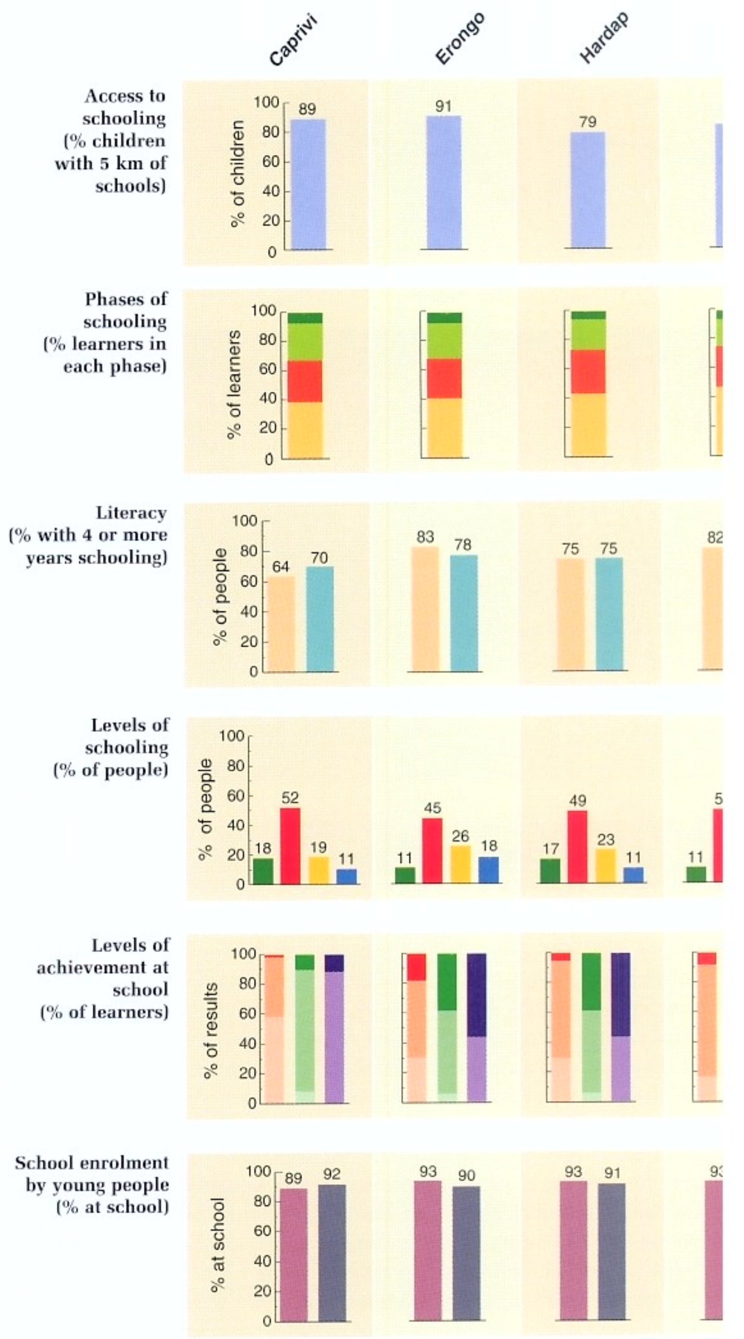
Formal education was offered in 2001 at 1,541 registered schools of which 1,491 were government schools run by the Ministry of Basic Education, Sport and Culture, offering Grades 1 to 12. Most of the 50 registered private schools are in the larger towns. Although primary and secondary grades are usually provided in separate schools, many so-called combined schools offer one or more grades in both phases. A total of about 540,000 pupils were at school, representing almost one in three of all people in Namibia. Over half of all pupils are at schools in the central northern regions. Some 17,700 teachers are employed in the education system. The map shows the distribution of formal education facilities in relation to areas that are comparatively densely populated (see Figure 6.3).

Education is also offered in several other forms. There are over 3,000 pre-primary schools, a few of which are subsidised by the government while the majority are privately funded. In 2001 approximately 49,000 adults attended literacy training programmes designed to improve the reading and writing abilities of adults who did not have an adequate education as children. Vocational training is offered at seven government and several private-sector facilities. Tertiary-level education is provided by the Polytechnic of Namibia and the University of Namibia at campuses in Windhoek and Oshakati and at several colleges for teachers, police officers, nurses and agriculturalists.

As a proportion of public spending, Namibia has spent much more on education than most other countries in recent years. One consequence is that comparatively high proportions of children have access to schooling. There is a need to reduce disparities between educational services offered at former white and black schools and between rural and urban schools, but the most important challenge is to improve the quality of teaching and learning.

6.27 Access to schooling

Namibia aims to ensure that all children have access to schooling. In this analysis, those living within 5 km of a school can be assumed to have reasonable access to education (although not all grades would be available in each school). This figure shows the proportions of children in each region who live within 5 km of schools that offer Grade 1. The total percentage of children within 5 km of schools with Grade 1 is 85%. Regions with the best access are Omusati, Oshana and Ohangwena, where more than 95% of children are close to schools. Children from Kunene, Omaheke and Otjozondjupa have the poorest access.



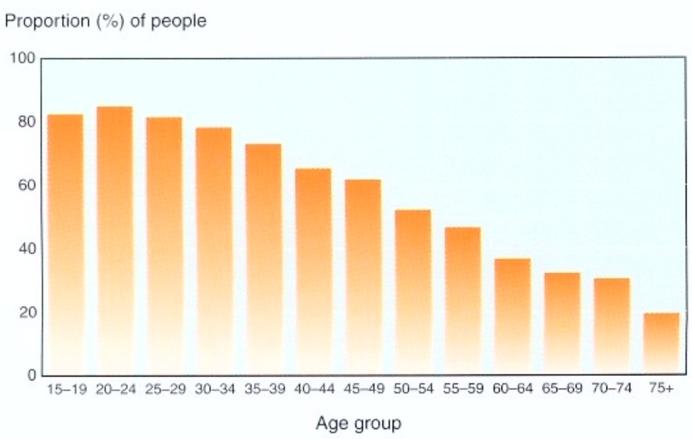
6.28 Phases of schooling

Although most children start school in Grade 1, many leave before completing their primary or secondary education, often because there are no schools nearby that offer higher grades. One can assess how many children progress to higher grades by comparing the percentages of all pupils in different phases. The high percentages of primary-level pupils in regions such as Kavango, Kunene and Otjozondjupa indicate that relatively few children here go through into secondary grades. Conversely, many pupils complete their schooling in regions showing high proportions of secondary pupils, such as Caprivi. This is also true of pupils in Khomas, Erongo and Oshana, though these regions also attract secondary pupils from other regions where there are fewer secondary schools.

6.29 Literacy [26]

The ability to read and write is important for the effective functioning of modern society. However, it is often difficult to measure literacy because many people exaggerate their ability to read and write if asked. An alternative measure of literacy uses the assumption that people can read and write if they have had four or more years at school.

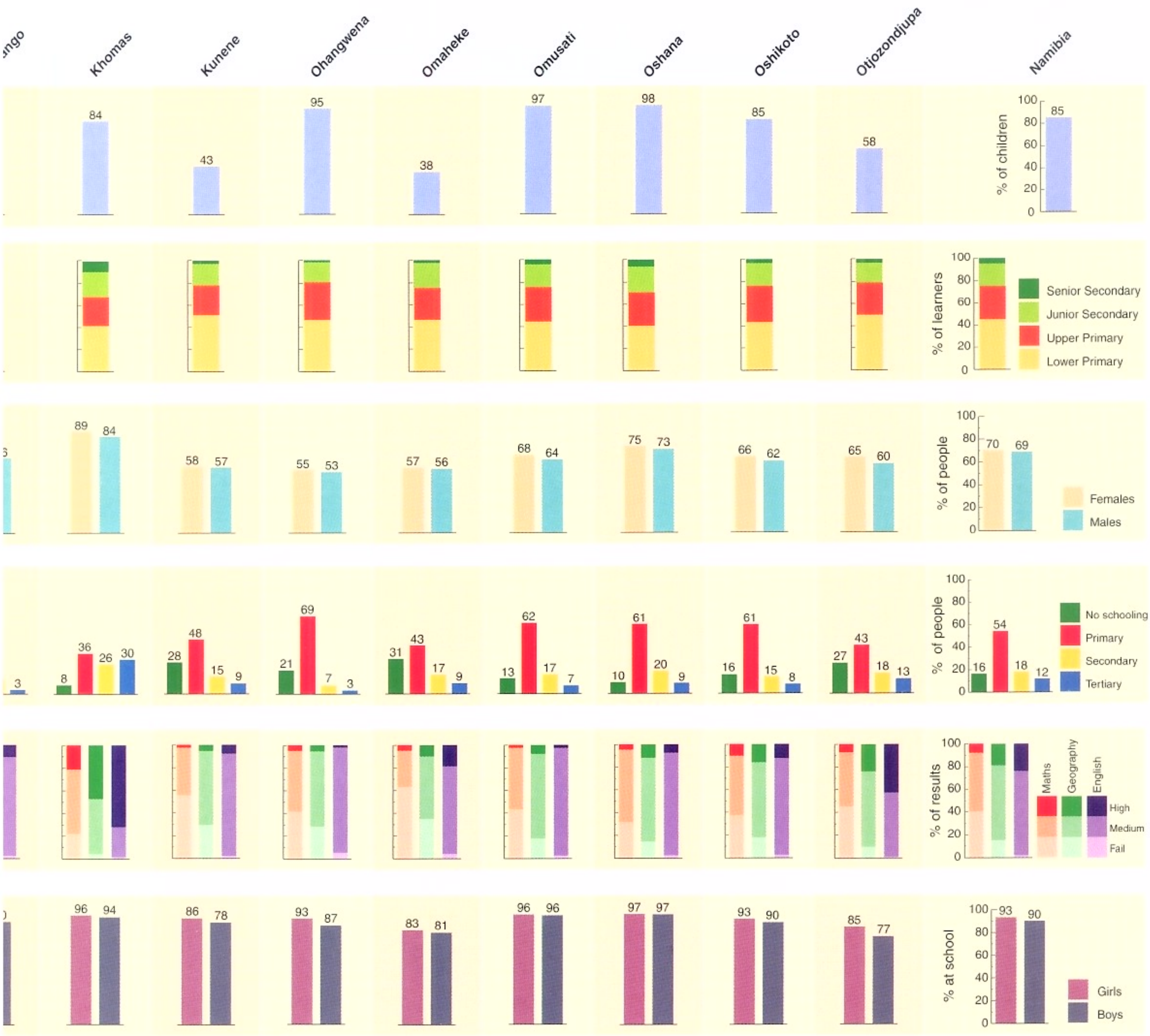
Several interesting patterns emerge from an analysis of the number of years of schooling. Firstly, levels of literacy vary from less than 60% in Kunene, Ohangwena and Omaheke to more than 80% in Karas, Erongo and Khomas. Secondly, higher proportions of women than men are literate in most regions, exceptions being Kavango, Caprivi and Hardap. Thirdly, older people are less likely to be literate than younger people, as shown in the graph below. This is the result of the gradual increase in the provision of schooling over the past 50 years or so, and the poorer educational opportunities available to people who are now elderly.



6.30 Levels of schooling [27]

In addition to variation in the number of people having four or more years of schooling (Figure 6.29) there are also substantial regional differences as to whether people have attended school or not and, if they did go to school, what phases of schooling were completed. Much of the variation in levels of education among adults can be ascribed to historical changes in the provision of schools.

The biggest regional differences are between Khomas, where only 8% of people aged 6 and older have not been to school, and Kunene and Omaheke, where about 30% have not attended any school. Similarly, about 30% of people in Khomas have a senior secondary or higher education compared to just 3% in Kavango and Ohangwena. Other regions in which less than 10% of people have a senior secondary or higher education are Kunene, Omusati, Oshana, Oshikoto and Omaheke. These low figures reflect several problems: a lack of places in high schools, low demands for education, and the fact that many people with higher levels of education move away from rural areas.



6.31 Levels of achievement at school [28]

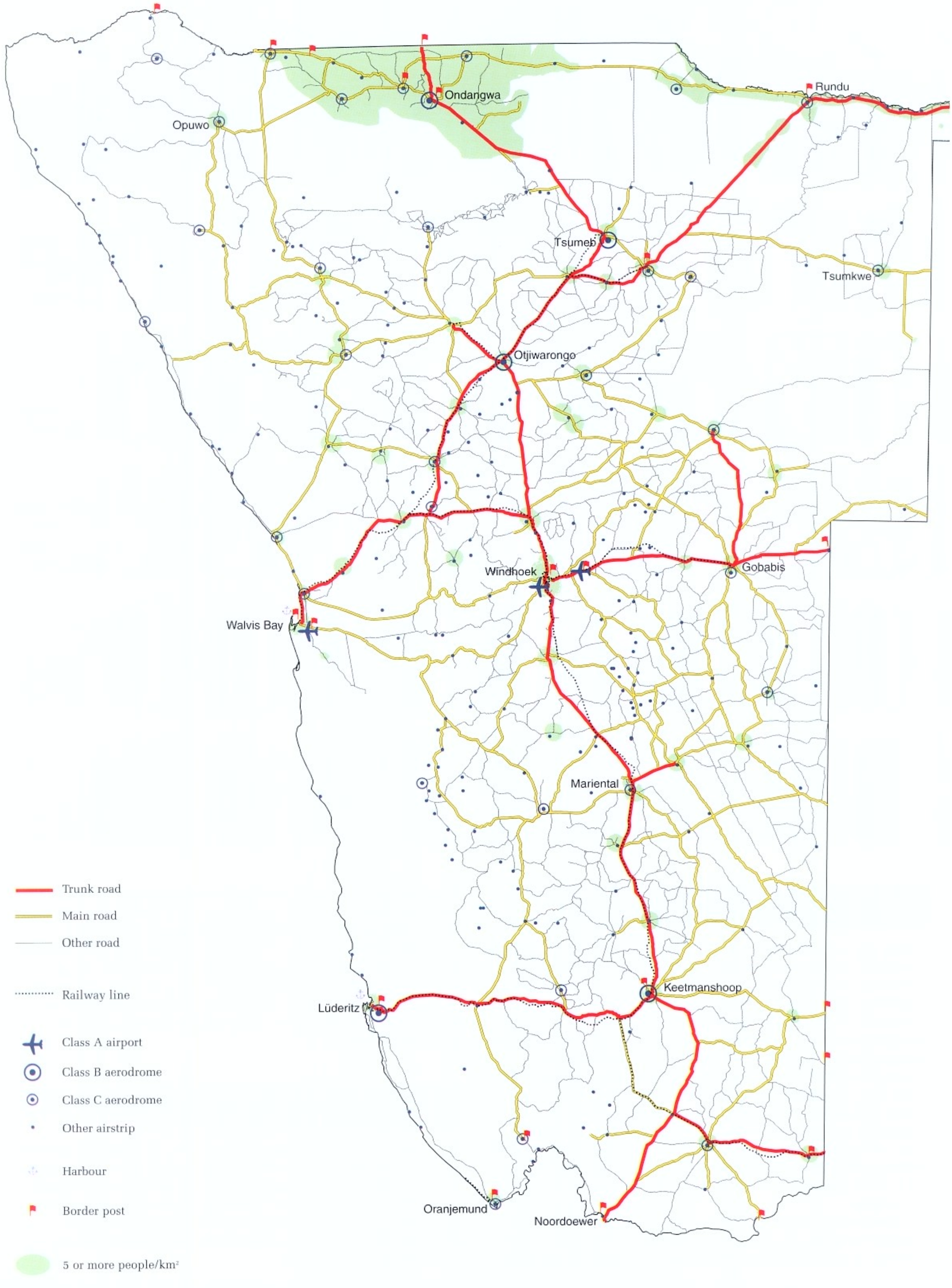
A large part of Namibia's budget and development effort is devoted to education, but what does this investment produce? This is difficult to answer, both because there is little good information available and because it is hard to know exactly what to measure. The results of the national Grade 10 examination provide several perspectives on the issue. Performance in three subjects is shown: Mathematics, Geography, and English as a second language.

Results for Mathematics are much poorer than for Geography, while those for English are much better. Only 8% of all pupils scored high marks for Mathematics, compared to 19% for Geography and 24% for English. Similarly, 40% of all pupils failed Mathematics, but only 15% and 2% failed Geography and English, respectively. The same pattern holds true in all regions, but it is not clear why results should differ so greatly between the subjects.

There are also major differences between the regions in the proportions of pupils getting high, medium or fail marks. More than half of all pupils failed Mathematics in Caprivi, Omaheke, Kavango and Kunene. Pupils in Khomas, Oshikoto and Erongo did much better, with 10% or more of them scoring high marks. About 30% or more of pupils failed Geography in Kunene, Omaheke and Ohangwena, while 40% or more pupils in Khomas, Karas, Erongo and Hardap got high marks. In English, the great majority of pupils received medium results and very few pupils failed. Only in five regions were there substantial numbers of pupils who got high marks: Otjozondjupa, Hardap, Khomas, Karas and Erongo.

6.32 School enrolment by young people [29]

This graph compares school enrolment rates for children aged 7–16 in 1996. Some 93% of girls and 90% of boys of these ages were at school. Higher enrolment rates for girls are evident in all regions except Caprivi and Kavango. The highest rates of enrolment were in Khomas, Oshana and Omusati, and the lowest in Kunene, Otjozondjupa and Omaheke. These rates are high compared to many developing countries.



Ondangwa
Rundu
Opuwo
Tsumeb
Tsumkwe
Otjiwarongo
Windhoek
Gobabis
Walvis Bay
Mariental
Keetmanshoop
Lüderitz
Oranjemund
Noordoewer
Trunk road
Main road
Other road
Railway line
Class A airport
Class B aerodrome
Class C aerodrome
Other airstrip
Harbour
Border post
5 or more people/km²

Infrastructure and services

The economic and social development of a country depends to a great degree on its infrastructure and public services which, for example, allow goods and people to be transported and enable people to communicate quickly and efficiently. Electricity supplies provide power to light homes and to cook food, as well as energy for factories, mines and other enterprises. Adequate and safe supply systems for water are important, especially in Namibia where water is such a scarce commodity. The judicial services aim to maintain law and order.

The maps in this section show where Namibia's infrastructure has been developed and needs to be maintained in good shape; some of the maps suggest areas where new developments are needed. Additional information on infrastructure for the health services and education is given in Figures 6.17 and 6.26, respectively. All these maps depict areas in which there are more than 5 people per km^2, to provide an indication of how the services are placed in relation to areas with comparatively large numbers of people.

6.33 Transportation systems and services [30]

Of the four transport systems (roads, railways, shipping and air), roads are by far the most important in terms of the volumes of people and goods they carry. There are about 140,000 road vehicles in Namibia but most traffic is concentrated on relatively few sections of roads. Thus, only 7% of the whole network of about 43,000 km of proclaimed roads carries an average of 200 vehicles or more per day. Tarred roads cover about 5,200 km and carry 75% of all traffic. Most of the remaining roads are gravel. Namibia's road network is reputed to be amongst the best maintained in the world.

The rail network consists of about 2,400 km of tracks. Railways are used largely for the bulk transport of goods; relatively few people travel by train in Namibia. Freight volumes declined at a rate of 5.2% per year between 1988 and 1998, mostly because road transport is considered better in getting goods delivered 'on time'.

An average of 2,000 vessels call at Namibia's two harbours each year. Walvis Bay is much the bigger, handling 95% of about 2,500,000 tonnes of marine freight transported in and out of Namibia in 1998, for example. Lüderitz harbour is devoted largely to the fishing industry and some coastal shipping.

There are about 365 registered aircraft, 41 Class A, B and C airports and aerodromes, and approximately 360 airstrips in Namibia. Most airstrips are small gravel runways on farms and in remote areas which are difficult to reach by road. The majority of passengers pass through Hosea Kutako and Eros airports; these two terminals respectively handled some 380,000 and 105,000 passengers in 2001. Border controls are offered at 28 points along the country's borders and at major airports.

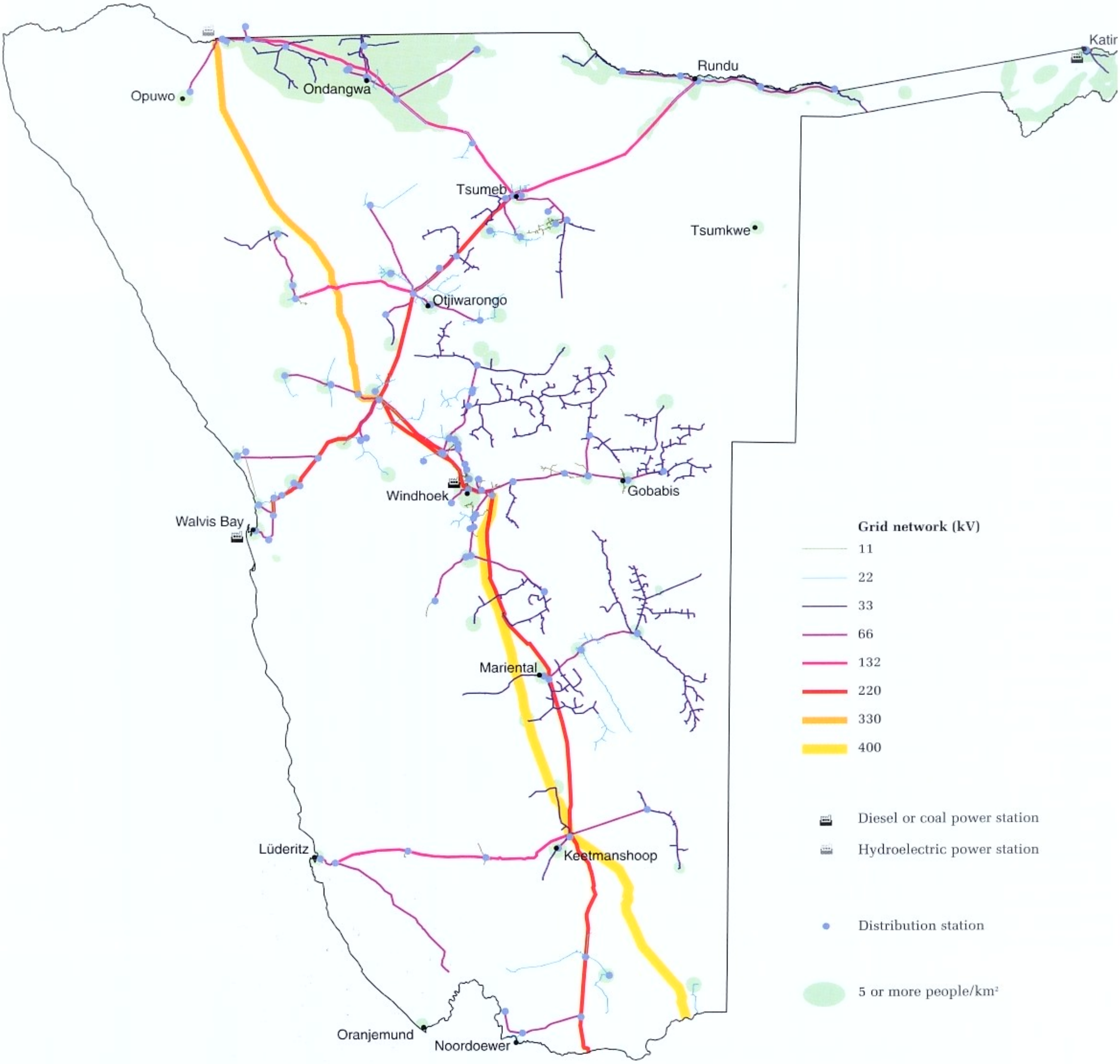
Existing networks and infrastructure for rail, road, marine and air transport are in comparatively good order. These important assets give Namibia a solid basis for further economic and social development.

6.34 Electricity [31]

The main sources of electrical power are South Africa (carried along two high-voltage lines of 400 kV and 300 kV with capacities of 500 MW and 200 MW, respectively), the hydroelectric scheme at Ruacana (240 MW), the coal-fired Von Eck power station in Windhoek (120 MW), and diesel-powered generators at Walvis Bay (24 MW) and Katima Mulilo (3 MW). A wind park (20 MW) near Lüderitz is being developed, while other sources that have been investigated in recent years include another hydroelectric scheme (400–500 MW) on the Kunene River and the Kudu Gas Field (750 MW) (see Figure 2.18). Namibia's current total annual consumption of some 300 MW is projected to grow to about 660 MW in 2020.

The national electricity grid of 15,500 km of transmission lines serves to distribute power from several primary sources of electricity. High-voltage lines deliver power via a network of lines of successively lower and lower voltages the closer they come to the final consumers of electricity. Sub-stations along the grid distribute and transform the power from higher to lower voltages.

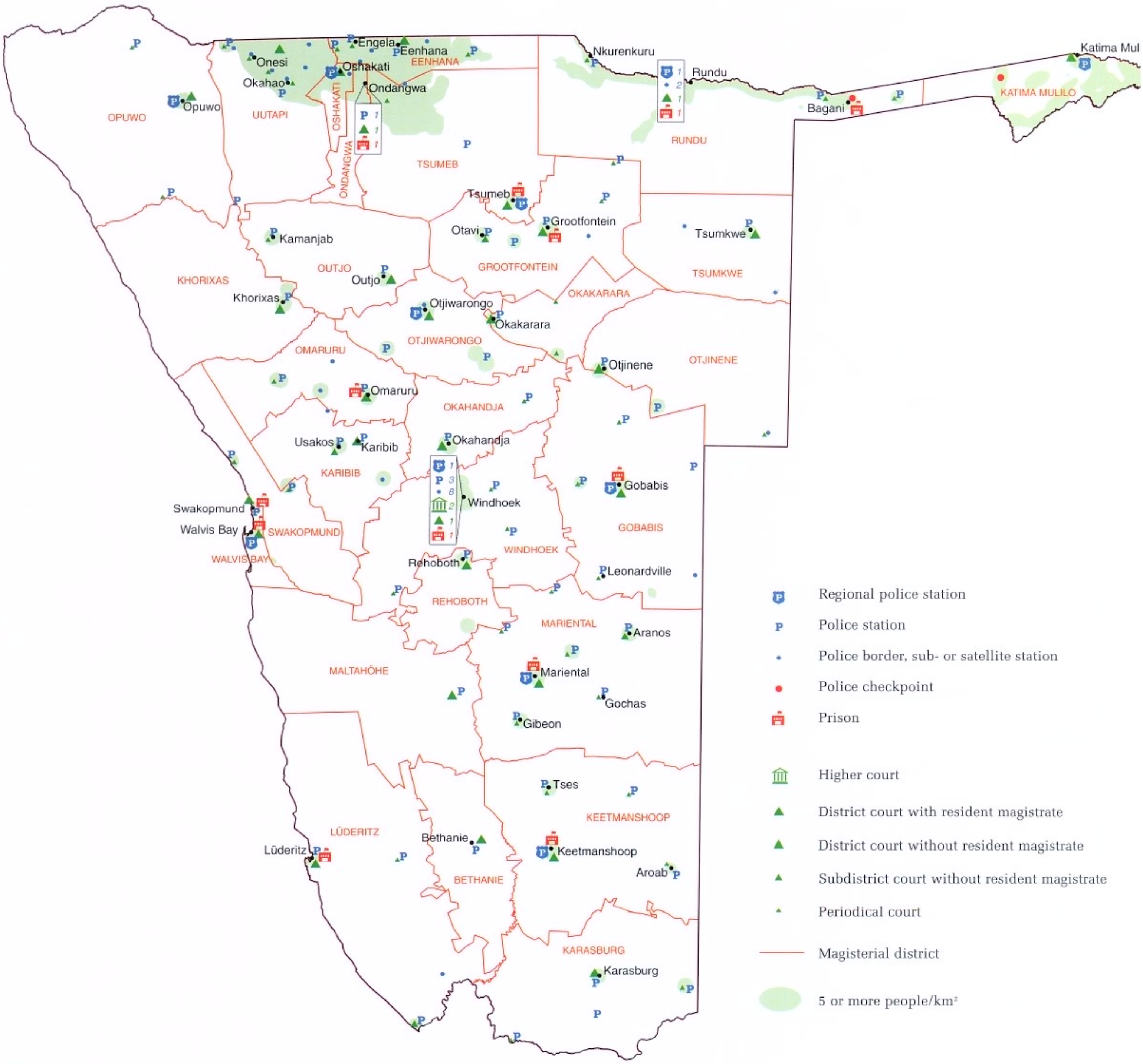
In addition to the electricity grid shown here, many rural homesteads, schools, clinics, tourist resorts and other small settlements use so-called off-grid sources of power. Most of these are diesel, solar power and other generators that produce relatively small amounts of electricity.



6.35 Judicial services

The police, courts and the prison service are responsible for maintaining law and order in Namibia. There are currently 13 regional police offices, 84 police stations, and 24 sub- and satellite police stations in the country. Police also serve at border posts (see Figure 6.33) and at various checkpoints.

There are two major categories of courts: lower and higher courts. Lower courts consist of 29 district and 4 sub-district magisterial courts, some of which are served by resident magistrates while others sit only when a visiting magistrate is present. There are 40 periodical courts, which sit normally in a police station or some other office that is not permanently used as a court. They, too, are convened only when a visiting magistrate is present. A number of community courts will be added to the lower court system. The higher courts consist of the High Court and the Appeal and Constitutional Court, previously called the Supreme Court. Both are in Windhoek. The High Court considers very serious cases that cannot be resolved or dealt with by the lower courts because they may merit stiffer sentences than the lower courts are authorised to pass. The 13 prison facilities comprise normal prisons and rehabilitation programmes and centres.

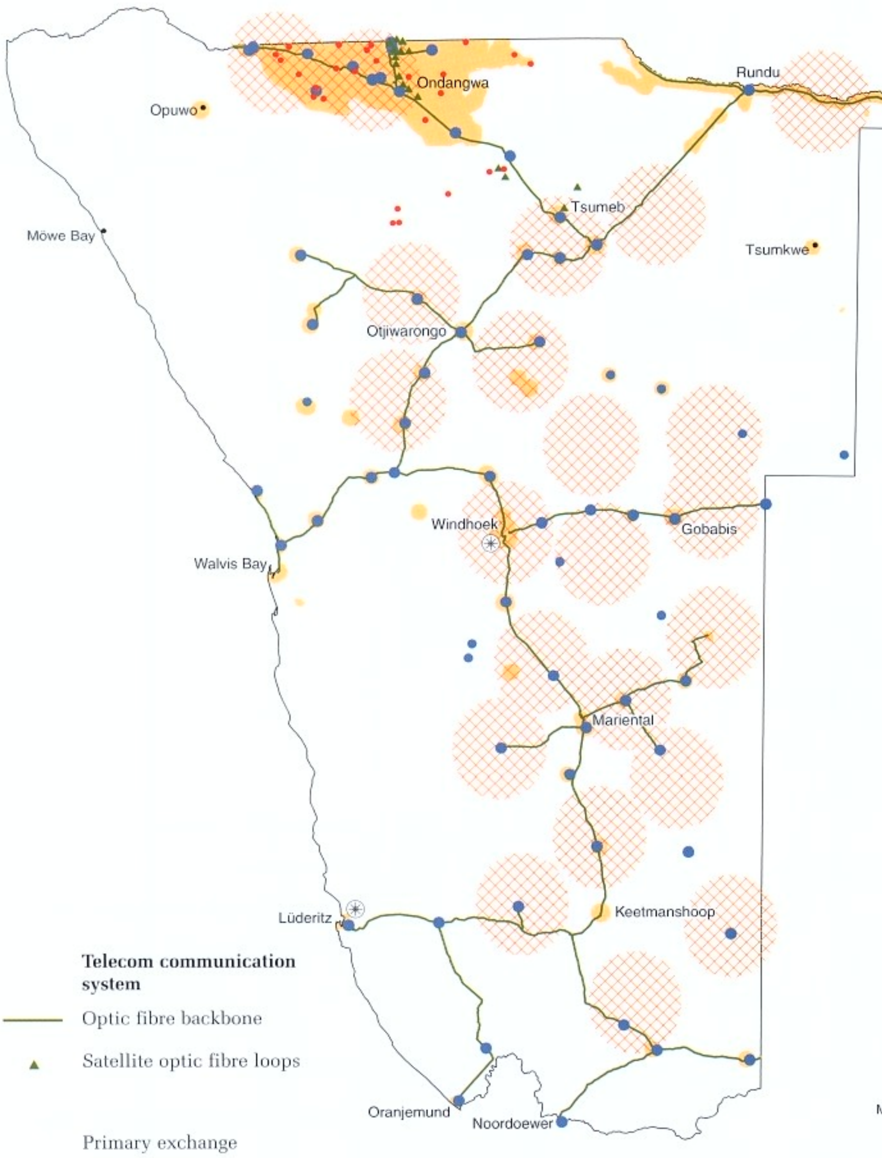


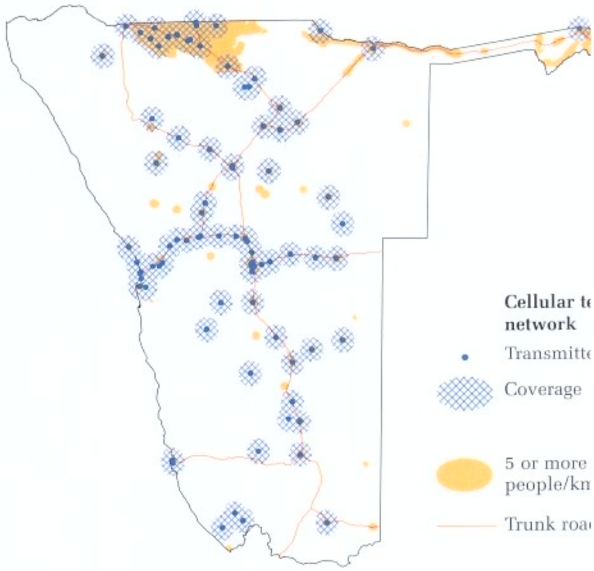
6.36 Telecommunications and post offices [32]

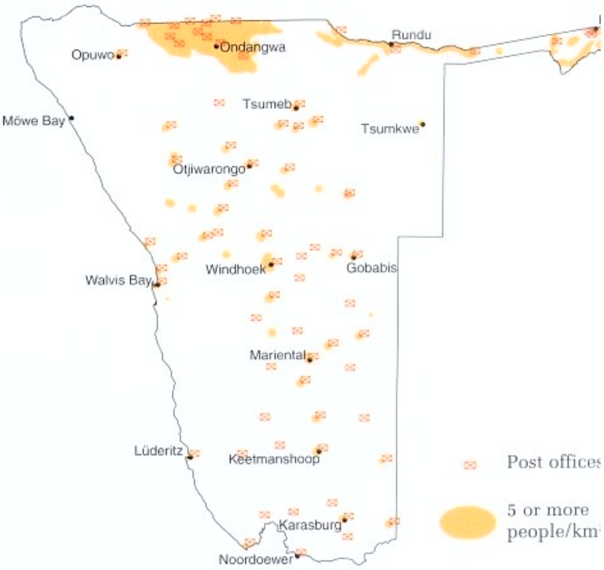
A variety of telephone systems provide coverage in Namibia. The backbone of the system is made up of optic fibre cables that serve five primary exchanges. A whole series of secondary exchanges or Remote Line Units further distribute telephone connections from the optic fibre backbone to local users. In some areas, physical copper lines connect additional Small Digital Exchanges to the backbone.

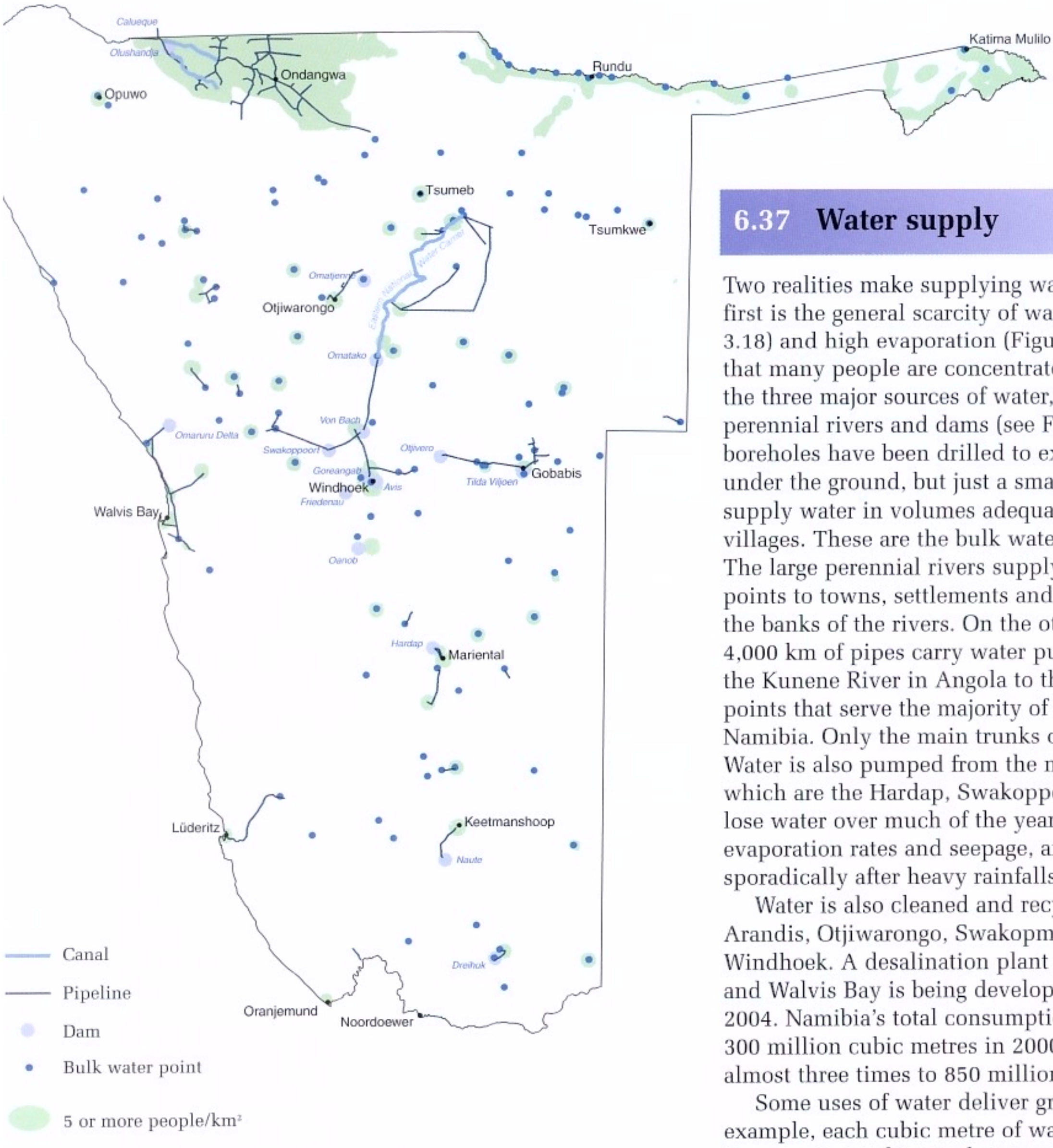
In parts of the north, Remote Line Units are extended by Satellite Optic Fibre Loops. Alternatively, the Rurtel system links local physical lines to Remote Line Units by one or more radio connections. Several other wireless connections are used in the fixed telephone system, including Ultraphone transmitters which serve users within a radius of about 50 km and smaller DECT stations that cover only a radius of about 6 km. Telecommunication links through satellites are provided by three transmitters. The Walvis Bay radio station also provides a service which allows telephone calls to be made via a radio from anywhere in the country. As the whole telephone system is developing rapidly, this service is likely to be replaced by more advanced wireless technologies.

The cellular network has expanded rapidly, and this service is currently available in most of the main centres in the country. Cellular telephone transmitters provide coverage over a radius of approximately 30 km. Postal services are provided at 87 post offices.









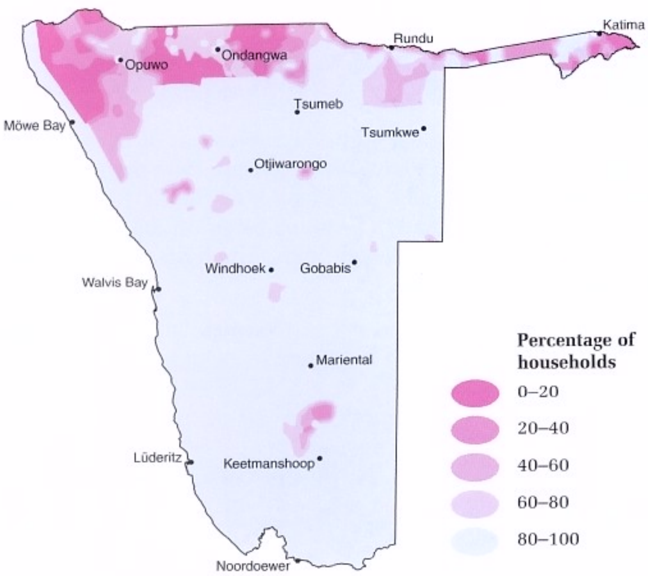
6.37 Water supply

Two realities make supplying water a difficult task in Namibia. The first is the general scarcity of water because of low rainfall (Figure 3.18) and high evaporation (Figure 3.27). The second problem is that many people are concentrated in areas (Figure 6.1) far from the three major sources of water, namely underground reserves, perennial rivers and dams (see Figures 2.21 and 2.24). Over 50,000 boreholes have been drilled to explore for and pump water from under the ground, but just a small number tap reserves that can supply water in volumes adequate for nearby towns and bigger villages. These are the bulk water supply points shown on the map. The large perennial rivers supply water through other bulk supply points to towns, settlements and irrigation schemes located close to the banks of the rivers. On the other hand, two canals and about 4,000 km of pipes carry water pumped from the Calueque Dam on the Kunene River in Angola to the Olushandja Dam and to water points that serve the majority of households in central northern Namibia. Only the main trunks of this network are shown here. Water is also pumped from the major storage dams, the largest of which are the Hardap, Swakoppoort and Naute. All storage dams lose water over much of the year as a result of abstraction, high evaporation rates and seepage, and they are only replenished sporadically after heavy rainfalls in their catchment areas.

Water is also cleaned and recycled in reclamation works in Arandis, Otjiwarongo, Swakopmund, Tsumeb, Walvis Bay and Windhoek. A desalination plant to produce water for Swakopmund and Walvis Bay is being developed and should be in operation by 2004. Namibia's total consumption of water amounted to about 300 million cubic metres in 2000, and it is predicted to increase almost three times to 850 million cubic metres by 2030.[33]

Some uses of water deliver greater benefits than others. For example, each cubic metre of water used for agricultural production is estimated to produce goods worth about N$7, while manufacturing production and tourism and other services are estimated to gain about N$272 and N$574, respectively, from each cubic metre of water used.[34]

All the water supplied through the schemes shown here is so-called clean or safe water, unlike water that people use directly from rivers, oshanas and hand-dug surface wells. The issue of access to safe water is considered in the next map



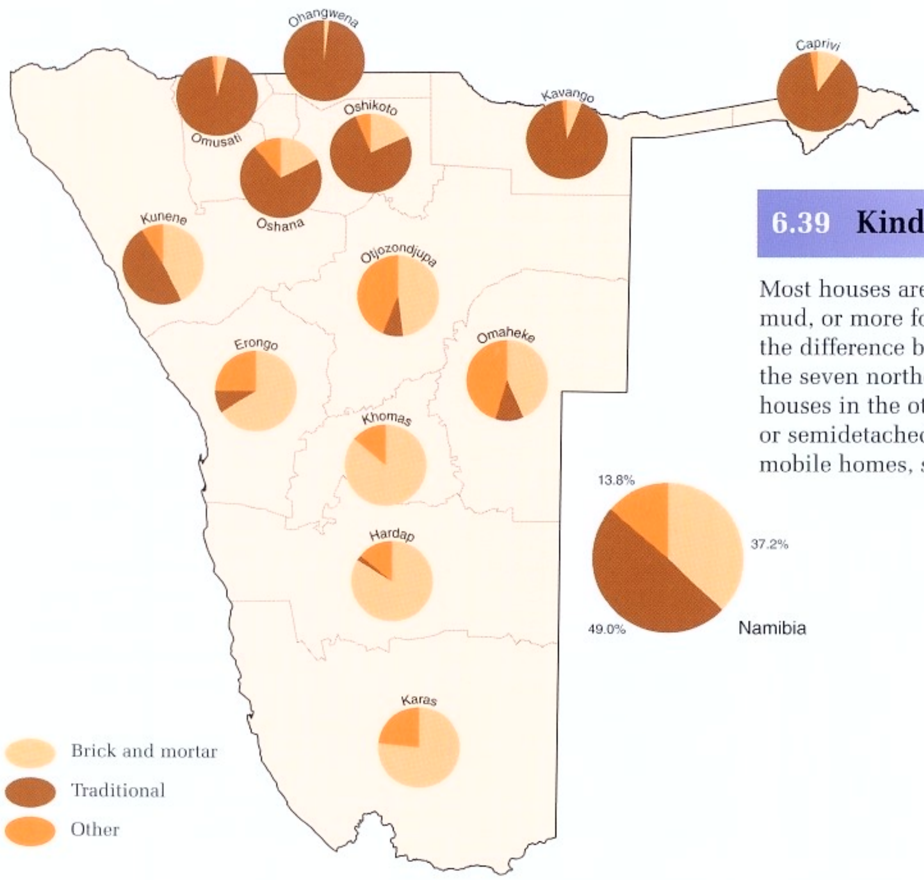
6.38 Access to clean water[35]

Having sources of clean water to drink is important, not least because a number of diseases are carried in contaminated water. This map shows that the majority of households in southern Namibia use clean water, largely provided from boreholes and piped water schemes. Towns in northern Namibia also have access to safe water but, apart from a few areas in Oshana, Ohangwena, Oshikoto and Omusati, many households in northern rural areas use unsafe water from rivers, open wells and seasonally flooded pans.

The proportion of all homes that had access to safe water increased from 65% in 1991 to 77% in 2000. Most of this improvement was the result of rural homes in Oshana, Ohangwena, Omusati and Oshikoto gaining access to new networks of pipelines laid in recent years. In 2000, almost all (98%) urban homes used safe water compared to only 67% of rural households.

Household and economic conditions

Few aspects in Namibia vary quite as much as the social and economic circumstances of people's lives. Several of these features are described in the maps that follow, including the types of houses, the sizes of their households, use of fuels, dependency ratios, the gender of head of the household, and numbers and sources of incomes. The composition of a household and the sources of its income are significant and complex issues because so many people live in homes that have a mix of incomes. Individual household members perform different jobs and contribute to the home in a variety of ways. Many people in rural households gather products of wild plants, produce crops and obtain meat and milk from livestock, and their homes can be described as having a subsistence economy. In other households, both in urban and rural areas, family members receive wages, pensions or remittances; all these incomes may contribute, to a greater or lesser degree, to the benefit of all household members. The welfare of a household is therefore often related to the number of people in the home and the diversity of incomes.

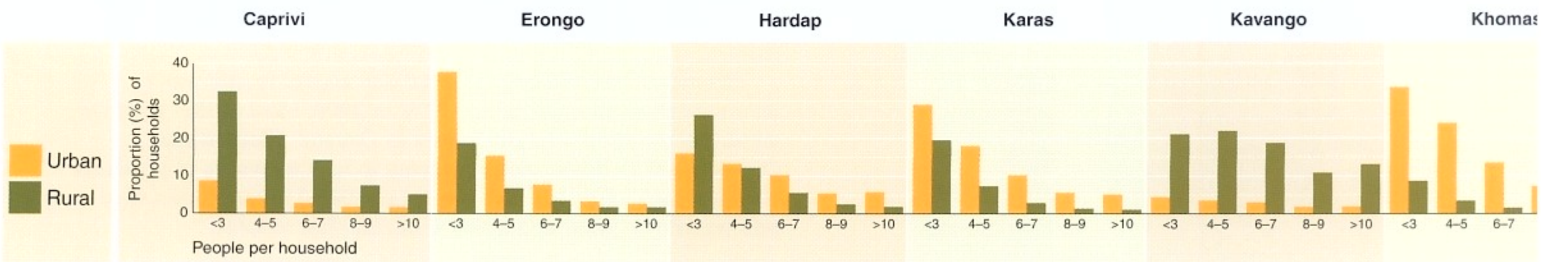


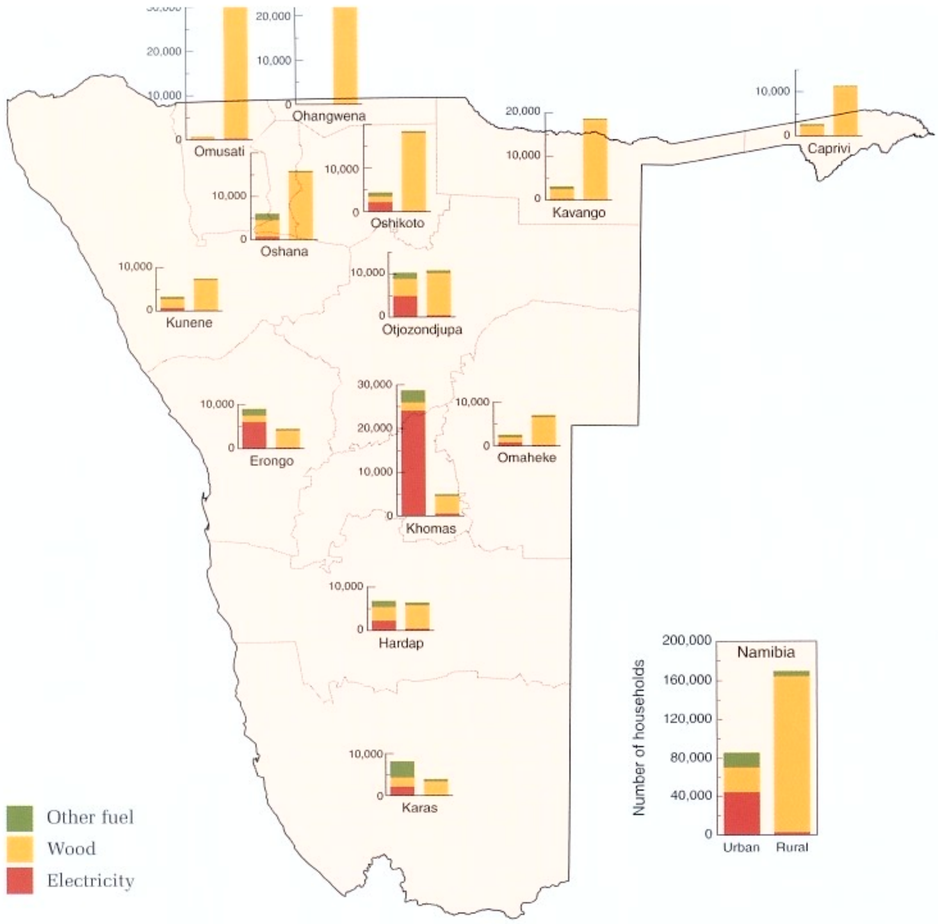
6.39 Kinds of houses [36]

Most houses are either traditional structures built of wood and mud, or more formal brick and mortar buildings. What is striking is the difference between the huge proportion of traditional homes in the seven northernmost regions and the predominance of formal houses in the other six regions. Most formal houses are detached or semidetached homes, or flats. Houses shown as 'Other' include mobile homes, single quarters and improvised dwellings.

6.40 Household sizes [37]

There is a good deal of variation in the number of people living in a household. The graphs suggest that there are two main kinds of trends in household size. The first is that the majority of homes are small: those with three people or less are most frequent, followed by smaller and smaller numbers of bigger homes. This pattern holds in all urban areas and in rural areas in 8 of the 13 regions. The second pattern is apparent in the rural areas of Kavango, Ohangwena, Oshikoto, Oshana and Omusati. Here there are roughly equal proportions of smaller and larger households. Larger households in these regions tend to be much better off than smaller ones, having more livestock and larger fields. The head of a large home is also often a wealthy person.[38]

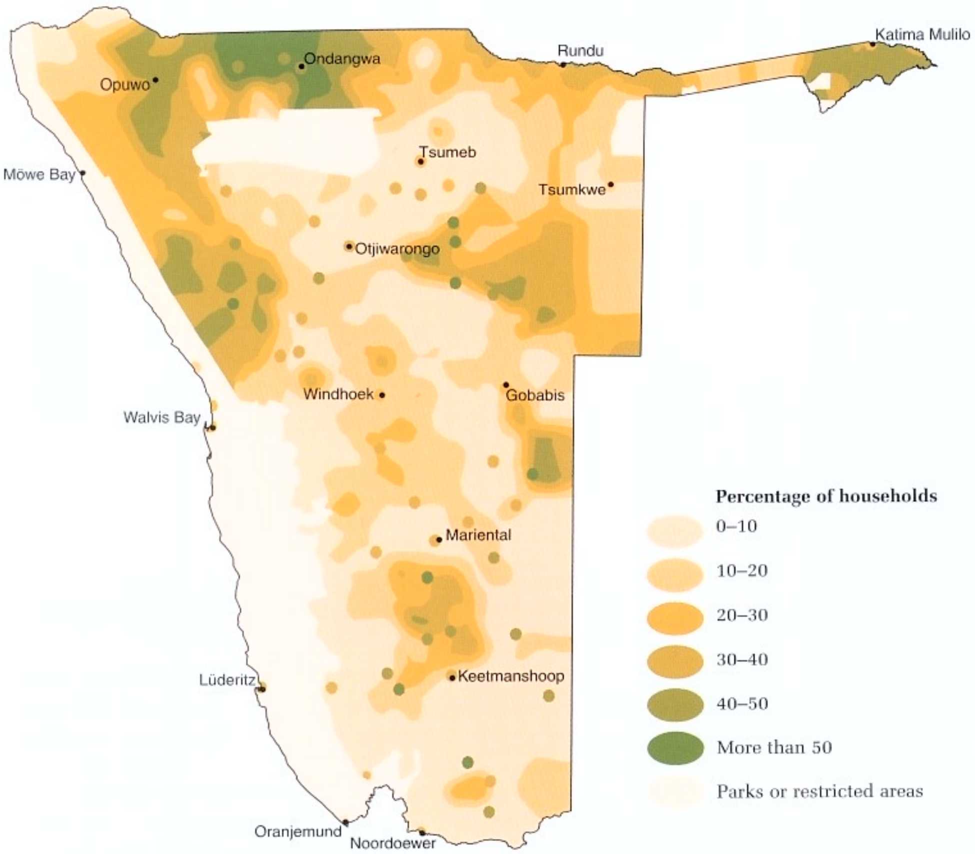




6.41 Use of wood and electricity for cooking [39]

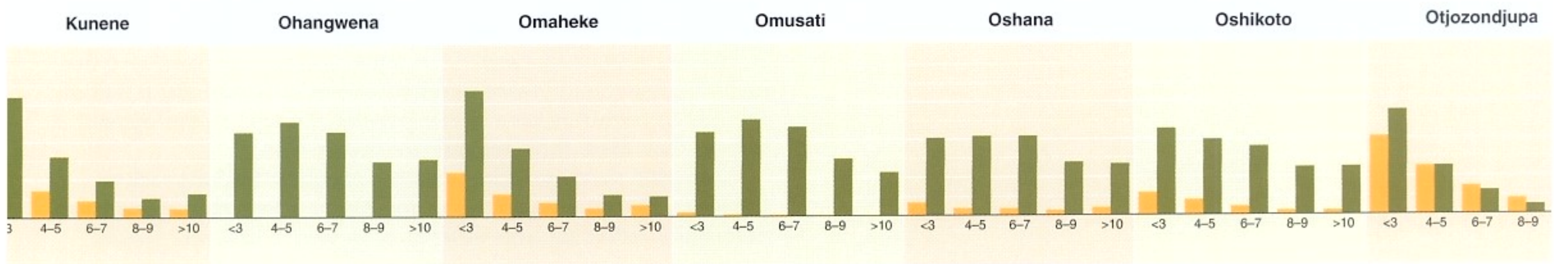
Wood is an extremely important resource for the majority of households in Namibia. It is used to build most homes (see Figure 6.39) and it is the most widely used fuel for heating and cooking. About 63% of all homes used wood for cooking in 1996, compared to 74% in 1991. Much of that decline was the result of the decreased use of wood by urban homes: 26% of urban homes used wood in 1991 while the corresponding figure in 1996 was 19%. For households in rural areas, 93% used wood for cooking in 1991 compared to 91% in 1996. The difference between urban and rural households was therefore great in both years – a difference apparent in all regions.

Electricity is the other major fuel for cooking, but it is only used widely in urban areas: 63% of urban households used electricity for cooking in 1996. Despite programmes to electrify rural areas, electricity remains unaffordable for most people. A very small proportion of homes use other fuels such as paraffin and gas.



6.42 Households headed by women [40]

It is usual for men to be the head of the household in most Namibian homes but, with so many men working elsewhere (see Figure 6.12), great numbers of women remain at home as the household head. This is true for many rural, communal areas, especially in Oshana, Ohangwena, Oshikoto and Omusati, where high proportions of homes are headed by women. Far more men from these four regions work away from their homes than in other communal areas. Quite a large number of towns, especially in southern Namibia, also have high proportions of homes headed by women.



6.43 Proportions of dependants per household [41]

Members of a household can be divided into people who are usually considered to be dependants (younger than 15 years or older than 64) and those considered non-dependants (between 15 and 64).

The most striking difference in the proportion of dependants per household is between urban and rural areas. Most rural homes have higher proportions of dependants, especially in northern communal areas, while dependency ratios in urban homes are very much lower. In urban areas in Khomas, Erongo, Oshana, Omusati and Oshikoto, for example, only one person or less is a dependant out of every three. This reflects the high numbers of people who have moved to urban areas in search of work to support their families remaining in rural areas.

6.44 Sources of income [42]

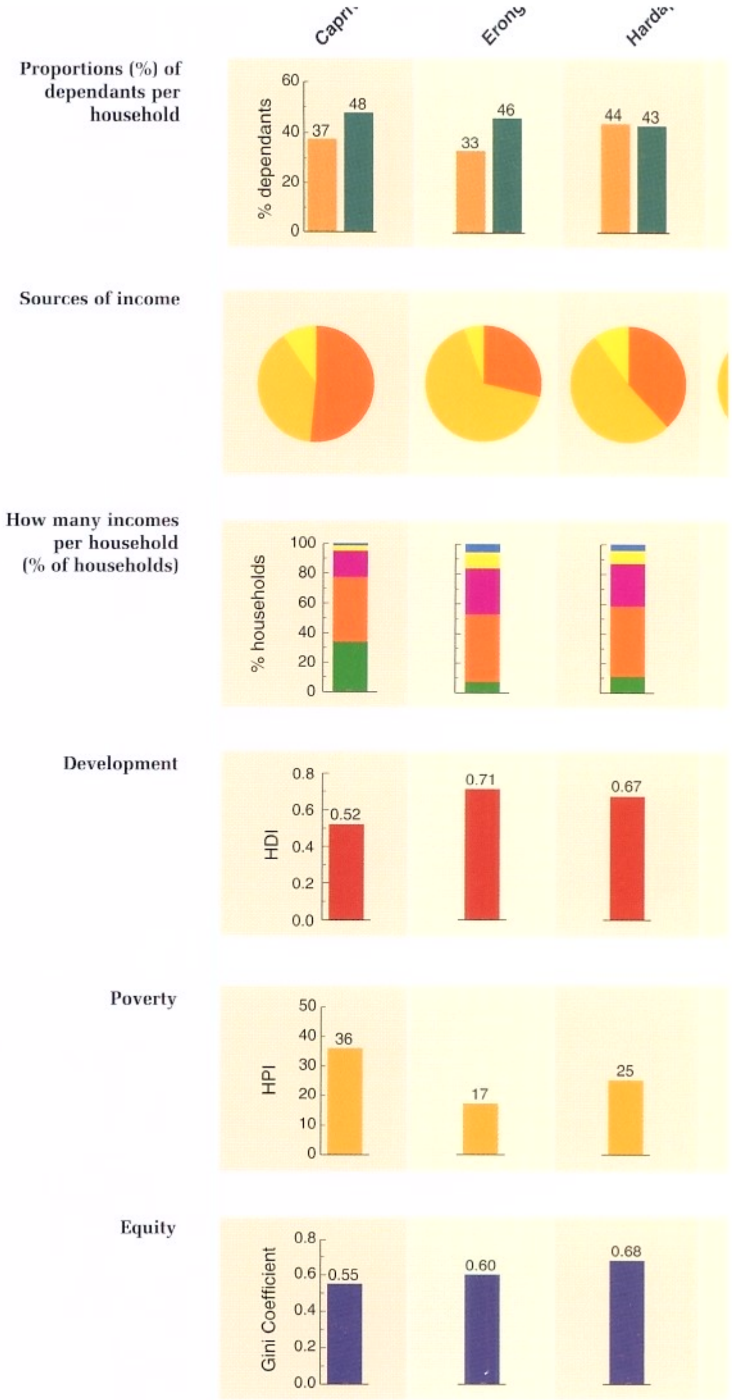
In 1996, of all people aged 15 and older who were not at school, just under half (47%) declared that they received cash incomes from wages or a business. The remaining people had no income (42%) or received a pension (10%) or remittances (1%) as their main source of income. There were, however, great differences between the regions. Over 50% reported having no income and less than 30% of people had wage or business incomes in Ohangwena, Omusati and Kavango, compared to more than 50% of people with salaried or business incomes in Khomas, Erongo and Otjozondjupa. Fewer people in rural areas had wage or business incomes (35%) than people in urban communities (61%). The proportion of pensioners in rural areas (13%) was higher than in towns (10%).

Some surveys treat the 42% of people who received no income as being unemployed. Although many of these people are certainly unemployed because they cannot find or create a job, a great many others work at home looking after their houses, collecting water and wood, caring for their families, and providing labour to grow crops and tend livestock. The number of these people who would choose to work more formally if there were opportunities for employment close to their homes is unknown, making the issue of unemployment a complex one.

6.45 How many incomes per household? [43]

The majority of households have a single cash income, usually in the form of a salary or earnings from a business or from a pension. Other households either have no income or enjoy incomes contributed by two, three or more household members. Regions that are generally regarded as being the poorest (see Figure 6.46) have high proportions of households with no incomes. Thus, about one-third of all homes in Ohangwena, Kavango, Caprivi and Omusati have no cash income. About 60% of households in Khomas, by contrast, have two or more incomes, as do about half the homes in Kunene, Erongo and Karas.

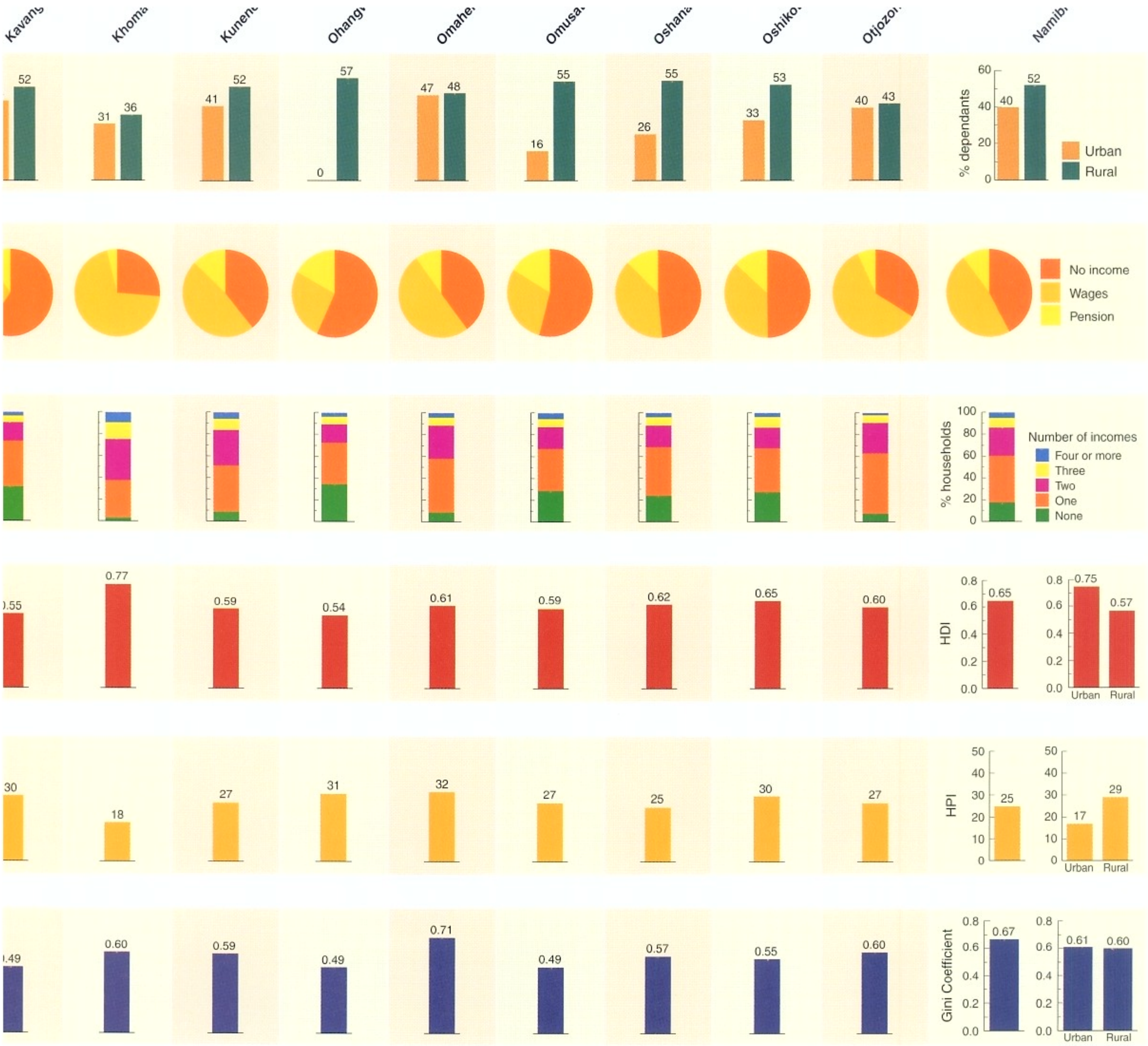
Many households also have high proportions of their income derived from non-cash sources, such as harvested food and the wood and other materials used to build rural houses. Thus, about 30% of total private household consumption comes from non-cash sources. These sources are much more important to poor households that have little or no cash income. [44]



6.46 Human development, poverty and equity

Many maps and graphs in this chapter show how conditions differ from one region to another, between urban and rural communities, and even within rural or urban communities. This variation reflects the unequal or disparate nature of many aspects of Namibian society. One way of summarising such variation is to combine various measures into indices, three of which are given here: the human development index, the human poverty index, and the Gini coefficient.45 The first two indices generally vary in opposite directions, so that poorly developed regions have a high poverty index, and vice versa. Caprivi, Ohangwena and Omaheke have the highest poverty and lowest development indices, and about half of all African countries have higher poverty and lower development indices than these three regions (see Figure 6.48).

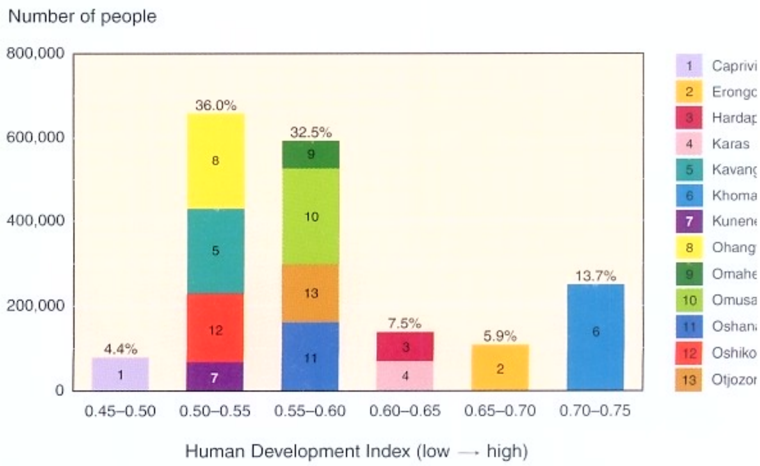
Gini coefficients provide a measure of equity. Regions such as Omaheke, Erongo, Hardap, Karas and Khomas have the highest levels of inequity, reflecting large differences in wealth between people.



6.47 Numbers of people at different levels of human development

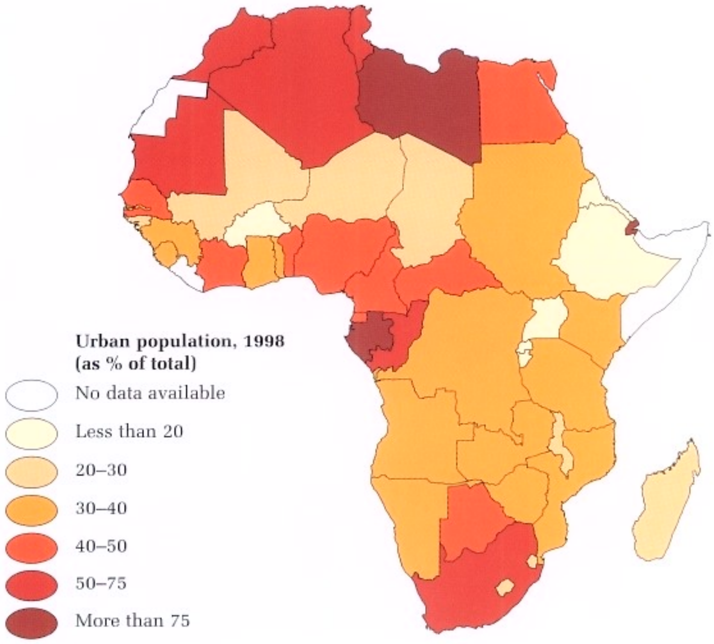
The human development index in the previous figure shows comparative levels of development in various regions. However, there are quite different numbers of people in each region, and the figure does not answer the question of how many people there are at these different levels of development. Nor does it give any idea of the proportions of people in the various categories.

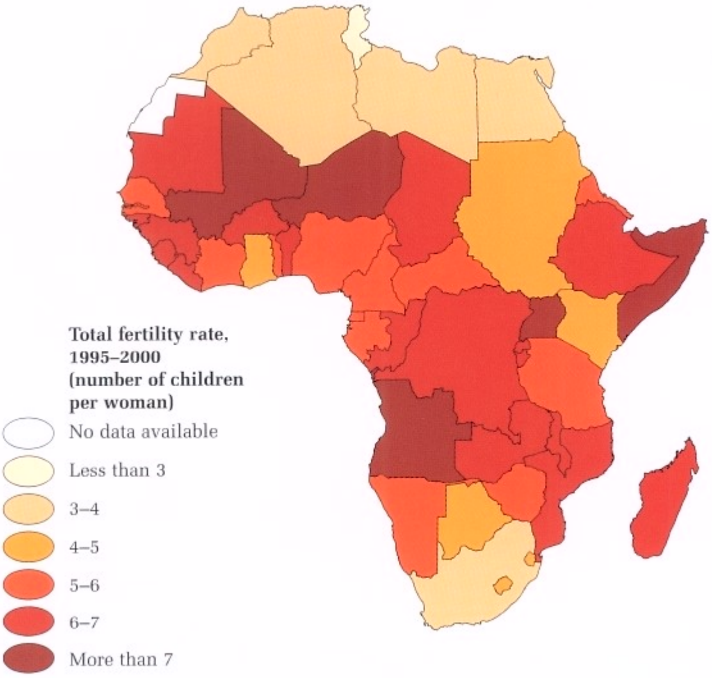
This graph provides approximate answers to these issues by dividing the human development index into six categories. The great majority of Namibians live in regions with indices of below 0.6: Caprivi, Ohangwena, Kavango, Oshikoto, Kunene, Omaheke, Omusati, Otjozondjupa and Oshana. Khomas, the region with the highest index, is home to about 250,000 people. It is obvious, however, that there is much variation in each region, with some people in the highest development category and many others in the lowest groups.

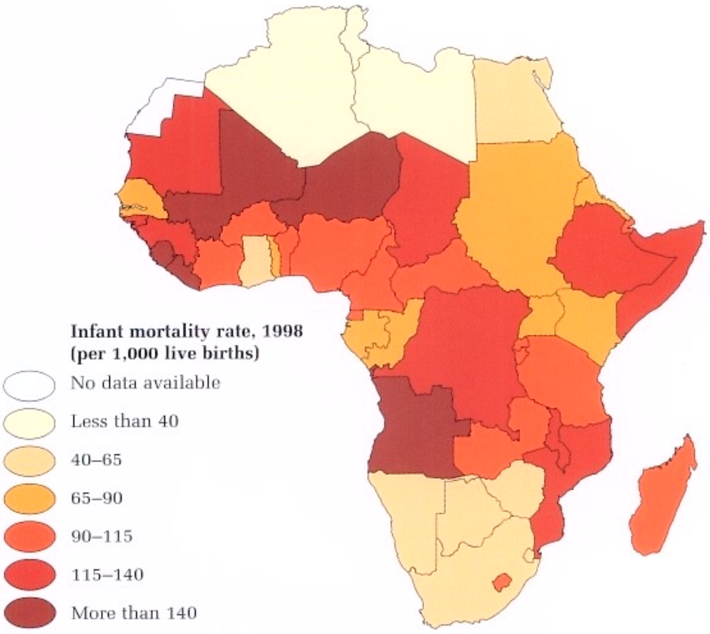


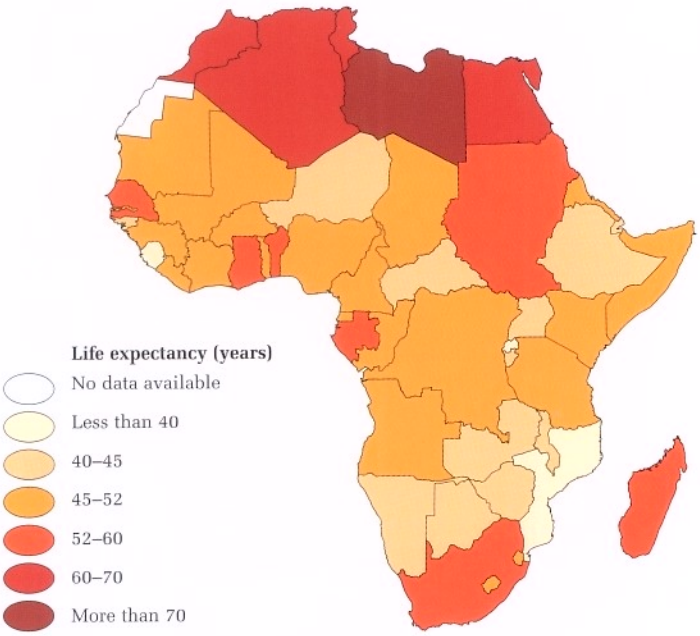
6.48 Comparative indices for African countries [46]

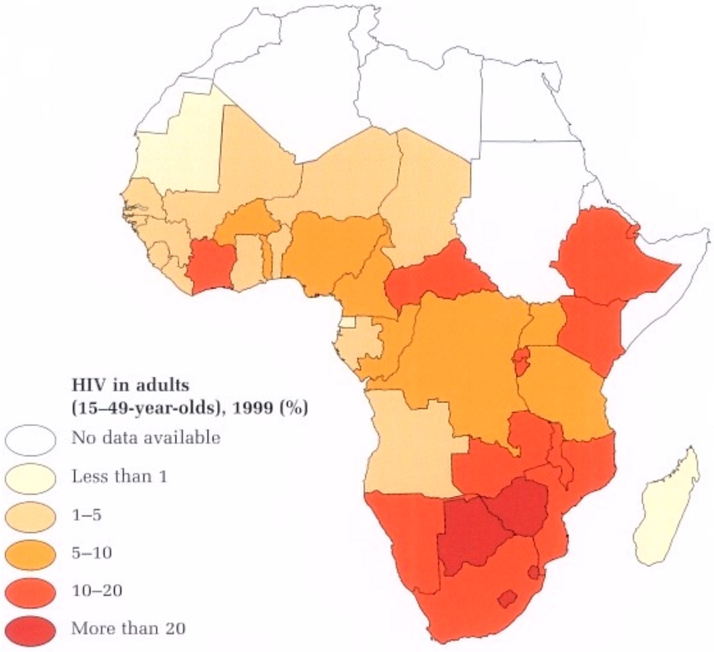
These eight maps show a selection of indicators for issues covered in this chapter. Namibia compares favourably in some respects with its neighbours and other African nations, having relatively low infant mortality rates and high proportions of literate adults. But Namibia also has amongst the worst rates of HIV infection and, consequently, low life expectancies. In terms of overall ranking, the country ranks 7th for human development and 31st for human poverty out of the 51 countries shown here. Namibia is thus comparatively well developed even though a large proportion of its population remains poor. Reducing poverty by developing economically and maintaining a healthy environment is surely the great challenge facing all Namibians in the years ahead.

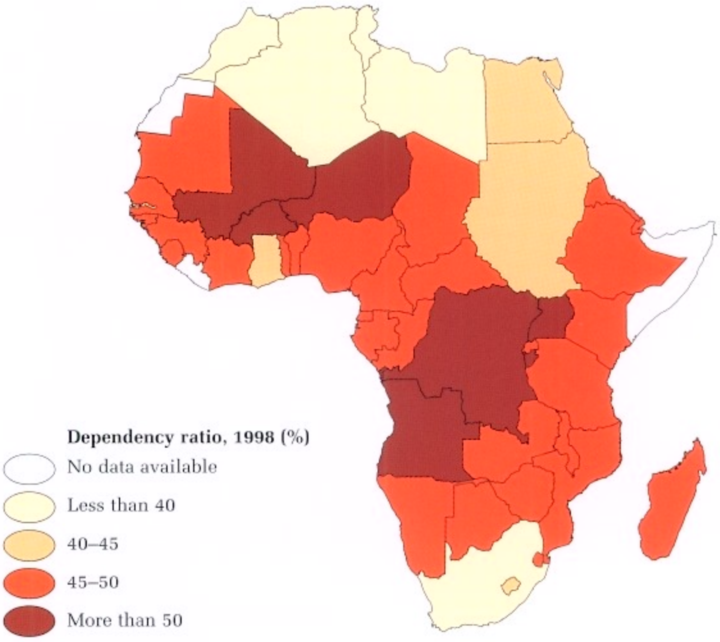


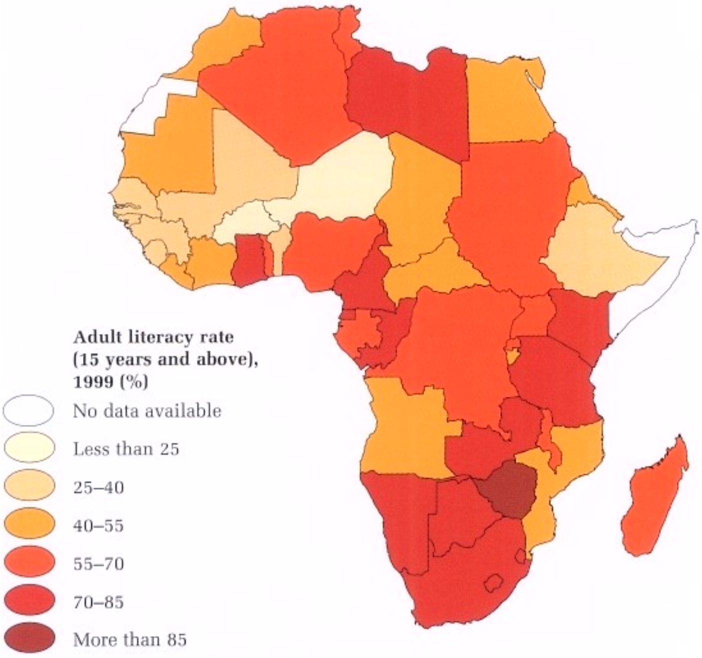


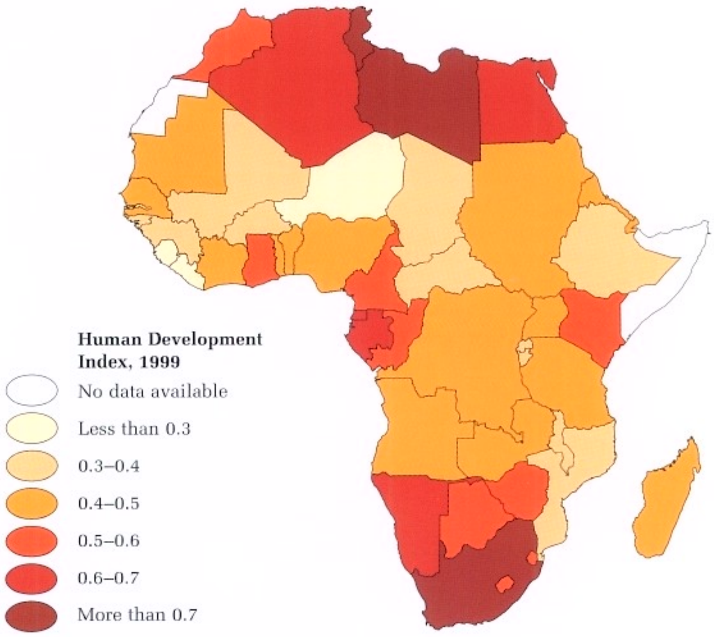





HIV in adults
(15–49-year-olds), 1999 (%)
No data available
Less than 1
1–5
5–10
10–20
More than 20


Dependency ratio, 1998 (%)
No data available
Less than 40
40–45
45–50
More than 50


Adult literacy rate
(15 years and above),
1999 (%)
No data available
Less than 25
25–40
40–55
55–70
70–85
More than 85


Human Development
Index, 1999
No data available
Less than 0.3
0.3–0.4
0.4–0.5
0.5–0.6
0.6–0.7
More than 0.7

NOTES

Where possible, data used in the Atlas have been made available for public use, and can be downloaded, with associated descriptions, from www.dea.met.gov.na. For further information on any map, please consult these descriptions.

Chapter 1 – Introduction

1 For more information, see Hangula, L. 1993. *The international border of Namibia.* Windhoek: Gamsberg Macmillan.
2 Compiled largely by Roger Swart of the Namibia Petroleum Corporation (NAMCOR).
3 Rivers and names from Van Wyk, AE, H Strub & WF Struckmeier (eds). 2001. *Hydrogeological map of Namibia.* Windhoek: Dept. Water Affairs and Geological Survey. Spellings of towns and settlements taken from Republic of Namibia (1996) 1:1,000,000 map, unless other more recent information was available.

Chapter 2 – Physical geography

1 More detailed maps are available from the Geological Survey of Namibia, which also provided information as a basis for this map.
2 Most of the text and the sketches on Namibia's geological history are based on ideas and information provided by Roger Swart of the Namibia Petroleum Corporation (NAMCOR).
3 Adapted from Scotese, CR. 1997. *Paleogeographic atlas, PALEOMAP progress report 90-0497.* Department of Geology, University of Texas at Arlington, Texas.
4 Ibid.
5 Based on information supplied by the Geological Survey of Namibia and NAMCOR.
6 The maps of soils were compiled from the following sources with the help of Sophie Simmonds (InterConsult) and Marina Coetzee (Ministry of Agriculture, Water and Rural Development): the 1:1,000,000 geological map produced by the Geological Survey; the National Soil Survey (1998–2000) conducted by the Ministry of Agriculture, Water and Rural Development and the Cartographic Institute of Catalonia; and Beugler-Bell, H & MW Buch. 1997. 'Soils and soil erosion in the Etosha National Park, northern Namibia'. *Madoqua*, 20(1):91–104.
The proportion that base cations (calcium, magnesium, potassium and sodium) make up of all cations in the soil is known as base saturation. Soils with higher base saturation, therefore, have higher proportions of base cations and are generally more fertile than those with low base saturation. 'Sesquioxides' refers to the combined oxides of irons and aluminium. The 'structure' of a soil describes the way in which the solid mineral and organic particles are arranged in relation to each other and to the pore spaces between them.
7 These figures exclude people living in towns such as Katima Mulilo, Rundu, Ondangwa, Oshakati and Outapi.
8 Data on catchment areas and river volumes were extracted primarily from: The Water & Environment Team. 1999. *State of the environment report on water in Namibia.* Windhoek: Ministry of Environment and Tourism. Similarly, river volume data shown in Figure 2.23 were derived from this source except for the Orange River and the Kwando River. These were supplied by the Department of Water Affairs and Forestry, South Africa, and Steve Crerar (Windhoek Consulting Engineers), respectively.
9 The map was compiled with the assistance of the hydrogeological mapping project (HYMNAM) of the Ministry of Agriculture, Water and Rural Development.
10 Based on an analysis of the groundwater database of the Ministry of Agriculture, Water and Rural Development.
11 Ibid.
12 Adapted from Mendelsohn JM, S el Obeid & CS Roberts. 2000. *A profile of north-central Namibia.* Windhoek: Gamsberg Macmillan.

Chapter 3 – Climate

1 Peter Hutchinson, formerly of the Namibian Meteorological Services, assembled much of the climate information in addition to assisting with the generation of maps and the provision of preliminary text. Unless otherwise indicated, the data used in this chapter were provided by the Namibian Meteorological Services. Some information attributed to Katima Mulilo was collected just across the Zambezi River at Sesheke in Zambia, and some information from Alexander Bay on the southern bank of the Orange River mouth in South Africa was used for Oranjemund.
2 The image on this page was captured by the MeteoSat satellite. Similar images can be viewed at www.eumetsat.de.
3 The images on this page were captured by the MeteoSat satellite.
4 Ibid.
5 Adapted from Cole, JFT. 1997. 'The surface dynamics of the northern Benguela upwelling system and its relationship to patterns of Clupeoid production'. PhD thesis, University of Warwick, United Kingdom. The temperatures were derived from NOAA (National Oceanic & Atmospheric Administration) images taken over ten years, from 1981 to 1990, but the measurements were accurate to only about 0.5°C.
6 This is based on one year of observations in 1984 using satellite imagery. Results of the observations were reported in Olivier, J. 1995. 'Spatial distribution of fog in the Namib'. *Journal of arid environments*, 29:129–138. However, the results were adjusted for this publication because the satellite images do not provide a distinction between low cloud and fog. The adjustments were based on surface observations collected from several weather stations.
7 Estimates of radiation are based on the NASA Langley solar radiation data, which were derived from NOAA (National Oceanic & Atmospheric Administration) satellite observations recorded between March 1985 and December 1988. However, by using records of the number of sunshine hours from various stations, a greater level of resolution (especially at the coast) was obtained. See also Eberhard, AA. 1990. *A solar radiation data handbook for southern Africa.* Cape Town: Elan Press.
8 The maps for rainfall were adapted from the following report: Namibia Resource Consultants. 1999. *Rainfall distribution in Namibia: Data analysis and mapping of spatial, temporal, and Southern Oscillation Index aspects.* Windhoek: Ministry of Agriculture, Water and Rural Development.
9 To illustrate the coefficient of variation, consider the following example: Take an area with an average rainfall of 400 mm per year and a coefficient of variation of 40%. A value of 40% means that the standard deviation is 160 mm (400 mm x 40/100 = 160 mm). As 68% of values fall within one standard deviation of the mean (average), that area would see annual rainfall totals of between 240 and 560 mm in two-thirds of all years. In the remaining third of all years, annual rainfall totals would be below 240 or above 560 mm.
10 Adapted from Agnew, C & E Anderson. 1992. *Water resources in the arid realm.* London: Routledge.
11 Adapted from Mendelsohn JM, S el Obeid & CS Roberts. 2000. *A profile of north-central Namibia.* Windhoek: Gamsberg Macmillan.
12 This is based on measurements of water loss from standard-sized evaporation ponds, but rates of water loss from open dams, pans and rivers are generally about 30% lower than those from small evaporation ponds. This is because rates of evaporation decrease as the air moving across large expanses of open water picks up moisture. Values given here are 30% lower than those recorded at weather stations.
13 Note that data are only available for 08h00 and 14h00 at Katima Mulilo.

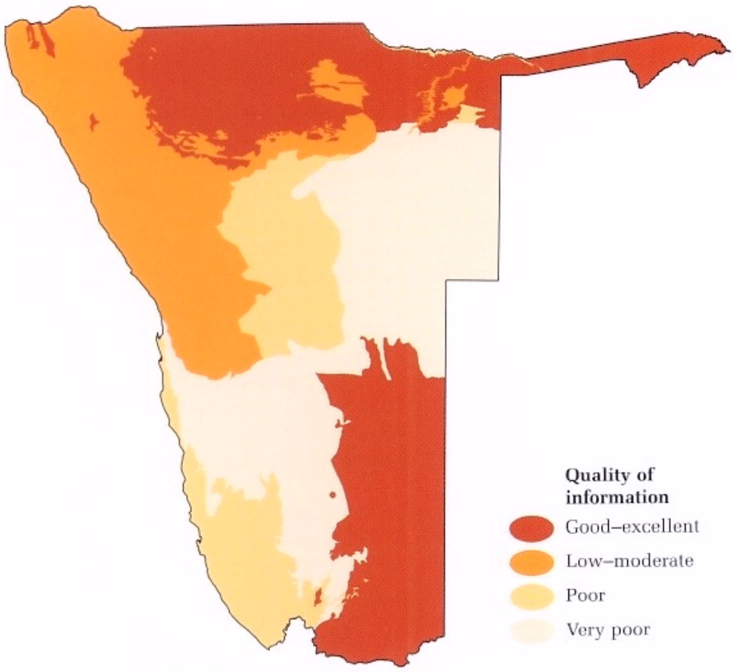
Chapter 4 – Plants and animals

1 The detailed maps and descriptions are available from the Atlas database at www.dea.met.gov.na. This new information was commissioned by the Atlas Project, and was compiled by Antje Burke, Wynand du Plessis and Ben Strohbach as a review and synthesis of data available since Giess's preliminary vegetation map of 1971 (Giess, W. 1971. 'A preliminary vegetation map of South West Africa'. *Dinteria*, 4:1–114).

2 The work reflected in Figures 4.5 and 4.6 was done by Wynand du Plessis while at the Etosha Ecological Research Unit. Images provided by the NOAA (National Oceanic & Atmospheric Administration) satellite system were collected every day. The images have a resolution (pixel size) of 1 x 1 km^2. Methods were developed to extract the maximum values reflecting green vegetation biomass for each square kilometre over a rainy season. The maximum values are numeric values ranging from 0 to 255, which allow them to be grouped into legend classes to show low, medium or high levels of biomass production, for example. Likewise, the values over the seven seasons can be averaged to produce a map of average biomass production, or the standard deviation and coefficient of the values can be calculated to show variation in plant growth. See also Du Plessis, W. 1999. 'Linear regression relationships between NDVI, vegetation and rainfall in Etosha National Park, Namibia'. *Journal of arid environments*, 42:235–260.

3 The map shows the coefficient of variation of the data in Figure 4.5. The coefficient is the standard deviation (see Note 9 for Chapter 3) expressed as a percentage of the average.

4 These ratings were derived from assessments of resource values for each vegetation type shown in Figure 4.2. The quality of information available for different units varied, however, as shown in the map below.



Accuracy of assessments for plant resources

5 The text was largely compiled by Antje Burke. The maps were compiled by the National Herbarium of Namibia based on the databases of the National Botanical Research Institute of Namibia.

6 These are maps of areas that have been burnt, as detected from NOAA satellite images. The interpretation of these satellite images and the mapping of burnt areas were done by Simon Trigg and Johan le Roux.

7 Compiled by Bessie Bester of the Ministry of Agriculture, Water and Rural Development.

8 Maps of plant and animal diversity were assembled from several sources as described below. Maps of this kind may suffer from two problems. In many cases, there is a collecting bias because areas that have been studied in depth appear to have more species than those where there has been little or no work. Secondly, the scale of mapping cannot reflect small, local variations in diversity. The various contributors to the maps made efforts to correct for these biases, e.g. by adding weighting factors to reflect collecting effort and by making predictions for areas that have not been covered adequately. A further problem is that there is inadequate information for many other groups of plants and animals. However, the maps shown here probably present a representative picture of the patterns of diversity in Namibia.

The maps of plant diversity were compiled from information contained in the databases of the National Herbarium of Namibia. For more information, see Craven, P. 2001. *Phytogeography of Namibia: A taxon approach to the spermatophyte flora*. MSc thesis, University of Stellenbosch, South Africa.

Information on birds was derived from an analysis of records collected for the Southern African Bird Atlas Project.

For mammals, frogs and reptiles Mike Griffin provided sketch maps showing the distribution of each species, based on all records available to him and his knowledge of habitat preferences. These were synthesised to generate estimated numbers of species per quarter-degree square (approx. 27 km x 27 km), from which isolines reflecting different numbers of species were interpolated.

The map of scorpion diversity was derived in the same way as those for reptiles, mammals and frogs, from original data provided by Eryn Griffin.

Information on termites was provided by Juliane Ziedler, some of which was based on her work reported in Ziedler, J. 1997. 'Distribution of termites (Isoptera) throughout Namibia: Environmental connections'. Unpublished research report for MSc degree. Johannesburg: University of the Witwatersrand, South Africa. For use of these data we acknowledge the Biosystematics Division, Plant Protection Research Institute of the Agricultural Research Council of South Africa.

Information on freshwater fish was provided by Clinton Hay of the Hardap Freshwater Fish Institute and Mendelsohn, JM, S el Obeid & CS Roberts. 2000. *A profile of north-central Namibia*. Windhoek: Gamsberg Macmillan.

9 Creating a synthesis of diversity is difficult because of the differences in the number of species in each taxonomic group of plants and animals. The simple method chosen for this map overlaps the areas of highest diversity for each group (top 3 classes in the maps for birds, mammals, reptiles and plants; top 2 classes of scorpions; and top 4 classes for termites). Areas of overall greatest diversity were then those with the highest overlap of the different groups.

10 Maps of endemism were based on the datasets described in note 8 using the classifications of endemism described in the introductory text 'Patterns of endemism'.

11 The synthesis of endemism was compiled by first obtaining the proportion of endemic species in each group (plants, reptiles, birds, mammals and scorpions) present within each quarter-degree square. A Shannon Index was calculated using these values to allow the squares to be ranked according to their overall level of endemism. The index takes into account both the number of groups represented and their relative abundance, so that squares with all or most groups present in high proportions will score high values. For more information on the Shannon Index, see Jarvis, A & T Robertson. 1997. 'Endemic birds of Namibia: Evaluating their status and mapping biodiversity hotspots'. *Research discussion paper*, No. 14. Windhoek: Ministry of Environment and Tourism, Directorate of Environmental Affairs; or Harrison, JA & P Martinez. 1995. 'Measurement and mapping of avian diversity in southern Africa: Implications for conservation planning'. *Ibis*, 137:410–417.

12 Distribution maps for marine fish, crabs and lobsters were adapted from data provided by the Ministry of Fisheries and Marine Resources and the Geological Survey of Namibia.

13 From Republic of Namibia, Central Bureau of Statistics and National Planning Commission, *Preliminary national accounts 2000*. Windhoek

14 From Roux, J-P & A Sakko. 1997. 'Proceedings of the international workshop on research and management of Cape fur seals in Namibia: held at Swakopmund, Namibia, 24–26 June 1997'. Ministry of Fisheries and Marine Resources.

15 Derived from counts of birds assembled over the years by the Ornithology Section of the Ministry of Environment and Tourism. Numbers of birds recorded during each count were averaged, as were the counts for wetlands close to each other, e.g. groups of islands off the south coast and various wetlands around Swakopmund.

16 Colin Craig and Holger Kolberg of the Ministry of Environment and Tourism supplied the aerial census and farm survey data.

17 Maps of the eight species were overlaid to obtain a simple rating of the number of animals per km².

18 Maps of the six carnivore species were derived by Flip Stander of the Ministry of Environment and Tourism from information collected by the Namibia Large Carnivore Atlas Project. Density estimates, and derived population estimates, were based on intensive studies in Etosha National Park, Khaudum Game Park, Nyae Nyae Conservancy near Tsumkwe, Otjiwarongo District and Kunene Region.

19 Information on ringing and recovery sites was kindly provided by Dieter Oschadleus of the South African Bird Ringing Unit, University of Cape Town.

20 Derived from vulture ringing data assembled over the years by the Ornithology Section of the Ministry of Environment and Tourism.

21 Based on information in Meyburg, B-U, DH Ellis, C Meyburg, JM Mendelsohn & W Schelle. 2001. 'Satellite tracking of two lesser spotted eagles, *Aquila pomarina*, from Namibia'. *Ostrich* 72:35–40.

22 Information on the movements of lions was provided by Flip Stander of the Ministry of Environment and Tourism. These lions were monitored for periods of between three months and over six years. Information on the movements of elephants was derived from the following publications: Lindeque, M & P Lindeque. 1991. 'Satellite tracking of elephants in north-western Namibia'. *African journal of ecology*, 29:199–206; and Rodwell, TC. 1996. *Caprivi elephant monitoring project*. Windhoek: Ministry of Environment and Tourism.

Chapter 5 – The land

1 John Kinahan provided data on the archaeological sequence and distribution of sites. In Figures 5.1–5.3, the presence of sites has been mapped for each quarter-degree square.

Of the many publications on Namibian archaeology, the following provide the best overview of what is known: Kinahan, Jill. 2000. *Cattle for beads: The archaeology of historical contact and trade on the Namib coast* (Studies in African Archaeology 17). Uppsala and Windhoek: Department of Archaeology and Ancient History, University of Uppsala, and Namibia Archaeological Trust; Kinahan, John. 1991. *Pastoral nomads of the Central Namib Desert: The people history forgot*. Windhoek: Namibia Archaeological Trust and New Namibia Books; Richter, J. 1991. *Studien zur Urgeschichte Namibias (Africa Praehistorica 3)*. Cologne; Shackley, M. 1985. *Palaeolithic archaeology of the Central Namib Desert*. Cimbebasia Memoir 6; Volman, TP. 1984. 'Early prehistory of southern Africa. In Klein, RG (ed.). *Southern African prehistory and palaeoenvironments*. Rotterdam: AA Balkema, pp. 169–395; Wendt, WE. 1972. 'Preliminary report on an archaeological research programme in South West Africa'. *Cimbebasia* (B) 2:1–61.

2 The term 'San' is adopted because most Namibians believe it to be less offensive than 'Bushman'. For the record, however, many other people consider 'San' more derogatory.

3 Jeremy Silvester compiled most of the data and information presented in this section.

4 Mandume ya Ndemufayo was later killed in 1917.

5 For much more information, see Dierks, K. 1999. *Chronology of Namibian history*. Windhoek: Namibia Scientific Society.

6 Olpp, J. 1884. *Angra Pequena und Gross-Nama-Land*. Elberfeld: Friedrichs.

7 South Africa. 1918. *Report on the natives of South-West Africa and their treatment by Germany*. London: His Majesty's Stationery Office.

8 Bollig, M & WJ Möhlig. 1997. *'When war came the cattle slept ...': Himba oral traditions*. Cologne: Rüdiger Köppe Verlag; Eggers, H. 1996. 'Das Ovamboland: Sonderstellung und Probleme eines Dichtegebietes in Südwestafrika'. *Geographische Rundschau*, Vol. 12; Fisch, M. 1999. *The secessionist movement in the Caprivi: A historical perspective*. Windhoek: Namibia Scientific Society; Gibson, GD, TJ Larson & CR McGurk. 1981. *The Kavango peoples*. Frankfurt/Main: Steiner; Hayes, P. 1992. 'A history of the Ovambo of Namibia c. 1880–1935'. Unpublished PhD thesis, Cambridge University, United Kingdom; Siiskonen, H. 1990. *Trade and socioeconomic change in Ovamboland, 1850–1906*. Helsinki: Societas Historicas Fennica.

9 Adapted from Bley, H. 1971. *South West Africa under German rule, 1891–1914*. London: Heinemann Educational Books.

10 Ibid.

11 Boundaries extracted from map of Namibia produced by the Surveyor General, 1921.

12 Boundaries extracted from map of Namibia produced by the Surveyor General, 1937.

13 Boundaries extracted from map of Namibia produced by the Surveyor General, 1955.

14 These areas and percentages of the country were calculated from the digital maps of Figures 5.8–5.13 and rounded to the nearest 100km².

15 Ibid.

16 These are areas declared as towns, villages or settlement areas in 2001. The Ministry of Regional and Local Government and Housing should be contacted to get up-to-date information on the status of each urban area.

17 The survey was conducted by the Ministry of Health and Social Services, and the Atlas Project used these data to estimate the areas as Thiessen polygons. These include all areas that are closest to the position of each headman's homestead.

18 Technical Committee on Commercial Farmland. 1992. *Report of the Technical Committee on Commercial Farmland*. Windhoek: Office of the Prime Minister.

19 Lang, H. 1999. 'The transition from communal to private land ownership in Rehoboth, Namibia'. *Zeitschrift für Ethnologie*. 124:319–333.

20 These consist of 106 farms in the Mangetti block of what was Owamboland, 44 in the Kavango Mangetti block, 56 farms near Okamatapati, and 91 farms in the Rietfontein block. In addition, about 170 so-called Odendaal farms in what was Damaraland were allocated to individual farmers.

21 Areas cleared for cultivation were traced off aerial photographs and satellite images taken since 1996 for various projects (Mendelsohn, JM & CS Roberts. 1997. *An environmental profile and atlas of Caprivi*. Windhoek: Directorate of Environmental Affairs; Mendelsohn, JM, S el Obeid & CS Roberts. 2000. *A profile of north-central Namibia*. Windhoek: Gamsberg Macmillan) and this Atlas, as well as 1:50,000 and 1:250,000 mapping projects by the Directorate of Surveys and Mapping.

22 These areas and livestock numbers were estimated from the information and analyses described in notes 21 and 23.

23 Maps of livestock densities were derived using data from the following sources: Mendelsohn, JM and CS Roberts. 1997. *An environmental profile and atlas of Caprivi*. Windhoek: Directorate of Environmental Affairs; Mendelsohn, JM, S el Obeid S & CS Roberts. 2000. *A profile of north-central Namibia*. Windhoek: Gamsberg Macmillan; Mendelsohn, JM & S el Obeid. 2001. *A preliminary profile of Kavango Region*. Windhoek: Namibia Nature Foundation; Directorate of Veterinary Services of the Ministry of Agriculture, Water and Rural Development, 1998 farm census data. For many areas, especially communal areas, data were used in combination with the human population density map (Figure 6.1) to 'spread' animals across rural areas. Resulting point maps were gridded at a resolution of 10 km.

24 For much more information, see Schneider, HP. 1994. *Animal health and veterinary medicine in Namibia*. Windhoek: AGRIVET.

25 Biomass values were added up from the previous density maps as follows: cattle (360 kg), goats and karakul sheep (40 kg), Dorper sheep (60 kg) and donkeys (250 kg) from figures provided by Nico de Klerk, Ministry of Agriculture, Water and Rural Development. The summed values were mapped at 10 km cell sizes. Carrying capacity estimates were obtained from the Agro-ecological Zoning Project of the Ministry of Agriculture, Water and Rural Development and from United Nations Development Programme. 1998. *Namibia: Human development report, 1998*. Windhoek: UNDP.

26 All four variables were converted to a scale of 0–100 and then summed. It is recognised that average rainfall and average plant production vary in direct relation to each other in many areas, as do variation in rainfall and variation in plant production. However, soil qualities, land uses and vegetation types also play a role, and these factors are reflected by the two plant production variables.

27 Hadley Centre. 2001. *Hadley Centre regional climate modelling system*. London: Meteorological Office.

28 Based on data on farm transactions assembled by the Social Science Division of the University of Namibia and made available to the Atlas Project by Ben Fuller.

29 Mendelsohn, JM, S el Obeid & CS Roberts. 2000. *A profile of north-central Namibia*. Windhoek: Gamsberg Macmillan.

30 For example, the West Caprivi Game Reserve is formally declared as a protected area but a variety of other land uses have been allowed there. Proposals to clarify land uses in the area and to change the boundaries of this reserve have yet to be implemented. Several state forests have also been declared by the Ministry of Environment and Tourism's Directorate of Forestry, but they have not been proclaimed legally.

31 Five components were used to derive a measure of potential for tourism, each being converted to a scale of 0–100: altitude range, used as a proxy for 'dramatic landscapes' (the range of altitude in each 10 km grid cell was calculated, converted to a 1 km grid, smoothed and converted to a scale of 0 to 100); human population density (Figure 6.1); large herbivore diversity (Figure 4.52); carnivore diversity (Figure 4.60); and bird diversity (Figure 4.12). These grids were then summed to give one value per 1 km grid cell.

Chapter 6 – The people

1 For Caprivi, north-central Namibia and Kavango, household data were used from sources in Mendelsohn, JM & CS Roberts. 1997. *An environmental profile and atlas of Caprivi.* Windhoek: Directorate of Environmental Affairs; Mendelsohn, JM, S el Obeid & CS Roberts. 2000. *A profile of north-central Namibia.* Windhoek: Gamsberg Macmillan; and Mendelsohn, JM & S el Obeid. 2001. *A preliminary profile of Kavango Region.* Windhoek: Namibia Nature Foundation.

For other urban and rural populations north of 21°, household data from the 1:250,000 mapping project for the Surveyor General, Ministry of Lands, Resettlement and Rehabilitation, were used.

For urban populations south of 21°, population estimates were taken from 'Analysis of present and future water demand in Namibia' prepared for Namibia Water Resources Management Review by Windhoek Consulting Engineers.

For communal areas south of 21°, households were marked from 1:80,000 aerial photos, and some data from the Directorate of Rural Water Supply's databases were used.

For populations south of 21° in commercial farming areas, the numbers of people per enumeration area in the 1991 Population and Housing Census were spread across commercial farms in that enumeration area. The 1991 Population and Housing Census data were used to derive the average number of people per household in each area.

Adding up all the data in this map produces an estimate of Namibia's population of 1.89 million people, slightly more than the total of 1.83 million counted during the 2001 Population and Housing Census conducted by the Central Statistics Office.

2 TRP Associates. 1995. *1995 residents survey Report* (Vols. 1 and 2 and Annexures). Windhoek: Municipality of Windhoek.

3 Numbers of people in the whole country and in each region are those recorded during the 2001 Population and Housing Census, while the other figures are based on information presented in Figure 6.1.

4 Based on information presented in Figure 6.1.

5 Ibid.

6 Based on information collected during the 1991 Population and Housing Census conducted by the Central Statistics Office.

7 The distribution of San and Hei//om languages is mapped for purposes of interest and because they are such a minority in most areas.

8 This map uses the 26 ethnic and magisterial districts that existed in 1991, and Walvis Bay. Languages were grouped as follows: Caprivian (Fwe, Subiya, Totela and Yeyi), San (!Xun, Hei//om, Kxoe), Kavango (Mbunza, Rukwangali, Rumanyo, Shambyu, Thimbukushu), Oshiwambo (Eunda, Oshikolonkadhi, Oshikwaluudhi, Oshikwambi, Oshikwanyama, Oshimbadja, Oshimbalantu, Oshindonga, Oshingandjera), and Others (Afrikaans, English, German, Portuguese and other languages).

9 Population estimates come from the population censuses and surveys conducted over the years by the Central Statistics Office.

10 The National Planning Commission and the Ministry of Health and Social Services compiled the projections.

11 Information for Walvis Bay is not included here because the data were taken from the 1991 Population and Housing Census. Although the information is from 1991, there is no evidence that overall patterns have changed significantly.

12 From Katjiuanjo, P, S Titus, M Zauana & T Boerma. 1993. *Namibia demographic and health survey, 1992.* Windhoek: Ministry of Health and Social Services and Macro International Inc.; and Republic of Namibia, Ministry of Health and Social Services. 2001. *Preliminary report: Namibia demographic and health survey, 2000.* Windhoek: Ministry of Health and Social Services.

13 Life expectancy at birth reflects the average number of years a newborn will be expected to live given the age-pattern of dying currently being experienced. Data from the 1991 Population and Housing Census; United Nations Development Programme. 1999. *Namibia: Human development report, 1999.* Windhoek: UNDP; and Republic of Namibia, Ministry of Health and Social Services. 2001. *Preliminary report: Namibia demographic and health survey, 2000.* Windhoek: Ministry of Health and Social Services.

14 Fertility rates are determined both by the number of children born per year and by the average number of fertile years per woman. From results of the 1991 Population and Housing Census and the 1996 InterCensal Survey by the Central Statistics Office and Republic of Namibia, Ministry of Health and Social Services. 2001. *Preliminary report: Namibia demographic and health survey, 2000.* Windhoek: Ministry of Health and Social Services.

15 From the 1991 Population and Housing Census. Similar results can be obtained from the 1996 InterCensal Survey data. However, this is a sample survey compared to the full census of every woman during 1991. Interestingly, results from the 1996 InterCensal survey suggest that women who have had little schooling produce fewer children than women with similar levels of education in 1991.

16 For more information see El Obeid, S, JM Mendelsohn, M Lejars, N Forster & G Brulé. 2001. *Health in Namibia: Progress and challenges.* Windhoek: RAISON.

17 All calculations are based on the provision of services by the government and government-subsidised facilities. Although there are about 650 beds in private hospitals, private facilities do not add significantly to improved access since almost all of them are in densely populated areas where people have access to nearby government facilities.

18 Analysis of data in the Ministry of Health and Social Services' Health Information System.

19 Analysis of data in the Ministry of Health and Social Services' Health Information System. The number of new cases of malaria amongst outpatients was compared to the estimated population served by each health facility.

20 These are cases of diarrhoea with bleeding. The number of new cases of diarrhoea amongst outpatients was compared to the estimated population served by each health facility. For more information see El Obeid, S, JM Mendelsohn, M Lejars, N Forster & G Brulé. 2001. *Health in Namibia: Progress and challenges.* Windhoek: RAISON.

21 Republic of Namibia, Ministry of Health and Social Services. 2001. *Preliminary report: Namibia demographic and health survey, 2000.* Windhoek: Ministry of Health and Social Services. Underweight measures are taken from the ratio between a child's weight and age. Children that are 'underweight' are so below weight that they are beneath the range of less than two standard deviations from what can be expected.

22 Republic of Namibia, Ministry of Health and Social Services, 2001. *Report of the 2000 HIV 2000 sentinel sero survey.* Windhoek: Ministry of Health and Social Services.

23 Analysis of data in the Ministry of Health and Social Services' Health Information System.

24 From a predictive model developed by Oddvar Jakobsen of the United Nations Development Programme in Namibia.

25 Unless otherwise stated, all figures are from 2001 and were obtained from the Ministry of Basic Education, Sport and Culture.

26 From the 1996 InterCensal Survey.

27 Ibid.

28 Results from the Grade 10 National Examinations in 2000, as provided by the Ministry of Basic Education, Sports and Culture. Under this system, each pupil is awarded a symbol: A, B or C (High mark), D, E, F or G (Medium), or U (Fail).

29 From the 1996 InterCensal Survey.

30 Airport classification categories as defined by the Industrialisation Environment Team. 1999. *State of the environment report on Namibia's industrialisation.* Windhoek: Ministry of Environment and Tourism. The official roads network was obtained from the Roads Authority.

31 EMCON. 2000. *Rural electricity distribution master plan for Namibia.* Windhoek: NamPower and Ministry of Mines and Energy.

32 Telecom communication system data and interpretation provided by Volker Pesch from Telecom. Cellular telephone network data from Jochen Traut, MTC. Telecommunications in Namibia are changing rapidly and updated data should be requested as required from these organisations.

33 Namibia Natural Resource Consortium. 2001. *Namibia's natural resource sector: A contribution to Vision 2030.* Windhoek: National Planning Commission.

34 Ibid.

35 From the 1991 Population and Housing Census and updated using information on new pipeline networks, and from the 2000 Demographic and Health Survey.

36 From the 1994 Namibia Household Income and Expenditure Survey conducted by the Central Statistics Office.

37 Based on information collected during the 1991 Population and Housing Census conducted by the Central Statistics Office.

38 Mendelsohn, JM, S el Obeid & CS Roberts. 2000. *A profile of north-central Namibia.* Windhoek: Gamsberg Macmillan; Mendelsohn, JM & S el Obeid. 2001. *A preliminary profile of Kavango Region.* Windhoek: Namibia Nature Foundation.

39 From the 1991 Population and Housing Census. More recent data are available from the 1996 InterCensal Survey, but these are based on samples that are too small to make reliable regional comparisons.

40 Based on information collected during the 1991 Population and Housing Census conducted by the Central Statistics Office.

41 Ibid.

42 From the 1996 InterCensal Survey.

43 Ibid.

44 From the 1994 Namibia Household Income and Expenditure Survey conducted by the Central Statistics Office.

45 The Human Development Index (HDI) is a composite of measures of life expectancy, literacy, income per capita, and school enrolment rates. The Human Poverty Index (HPI) combines measures of the percentage of people who will not reach the age of 40, the percentage of households that spend less than 20% of their income on non-food items, the percentage of the adult population that is illiterate, the percentage of underweight children, and the percentage of homes that do not have access to safe water. The maximum value for the development index is 1, while 100 is the maximum level of poverty. For more information, see United Nations Development Programme. 2000. *Namibia: Human development report, 2000.* Windhoek: UNDP, from which these figures are derived.

46 From the United Nations Development Programme. 2001. *Human development report, 2001.* UNDP.

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