1.1 Geographical features

Namibia's landscape is a stark, vividly coloured and remarkably varied one. It stretches from cold and desolate coasts through gravel plains, "dune seas" and rugged inselbergs to the scrublands, thorn savannas, ephemeral pans and rocky hills of the interior. Contrasting softly with these forbidding lands, the moist woodlands and tropical floodplains of the northeast help make Namibia one of the most fascinatingly varied countries of its size on earth. Its rapidly expanding tourism industry attests to the geographic variety of the country, with its unusual habitats and invigorating wilderness that people pay considerable money to experience.

Namibia is undoubtedly scenically diverse. But to what extent does this geographic diversity contribute to biological diversity? Because the country is so arid overall, one would think perhaps rather little. Compared to South America's or Australasia's tropical moist forests, or South Africa's Cape floral kingdom, Namibia does not have huge numbers of species. This reflects not only its aridity, but also its past ecological and climatic history. However, we have a high proportion of biota which are unique to the Southwestern Arid Zone, with many unusual restricted-range species. This first chapter sets the scene for a portrayal of this unusual and impressive biodiversity.

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*Updated from: NPC; EIU*
Climate and palaeoclimate

The overwhelming two features of Namibia’s climate are the scarcity and unpredictability of rainfall. Within Africa, our climate is second in aridity only to the Sahara. Rainfall everywhere in the country is lower and more variable than in the eastern subcontinent, and lower and more variable the further west one travels. Steep gradients thus characterise the country’s rainfall (map 1.1), from tropical semi-humid in the northeast (3% of land area) to hyper-arid in the west (12%). The country-wide average rainfall of under 250 mm per year is coupled with annual mean evaporation of up to 3700 mm (map 1.2). Overall, 69% of the country is regarded as semi-arid, with the remaining 16% as arid. What little rain reaches the hard-baked soil is mostly lost again to the clouds. It is estimated that about 83% of rainfall evaporates, and a further 14% is transpired by plants. This leaves 2% to enter drainage systems, where some is retained in dams, and only 1% to recharge the land’s severely stressed groundwater tables.

By themselves, the low rainfall and high evaporation over most of Namibia strongly limit the species composition of natural ecological communities, as well as the options for human development. The combination of a cold, subantarctic upwelling on the Atlantic coast and a hot subtropical interior have led to hyper-arid, bleak coastal conditions in the Namib Desert, similar to those of Chile’s Atacama Desert and of Baja California, México. The effect of the Benguela Current on climate of the Namib is pervasive. Not only has the cold, nutrient-rich, north-flowing upwelling fostered one of the most productive marine ecosystems in the world, but it has also created a dramatic clash of sea and land, fog and dust, with implications for the southern African region as a whole. However, the obvious zone of transition between cold sea and hot desert is narrow. A thin strip of coastal fog, seldom reaching more than 30 km inland, frequently blows over the hyper-arid coast and sustains life there in the absence of rainfall (map 1.2).

Most of Namibia’s rain falls in summer, from November to April. There is extraordinary variation between years, with the driest areas having the least predictable rainfall. However, southwestern Namibia lies in the winter rainfall zone, which characterises Africa’s entire southwest corner. In this zone, a diverse succulent flora has proliferated.

Temperatures in Namibia can also be extremely variable and challenging to plant and animal life, with temperatures well over 50°C and under 0°C recorded in the same parts of the country. Daily fluctuations are greatest in the hyper-arid zones, where there is little vegetation cover to moderate the temperature. In the tropical northeast and along the coast, by contrast, daily highs and lows can differ by as little as 2-5°C. Large diurnal temperature changes may act as a strong selective pressure on many plants and poikilothermic (‘cold blooded’) animals. Along with sporadic rainfall, high temperatures in the arid interior help create a high water deficit (map 1.2).

In geological time, the Namib Desert and its adjacent plateaus have been arid or semi-arid for many millennia. The convergence of the Benguela upwelling and the hot interior has certainly maintained, and perhaps increased, the aridity of the region in recent times. Yet this convergence did not by itself generate the aridity. There is ample evidence that the Namib has been semi-arid to arid for at least 55 and possibly up to 80 million years, despite significant climate fluctuations, while the Benguela Current was forced northward along the southwest African coast only about 5-10 million years ago. The slow continental breakup of west Gondwana, 130-145 million years ago, set overlying conditions for the region’s aridity, by shifting southern Africa to its present position astride the Tropic of Capricorn, and slowly readjusting adjacent marine currents and prevailing winds. In effect, the region has been an island of aridity in a ‘sea’ of more changeable climes.
Mean Annual Rainfall

- **0-50 mm/yr**
- **50-100 mm/yr**
- **100-150 mm/yr**
- **150-200 mm/yr**
- **200-250 mm/yr**
- **250-300 mm/yr**
- **300-350 mm/yr**
- **400-450 mm/yr**
- **450-500 mm/yr**
- **500-550 mm/yr**
- **550-600 mm/yr**
- **600-650 mm/yr**
- **650-700 mm/yr**
- **700-750 mm/yr**

**Arid**

**Semi-Arid**

Source:
Ministry of Agriculture,
Water and Rural Development
Department of Water Affairs

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Map 1.2  Mean water deficit in Namibia (mean annual rainfall minus mean annual evaporation, in mm)

Water Deficit

(Mean annual rainfall - mean annual evaporation in mm)

-3800 to -3400
-3400 to -3200
-3200 to -3000
-3000 to -2800
-2800 to -2600

-2600 to -2400
-2400 to -2200
-2200 to -2000
-2000 to -1800
-1800 to -1700

Border
Major Towns

Source:
Ministry of Agriculture,
Water and Rural Development
Department of Water Affairs

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This very long, very dry period has had a profound influence on the region’s biodiversity. The Namib is widely called the world’s oldest desert, a description which reflects not only the age of its rocks and sands, but also, indirectly, its unique species and biological communities. Today, we find our major centres of endemism (areas rich in species unique to Namibia or the region) not in the tropical northeast, but in the arid northwestern escarpment and southern winter-rainfall zone (Chapter 2). While most of Africa has undergone ceaseless climate fluctuations, generating the expansion and contraction of savannas and forests over millennia, the continent’s arid coasts have remained relatively stable centres for the evolution of desert and dry-savanna species. Dramatic bouts of volcanism have taken place in parts of Namibia over the past 40 million years, but these have had only sporadic local effects within an overall context of stability. Namibia’s centres of endemism are taken up further in Chapter 2.

Geology, soil and landforms

Namibia is a geologist’s paradise. With so little ‘annoying vegetation’ to get in the way, so to speak, and with rich ore deposits over much of the country, it is hardly surprising that Namibia is very well known geologically and geographically. Even in the 1960s, a rather broadly defined bibliography of geography and related fields in the then South West Africa contained over 2000 titles.

The geology of Namibia is complex and fascinating, and attempts to distill it into a few landform categories will always seem simplistic. However, although the country is divided into numerous minor landforms or geophysical zones (map 1.3), four major categories can be distinguished: coastal plain and Namib Desert; the broken and rugged Namib escarpment; the rocky central plateau; and the Kalahari sandveld. Only the sandveld is fairly simple geologically; the other zones conceal a hodgepodge of intrusions, ridges, dykes, sills and outcrops.

The Namib Desert and coastal plain give the country its name, as well as its most forbidding and distinctive scenery. Yet the Namib as a geo-ecological zone extends about 2000 km from the Carunjamba River in Angola to the Olifants River in South Africa. Bounded sharply by the Atlantic on the west, its eastern reaches are ill-defined. The Namib reaches 80 to 200 km inland, roughly coinciding with the 100-mm annual rainfall line (map 1.1), the 1000 m altitude contour line (map 1.4), or the Namib escarpment. It covers about 15% of Namibia’s land area. There are three broad desert landforms:

- the southern Namib, with spectacular “dune sea” and “islands” of black outcrops and inselbergs;
- the central Namib, with gravel plains between the Ugab and Kuiseb Rivers;
- the northern Namib, with rugged mountains and dunefields reaching northwards into Angola.

Fig. 1.1 The Kuiseb River slices through the central Namib, cutting off the northward movement of dunes. Courtesy NASA.
Map 1.3  Landforms of Namibia

Landforms
- IA: Namib sand dunes
- IB: Complex of Namib sand drift and association of hills and valleys
- IC: Namib desert pavement
- ID: Namib hills and valleys
- IIA: High mountains of the escarpment
- IIB: Plateau remnants of the escarpment
- IIC: Erosion surface of the degraded escarpment
- IIDA: Plateaus proper of the plateau
- IIBA: Plateau with ridges in the plateau
- IIIB: Highlands of the plateau country
- IIIC: Dissected plateau fringes of the plateau country
- IIID: Foothills and slopes in the plateau country
- IIIE: Plateau of soft porous Kalahari limestone in the plateau country
- IIIF: Karst and hard Damara limestones in the plateau country
- IIIG: Erosion forms (hills and slopes) on Karoo rocks in the plateau country
- IIHA: Structural hills in the plateau

Source:
- FAO 1983
- AG: DP/NAM/78/004

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In reality, the Namib Desert has few sharp transitions. A dramatic exception is the Kuiseb River, which cuts off the northerly march of the southern Namib’s dune sea in a dividing line as sharp as a knife edge and spectacularly apparent from satellite images (Fig. 1.1, map 1.3). Other ephemeral, normally dry riverbeds dissect much of the Namib at wide intervals, flowing only irregularly. The southern Namib is nearly devoid of surface water or ephemeral rivers, but rivers are prominent features, as well as important corridors for biological diversity, in the central and northern Namib (map 1.5).\(^6,7\)

The Namib escarpment is a thin, sometimes poorly defined transition zone between the desert and the central highland plateau. Narrow, broken and deeply dissected (map 1.4), the escarpment and the ephemeral rivers which breach it are critically important in terms of biological diversity. Many unique Namibian endemic vertebrates, invertebrates and plants are found in this zone. Although poorly known, the escarpment and adjacent mountains are extremely valuable biologically. The Brandberg or Dāures massif is Namibia’s highest mountain at 2579 m above sea level. Other mountains such as Baynes (2038 m), Erongo (2319 m), and Naukluft Mountains (1974 m), Spitzkoppe (1759 m) and the Gamsberg (2347 m) also lie along or near the escarpment edge\(^1\) and support endemic species (see section 2.3).

The central plateau lies above and east of the escarpment zone, and runs north to south the full length of the country. Most of the rivers in Namibia have their major watersheds in this highland (map 1.4). It is stony and flat in places, and dramatically mountainous in others, at altitudes between about 1000 and 2000 m.\(^13\) The capital city, Windhoek, lies between two mountain ranges running along the south and east, with the Khomas Hochland plateau undulating west to the Namib escarpment. The northwestern highlands are rugged, with broad valleys and inselbergs, while the south is a flat stony plateau dissected by deep valleys.\(^12\) Mountains in both regions are ecologically valuable and interesting.

Finally, the Kalahari sandveld stretches east from the central plateau, with deep sands overlaying bedrock. A thick layer of red or pale sand is characteristic of the Kalahari, but the brittle alkaline soils of the north, including the Etosha Pan region, are also part of this system.\(^12\) In contrast to the rugged and stony land to the west, most of the sandveld is excruciatingly flat, with sporadic thorn or broadleaved trees. To the northwest, the sandveld undulates in low, fossilised dunes interspersed with shallow ephemeral river valleys or omirambo. Most omirambo simply form lines of pools or pans in the rainy season,\(^12\) as the coarse sand is very porous (map 1.6).

**Water resources and hydrology**

Water is undoubtedly Namibia’s most limited and, ultimately, limiting natural resource. Its distribution and abundance have for at least two millennia determined the settlement and migration patterns of humans and their livestock, as strictly as other fauna and flora.\(^15\) Perennial, if variably flowing, rivers occur only on our northern and southern borders (map 1.7). Patchy and ephemeral surface water is only briefly available in some areas in the rainy season, groundwater tables have dropped in the central and western regions, and fossil groundwater is already widely mined. Groundwater sources are of limited quantity and variable quality.\(^5\) Larger water sources in the country’s interior are now virtually fully exploited,\(^18\) although small springs of ecological importance remain. The only truly abundant water source is the Atlantic Ocean. The high water deficit throughout the country (map 1.2) makes water management and storage difficult.

Such data make one wonder how economic or population growth can continue in Namibia, given the human and livestock pressure that already exists. Water management strategies to sustain economic growth are neither easy nor palatable, and include conservation, demand management, prioritisation of uses, and development of alternative sources.\(^18\)
Map 1.5  Drainage basins or catchments of Namibia

Drainage Systems

- **A1** Fish River
- **A2** Orange River
- **A3** Kunene River
- **A4** North Coast
- **A5** Khumib
- **A6** Hoarusib
- **A7** Uinib
- **A8** Koigab
- **A9** Huab
- **A10** Ugab
- **A11** Omaruru
- **A12** Swakop
- **A13** Kuiseb
- **A14** Namib
- **A15** Tsaris
- **A16** Koichab
- **B2** Zambezi via Kwando
- **C1a** Okavango Delta
- **C1b** Okavango
- **C1c** Omatako
- **C1d** Omurambas
- **C2a** Cuvelai
- **C2b** Etosha
- **C2e** Noesob
- **C3a** Auob
- **C3b** Tsandab
- **C3c** Tschaub

Source:

United Nations, Cartographic Unit
Department of Conference Services
New York

Jacobson et al. 1995
Ephemeral Rivers and their Catchments. DRFN, Windhoek

© National Remote Sensing Centre 1997
Map 1.6  Simplified soil map of Namibia

Soils
- Lithosols
- Fersiallitic soils
- Solonetzic and planosolic soils
- Halomorphic soils
- Arenosols
- Alluvial and other soils of low-lying areas
- Weakly developed shallow soils of arid regions

Source:
© National Remote Sensing Centre 1997
Map 1.7 Wetlands and ephemeral rivercourses of Namibia

Wetlands

- Border
- Perennial river
- Non-perennial drainage line
- Ephemeral river or main drainage line

Black text indicates the names of drainage systems and pans
Blue text indicates the names of dams

Pans
Marshes
Salt marshes
Springs according to MAWR database
Dams according to MAWR database

Source:
United Nations, Cartographic Unit
Department of Conference Services
New York

Ministry of Agriculture, Water and Rural Development
Department of Water Affairs

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Vegetation zones

Namibia's steep northeast-to-west climatic gradient, plus its varied soil types and landforms, largely determine the distribution of its characteristic vegetation zones. Annual rainfall determines the three main vegetation zones of Namibia: deserts, savannas, and woodlands. Temperature and seasonality of rainfall, plus topography and soil, influence the 14 major subdivisions of these vegetation zones (map 1.8).

The Namib can be subdivided into true Namib (Northern, Central and Southern Namib) and Succulent Steppe vegetation zones. The Succulent Steppe lies within and is determined by Namibia's winter rainfall area. This is the northern limit of southwestern Africa's Mediterranean-type winter rainfall zone, which contains two of the world's major hotspots of botanical diversity and endemism, the Cape Floristic Kingdom and Succulent Karoo. The winter rainfall area and foggy coast are typified by succulent shrubs, mainly in the family Mesembryanthemaceae. Perennial grasses such as Stipagrostis sabulicola characterise the Namib mobile dunes, while annual herbs and grasses including other Stipagrostis species occur on gravel plains.

The desert fringe, including inselbergs and the Namib escarpment, forms a transition between desert and savanna, termed the Semi-desert/Savanna Transition zone. Many endemics and species of conservation importance occur here (section 2.3). Although the mountainous Kaokoveld, in the northwest escarpment zone, was classified as Mopane Savanna by Giess, he recognised this as due to inadequate data. The Kaokoveld is part of the transition zone, and is extremely valuable botanically, with high endemcity (Fig. 1.2) and several monotypic general.

Most of Namibia is covered by savanna, especially thorny shrub and tree savanna. Mountain, Thornbush and Highland Savannas dominate the central highlands, while Dwarf Shrub Savanna covers the southern inland plateau. Camelthorn Acacia erioloba and Mixed Tree and Shrub Savannas are largely confined to the Kalahari sandveld, and Mopane Savanna dominates the northwest of Namibia, east of the escarpment.

Two types of woodland are distinguished in Namibia. Forest Savanna and Woodlands cover the moist northeastern region, with tropical trees such as Baikiaea plurijuga, Berkea africana, Lonchocarpus capassa and Terminalia sericea. Riverine Woodlands are azonal and associated with the continuous moisture supply along rivers. Virtually all rivers are lined with woodlands. Permanent rivers harbour lush, diverse vegetation; the ephemeral riverbeds support trees and shrubs such as Faidherbia albida, Salvadora persica and Ziziphus mucronata.
Map 1.8  Vegetation types of Namibia (Giess 1970)

Vegetation

1. Northern Namib
2. Central Namib
3. Southern Namib
4. Desert and succulent steppe
5. Saline desert with dwarf shrub savanna fringe
6. Semi-desert and savanna transition
7. Mopane savanna
8. Mountain savanna and karstveld
9. Thornbush savanna
10. Highland savanna
11. Dwarf shrub savanna
12. Camelthorn savanna
13. Mixed tree and shrub savanna
14. Forest savanna and woodland

Border
Major Towns

Source:
Giess W., 1970
Dinteria 4:5-114

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What makes the Namibian flora unique? Variable environmental conditions have created a diverse flora with mainly palaeotropical floral elements in the north, cold-temperate elements in the south, and transitional elements between the two. Apart from current conditions, climatic history plays an important role in determining the present floral composition of Namibia. Moister conditions in the distant past, prior to establishment of the Benguela Current, created relatively mesic conditions supporting a less arid-adapted flora. With increasing aridity since then, many tropical and cold-temperate species were forced to retreat to wetter habitats. Some of these species survived in favourable microhabitats even in the desert. The Namib escarpment harbours many relics from wetter periods in the past.

Apart from many taxa with an interesting history, the aridity which has prevailed for millions of years has fostered a variety of arid-tolerant species. Species with bizarre growth forms and strategies, such as *Welwitschia mirabilis*, have made the Namib a popular destination for scientists for over a century.

—Antje Burke

### 1.2 Social and economic features

Namibia is a dry land with a small human population, a young government, and an excellent modern infrastructure. Yet it also has a tormented and bitter sociopolitical history that might surprise visitors, who are normally impressed with its current peaceful stability and its multiparty democracy.

How have Namibia’s social, economic, political and historical contexts influenced our present-day environmental policies and institutions? What legacy have they left on processes of environmental management, scientific research, conservation and land use planning? More specifically, do these contexts have a specific bearing on the biological diversity conservation strategies we must develop? The following sections sketch out an overview of these factors, and attempt to draw broad conclusions about the social, economic and political contexts in which biodiversity conservation actions must proceed.

**Human palaeoecology**

People have roamed Namibia’s landscapes for an extraordinarily long time, as judged from a patchy but intriguing palaeoecological record. Stone tools from the south-central plateau of the country, for example, span a sequence dating back more than one million years. Perhaps the earliest inhabitants were related to the Khoi and San pastoralists and hunter-gatherers. While dating of archaeological sites is often controversial, pastoral sites date from at least two millennia before present, and foraging bands of San people have probably roamed southern Africa, including Namibia, for at least 20 000-30 000 years.

![Early 'written' records of Namibian biodiversity — rock engravings at Twyfelfontein. Courtesy L C Weaver](image1)

![The Naukluft holds many clues to early human settlement. Courtesy National Museum of Namibia](image2)

These early Namibians inhabited a land not very different to that of today: an arid interior and coastal plain, with a productive intertidal zone influenced by the Benguela Current. Radiocarbon dates of shellfish middens in the