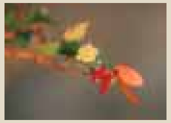
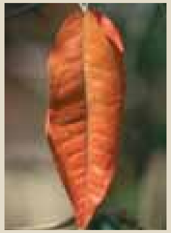




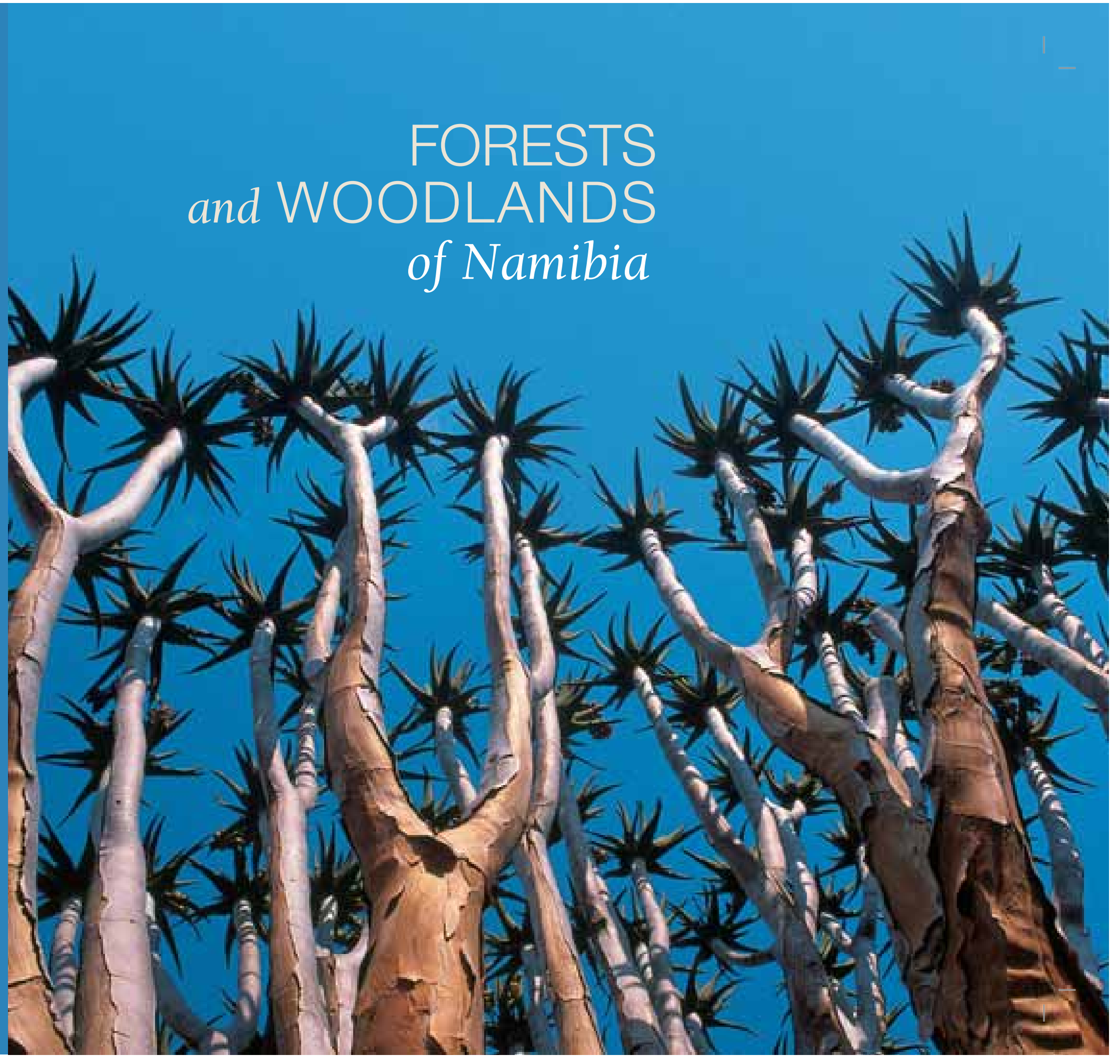


Namibian forests and woodlands – an unusual, perhaps a peculiar concept, yet it is the relative scarcity of trees that makes them so valuable in arid areas. Where each tree is an island, it is a local treasure of resources for insects, birds, game, livestock, and people. As perennial plants, trees are resilient, able to withstand and survive the onslaughts of drought. Their bounty remains permanent throughout the years, providing secure resources to all who depend on them.

ISBN 99916-780-3-4

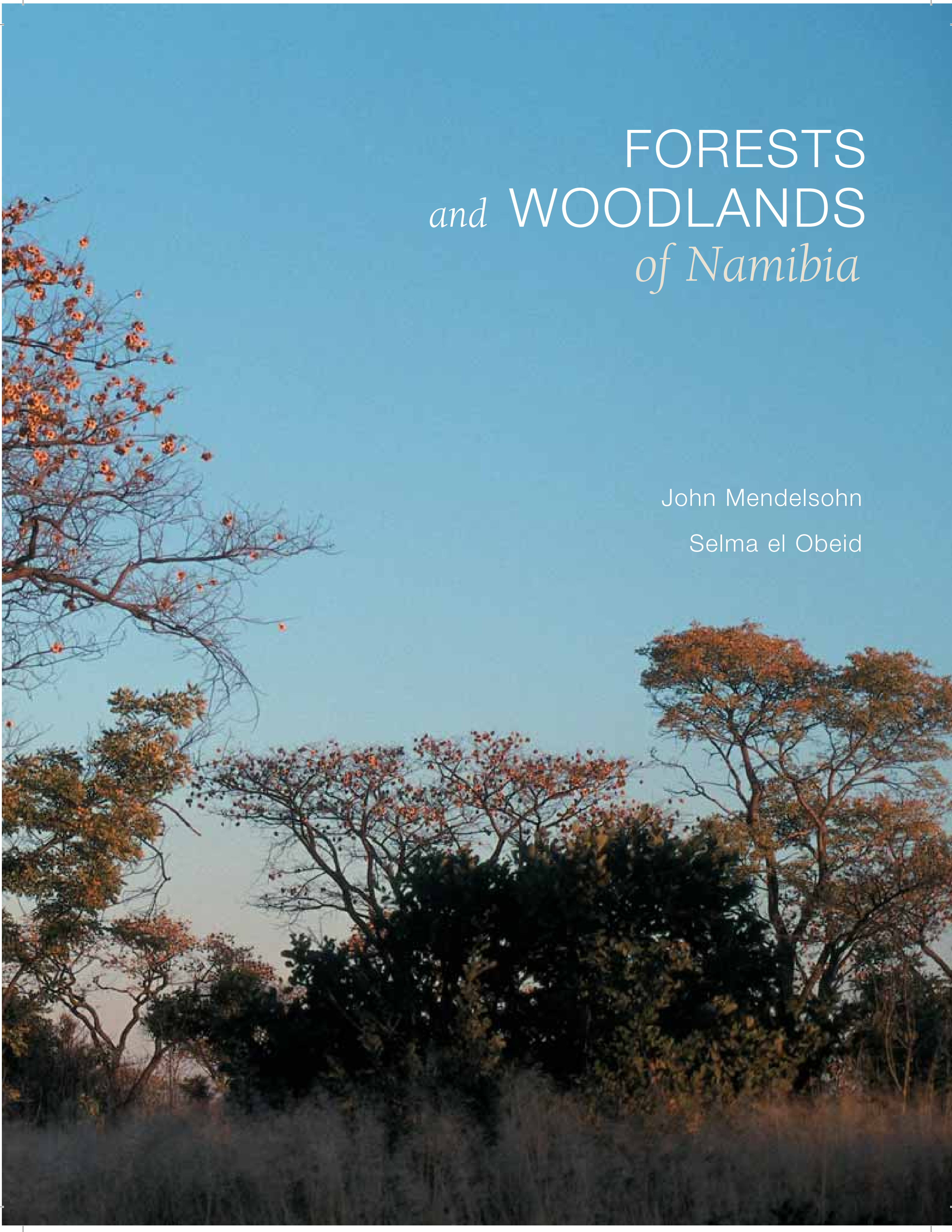
FORESTS *and* WOODLANDS *of Namibia*

FORESTS *and* WOODLANDS *of Namibia*



FORESTS
and WOODLANDS
of Namibia

A publication for the Directorate of Forestry
Ministry of Agriculture, Water & Forestry



FORESTS *and* WOODLANDS *of Namibia*

John Mendelsohn

Selma el Obeid

First published in 2005

By RAISON (Research & Information Services of Namibia)
PO Box 1405, Windhoek

Copyright © text, maps and graphs: Ministry of Agriculture, Water and Forestry
Copyright © photographs with individual photographers, listed on page 152
Designed by: PETALDESIGN, Cape Town
Repro by: Resolution, Cape Town
Printed by: Sing Cheong Printing, Hong Kong

ISBN 99916-780-3-4

Published for the Directorate of Forestry
Ministry of Agriculture, Water and Forestry
Government of Nambia

Funded by Government of Finland
through the Namibia-Finland Forestry Programme

Government of Finland   Government of Nambia



PREFACE 6

INTRODUCTION: context and early beginnings 8

ECOLOGY: the life of trees 22

BENEFITS AND USES: more than wood 58

CHANGING MANAGEMENT: conservation for use 84

PROSPECTS: seeing the wood and the trees 102

TWENTY NAMIBIAN TREES 126

SOURCES AND NOTES 148

PREFACE

"Trees not only provide wood and non-wood products but also provide numerous environmental goods and services such as the conservation of biological diversity and mitigation of climate change, and they have a key role in alleviating poverty and improving food security." ***Food and Agriculture Organization of the United Nations (FAO)***

Forests and Woodlands of Namibia is about trees and shrubs, the organisms that help to shape and enrich the environment and provide much value to the country.

Seen separately, the organisms are trees or shrubs, but collectively they form habitats known as forests, woodlands, savannas or shrublands. In turn, habitats are areas that provide people, livestock and other animals with resources which contribute greatly to their livelihoods.

One role of this book is to illustrate the major processes that cause Namibian woodland habitats to be the way they are. The book also describes the many ways in which woody plants are used, and the ways we hope to manage and conserve woody habitats.

The idea of woodlands – especially forests – in Namibia may seem odd to many people, particularly those who live in the more arid southern regions where there are few trees. It may also seem peculiar to people who know the splendour of tall tropical forests in Africa, central America or Asia, or to those who have enjoyed the vast expanses of boreal forests in the temperate regions of the northern hemisphere. But, as this book will show, Namibia has forests and woodlands that are every bit as important as those much bigger wooded habitats. Their importance lies in the goods and services they provide in a local context for Namibia itself. In a country that is generally arid, the value of each individual tree is relatively greater than in a wetter, more wooded environment. As perennial plants in dry areas, trees are more buffered against drought and fire than other plants. Their resource values are thus more dependable. Trees in Namibia provide wood and non-timber forest products to hundreds of thousands of people, and they support the lives and existence of browsing mammals, other vertebrate animals and countless species of insects and other invertebrates. If these statements seem abstract, a more powerful way to think of the value of trees is to visualize what would happen if they were removed from a landscape. Among many losses, there would be no shade, browsing animals would be gone, most birds would lack places to nest and roost, firewood would have to be collected elsewhere, and the scenery would be much bleaker.

Think of these and other impacts, and the value of each tree becomes clear. But too few of us care to think enough. Day in and day out, we take indigenous trees, woodlands and forests for granted. Few of us bother about bush fires killing trees or the clearing of trees for crops. When a tributary is dammed little thought is given to the effects on riverine trees downstream. And ideas that trees might provide essential medicines in the future or help reduce the effects of global warming are unknown or remote to most people.

However, all these issues and potentials are real and vital, important enough to concern all Namibians, and it is for this audience that this book is intended. Woodlands provide Namibians with habitats to live in and resources to live by, and the significance of these habitats must be recognised, valued, and celebrated. One simple goal of this book is thus to uplift the profile of forests and woodlands in Namibia. Another is to bring together information on woodlands and forests as reference material for students, teachers, policy and decision makers, agriculturalists, planners, development specialists, public servants, and the general public. That information should help to guide the decisions, policies and endeavours that are required if forests and woodlands are to continue providing the goods and services on which this and future generations depend.

Forests and Woodlands of Namibia was commissioned by the Directorate of Forestry through the Namibia-Finland Forestry Programme. At the time of commissioning, the Directorate was in the Ministry of Environment and Tourism but it was moved to the Ministry of Agriculture, Water and Forestry as the book was being completed. The publication of the book marks the end of Finland's direct technical and financial support to the forestry sector. Namibia is grateful for this support, which started in 1991 and continued over the past 14 years. A great number of people provided information and ideas for the book, and we are specially grateful to Jon Barnes, Barbara Curtis, Antti Erkkilä, Joseph Hailwa, Stig Johansson, Risto Laamanen, Pauline Lindeque, Ester Lusepani Kamwi, Celia Mendelsohn, Tuulikki Parviainen, Mary Seely, Sem Shikongo and Peter Tarr.

Other contributions were kindly provided by Simon Angombe, Ben Bennett, Antje Burke, Central Bureau of Statistics, Moses Chakanga, Dave Cole, Andrew Corbett, Pat Craven, Tony Cunningham, Diane Davies, Nico de Klerk, Helge Denker, NP du Plessis, Pierre du Plessis, Antje Eggers, Klaus Endresen, Björn Finne, Peter Frost, Coert Geldenhuys, Patrick Graz, Joh Henschel, Luise Hoffmann, Caren Jakubaschk, Brian Jones, Vesa Kaarakka, Kahijoro Kahuure, Ndapanda Kanine, Johan Le Roux, Malan Lindeque, Cyril Lombard, Vincent Louw, Michel Mallet, Coleen Mannheimer, Ralph Meyer, Ministry of Agriculture, Water and Forestry, Ministry of Environment and Tourism, Petra Moser, Simon Mutabazi, Felix Muyoba, Jonas Mwiikinghi, Namibia Scientific Society, National Archives of Namibia, Esa Puustjärvi, Peter Reiner, Carole Roberts, David Roy, Tapani Ruotsalainen, Bob Scholes, Wikus Scholtz, Denis Sikabongo, Nico Smit, Rolf Sprung, Carol Steenkamp, Ben Strobach, Ahmed Talha, Kobus Theron, Mark Thompson, Simon Trigg and Alex Verlinden. Our sincere thanks to all these people and organizations.

The value of trees (left) becomes starkly clear once they are gone (right). It is easy to remove trees, but putting them back to restore the value of a wooded habitat is much harder.

INTRODUCTION: *context and early beginnings*

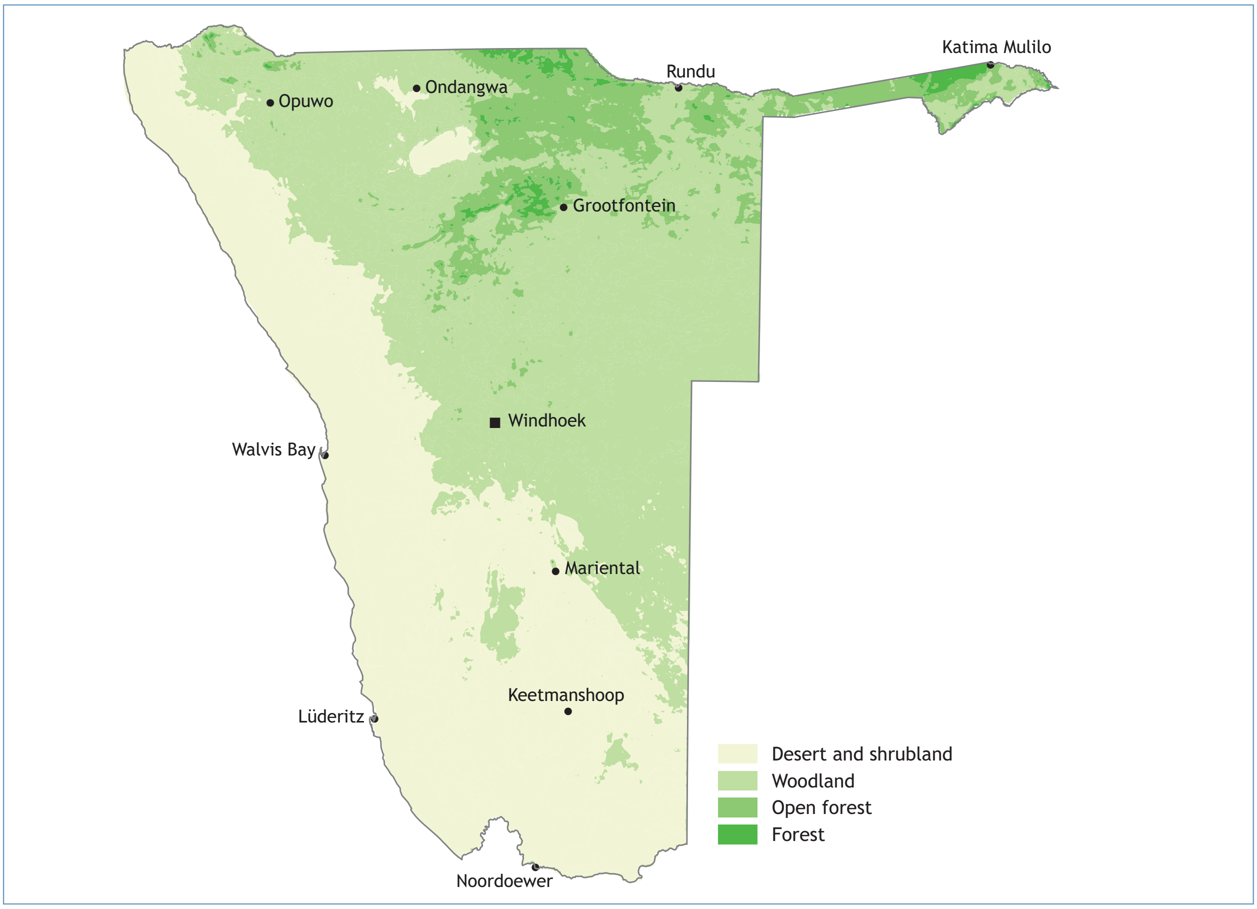
Namibia may not seem like a place with many plants, at least compared to lots of other places on earth. However, about 4,000 species of plants have been identified in the country. Approximately three-quarters (76%) are forbs (more usually called herbs or herbaceous plants), 10% are grasses, 2.3% are mosses and liverworts (bryophytes) and 1.6% are ferns. The remaining 10% of species are the woody trees that form the subject of this book. What, however, is a tree? The definition adopted here is the one used by the *Tree Atlas of Namibia*[1] as any woody plant, including shrubs, that usually grows to a height of one metre or more. The focus here is on woodiness, an emphasis that is appropriate because wood has traditionally been the major interest of the forestry sector.

By day or night, Baobab trees are perhaps the most impressive of about 400 plant species defined as trees in Namibia.

This leads to the question of what constitutes a forest. The Food and Agriculture Organization of the United Nations (FAO) defines forests as land covered by trees with a canopy cover of more than 10% and higher than five metres. A forest should extend over more than half a hectare, and includes plantations and stands of young indigenous trees that are expected to develop into taller groves. An accurate assessment of land cover has yet to be done, and so it is hard to estimate what proportion of Namibia is forested in FAO terms. However, Figure 1 shows areas that probably have a canopy cover of more than 10% and thus qualify as forest. Most of these areas are in north-eastern Namibia, especially in eastern Caprivi, western Kavango, eastern Ohangwena and in the hills around Tsumeb, Otavi and Grootfontein. More open woodlands lie to the west and south of the forested area, while shrubland and desert covers the most western and southern parts of the country.

As a term, woodland is much broader and includes landscapes which are not forests but where reasonably tall trees are conspicuous.[2] Shrubland, on the other hand, consists largely of shrubs, perhaps with the odd scattered tree. Savannas are really woodlands, but with a characteristic and prominent grass layer under a stratum of fairly widely spaced trees that often gives the appearance of open parkland. A range of environmental factors – operating alone and in combination – determine the structure and composition of plants in any one place. The most important of these factors are factors are aridity, soils and fire. It is they that affect the mix of grasses, shrubs and trees, and that make an area a forest, woodland, shrub-land or desert. Chapter 2 offers a review of these factors and their effects.

So far we have been concerned largely with biological definitions that distinguish woodlands from forests. But there is a subtler set of implications in the book's title *Forests and woodlands of Namibia.* As will become apparent in the chapters on the uses and management of these resources, priorities are changing. The official champion of trees in Namibia is the Directorate of Forestry, an organization that has largely been concerned with wood production, either from indigenous trees or exotic plantations. This is what forestry has conventionally been about, and this is partly why forests are defined as consisting of trees that are at least five metres tall. However, timber resources in Namibia are extremely scarce, and cheaper wood and substitute chipboards can be readily imported. Foresters are thus increasingly changing their focus away from forests to woodlands. Put another way, the switch is from timber products to non-timber forest products, and other indirect uses of woodlands widely known as NTFPs. These are useable natural resources that can be found arguably almost anywhere. And if the importance of NTFPs is advocated, then more emphasis on woodland habitats is needed and perhaps less on forests and wood. So where is the focus, what comes first: forests or woodlands, especially if it is difficult to see the wood for the trees, as the saying goes?



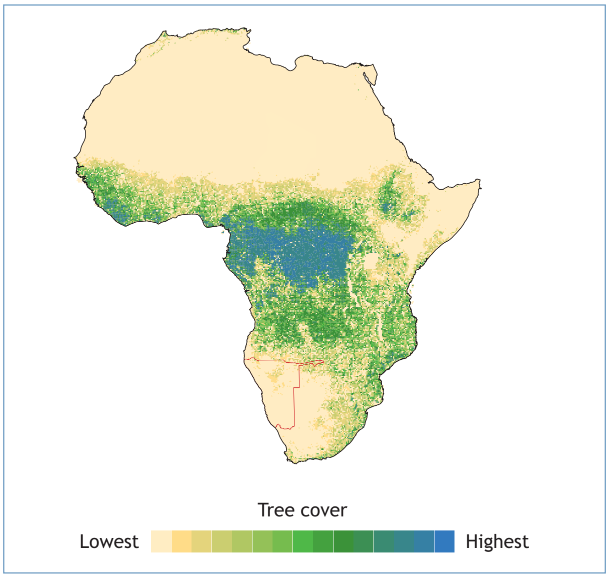
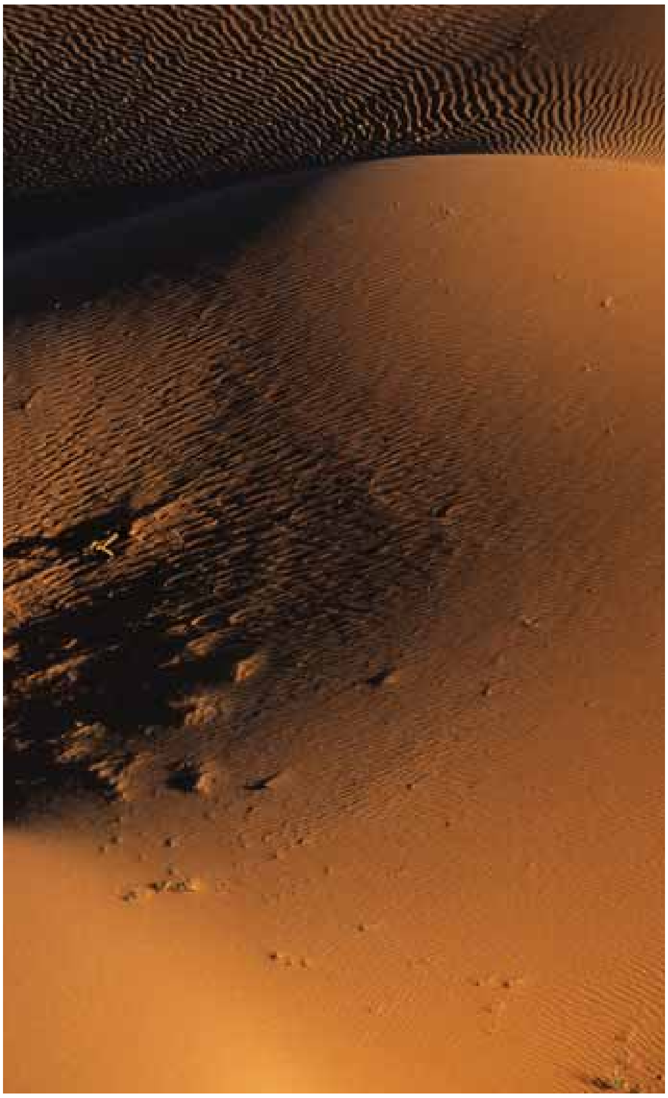


Figure 1.
The approximate distribution of forests and woodlands in Namibia. Forested areas make up less than 10% of the country, while woodlands cover approximately 50% and shrub-land and desert the remaining 40%. The smaller map provides a comparative perspective on the distribution of tree cover on the African continent.[3]

Namibian trees come in diverse shapes and sizes: tall and broad-leaved, gnarled and thorny, succulent, squat and bulbous, very thorny, papery-barked, and resplendent in vivid colour. From top left to bottom right: Kaoko Kobas, Omutenge, Burkea, Camel Thorn, Shepherd's Tree, Quiver Tree and Makalani Palm.



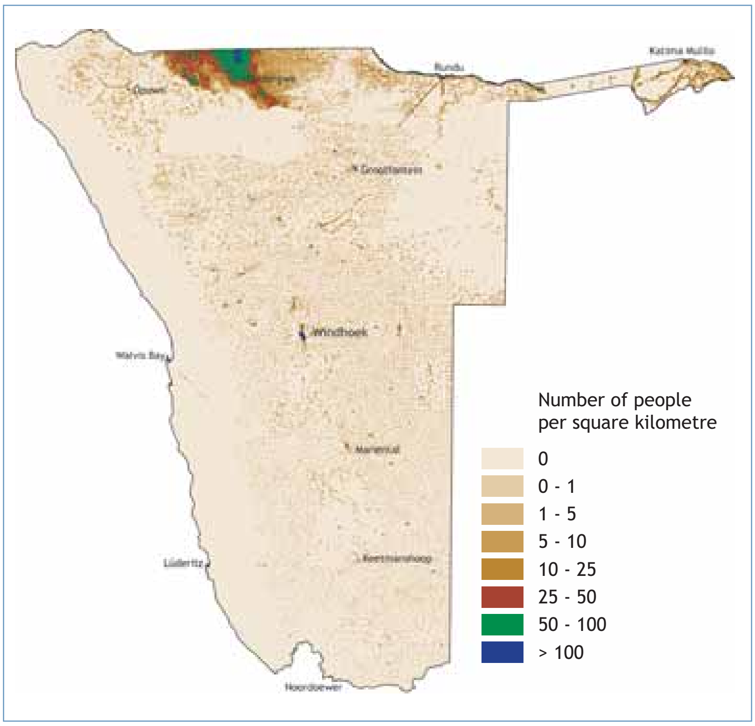


Figure 2.
The distribution of people in Namibia.[4]

THE GEOGRAPHY OF NAMIBIA

Namibia' surface covers an area of about 823,680 square kilometres. Its western border is formed by the Atlantic Ocean, a coastline of approximately 1,570 kilometres. The total population of an estimated two million people in 2005 is spread very unevenly across the country. Urban areas are growing rapidly as more and more people leave their rural homes. About 40% of people live in towns and the great majority of the remaining rural population resides in the northern, more wooded regions of Caprivi, Kavango, Ohangwena, Oshikoto, Oshana and Omusati (Figure 2). Most of the population is young. For example, 43% of all Namibians are under the age of 15 years. Population growth rates have dropped over the past 15 years – from about 3% to 2.6% per year – as a result of fewer births and lower life expectancies caused by AIDS deaths. The country is home to diverse cultures and languages, especially in the northern regions where most of the 25 distinct languages or major dialects are based.

Although large parts of the country are uninhabited, all land is allocated for one use or another (Figure 3). Approximately 43% of Namibia is now allocated as freehold land, 37% as communal land, and 20% as government land. Freehold land is mainly used for commercial livestock and tourism, while most government areas are set aside for conservation, farming and resettlement. Communal land is used largely for small-scale farming (each unit comprising several hectares), large-scale farming (each farm generally covering several thousand hectares), or open access grazing. Communal land is formally owned by the state but farmers have traditional and permanent rights to its use. The livelihoods of most Namibians depend directly or indirectly on indigenous natural resources, and much more land is thus used for agriculture than other purposes. The main crops of millet, sorghum and maize are cultivated on about 3,000 square kilometres, while other farmland is used for livestock and game production.

Geologically, the country is broadly divided in two halves. The western half is characterized by diverse rock features, which are largely exposed at the surface in rugged landscapes of valleys, escarpments, hills and expanses of plains. Most of these geological formations formed hundreds of millions of years ago. The surface of the eastern half, by contrast, is rather flat and almost completely covered by sand and scattered water-borne sediments deposited much more recently during the past few million years. A crucial consequence of the predominance of exposed rock in the western half and sand in the east is that soils in most areas are generally shallow, low in nutrient content and poor in retaining soil moisture.

The majority of soils are thus poorly suited to plant growth. Limits on plant growth are exacerbated by severe climatic conditions, especially low rainfall, high temperatures and high rates of evaporation. More information on these aspects is provided in Chapter 2, pages 27-36. The arid climate is a result of Namibia lying along the edge of south-western Africa where it is placed between two climate systems: the Inter-tropical Convergence

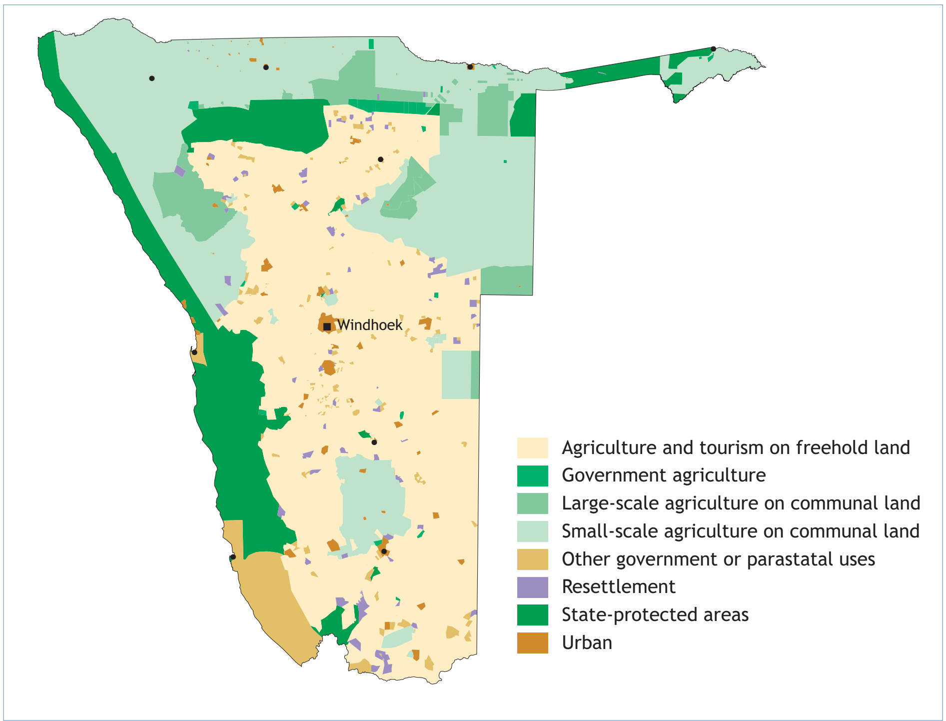


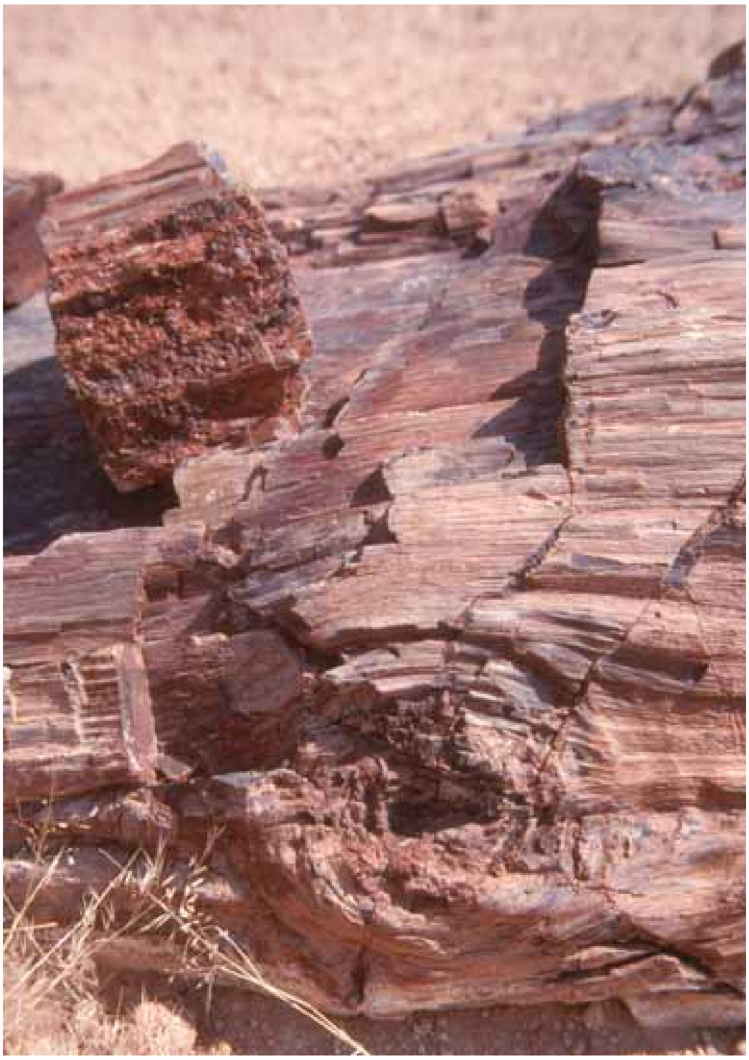
Figure 3.
The major uses of land in Namibia.[5]

Zone (ITCZ) and the Subtropical High Pressure Zone. The ITCZ feeds moist air southwards from the tropics and Indian Ocean, while dry, cooler air from the Subtropical High Pressure Zone to the south pushes the tropical moist air away to the north. Dry air from the latter system dominates the weather for much of the year. Consequently, there are few clouds, humidity is low, solar radiation is intense, temperatures are often high, and water (including soil moisture) evaporates rapidly. As a result of the low rainfall, very few of the rivers carry permanent water. There are only six such perennial rivers, all of which flow largely along the country's borders: the Zambezi, Chobe, Kwando-Linyanti, Okavango, Kunene and Orange Rivers. All other rivers within the Namibian borders are ephemeral, with sporadic flows, or fossil rivers that have not flowed for any distance in recent decades.

A BRIEF HISTORY OF FORESTRY

The history of forestry in Namibia can be divided into three periods, corresponding to the three governments to have administered the country. Each period was characterized by strong foreign influences: from the German and South African administrations and then by development advisors working with the Namibian government since 1990. The first two periods are ably reviewed in the book *Forestry in Namibia: 1850-1990*[6], from which much of the material in this section is derived.

Formal forestry activities really began in 1894 when a small area near Windhoek was cleared to grow trees experimentally. Kurt Dinter, a well-known botanist after whom several Namibian plants were named, was appointed in 1900 in a forestry post at the Brakwater Forest Station, which was Namibia's first forest station. However, the station moved to Okahandja in 1901 when Dr Gerber became the first Chief Forestry Officer. He divided the country into four administrative forestry districts: Windhoek, Okahandja, Otavi and Keetmanshoop. Each district had a forest station, with the forestry headquarters in Windhoek. This



Coniferous trees were apparently swept down a river and left to form the famous Petrified Forest to the west of Khorixas. The trees, belonging to the seven species collectively known as Dadoxylon arberi Seward*, were fossilized between about 250 and 270 million years ago. Some of the trunks are up to 45 metres in length.*

zonation reflected the German administration's lack of interest in woodland or forest resources in the northern areas of the country. Officials instead focused heavily on how to meet demands for wood by German settlers and the developing infrastructure, such as railways and mines.

Two strategies were adopted to supply wood: importation of wood and cultivation of suitable timber species. Much of the administration's efforts settled on the latter option. By 1910, ten forest stations and nurseries had been established to supply seedlings to farmers and to test species that could be grown to supply wood. A total of 201 species, subspecies and varieties was propagated at the nurseries, of which 23 were indigenous to Namibia. Exotic seeds were mainly imported from South Africa and Germany, with Eucalyptus and Casuarina trees favoured as having the greatest potential. The first Prosopis (or Mesquite) were grown in the Windhoek nursery in 1905.

While German policy and activities were devoted mainly to increasing the supply of wood, the administration was also concerned with issues of woodland loss and over-exploitation, particularly around settlements and along riverbanks. The concern went hand in hand with the theory that the local climate and fertility of the soil could be improved if there were more trees in the country. In 1894, an ordinance was issued to restrict the cutting of trees in the Windhoek district. This was followed in 1900 by another regulation on the felling of trees for domestic and commercial use, and yet another ordinance in 1914 that gave farmers more freedom to use wood for their own consumption but not for commercial logging.

German forestry policies were evaluated in 1908 as being too expensive and ineffective. As a solution, it was recommended that the task of planting trees be shifted to private farmers with the motivation that this would enable farmers to increase their income. In a sense, these recommendations mirror some of the thinking behind the introduction of community forestry in Namibia about 80 years later, as discussed in Chapter 4.

South Africa assumed control of Namibia in 1915, and was given a mandate to administer the country in 1920. Little interest was shown in forestry until 1926, when the South African forestry expert, J.D.M Keet, was sent to evaluate aspects of the sector. Among the main findings of his work was the conclusion that the increasing demand for fuel and fencing wood could not be met from local trees. His report further warned against the establishment of large plantations of exotic trees, particularly those with rapid transpiration rates (such as Eucalyptus), which might lower the levels of valuable underground water reserves.

For the first time, attention shifted towards timber production in Caprivi, Kavango and the former Owambo region. Indeed, commercial aspects of forestry were to remain at the forefront of policy and practice throughout the 75-year South African administration which ended with independence in 1990. The first permit to cut 1,000 trees in Kavango was issued in 1933. Figures on annual timber harvests have not been collated, an almost impossible task because large volumes were evidently harvested illegally. Nevertheless, it appears that harvests increased substantially after the Second World War, both as a result of rising demand for timber and improved access to wooded areas in the northern regions. Logging perhaps reached a peak in the late 1960s and early 1970s when, for example, 28,000 cubic metres were harvested in the first nine months of 1972 in Kavango and the former Owambo and Bushmanland (now north-eastern Otjozondjupa) areas. In 1990, by contrast, only 8,850 cubic metres were harvested in these areas and in eastern Caprivi. Three sawmills were then in operation: at Katima Mulilo, Rundu and Tsumkwe.

Large volumes of wood had been harvested around Grootfontein, Tsumeb and Otavi for fuel and props at local mines from the early 1900s onwards. Demand and harvesting rates increased as the mines were deepened and more prop support was needed. Again, systematic figures on the volumes are not available, but the harvests were large, at least in relation to what was available.

Pupils at the Ongwediva Industrial School practice sawing logs in 1930, reflecting the then predominant interests of foresters in producing timber from tall deciduous trees in northern Namibia.

Young trees being prepared for transport at the Windhoek Forest Station in 1913. The German administration was primarily interested in propagating trees to meet demands for wood.

Tamboti was preferred for props, and a 1954 report concluded that over-exploitation of these trees had led to serious bush encroachment around Tsumeb. Annual harvests at Tsumeb in the mid-1920s were reported as being about 2,700 cubic metres, while in the 1950's they had risen to approximately 13,000 cubic metres per year. Most of this was Tamboti.

The experimental growth trials and forestry stations established by the German administration were largely abandoned or neglected during the South African period. Only the Okahandja Railway Nursery remained functional until the 1950s, although three more nurseries were later started and remained operational at independence. These were at Katima Mulilo, Grootfontein and Ondangwa. A number of plantations were established over the years near Tsumeb to supply the mines with Eucalyptus poles for props. For example, 65,000 seedlings were planted in 1954 near Lake Oshikoto. However, all these plantations were poorly maintained and later abandoned.

Several small trial plantations were established between the 1960s and 1980s in the northern regions (see page 54). Most other research activities during South Africa's tenure focussed on timber resources in Kavango and Caprivi. These included the mapping of woodland types and potential timber resources, and estimation of timber volumes and growth and regeneration rates. Forest resource management plans were completed for East Caprivi and Kavango in 1968 and 1975, respectively.[7]

Two important pieces of forestry legislation were promulgated during the South African period: the *Preservation of Trees and Forests Ordinance of 1952* and the *Forest Act of 1968.* Both emphasized aspects of control and regulation of logging, but also provided for various conservation objectives. These included the special protection of 23 tree species in 1952, and the establishment of nature reserves and protected forest areas in 1968. Other than its focus on commercial harvesting of timber, the South African mandate was characterized by a minimal presence of forestry administration. The magistrate at Grootfontein and the Native Commissioners of Kavango and former Owamboland issued all harvesting permits. They often had little idea of what was acceptable forestry practice, and lacked measures to supervise or control harvesting. Matters improved in 1957 when P.J. le Roux was appointed as the first Regional Forestry Officer in Grootfontein. In later years, foresters were appointed to the ethnic administrations of Caprivi, Kavango and former Owamboland. They were administered by the Department of Agriculture in Windhoek, while all commercial aspects of forestry were run through the forestry office in Grootfontein where three foresters were stationed until independence in 1990.

INDEPENDENT NAMIBIA

South Africa's minimalist approach meant that the forestry enterprises and administration inherited by Namibia at independence were tiny. Much of the past 15 years has been spent building a forestry sector, especially the Directorate of Forestry as an institution to a point where it had 646 posts by the end of 2004, of which 38 are for professional foresters. Many of these people were specifically sent to foreign universities for training as foresters.

The Directorate now has offices in 34 places across the country. A great deal was also done to develop policy and strategy, which were laid out in detailed policy statements in 1992, 1996, and 2001. The development of a policy framework finally resulted in the promulgation of the *Forestry Act of 2001.* Much of all this development work was based on financial support and technical advice from various donor support programmes. Chapter 4 provides more information on the management of forestry.

The German administration was largely concerned with finding ways of providing wood while the South Africans concentrated mainly on commercial harvesting of timber in northern Namibia. Where is the focus in independent Namibia? Perhaps the most important shift has been towards community-based forest management, and the sustainable use and conservation of forest and other woodland resources, especially in extensive areas of rural, communal land. This presents an interesting challenge, since it is true that Namibian forestry activities over the past century have largely concentrated on small, select patches of plantations and timber. Most woodland has not been managed in any direct way. This applies to almost all farmland and also to game reserves and national parks. Namibian trees have largely been left to their own devices, although they are greatly affected by land uses, as described in Chapter 5. Will the new approach to community-based management and resource utilization work, and can it be extended to other categories of land tenure and use?

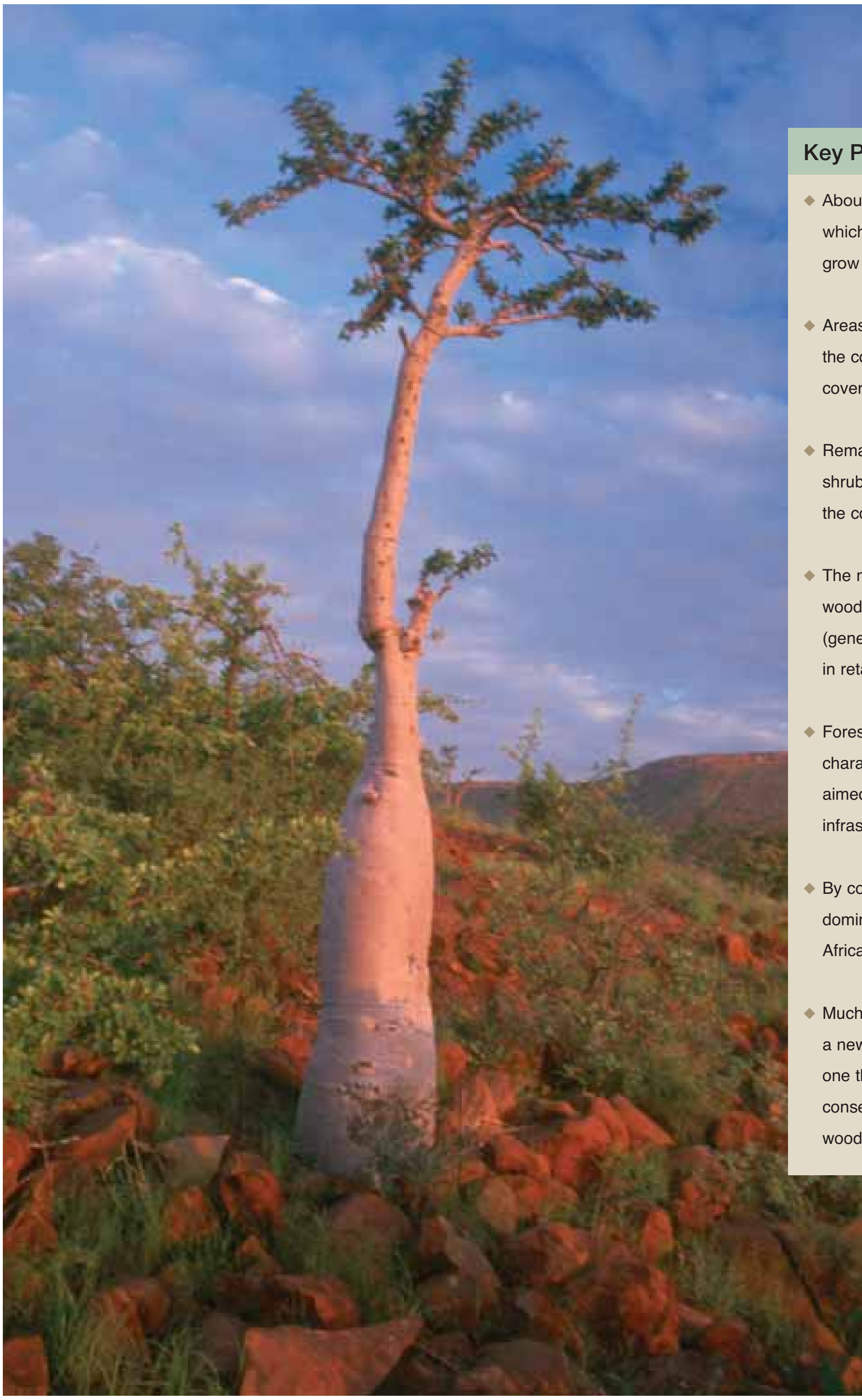
NAMES

Making a choice about what names of trees to use in this book was difficult. Botanists much prefer scientific Latin names, but these are unfamiliar to most lay people. Moreover, many trees do have familiar vernacular names, and many more people are comfortable with Mopane and Camel Thorn than with *Colophospermum mopane* or *Acacia erioloba.* Our choice was to use common names throughout, even though some names are not well known. Contrary to normal practice, the names are capitalized to reflect their status as pronouns and to lift their prominence in the flow of text. The table below lists all the names used together with their scientific equivalents. The names used are largely the same as those used in the *Tree Atlas of Namibia.*

Wood has always been a crucial resource, for example in supporting huge omashisha *baskets used to store surplus harvests or for mortars and pestles used to pound grain.*

Name used in this book	Latin or scientific name
!Nara	*Acanthosicyos horridus*
African White Protea	*Protea gaguedi*
Ana Tree	*Faidherbia albida*
Apple-leaf	*Philenoptera violacea*
Baobab	*Adansonia digitata*
Bergdorn	*Acacia hereroensis*
Bergsering	*Kirkia acuminata*
Bird Plum	*Berchemia discolor*
Black Thorn	*Acacia mellifera*
Blue Sourplum	*Ximenia americana*
Brandberg Acacia	*Acacia montis-usti*
Buffalo Thorn	*Ziziphus mucronata*
Burkea	*Burkea africana*
Camel Thorn	*Acacia erioloba*
Camphor Bush	*Tarchonanthus camphorates*
Candle-pod Acacia	*Acacia hebeclada*
Casuarina	*Casuarina* species
Corky Monkey-orange	*Strychnos cocculoides*
Devil's Claw	*Harpagophytum procumbens*
Driedoring	*Rhigozum trichotomum*
Giant Quiver Tree	*Aloe pillansii*
Guava	*Psidium guajava*
Hoodia	*Hoodia currorii*
Jackal Berry	*Diospyros mespiliformis*
Kalahari Melon	*Citrullus lanata*
Kalahari Podberry	*Dialium engleranum*
Kaoko Kobas	*Cyphostemma uter*
Karee	*Rhus lancea*
Kiaat	*Pterocarpus angolensis*
Knob-thorn	*Acacia nigrescens*
Kobas	*Cyphostemma* species
Kudu Bush	*Combretum apiculatum*
Laventelbos	*Croton gratissimus*
Leadwood	*Combretum imberbe*
Lekkerbreek	*Ochna pulchra*
Makalani	*Hypheane petersiana*
Mangetti	*Schinziophyton rautanenii*
Mango	*Mangifera indica*
Mangosteen	*Garcinia livingstonei*
Marula	*Sclerocarya birrea*
Mobola Plum	*Parinari curatellifolia*
Monkey-oranges	*Strychnos* species
Mopane	*Colophospermum mopane*
Mukondekonde	*Friesodielsia obovata*

Name used in the book	Latin or scientific name
Mupako	*Erythrophleum africanum*
Musese	*Albizia versicolor*
Namaqua Rock Fig	*Ficus cordata*
Namibian Resin Tree	*Ozoroa crassinervia*
Natal Mahogany	*Trichilia emetica*
Neem	*Azadiracta indica*
Omundjimune	*Lannea discolor*
Omutenge	*Commiphora anacardiifolia*
Peter's Fig	*Ficus petersii*
Pod Mahogany	*Afzelia quanzensis*
Propeller tree	*Gyrocarpus americanus*
Prosopis	*Prosopis* species
Purple-pod Terminalia	*Terminalia prunioides*
Quiver Tree	*Aloe dichotoma*
Raisin bush	*Grewia* species
River Rhus	*Rhus quartiniana*
Rooihaak	*Acacia reficiens*
Sand-veld Acacia	*Acacia fleckii*
Sausage Tree	*Kigelia africana*
Shepherd's Tree	*Boscia albitrunca*
Sickle-bush	*Dichrostachys cinerea*
Sickle-leaved Albizia	*Albizia harveyi*
Silver-leaf Terminalia	*Terminalia sericea*
Spiny Monkey-orange	*Strychnos spinosa*
Spiny-leaved Monkey-orange	*Strychnos pungens*
Sweet Thorn	*Acacia karroo*
Sycamore Fig	*Ficus sycomorus*
Tamboti	*Spirostachys africana*
Umbrella Thorn	*Acacia tortilis*
Ushivi	*Guibourtia coleosperma*
Variable Combretum	*Combretum collinum*
Velvet Wild Medlar	*Vangueria infausta*
Water Pear	*Syzygium guineense*
Welwitschia	*Welwitschia mirabilis*
White Karee	*Rhus pendulina*
White Puzzle-bush	*Ehretia alba*
Wild Ebony	*Euclea pseudebenus*
Wild Tamarisk	*Tamarix usneoides*
Wild Tobacco	*Nicotiana glauca*
Wild Willow	*Salix mucronata*
Wonderboom	*Leucaena leucocephala*
Yellow-bark Acacia	*Acacia erubescens*
Zambezi Teak	*Baikiaea plurijuga*



Key Points

- About 10% of all plant species in Namibia are trees, which are considered to be woody plants that normally grow to one metre or more in height.
- Areas defined as forests cover just less than 10% of the country. This is land covered by trees with a canopy cover of more than 10% and higher than five metres.
- Remaining areas of woodland, and desert or shrubland cover approximately 50% and 40% of the country, respectively.
- The most important geographical features to affect woodlands and forests in Namibia are its soils (generally shallow, low in nutrients or poor in retaining water), the arid environment and fire.
- Forestry during the German administrative period was characterized by experimentation and development aimed at meeting demands for wood needed for infrastructure development and by settler farmers.
- By contrast, commercial aspects of timber harvesting dominated policy and practice during the South African administration.
- Much of the past 15 years has been spent establishing a new policy and institutional framework for forestry, one that focuses on community-based management, conservation and use of indigenous forest and woodlands resources.

ECOLOGY: the life of trees

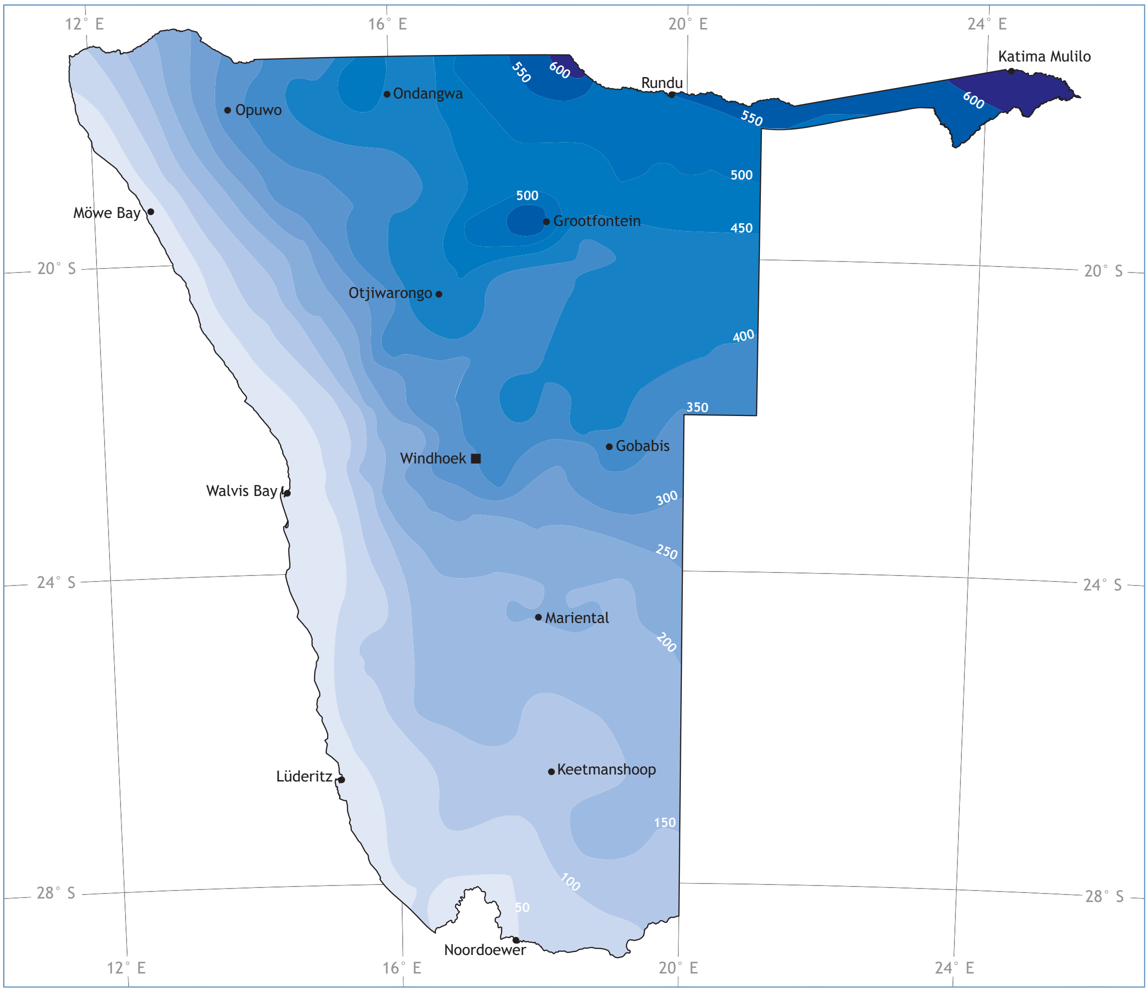
Many Namibians may wonder why are there no tall, evergreen forests in this country; why trees along rivers are taller than elsewhere; why different species grow on drier ground away from water courses; why timber resources are largely concentrated in the north-east; why there are so many Acacia species; and where most tree species are to be found in Namibia? Simple questions, but often hard to answer. This chapter presents a digest of information that should go some way towards providing answers. More importantly, we hope that other questions will be raised in the reader's mind to stimulate further questions, since it is through enquiry that knowledge on forests and woodlands will expand.

The chapter begins by exploring factors that affect the distribution and abundance of trees in Namibia. These are the influences that combine to determine patterns of distribution and abundance. The patterns represent what now grows and survives. However, reproduction is arguably more important than survival, and the second section reviews information on germination, recruitment and growth. These earlier parts provide a basis for the next two sections on woodland resources (types and diversity of woodlands, and wood resources) and what areas of woodland are perhaps most important. The final section looks at the introduction and establishment of exotic trees and plantations in Namibia.

Silver-leaf Terminalia form an avenue over a track along the abandoned firebreak between the Caprivi State Forest and Zambia. This pioneer species is one of the first woody plants to colonise disturbed areas such as firebreaks and abandoned fields in areas of Kalahari sand. Climax species (such as Burkea, Kiaat and Zambezi Teak) should eventually replace the pioneers after many decades.

THE ECOLOGY OF NAMIBIAN WOODLANDS

Ecology is the study of how living organisms interact with each other and with the natural environment. The focus here is on the latter, particularly in looking at how different aspects of the environment influence trees. There are six major factors that separately, and in combination, play major roles in determining where trees occur, how many there are, and the form in which they grow. The factors are climate, soils, fire, elevations, historical and human influences. Their roles vary from place to place, and often affect young and old trees differently. Some factors play crucial roles at certain



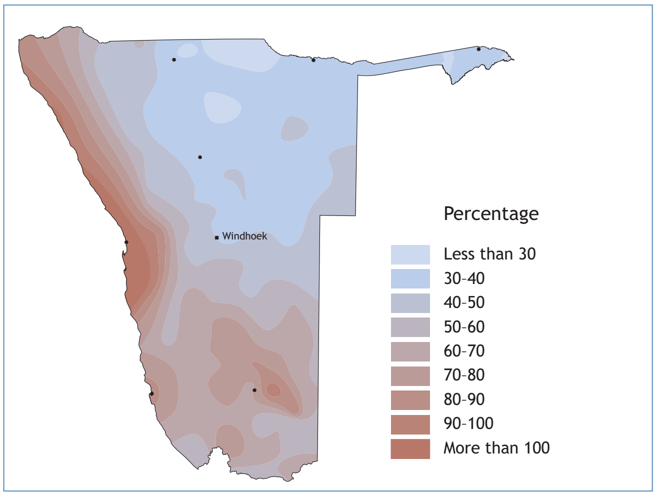


Figure 4.
Average rainfall (above) declines in a gradient from the north-east to the south-west.
Variation in rainfall (right) is greatest in the west and south, as shown by the co-efficient of variation of total annual rainfall[1].

times but have little influence at others. The effects are also often related to landscapes. For example, higher rainfall on hills – caused by moist air rising and cooling over the higher ground – leads to better tree growth. In this case, rainfall has the immediate or proximate influence, but the landscape of hills generates rain and has an ultimate effect on woodlands.

Climate

Of the many aspects to climate, rainfall, temperature and frost are most influential on Namibian woodlands and forests. Indeed, these have been fundamental in influencing the nature of trees across the whole African continent over the past 50 million years. By rainfall we really mean the availability of water, which is determined by how much water falls as rain, how it is concentrated in rivers, and how it is lost by seepage and evapotranspiration (the combination of water lost through direct evaporation and by transpiration of the leaves).

Rainfall varies rather evenly across the country, from the highest annual averages of approximately 650 millimetres in eastern Caprivi to less than 50 millimetres along the western coast (Figure 4). Much of the country is thus arid, offering little water for trees to grow (by contrast, the tall rain forests that blanket equatorial Africa receive 2,000 to 3,000 millimetres per year). The other key feature of rainfall in Namibia is that it is highly variable, within any given year as well as from year to year. Rain may fall at any time of the year in the south-western corner of the country, but elsewhere almost all rains fall within three to four months during the summer. For the rest of the year, the environment is dry, and often hot. The wet season is shortest in the driest parts of the country (Figure 5).

The long dry spells set severe limitations on tree growth, but Namibia also experiences substantial variation in rainfall from year to year, particularly in the driest western and southern areas where dry periods may last several years (Figure 4). Trees use several strategies to cope with aridity and variable access to water. Some species store water in their succulent leaves, branches or stems (for example, Baobabs and Kobas trees). Others grow only on deep soils, using their long roots to draw on underground water sources (Camel Thorns and Zambezi Teak are good examples). Many trees have waxy or hairy coatings on their leaves to reduce water loss. Wax reduces water vapour diffusion across the leaf surface, while hairy surfaces trap moist air to create a slightly humid zone on the leaf surface. This reduces the moisture gradient - and thus rate of diffusion - between the leaf tissues and dry outside air. Examples of trees with waxy leaves are Blue Sourplum and Ushivi, while trees with hairy leaves include Candle-pod Acacia, Velvet Wild-Medlar, and species in the genera of *Ozoroa*, *Grewia* and *Sterculia*. Many trees drop their leaves during the dry months, particularly the broad-leaved species that dominate north-eastern Namibia. However, in areas where rainfall is seasonally unpredictable some species do not lose their leaves, thus maintaining their ability to grow should unseasonable rains fall.

Trees in Namibia are also generally sparsely distributed, small in size and have slow rates of growth, largely as a consequence of variable and low supplies of water. Species that are least tolerant of water shortages are confined to north-eastern Namibia and water courses where they draw water from the moist sediments. Since they do best in these wetter areas, they out-compete and exclude other species from growing there. Those species that can grow in drier areas obviously do so, but

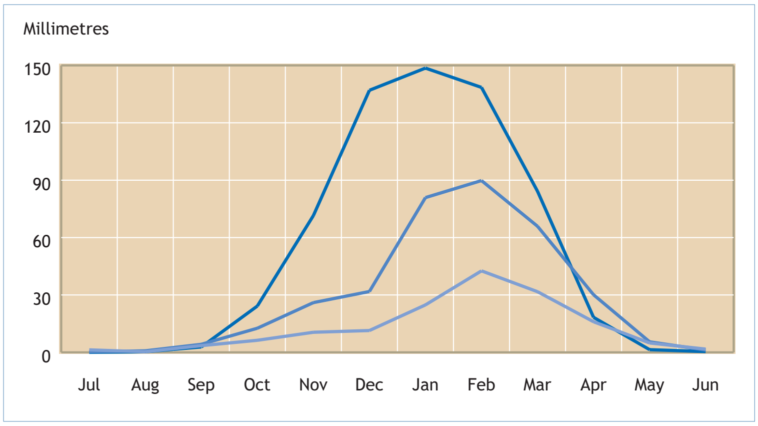


Figure 5.
Average rainfall (in millimetres) per month at Katima Mulilo (dark blue line), Windhoek (blue) and Keetmanshoop (pale blue). With an average of 148 millimetres per year, Keetmanshoop usually has only two rainy months each year, Windhoek (average of 352 millimetres) has about three wet months, and Katima Mulilo (annual average of about 628 millimetres) can expect rain during five months from December to April.

Trees alongside roads are often taller, and produce leaves earlier than those further away because they benefit from water that runs off the road surface. This is the old road between Katima Mulilo and Kongola (left). Much of the water used by a Wild Tamarisk growing in the dry Namib is provided by condensed drips of fog water (below). Every Bergdorn leaf has a silvery lining of tiny hairs that help reduce water loss (bottom).

the number of such species declines as the environment becomes increasingly dry. This is the main reason why there are more species in the north-east than in the drier southern and western areas (see page 43).

Perhaps the most important effect of rainfall is on germination and the early growth of young trees. Seeds often germinate only after a good soaking, and seedlings require the surface soil to remain moist long enough for their growing roots to reach wetter and deeper soil. Germination and early growth thus need repeated good falls of rain. Such events are usually rare in Namibia and many years may pass before new cohorts of trees are recruited (see page 36).

The flipside of water availability is water loss, which happens primarily through seepage and evapotranspiration. Unlike the deep humus-rich ground on which many forests grow elsewhere in the world, most soils in Namibia retain little water. Evaporation rates are also very high, volumes of water potentially evaporating each year being several times greater than the amounts received as rain. Rates of evaporation rise with increasing temperature, wind speed and decreasing humidity, and are thus highest during the hottest, driest and most windy periods (Figure 6). In addition to water lost through evaporation, plants transpire water pumped by their roots from the ground. The water is lost through stomata on the leaves. Rates of transpiration and water loss depend on the kinds of plants (some species use less water as a result of lower metabolic and growth rates), their access to water (those with plentiful supplies transpire more), temperature and humidity (more water is lost on hot, dry days), and season (transpiration rates in the summer growing season are higher than during the dormant winters).

The effects of temperature (heat, more correctly) on the distribution and abundance of trees is greatest on young plants. Tolerance towards temperature extremes increases as plants grow and age, and temperature is thus seldom a limiting factor for big trees. However, trees have to cope with seasonal and daily fluctuations in temperature, adjusting their metabolism to warm and cool conditions as appropriate. For example, temperatures often vary by over 20°C in a day. Examples of how temperatures fluctuate seasonally are given in Figure 7. Certain seeds are stimulated to germinate at specific temperatures, and the growth rate of young trees is often directly related to temperature. The warmer conditions are, the faster plants grow, but at very high temperatures plants lose too much water, causing wilting and sometimes death. Indeed, the main effect of high temperatures is to cause high rates of evapotranspiration and water loss.

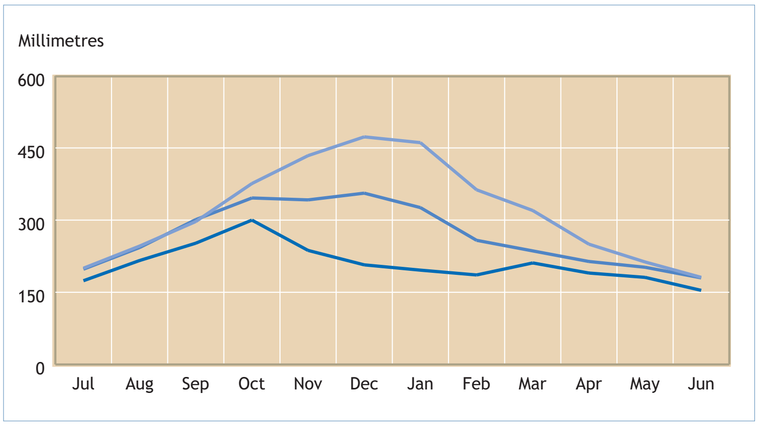


Figure 6. The highest rates of potential evaporation are in southern Namibia, and the lowest are in Caprivi. Keetmanshoop (pale line) has a potential annual evaporation rate of 3,814 millimetres, Windhoek 3,203 millimetres (blue line), and Katima Mulilo 2,504 millimetres (dark line). The graphs show that evaporation rates are generally highest in the windiest, driest, early summer months.

Conversely, cool temperatures slow growth, and very low temperatures can result in frost. Again, young or small trees are most at risk. Many species simply cannot withstand frost and thus occur only in subtropical or other climates not prone to frost. The distributions of Welwitschia and Mopane are probably limited by frost, although Mopane occurs in frost areas in Etosha and Zimbabwe, often as shrubs.[2] Frost is most prevalent in the central eastern regions of Namibia (Figure 8), elsewhere occurring only sporadically and usually only in low-lying valleys. Thus, trees on higher ground are seldom affected. Amongst larger trees susceptible to frost, it is often only water in the growing tips on their outer branches that freezes.

Soils

Trees are influenced by two main properties of soils: moisture and nutrient content. Soils in many areas

Figure 7.
Average temperatures and average monthly maximum and minimum temperatures at Windhoek, Rundu, Walvis Bay and Keetmanshoop.[3]

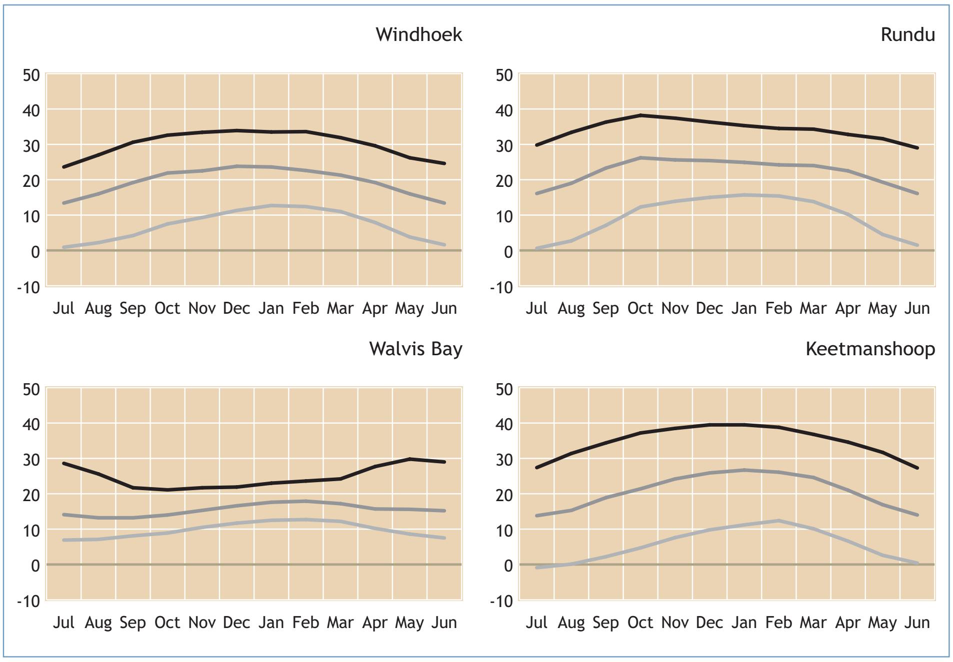
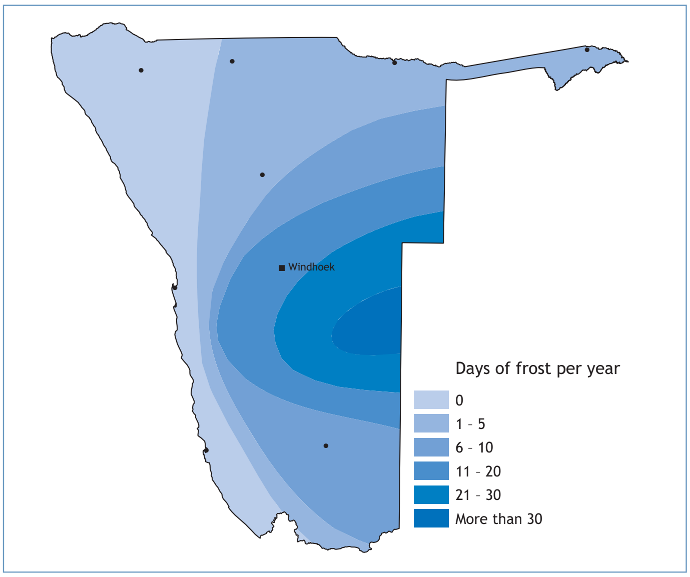


Figure 8.
The average number of days on which frost can be expected each year in Namibia.[4]



of Namibia make little moisture available to trees because they are shallow or sandy. The shallowest soils are in rocky areas where most rainwater is lost swiftly as surface flow, evaporation or seepage into rocky crevices. The surface layers of sand likewise dry quickly because water percoloates away rapidly. The nutrient contents of most Namibian soils are also very low, and the poor quality of soils is often more of a limiting factor to the growth and productivity of crops and indigenous plants than the arid climate. Sandy soils are always low in nutrients because they consist largely of quartz sand grains and thus contain little humus. Moreover, the Kalahari sands that cover much of north and eastern

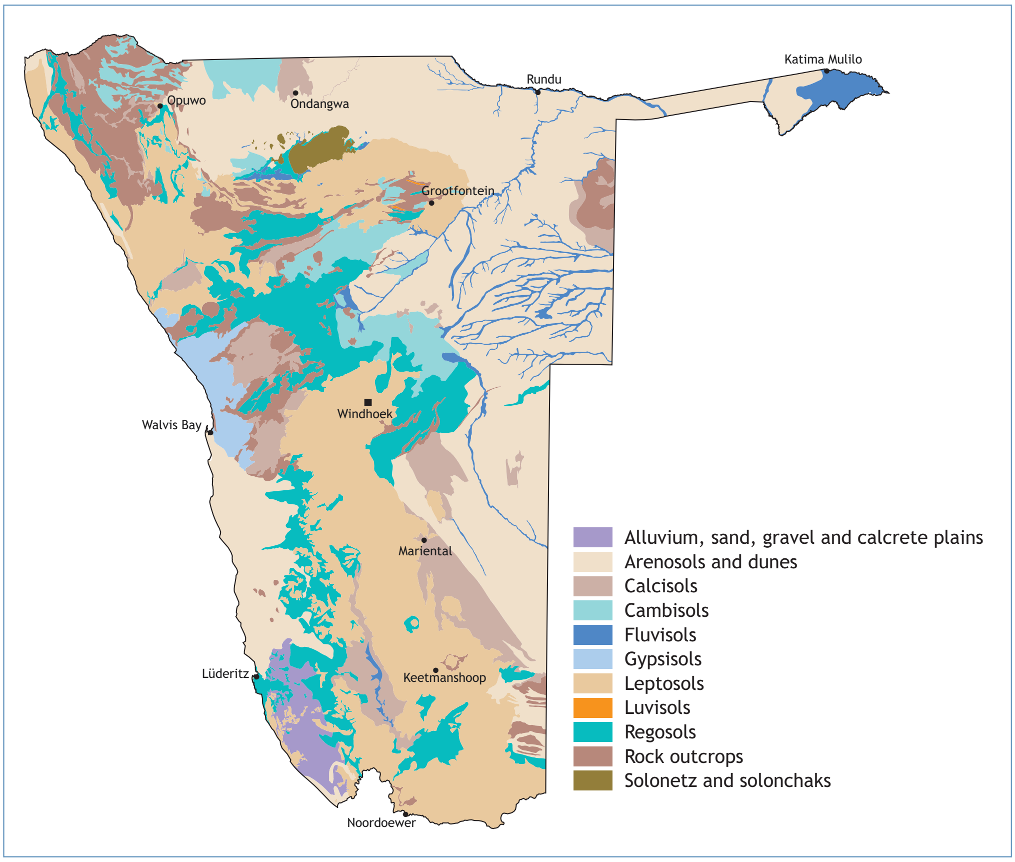


Figure 9.
Much of Namibia consists of arenosol sands, as shown in this map of major soil groups.[6]

Namibia (Figure 9) are inherently low in phosphorous. This is a constraint in itself, but the problem is compounded because low phosphorous levels limit the nitrogen content of soil.[5]

Other soils in most areas of Namibia are also low in nutrients, mainly as a consequence of the arid climate. Under wetter conditions, soils would be formed more rapidly by the weathering of rocks and more nutrients in the rocks would be released. Greater quantities of organic matter would also be available as a result of decomposition, because of more luxuriant plant production and because dead leaves and twigs would be blown away or burnt less frequently.

Soils in certain areas are so salty that only specialized plants – including very few trees – grow in them. The best example is Etosha Pan, but soils to the north in the Cuvelai drainage system also have high concentrations of salt due to high rates of evaporation. The most saline soils are called solonchaks and solonetzs. Gypsisols in the Namib gravel plains inhibit the growth of plants as well by having high concentrations of calcium sulphate salts. The salts are dissolved out of rock by water and then carried below the soil surface where they crystallize, sometimes into the well-known desert roses.

Tree growth is likewise constrained by waterlogged soils, such as those on floodplains along the Okavango and Kwando/Linyanti Rivers and between the Zambezi and Chobe Rivers in the eastern Caprivi. Water restricts the movement of air amongst the particles of soil with the result that the roots are unable to breathe.

These are soils that limit the presence of most woody plants. Other soils tend to be dominated by particular species that grow so well in them that they competitively exclude most other

species. A case in point is the almost mono-specific stands of Mopane on alluvial clays in the Cuvelai Dédrainage system and in fossil wetlands in eastern Caprivi. Kalahari sands are dominated by a much more diverse assemblage of characteristic species, which do not occur on other types of soil. While other species that prefer different soils might grow on the sands, their growth is usually so poor that they are dominated by species that do indeed grow well on sands.

Fire

The widespread bush fires that occur so frequently (see page 109) have a major impact on the structure of woodlands in north-eastern Namibia. The most important effect is in limiting the growth of young trees and in killing older, larger trees. This keeps the woodlands more open and savanna-like with a greater cover of grass. As a consequence, that part of the country would be more heavily wooded, and bush encroached, if fires were less frequent.

These effects are most prevalent in higher rainfall areas since grass cover in arid areas is usually too sparse to fuel the hot fires that limit tree growth.[7] In exceptional cases, patches of woodland in areas of high rainfall may escape being burnt over several years. Tree growth in these patches may then become so dense, and grass cover so low, that fires are unable to enter – and damage – the forests.

The other major impact of fires is on the species composition of woodlands. Some species are more vulnerable to fires than others. Unfortunately most valued timber species are sensitive to fires, and there would probably be many more Zambezi Teak, Ushivi and Kiaat trees if broad-leaved woodlands in north-eastern Namibia burnt less often.

Altitude

The distribution of trees is greatly affected by relief and elevations in many parts of Namibia (Figure 10). However, these effects are largely due to other environmental factors that vary themselves in relation to topography, hence the earlier example of higher rainfall over raised ground and its effect on plant growth (see page 27). Many hills or raised plateaus are at higher elevations because they differ geologically from surrounding lower areas, and soils formed on areas of higher relief therefore differ from those below. For this reason, the characteristic tree communities (dominated by Bergsering, Propeller Tree and Omundjimune) on dolomite hills around Otavi, Grootfontein and Tsumeb are quite different from the mosaic of Acacias, Tamboti, Purple-pod Terminalia and Sickle-bush that grow on the loams, turf and calcrete soils in the nearby valleys.

Temperatures on raised ground are usually lower than those in lower places (except on cold winter mornings when cold air settles in valleys). However, there are few mountains in Namibia

The densely wooded areas in this area of south-western Kavango are on Kalahari sands, while more clayey soils dominate the long sparsely covered inter dune valleys (left). The dunes were formed during very arid periods, most recently about 10,000 years ago. Many of the inter dune valleys have been cleared because the soils are better for crop growth than in the surrounding sands. Savanna woodlands, with their characteristic carpet of grass beneath scattered trees, are formed as a result of sporadic fires (above).

The Acacias in the foreground grow on loamy soils below a hill just south of Windhoek. The cover of Kudu Bush, Camphor Bush, Yellow-bark Acacias increases down the hill, probably because soils are deeper lower down than at the top.

that are high enough for temperature zones to be noticeable. Such zones have conspicuous effects on tree growth on mountains in East Africa, where temperatures drop by an average of 6°C per 1,000 metres of elevation. Many of these mountains have a belt of tropical forests at their bases, while only stunted shrubs grow in the cold alpine zones at the highest altitudes. Perhaps the only Namibian mountain where temperature changes might substantially affect vegetation is the Brandberg, which rises to 2,579 metres from about 700 metres above sea level on the surrounding plains.

Historical effects

History has an impact on tree distributions in two ways. The first is through historical chance, and its effect is mainly on the short term. Seeds drop

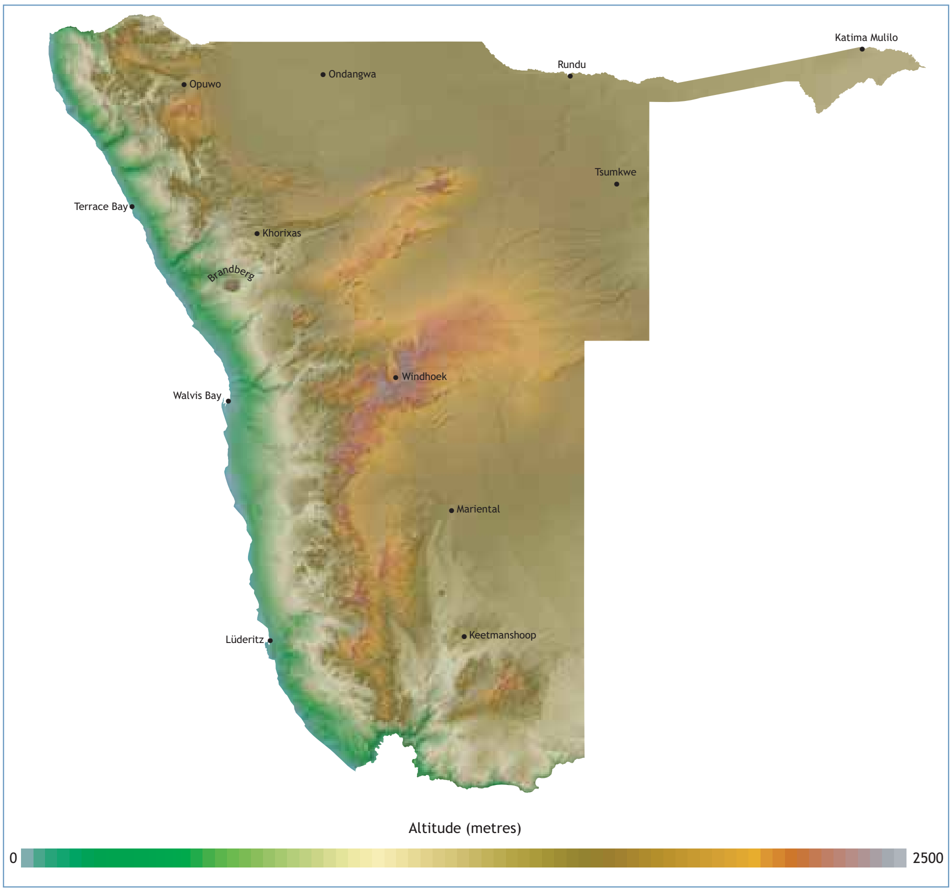


Figure 10. Most of the country lies between 800 and 1,200 metres above sea level, but much of the high ground around Windhoek is above 2,000 metres.[8]

in odd places, some might germinate, others get eaten by birds or rodents, for example. A seed that finds itself along a watercourse has a better chance of becoming a tree than a seed dropped elsewhere. Likewise, a seedling that happens to be found by a browsing animal will not become a tree, nor will a seedling that happens to be in the path of a raging fire. Other seedlings are luckier and their survival is thus often due to chance.

History also has longer-term effects, the study of which is called biogeography. Many of these effects are due to climate change. A local example is provided by the concentration of Commiphora species (paper-bark trees) in north-west Namibia (see page 49) and another area of high Commiphora diversity in north-east Africa. In both areas, most species are isolated as relics from a much drier period when Commiphoras were distributed widely across Africa. Nowadays, there are few species between south-western and north-eastern Africa because the environment is more tropical in the intervening zone.

Human influences

The abundance of Marula trees in north-central Namibia provides another example of possible historical effects. It is widely thought that the trees were introduced from elsewhere and nurtured over hundreds of years by Owambo people. Similarly, Prosopis and other alien tree species were introduced to southern Namibia more recently. People have also done much to damage woodlands and forests in Namibia. Large areas have been cleared of trees for the planting of crops or building of homes and fences, especially in northern Namibia (see page 105). Many trees have been cut for firewood around major centres of habitation, and tens of thousands of Tamboti trees were cut for use as mine props at Tsumeb, Kombat and Abenab. Bush encroachment is very likely to be a consequence of fire control and over-grazing by livestock farmers (see page 113). The growth of trees along some of the westward flowing ephemeral rivers has perhaps been limited by the construction of many dams on farms in the catchment areas. The dams reduce the flow and frequency of flood waters to riparian trees.

Intricate patterns reveal the paths of caterpillars that have munched their way through the leaves of a Buffalo Thorn.

Minor influences

In addition to the major effects described above, several other factors can have important influences on tree distribution and abundance. For example, fungi known as mycorrhiza live in association with the roots of some plants, and enable the roots to absorb water and nutrients more efficiently. Mopane have these fungi, which might allow the trees to grow in relatively nutrient-poor soils. All manner of herbivores, such as insects and large mammals, may affect the growth and structure of plants. For example, elephants have caused substantial damage and loss to riverine forest in the Mahango Game Reserve (see page 116), and caterpillars often strip foliage and retard the growth of trees. Day length plays a major role in controlling growth at high latitudes, where plant growth responds to the substantial changes in the number of hours of sunlight each day. Smaller changes occur in Namibia, but some trees nevertheless probably accelerate their growth as the days lengthen and then slow down as shorter, winter days approach. Finally, there is evidence that rising carbon dioxide levels may enhance plant growth, and it is possible that some degree of bush encroachment might be due to the greater abundance of carbon dioxide in the atmosphere in recent decades.[9]

In concluding this section on factors affecting the distribution and abundance of trees, three points need to be made. First, a multitude of factors are at play, and they vary in effect from place to place and from one day or period to the next. Second, the availability of water is the crucial factor to affect trees in Namibia. But this is not a simple matter of how much rain falls. Rather, water availability is affected by a host of other factors: temperature, humidity, wind speed, soils, human activities and landscapes. Third, trees are much more affected by environmental factors when they are young. This is when they are most likely to be influenced by fire, shortages of water, the effects of temperature extremes and browsing by animals, for instance. What happens to a tree in its early life is pivotal, and it is to aspects of germination and growth that the chapter moves.

GERMINATION, GROWTH AND RECRUITMENT

The trees that we see and use are short-lived manifestations or expressions of genes that reproduce and survive over millions of years. Our focus is on the here and now – what trees are growing, how long they might survive, and what resources they may provide. But from the view of genes that control and produce tree growth, reproduction is arguably much more important than survival. This can create an interesting conflict of views between our short-term perspectives and the biological requirement to replicate.

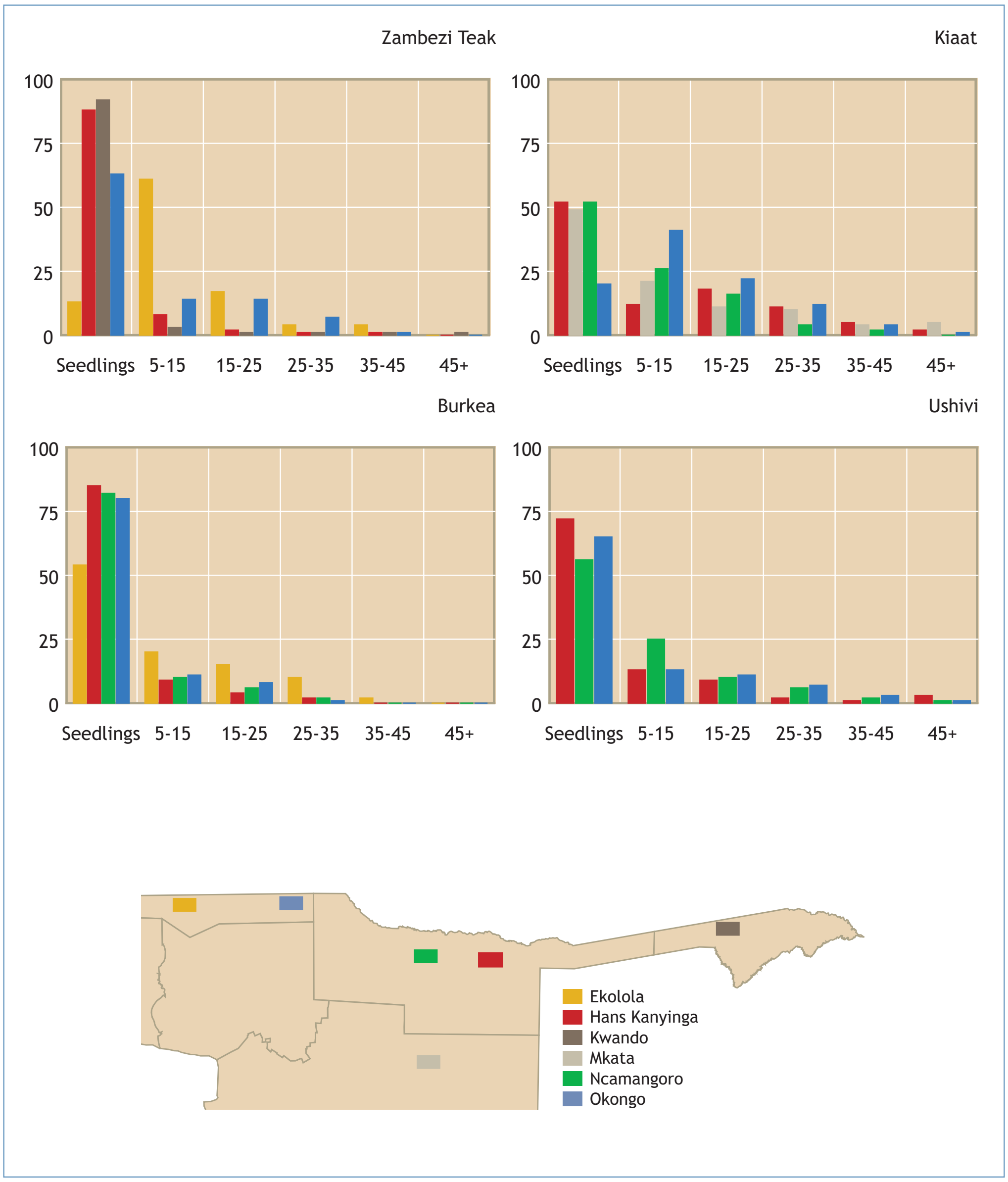
Trees reproduce in several steps. Mature trees produce flowers, which must be pollinated to develop fruit and seeds. In turn, these need to ripen and harden for dispersal and to survive as dormant seeds. Dormancy may last from a few months to several years before germination occurs, which is followed by rapid growth as trees struggle to mature and reproduce again. These are the main stages of sexual reproduction. Some species – such as the White Puzzle Bush – also reproduce asexually by producing runners, which are roots that later develop into individual trees.

All stages of reproduction are subject to trials and tribulations, often made more trying by aridity and poor soils in Namibia. To produce flowers, mature trees need energy that is additional to their normal metabolic energy requirements for growth and maintenance. Flowers and fruit attract large numbers of predators, as do seeds after falling to the ground. To germinate, seeds must fall in appropriate microenvironments, which have suitable soils and climatic conditions. Some seeds, for example those of Camel Thorns, germinate more readily once they have passed through the digestive tracts of herbivores, such as cattle or kudus.[10]

The seeds of most species only germinate when it is warm and good rains have fallen. More crucially, the rains must be followed by successive falls and relatively high humidity so that the soils remain moist. These conditions are essential if young seedlings are to survive more than a few weeks. Such events in many parts of Namibia occur infrequently or episodically, and it is for this reason that it is often hard to find young trees. The younger Ana Trees and Camel Thorns in the central Namib along the Kuiseb River are all thought to have germinated and survived following good soaking rains and river flows in 1934, 1974 and 2000 and 2001.[11] Thus, conditions suited to the recruitment of new trees only occurred four times over a period of 70 years.

Finally, predators, competitors, pests, fire, drought or other hazards easily kill small trees. Their vulnerability decreases as they become older and bigger, which means that it is vital that they grow rapidly. More immediately, young seedlings have to grow their roots quickly to tap water from moist soil beneath the surface. Growth rates can indeed be rapid. For example, the roots of young Ana Trees and Camel Thorns can grow at between 1.0 and 1.3 centimetres per day, and so a seedling could have roots reaching half a metre down after one month.[12] Young trees in areas prone to fires also need to grow quickly, especially in developing a thick coating of bark to protect the layer of

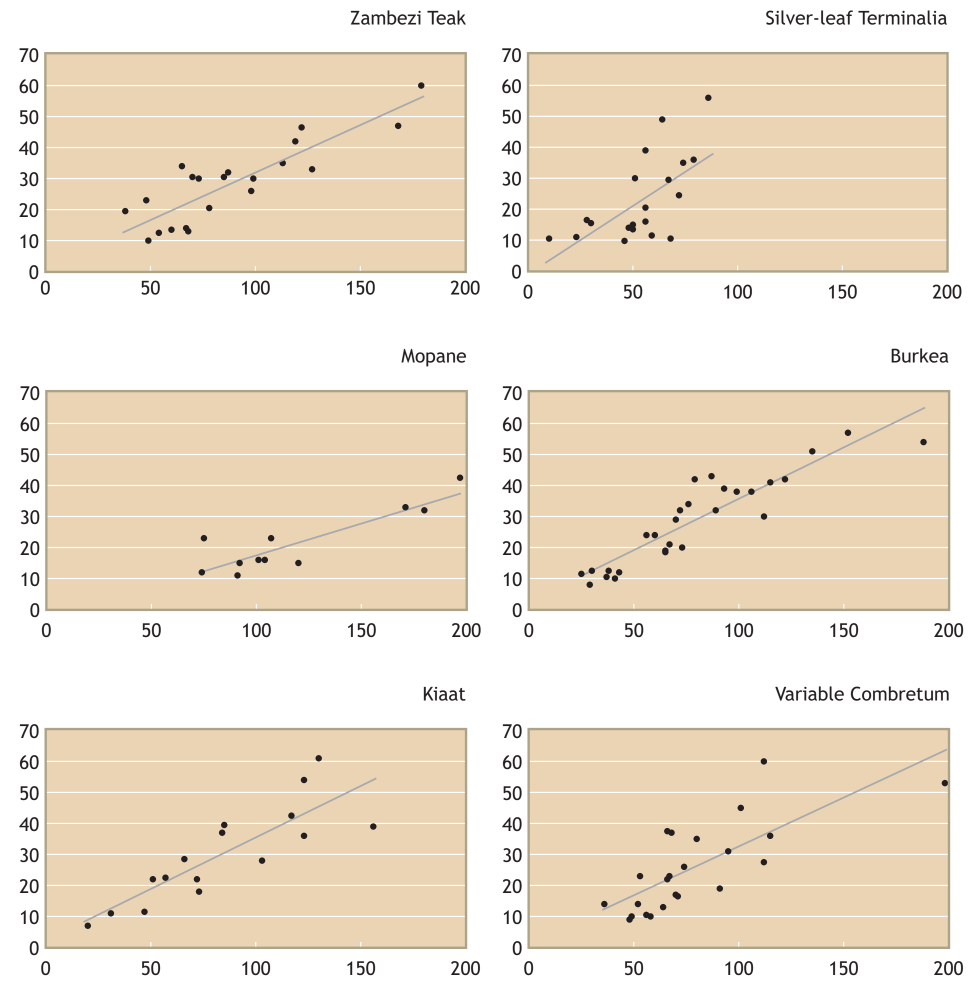
Figure 11.
The majority of trees in any area are small, as shown in these graphs for Zambezi Teak, Kiaat, Burkea and Ushivi. The graphs show the percentages of all trees in various inventory areas in different size classes (along the x-axis).[13] The inventory sites are shown on the small map.



cambium cells through which water and nutrients are transported.

That it is difficult for Namibian trees to reproduce is clear. But how their reproduction translates into recruitment – the rate at which new trees are recruited to populations – is much less clear. Perhaps less information is available on this aspect of tree biology in Namibia than on any other quality. The lack of information is particularly troublesome for purposes of woodland management because it is difficult to know whether timber and other tree populations are stable, or whether they are declining or increasing. Using size as a proxy for age, examples of the population age structure of four timber species in the north-east are given in Figure 11. Most populations are characterized by large numbers of

Figure 12. Relationships between the diameter of trees (in centimetres on y-axis) and estimated ages (in years on x-axis) for Zambezi Teak, Silver-leaf Terminalia, Mopane, Burkea, Kiaat and Variable Combretum in Caprivi and north-central Namibia.[14]



thin saplings, and then declining numbers of larger, older trees. This is particularly true for Burkea and Zambezi Teak. By contrast, Kiaat and Ushivi populations have relatively fewer younger trees but more older trees, and so their survival rates might be better than those of the two former, more prolific species.

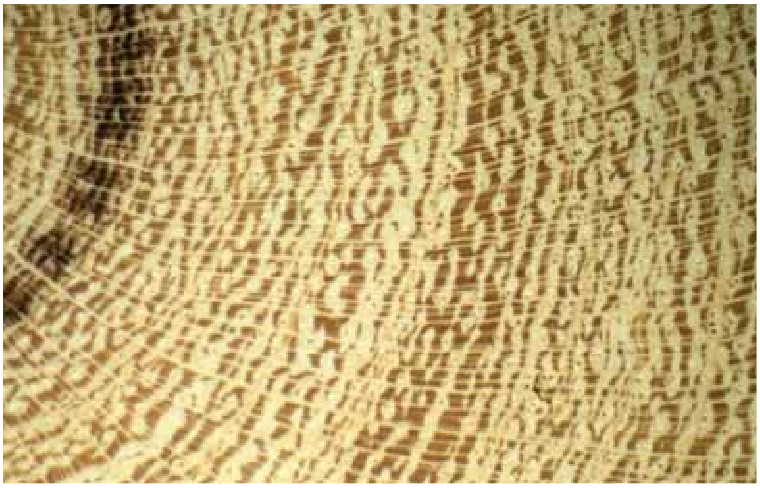
The abundance of small trees suggests that many young individuals are available to grow into larger trees in the years ahead. However, the interpretation of data in Figure 11 is complicated by the fact that the surveys did not distinguish whether trees with thin trunks were indeed young or older, damaged trees that had sprouted new growth. In addition, to be sure that there are enough smaller trees to take the place of larger ones requires information on survival and growth rates. Measuring survival is made particularly difficult by the fact that the environments in which these trees occur are often disturbed severely by sporadic droughts and high-intensity fires. It is also not known if older trees that coppice or sprout new growth (with new thin trunks) can later develop into tall trees that can reproduce and possibly be harvested for timber.

Some estimates of growth rates have been made for several species based on counts of growth rings, which were calibrated to radiocarbon dates (Figure 12). A number of interesting results emerge from these studies. First, many of the biggest trees were aged at between 100 and 200 years old. However, no Silver-leaf Terminalia trees older than 100 years were recorded. Whether they normally die before this age is not known. Second, Zambezi Teak and Kiaat – as potential sources of timber – grew for approximately 130 years before reaching diameters of about 45 centimetres at breast height; roughly the diameter of a trunk that could be harvested to produce sizeable planks. Third, average growth rates varied between the fastest by Silver-leaf Terminalia (0.45 centimetres/year), Burkea and Kiaat (both 0.33), Variable Combretum (0.31), Zambezi Teak (0.30) and the slowest by Mopane (0.21 centimetres/year). Fourth, this study compared growth rates for the same species in Caprivi and north-central Namibia. Those of Zambezi Teak, Silver-leaf Terminalia and Burkea were considerably faster in Caprivi, while Mopane grew more rapidly in the north-central regions. Finally, growth was faster during years of good rain than in drier ones. Perhaps this is one explanation for the variation in growth rates between individuals of the same species. Those with rapid growth might have been lucky in receiving good rains more often than the slower growers.

The considerable ages of larger trees are impressive. Camel Thorns aged between 200 and 400 years old have been found at Tsondab Vlei and in the Kgalagadi Transfrontier National Park near the Namibia/Botswana border. Other noteworthy ages are those of Ushivi trees being about 300 years old and up to 600 years for Welwitchias.[15] The two Welwitschias aged using carbon dating were relatively small and so larger plants could be much older.

WOODLAND AND FOREST RESOURCES

Woodlands and forests can be described and mapped in various ways: in terms of species composition, growth structure, biomass, or relative importance as resources, for example. These measures are explored below, but a useful way to start is to consider the three main landscapes in which Namibian woodlands occur: river valleys, plains, and hills. The landscapes also help us assess vegetation locally because each is characterized by different woodland structures. A look around Windhoek illustrates the point. Such taller trees as Sweet Thorn, Camel Thorn and Buffalo Thorn characterize river valleys; flatter ground is dominated by Black Thorn, while hillsides are largely covered in Yellow-bark Acacias and Kudu Bush.



Tree rings are used to estimate the ages of trees, since each ring corresponds to growth over one year. It is sometimes claimed that rings are unreliable indicators of age in arid environments. To validate their ages, however, the rings can be calibrated against fluctuations of carbon isotopes. Some Camel Thorns at Tsondab and Sossus Vleis have been dead for about 600 years, while others died some 300 years ago.[16]

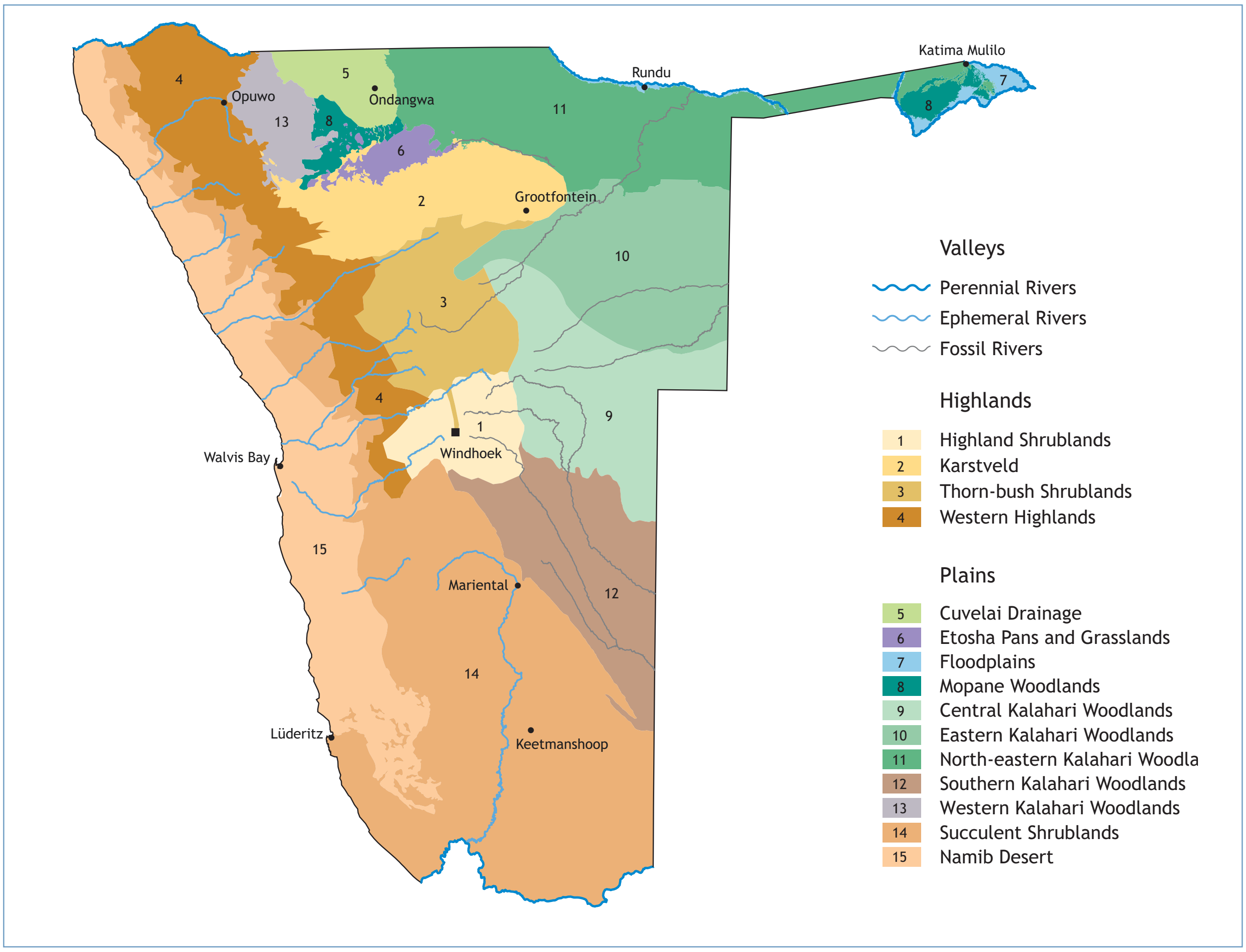


Figure 13. Major types of woodlands grouped into three landscapes.[17]

Woodland types

The three landscapes form the basis for features that characterize woodland types across the country, as shown in Figure 13. River valleys, which include the smallest dry river courses and the large Zambezi and Orange Rivers, form the first landscape. Only the biggest river systems and valleys are shown on the map, but all support woodlands that are taller, denser and different in species composition from those in surrounding areas. Broad-leaved trees form the riparian forests that line the banks of *Perennial Rivers*. In northern Namibia these are often Jackal Berry, Mangosteen, and various Combretum and fig species. Trees fringing the Orange River, on the other hand, are mainly Rhus species, Wild Willows, Wild Tamarisk and Sweet Thorns. *Ephemeral Rivers* and *Fossil Rivers* are dominated by Acacia species, especially Camel and Sweet Thorns. The majority of west-flowing *Ephemeral Rivers* carry water in most years (see page 53), while the *Fossil River* courses that mainly flow east seldom flow because their catchments are largely in sandy areas. Very little surface run-off occurs even after the heaviest falls, and most of the *Fossil River* valleys were carved during much wetter periods long ago.

One might assume that the main feature of all these riverine trees is that they benefit from water carried down the valleys. However, soil depth has an equally important effect in determining the nature of woodlands in river valleys. The Kunene and Orange River largely flow over rocky terrain while the Zambezi, Chobe, Kwando and Okavango Rivers flow across deep sediments in most areas. As a result, these four rivers are largely flanked by floodplains. But it is along *Ephemeral* and *Fossil Rivers* that the effect of soil depth is particularly noticeable. River courses in rocky areas are usually lined with Sweet Thorns, Karee and Namaqua Rock Figs, their roots seeking out cracks in the underlying rocks. By contrast, Camel Thorns, Leadwood, and Ana Trees are most abundant along stretches where deeper sediments have filled in ancient river valleys. Many of the sediments are wind-blown sands. Remarkably, the roots of Camel Thorns have been measured to extend as deep as 40-50 metres where they tap river and rainwater from local falls trapped in the sands. Soils in the lowest stretches of ephemeral rivers are most fertile and deepest because of the accumulation of sediments washed down during sporadic flows. However, water flows are more frequent in the upper reaches, often petering out before reaching the lower stretches of river. Most valleys broaden downstream where they support more expansive riverine woodlands.

The second landscape of hills and mountains is found mainly in the western, rather arid half of Namibia. The majority of trees are sparse and short as a result of the dry conditions, even though the elevated areas may get slightly more rain than nearby lowlands. In addition, hilly areas are generally rocky which means that the soils are extremely shallow and that trees need roots that can penetrate cracks and crevices between the rocks. The western highlands support four woodland types: *Highland Shrublands*, *Karstveld*, *Thorn-Bush Shrublands*, and the *Western Highlands* (Figure 13). Most species are

While few trees grow in southern Namibia, there is an astounding diversity of succulent shrubs, a great many of which occur nowhere else in the world.

The endemic Brandberg Acacia is most abundant around the Brandberg, but also occurs in a narrow belt stretching north-west towards the Kunene River.

thorny, have small leaves, and many are succulents. A high proportion of endemic species are found in the four units, especially so in north-western Namibia where Commiphora species are particularly prominent (see page 49). The only fairly tall and dense woodlands are those on dolomite hills in the eastern parts of the *Karstveld* near Otavi, Grootfontein and Tsumeb. Two significant highlands are isolated from the western belt of rocky, hilly ground. These are the Waterberg and Karas Mountains. Both have tree communities distinct from those on nearby lowland plains.

As the third major landscape, plains characterize four stretches of Namibia. The coastal plain or *Namib Desert* is the first, a very arid strip some 50 to 150 kilometres wide between the Atlantic Ocean and the escarpment. The few woody species in the *Namib Desert* are either small shrubs, including the famous Welwitschia, or larger trees on sand dunes along the eastern flanks of the Namib. The second zone of plains across southern Namibia is also very dry, and most woody plants are consequently dwarf shrubs. With the notable exception of Quiver Trees, most trees are confined to drainage lines. These are the *Succulent Shrublands,* a unit renowned for its very high diversity of endemic dwarf shrubs.

The third stretch of plains extends over much of the southern, eastern and northern parts of Namibia, and continues north and east across much of Angola, Zambia and Botswana. These plains are dominated by Kalahari sand, and five of the woodland units in Figure 13 are found here: *North-eastern Kalahari, Eastern Kalahari, Western Kalahari, Central Kalahari* and *Southern Kalahari Woodlands.* Soil type and rainfall are the major features affecting the structure and species composition of these woodlands. The more rocky, often calcrete, ground along the western margins of the plains is dominated by Acacia species, while broad-leaved species characterize the sands to the east and north. Trees in the northern, wettest parts are taller and denser than anywhere else. Burkea, Zambezi Teak, Kiaat, Ushivi, Variable Combretum and several other Combretum species are the common, well-known trees in the *North-eastern Kalahari Woodlands.* The other units to the west and south are progressively distinguished by shorter and sparser trees of Silver-leaf Terminalia, Shepherd's Tree and various Acacias.

The fourth zone of plains consists of two wetlands, one in the north-east and the other in north-central Namibia. Freshwater *Floodplains* cover much of the area between the Zambezi and Chobe Rivers, and also form wide margins to the Kwando/Linyanti and Okavango Rivers. A large part of eastern Caprivi is *Mopane Woodlands* growing on clayey soils that were wetlands perhaps 50,000 years ago. Another area of *Mopane Woodlands* in north-central Namibia likewise grows on soils formed in a wetland long ago. Mopane is also a very common species in the *Cuvelai Drainage,* which is characterized by a network of grassy oshana channels that carry floodwater from heavy local rains and from higher areas to the north in Angola. Very high flows of water in the oshanas reach the Etosha Pan, where the water evaporates to leave a salty substrate on which no woody plants grow. The pan and surrounding areas form the *Etosha Pans and Grasslands.* Soils in the grasslands are salty too, and support few trees.

Diversity of woodlands

The first part of this chapter describes the environmental factors that influence the distribution and abundance of trees. The combined effect of all these factors is that the kinds of woody plants (of which

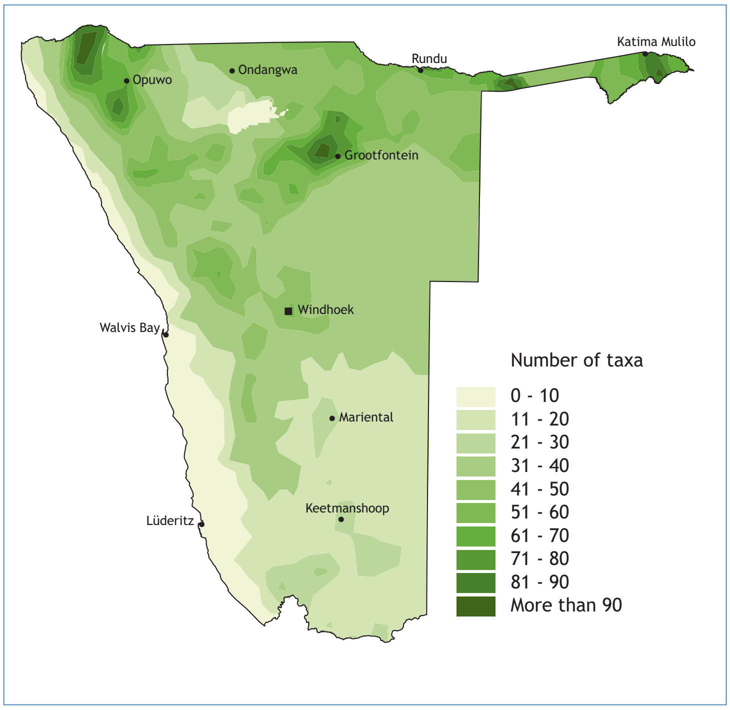
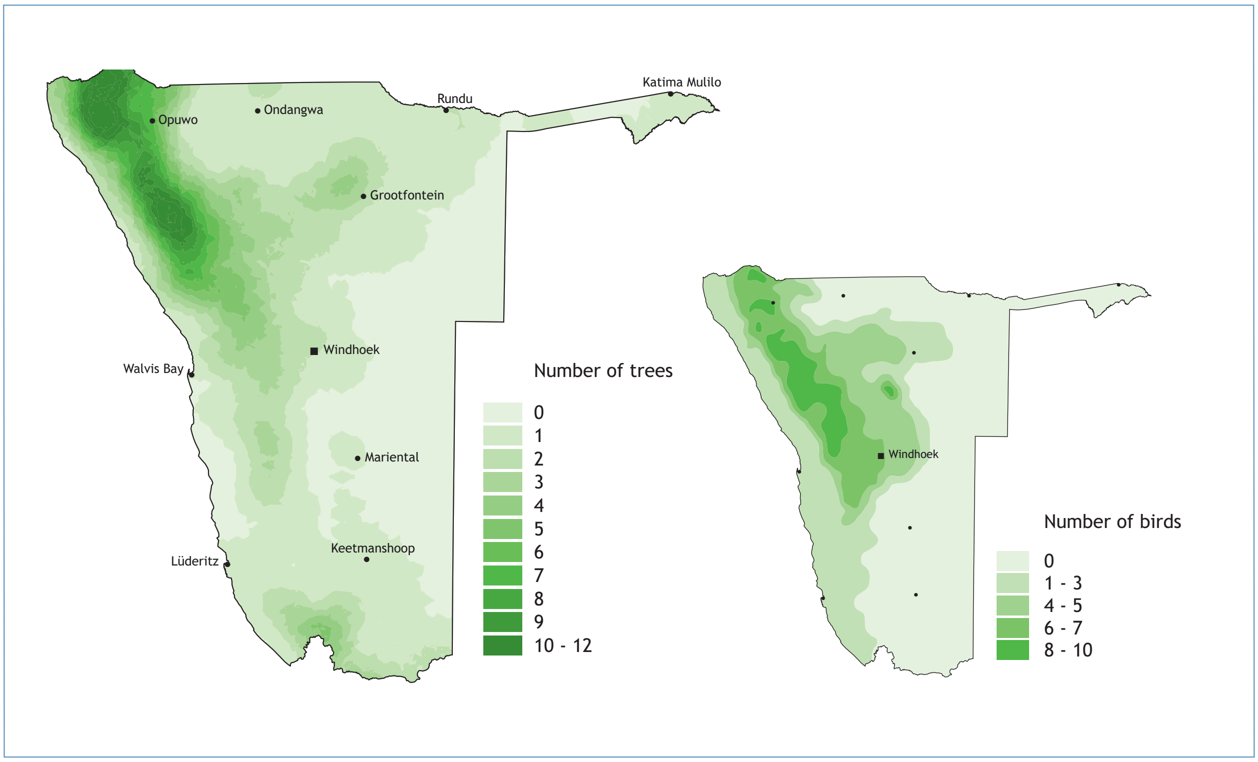
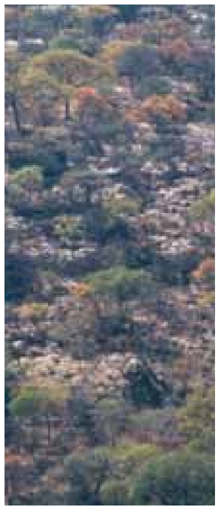
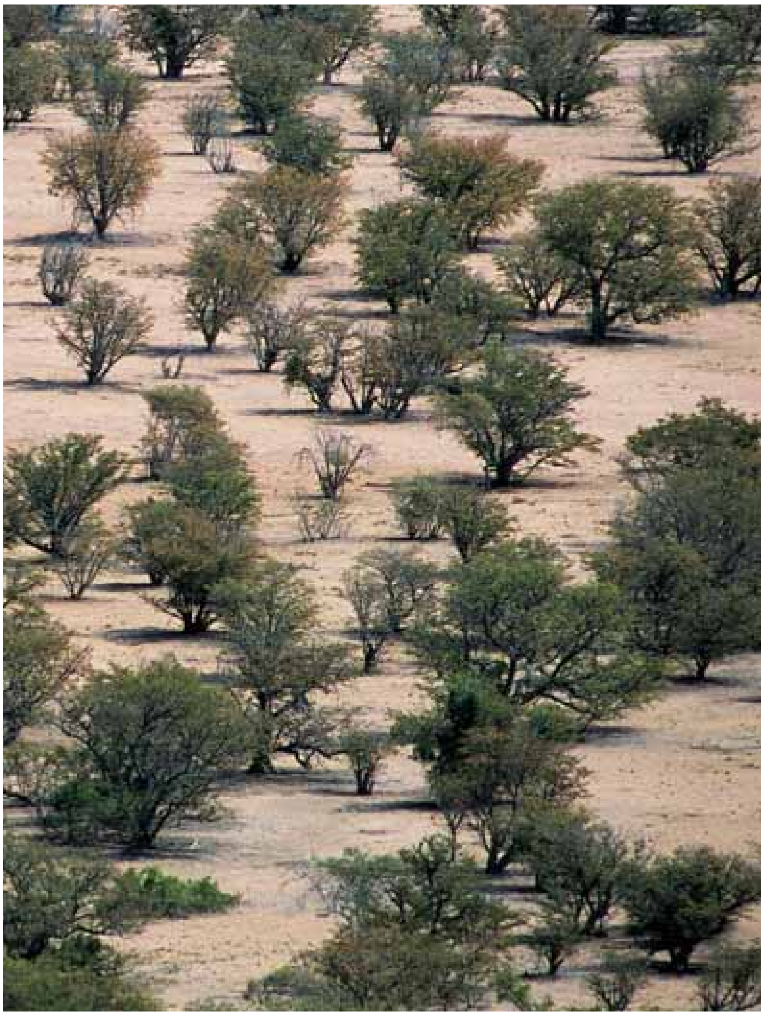


Figure 14.
The diversity of trees in Namibia, as shown by the average number of species and subspecies of trees recorded throughout the country. The map was generated from data collected by the Namibian Tree Atlas project.[18] Coverage was extensive but in all such projects the more field observations are made, the more species are usually recorded. The number of species is therefore conservative, and most areas are likely to have slightly more species than now shown on the map.

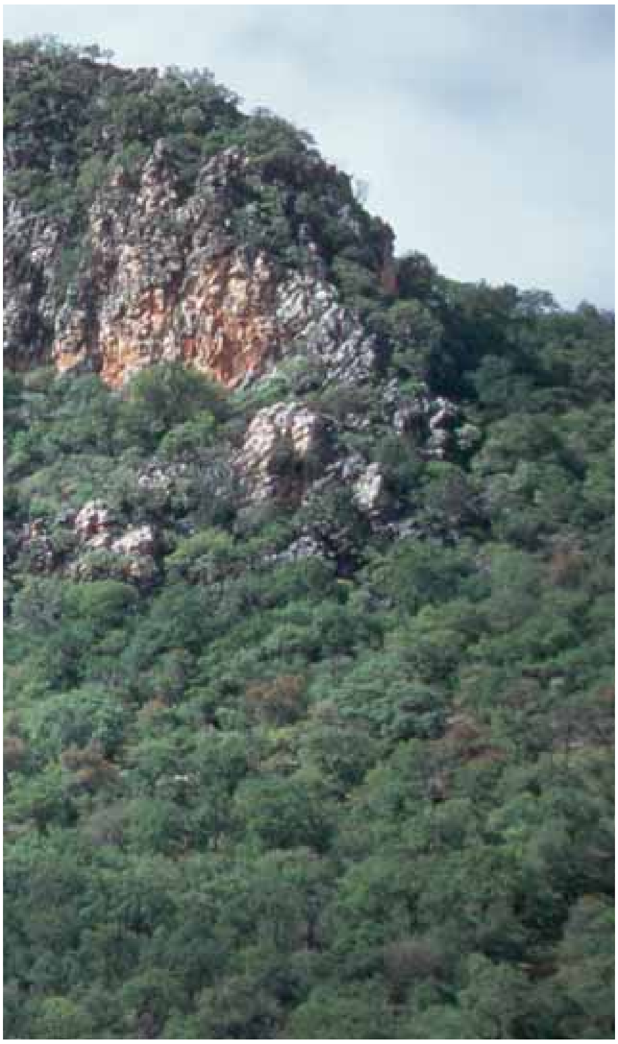
Figure 15.
The distribution and abundance of endemic trees and birds.[19]







A first selection of types of forests and woodlands in Namibia as shown in Figure 13. To the left, Mopane Woodlands, *below a scene over the* Cuvelai Drainage, *and from left to right at the bottom: forest fringes on a* Perennial River, *dense woodland along an* Ephemeral River, North-eastern Kalahari Woodlands, Highland Shrublands, *and plains on the eastern margin of the* Namib Desert.



More diversity of forests and woodlands, from top left to right: sand dunes in the Namib Desert, Thorn-bush Shrublands *beneath the Omatako Hills, the* Etosha Pan and Grasslands, *shrubby growth form of* Mopane Woodland. *Dense woodland on hills in the* Karstveld *(bottom left) and a broad valley in the* Western Highlands *(below).*

there are about 400 species and subspecies, collectively called taxa) are very unevenly spread as indicated in Figure 14. Readers interested in more information should consult the *Tree Atlas of Namibia*.[20] There are four 'hot spots' where more than 90 taxa occur: in the north-western highlands south of the Kunene River, in the dolomite hills around Otavi, Tsumeb and Grootfontein, along the Okavango River near Bagani and the Mahango Game Reserve, and south-east of Katima Mulilo near the Bukalo, Sikanjabuka and Zilitene Community Forests (see page 93). The lowest number of species is in southern and western Namibia, and in Etosha Pan where there are no trees.

The ranges of most trees stretch beyond our borders. However, the distributions of 80 taxa are very largely confined to Namibia, and their conservation is thus mainly our responsibility. These are called endemics, and the great majority occur in north-western Namibia (Figure 15) where they grow on rocky highlands. Some of the species extend into similar habitats across the Kunene River in southern Angola, and also across the Orange River into South Africa. It is interesting that the distribution of endemic trees and birds is so similar, suggesting that endemic species in both groups evolved at similar times and for comparable reasons.

The 80 species, subspecies and varieties that are endemic to Namibia.[21] Most do not have well-known common names.

Acacia montis-usti	*Commiphora saxicola*	*Heteromorpha papillosa*
Acacia robynsiana	*Commiphora virgata*	*Kirkia dewinteri*
Adenia pechuelii	*Commiphora wildii*	*Lycium grandicalyx*
Aloe pillansii	*Cyphostemma bainesii*	*Maerua gilgii*
Aloe ramosissima	*Cyphostemma currorii*	*Manuleopsis dinteri*
Balanites angolensis subsp. *welwitschii*	*Cyphostemma juttae*	*Moringa ovalifolia*
Boscia microphylla	*Cyphostemma uter*	*Neoluederitzia sericeocarpa*
Cadaba schroeppelii	*Didelta spinosa*	*Obetia carruthersiana*
Caesalpinia merxmuellerana	*Diospyros acocksii*	*Ozoroa concolor*
Caesalpinia pearsonii	*Ectadium latifolium*	*Ozoroa dispar*
Caesalpinia rubra	*Ectadium rotundifolium*	*Ozoroa namaensis*
Ceraria fruticulosa	*Ectadium virgatum*	*Ozoroa okavangensis*
Ceraria longipedunculata	*Ehretia namibiensis* subsp. *kaokoensis*	*Ozoroa schinzii*
Ceraria namaquensis	*Elephantorrhiza rangei*	*Pachypodium lealii*
Combretum wattii	*Elephantorrhiza schinziana*	*Pachypodium namaquanum*
Commiphora anacardiifolia	*Entandrophragma spicatum*	*Rhigozum virgatum*
Commiphora capensis	*Erythrina decora*	*Rhus volkii*
Commiphora cervifolia	*Erythrophysa alata*	*Salsola arborea*
Commiphora crenato-serrata	*Erythroxylum zambesiacum*	*Sesamothamnus benguellensis*
Commiphora dinteri	*Euclea asperrima*	*Sesamothamnus guerichii*
Commiphora discolor	*Euphorbia congestiflora*	*Sesamothamnus leistneri*
Commiphora giessii	*Euphorbia damarana*	*Strophanthus amboensis*
Commiphora glaucescens	*Euphorbia eduardoi*	*Turnera oculata* variety *oculata* and *paucipilosa*
Commiphora gracilifrondosa	*Euphorbia monteiroi* subsp. *brandbergensis*	*Welwitschia mirabilis*
Commiphora krauseliana	*Euphorbia venenata*	
Commiphora multijuga	*Euphorbia virosa virosa*	
Commiphora namaensis	*Grewia olukondae*	
Commiphora oblanceolata	*Haematoxylum dinteri*	

Sixteen of the endemic tree species belong to the genus Commiphora. This is one of the most diverse genera in Namibia, with a total of 26 Commiphora taxa in the country. There are also 29 Acacia taxa and 19 Combretum species and subspecies. The diversity of taxa in these three genera is shown in Figure 16. Commiphoras are mainly found in north-western Namibia; this at least partly reflects their preference for arid areas and there is another centre of diversity of Commiphoras in north-eastern Africa. Acacia taxa are more widespread, with pockets of high diversity south of Opuwo, around Otjiwarongo, Otavi, Tsumeb and Grootfontein, and east of Etosha Pan. Combretums are more tropical and the majority of Namibian taxa occur in the wettest areas of the north-east.

The abundance of wood

What wood resources does Namibia have, where are they, and what do they amount to? Some first answers to these questions come from the approximation of tree cover in Figure 17. The darkest areas, with the highest wood biomass, have more than 40 cubic metres of wood per hectare. By complete contrast, Etosha Pan, much of the Namib Desert and many parts of southern Namibia have little or no wood. Areas with a high wood biomass often provide the best habitats for animals that browse or depend on trees in other ways. They also offer more fuel wood and poles for building rural homes, and in some areas also good quality timber for furniture. The table on page 51 shows estimates of average wood biomass collected by the National Forest Inventory Project at 23 sites, mainly in northern Namibia. A total of about 15,3 million hectares was covered by the inventories.

Harvestable Zambezi Teak is very largely confined to the Caprivi State Forest, where volumes of 2.7 cubic metres/hectare have been estimated. However, these are rapidly being decimated by frequent fires (see page 107). Other timber species are more widely and sparsely distributed at less than 0.3 cubic metres/hectare for Kiaat, and less than 0.2 cubic metres/hectare for Ushivi and Burkea. From estimates of total wood volumes and the proportion that might be used for timber in each region, there might be about 2.5 million Zambezi Teak and Kiaat trees suitable for furniture-quality timber in Namibia. At an average of about 0.8 cubic metres of timber per tree, all these trees amount to a standing stock of just over 2 million cubic metres of timber.[22]

While most timber resources are in north-east Namibia, their distribution in those regions is patchy. The patches are often small and limited to places where soils and perhaps other environmental conditions are most conducive to the growth of Zambezi Teak, Kiaat and Ushivi trees. An example of this patchiness is given in Figure 19. The map is based on an interpretation of satellite images to highlight

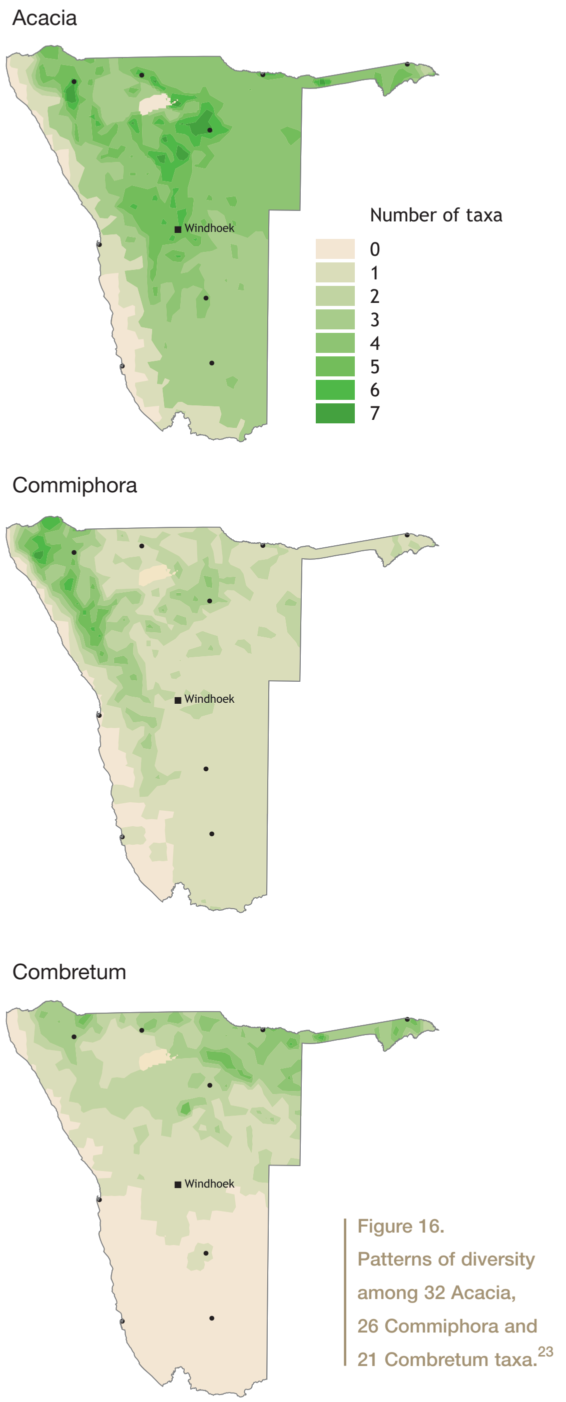


Figure 16. Patterns of diversity among 32 Acacia, 26 Commiphora and 21 Combretum taxa.[23]

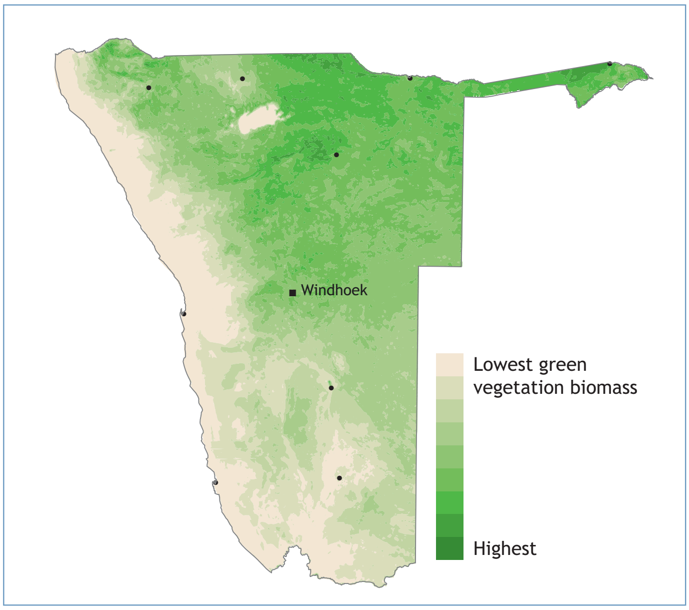


Figure 17.
The biomass of wood varies greatly, from the highest volumes in the north-east to the lowest in the west and south where there are few trees.[24]

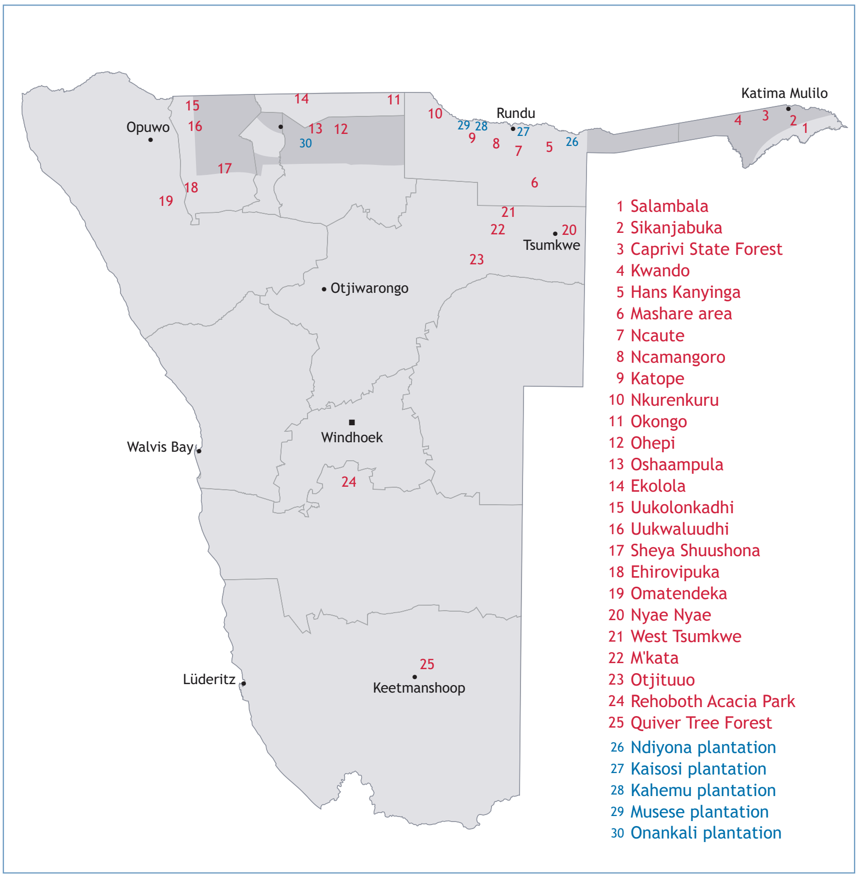


Figure 18.
Places at which inventories were conducted over the past eight years. In addition to the inventory sites and areas listed in the next table, regional inventories were conducted over large areas in Caprivi (16,479 km^2), Omusati (13,839 km^2), Oshana (2,597 km^2), Oshikoto (16,464 km^2) and Otjozondjupa (88,203 km^2).

Estimates of wood and timber biomass.[25] Timber is limited to Zambezi Teak, Kiaat, Ushivi and Burkea trees with diameters at breast height of more than 45 centimetres and straight trunks longer than 2 metres.

Location	Region	Area (square kilometres)	Wood biomass (cubic metres per hectare)	Timber biomass (cubic metres per hectare)	Percentage timber of all wood
Salambala Conservancy	Caprivi	84	18.0	0.00	0.0%
Sikanjabuka Community Forest	Caprivi	49	52.0	0.00	0.0%
Caprivi State Forest	Caprivi	1,461	33.3	2.99	9.0%
Kwando Community Forest	Caprivi	199	23.1	0.74	3.2%
Rehoboth Acacia Park	Hardap	87	9.7	-	-
Nkurenkuru Concession Area 1	Kavango	56	48.0	0.56	1.1%
Nkurenkuru Concession Area 1	Kavango	122	33.4	0.78	2.3%
Hans Kanyinga Community Forest	Kavango	121	40.4	0.35	0.9%
Mashare area	Kavango	1,863	22.6	0.28	1.2%
Ncaute Community Forest	Kavango	119	32.7	0.26	0.8%
Ngamangoro Community Forest	Kavango	219	32.0	0.15	0.5%
Katope Community Forest	Kavango	38	24.4	0.74	0.9%
Omatendeka Community Forest	Kunene	1,212	4.0	0.00	0.0%
Okongo Community Forest	Ohangwena	559	43.2	0.19	0.4%
Ekolola Community Forest	Ohangwena	6	43.8	-	-
Sheya Shuushona Community Forest	Omusati	1,282	1.1	0.00	0.0%
Ehirovipuka Community Forest	Omusati	785	3.6	0.00	0.0%
Uukwaluudhi Community Forest	Omusati	825	6.3	0.00	0.0%
Uukolonkadhi Community Forest	Omusati	830	14.3	0.00	0.0%
Ohepi Community Forest	Oshikoto	52	28.0	-	-
Oshaampula Community Forest	Oshikoto	7	20.8	-	-
Nyae Nyae area	Otjozondjupa	1,412	19.9	0.00	0.0%
M'kata pilot forest area	Otjozondjupa	11	14.6	0.25	1.7%
West Tsumkwe area	Otjozondjupa	6,079	17.8	0.3	1.7%
Otjituuo forest area	Otjozondjupa	694	1.6	0.03	2.0%

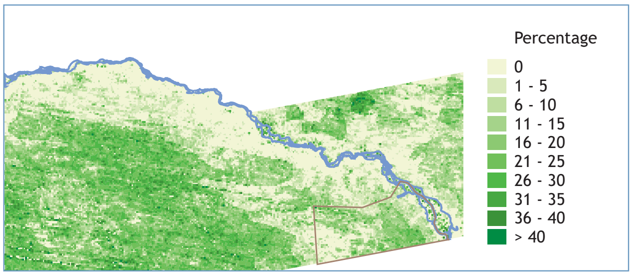


Figure 19.
Tree cover as a proxy for wood and perhaps timber biomass in the Mukwe area of the Kavango Region. Note that along the river, much of the woodland has been cleared.[26]

varying levels of tree cover as an approximation of tree density. Areas of high tree cover may, or may not, be those with the greatest timber biomass, and more work on the ground would be required to investigate whether the clumps of dense tree cover are timber or other species.

SOME IMPORTANT FORESTS AND WOODLANDS

To list and describe 'important' forests and woodlands is a difficult, but worthwhile task. Difficult, because choices must be made using value systems that may be somewhat arbitrary and temporary. What is valued today is different from what was important 100 years ago, and might differ from resources considered essential 50 years from now. But the task is worthwhile because there are areas of woodland and forest with resources that need to be highlighted specially. This brief account does not claim to document all significant forests and woodlands in Namibia. Rather, it serves to illustrate the presence of forests and woodlands about which Namibians should be concerned. It also builds on the concept of Important Plant Areas and Environmentally Strategic Forests promoted by the National Botanical Research Institute in Windhoek and Directorate of Forestry, respectively. Strategic Forests are areas judged to be important in terms of biodiversity, socio-economic and river catchment values, and where 'the management of forests will mainly produce environmental public goods and external benefits'.[27] The order in which the areas are described does not imply any judgment of importance.

North-eastern Broad-leaved Woodlands harbour the greatest resources of wood and timber in the country. They also support a high diversity of species and animals associated with trees. Dominant and characteristic species are Burkea, Kiaat, Zambezi Teak, Silver-leaf Terminalia, Camel Thorn, and several Combretum species (see Figure 16). The whole area encompasses the *North-eastern Kalahari* and *Eastern Kalahari Woodland* units mapped in Figure 13 and lies on Kalahari sands, which are poorly suited to crop cultivation. Relatively few people live in the woodlands as a result, and only small areas of trees have been cleared. Frequent fires have resulted in the loss of many trees, particularly in the Caprivi Game Park and Caprivi State Forest (see page 111). The woodlands contain the great majority of Namibia's good quality timber.

Much of Namibia would be more devoid of life were it not for the linear oases formed by *Ephemeral Riverine Woodlands*, ribbons of trees that enable many animals and people to live in areas where they would otherwise not be able to subsist. The leaves and pods of such species as Ana Trees, Camel Thorns and Sweet Thorns provide forage of high nutritional value to livestock and wildlife, particularly because there is little to eat in the surrounding dry landscape. In this respect, the biggest, most significant ephemeral riverine woodlands are in arid areas in the south (the Fish, Löwen, Konkiep, Gamseb, Auob and Nossob Rivers, for example) and west (from north to south: Khumib, Hoanib, Hoarusib, Huab, Uniab, Ugab, Omaruru, Khan, Swakop, Kuiseb, Tsondab and Tsauchab). The Omatako, Eiseb, Epukiro, Nossob and Auob Rivers and are important lifelines in eastern Namibia.

The biggest threats to woodlands along ephemeral rivers are the damming of water in upstream tributaries and water abstraction. Both damming and abstraction reduce the availability of water to trees, largely by causing the water table in the underlying sediments to drop. Ana Trees are particularly affected. These effects are usually felt after successive dry years in which there are no flows (Figure 20). Another major threat to riverine woodlands is heavy browsing pressure, especially on young trees, which results in low rates of regeneration and recruitment.

Two forests along ephemeral rivers are frequently noted as having special value. These are the *Rehoboth* and *Tsumis Camel Thorn Forests* where there are very large numbers of old and tall Camel Thorns. Respectively, the two forests lie along stretches of deep sands in the Oanob and Tsumis Rivers.

There are two zones of Mopane woodland in

Namibia: one in Caprivi and the other to the west where it forms the *North-central Mopane Woodlands*. The particular value of these large stands of Mopane trees and shrubs lies in the resources they provide to the many people living there. Of greatest value is wood for cooking fuel, poles for building homes, branches and brush for fencing, browse for goats and cattle, and Mopane worms for food. Taller trees predominate in the northern areas of this zone, while the southern area is characterized by large expanses of Mopane shrubs. Most tall trees have been cut in many areas, but Mopane fortunately coppices and many people now only harvest new growth.

Riparian Forest lines the banks of permanent rivers. The Orange and Kunene rivers have relatively narrow fringes of forest consisting of a few species. Wild Willow, Sweet Thorn, Wild Ebony and Orange River Karee characterize those along the Orange River while riparian woodlands along the Kunene are dominated by Mopane, Ana Trees, Jackal Berry and Makalani Palms. Riparian forests in north-eastern Namibia, by contrast, are comprised of a much greater variety of dense trees, many of them tall and luxuriant. They form the most biologically diverse habitat in the country, and thus provide food and refuge to many different animal species. Only small patches of riparian forests remain along the Okavango River because most have been cleared for farming or, in the Mahango Game Reserve, damaged by elephants. The main species are Mangosteen, Sycamore Fig, Jackal Berry, Marula and Mukondekonde.

The forests along the Kwando River are in good condition but increasing elephant numbers pose a threat. Knob-thorn, Camel Thorn, Sycamore Fig, Apple-leaf, Mangosteen, Umbrella Thorn, Sickle-leaved Albizia and Purple-pod Terminalia are dominant species. There are few forests along most of the Zambezi River, especially downstream of Schuckmannsburg where floodplains line the river. Woodlands on moist soils close to the river and on islands in the east Caprivi floodplains are dominated by Water Pear, River Rhus and Jackal Berry, while on drier soils Mobola Plum, Sausage Tree, Camel Thorn, Knob-thorn, Apple-leaf, Natal Mahogany and Musese are characteristic. Maningimanzi, just east of Katima Mulilo, is a special zone of woodlands growing on sands around old river channels which flood when the Zambezi is high. Here the dominant trees are Silver-leaf Terminalia, Musese, Burkea and Mupako on the sands, and Water Pear, River Rhus, Natal Mahogany, Mangosteen, Pod Mahogany and Sausage Tree on the clay soils closer to the channels.

PLANTATIONS AND EXOTIC TREES

This chapter has been concerned with indigenous forests and woodlands, but many exotic trees have

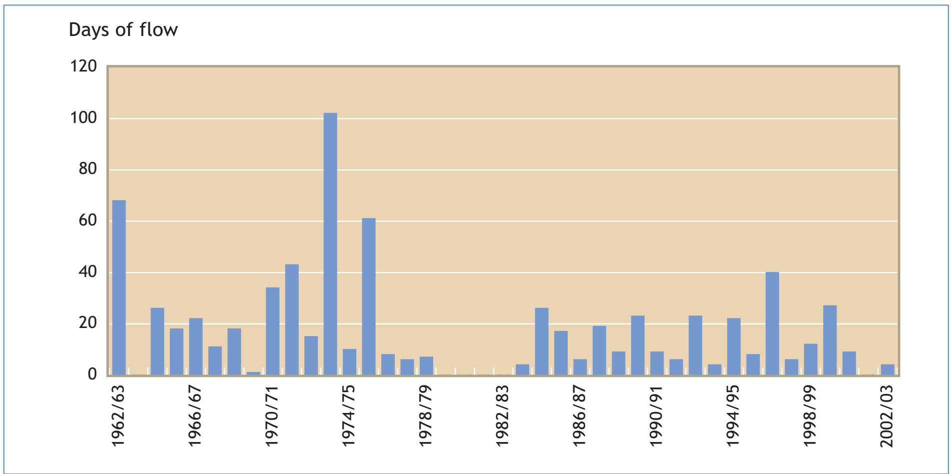


Figure 20.
Water flows down ephemeral rivers are highly variable, as shown by the number of days on which the Kuiseb River flowed at Gobabeb each year. Years of frequent flow lead to the germination and survival of young trees, while successive years in which there is no flow cause water tables to drop and trees to die.[28]

An inventory of Rehoboth Acacia Park revealed there to be about 75,000 Camel Thorns in an area of 8,732 hectares. The average height of the trees was 10.6 metres.[29]

also been introduced to Namibia. Some were planted deliberately and remain in plantations, gardens and orchards, while others have become feral and potentially invasive. The earliest introductions could have been in the 1500s, when Wild Tobacco may have been traded and spread south from West Africa. However, more systematic efforts to introduce trees began in the late 1800s when the German administration started to grow trees experimentally. Up until the end of the German rule in 1915, some 201 different trees had been tried, 23 of them indigenous to Namibia. Trials for Casuarinas started in 1892, while 28 varieties of Eucalypts were planted in 1894 alone. A plantation for Date Palms was started at Ukuib in 1901, and the first Prosopis were planted in 1905.

Fifteen plantations, covering a total area of about 300 hectares, have been established in Namibia.[30] Most of these cover just a few hectares and were intended more as experiments than as plantations to produce timber. Figures on accumulated Eucalyptus wood stocks are available for five of the plantations: Onankali 10 m^3/hectare, established in 1976; Kaisosi 23 m^3/hectare, established in 1979; Kehemu 59 m^3/hectare, established in 1987; Ndiyona 77 m^3/hectare, established in 1975; and Musese 128 m^3/hectare, established in 1967 (see Figure 18 on page 50).[31] The estimates were made at roughly the same time (in 1999 and 2001), which means that the wide variation in growth is probably related more to the productive potential of the sites than to the age of the plantations. These rates of growth and production are also extremely low. For example, a general rule of thumb applied in South Africa is that commercial forests should produce at least 12 cubic metres (m^3) per hectare each year if they are to be viable.[32]

Casuarinas and Sausage Trees are being grown at Siya, west of Rundu, but most plantations consist largely of Eucalypts. A wide range of species and varieties of these Australian trees have been tried, but none have grown well. Also, in the absence of any new information or prospects, it remains unlikely that Eucalypts will be grown successfully in Namibia, and perhaps so for two reasons: the low and erratic rainfall, and the generally poor quality soils. Moreover, any efforts to produce wood efficiently would require a great deal more maintenance (thinning, weeding, pest control and watering) than has been given to plantations recently.[33]

From a conservation point of view, strong arguments against planting alien trees are also often made, mainly to guard against the possible spread of invasive species and to preserve indigenous habitats. In this respect, the Directorate of Forestry is often criticized for promoting the propagation of exotic species. Some of these are known to be potentially invasive, for example Mango and Guava. However, many people – including senior and influential political leaders – are less concerned with potential environmental problems and advocate that much more afforestation should occur in Namibia. Clearly, there is a need to grow trees for fruit, fuel and construction wood, but the short and long-term advantages and disadvantages of all such efforts need to be assessed carefully before implementation.

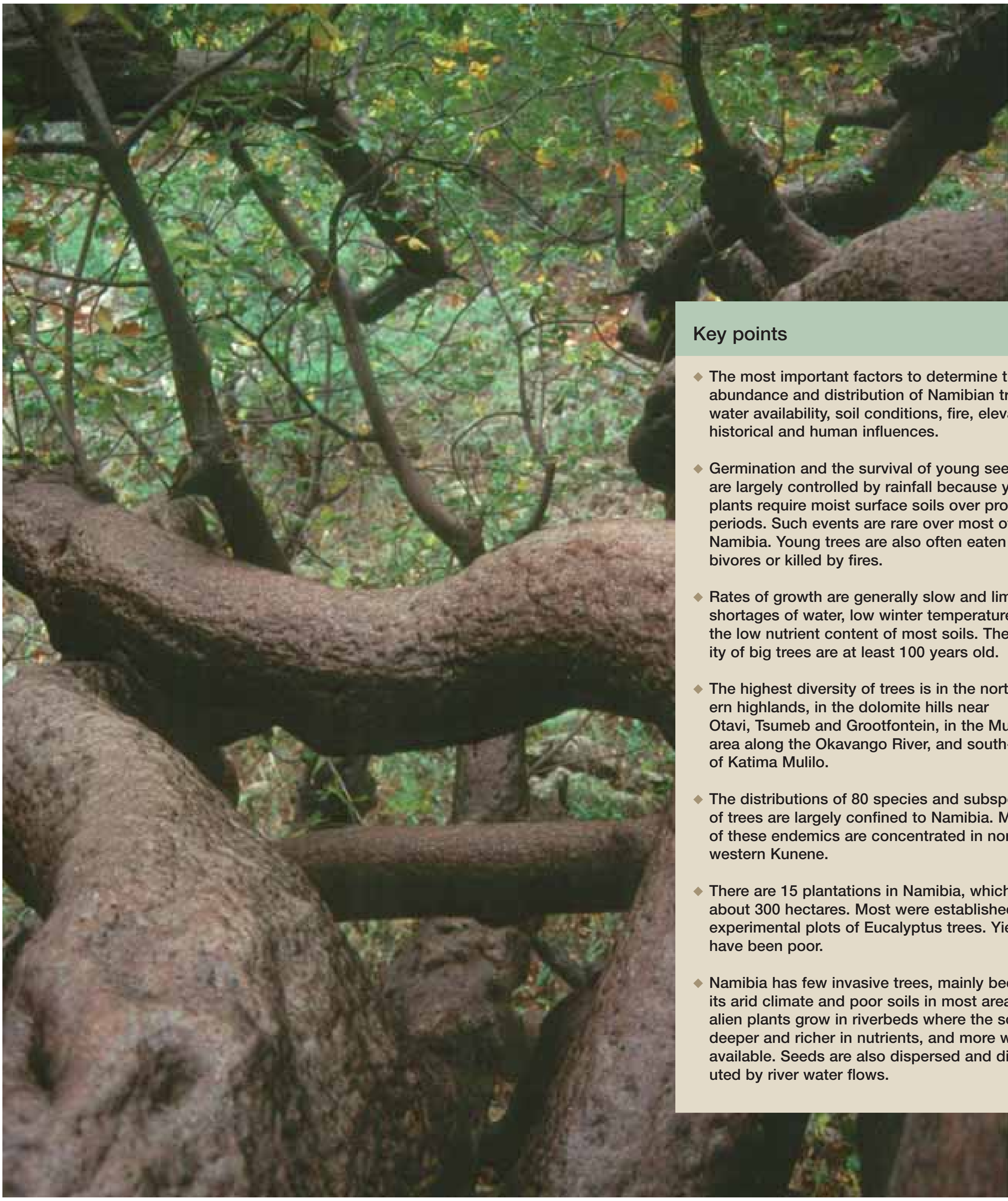
Compared to many other countries with wetter climates, Namibia has few invasive alien plants. This is because of the generally low, variable rainfall and poor soils in most areas. As a result, most alien plants in Namibia grow in riverbeds where the soils are deeper and richer in nutrients, and more water is available. Seeds are also dispersed and distributed by river water flows. A recent review of aliens lists six tree species as invasive.[34] Three are species of Prosopis, which are collectively considered to be the most important and well-known invasive plants. However, little information is available on their impacts on indigenous habitats. They may displace and prevent other trees, such as Ana Trees and Camel Thorns, from growing along ephemeral rivers, and they may reduce flooding and lower groundwater levels. Although Prosopis are widespread, they are really only abundant along certain rivers and tributaries, notably those in the Swakop, Nossob and Auob river systems. Prosopis also provide valuable fuel wood, shade and fodder in many more arid areas where these resources are scarce. The other tree species listed as invasive aliens are Syringa (growing wild in a few places along the Omatako Omuramba), Wonderboom (largely restricted to disturbed areas in towns), and Wild Tobacco (which are widespread in towns and along rivers in the western half of the country).

In addition to the availability of water, soils and nutrients, several other factors influence the occurrence of invasive aliens. These are the absence of natural enemies, the activities of people in translocating plants and altering habitats (many exotic trees grow on cleared land), a lack of awareness, and the absence of legal controls and policies to prevent the introduction and spread of exotic species that could be invasive. There are also a number of characteristics that predispose certain species to being potentially more invasive than others. These features include high rates of seed production and plant growth and the ability to tolerate a wide variety of environmental conditions.

In summary, invasive alien trees are rather localized in Namibia, largely as a result of aridity and the absence of suitable soils in most areas. However, there is need for policy, legislation and vigilance to ensure that invasive species do not become a problem, especially in the northern areas where rainfall and soil conditions are best suited to the growth of exotic species. This, of course, is also where Namibia's most valuable indigenous woodland resources are concentrated.

Unlike other stretches of the Okavango River, the forested areas on islands near Andara remain pristine because people cannot easily reach the islands and many are holy burial grounds for Mbukushu chiefs.

Images and values provided by a Namibian Resin Tree on a ridge in the Brandberg (top) are very different from those offered by a copse of Prosopis along a road near Windhoek (below). The Resin Tree adds majesty and beauty to a rugged, unspoiled landscape, while the Prosopis trees offer valuable fodder and fuel wood, and possible threats to other natural resources.



Key points

- The most important factors to determine the abundance and distribution of Namibian trees are: water availability, soil conditions, fire, elevations, historical and human influences.
- Germination and the survival of young seedlings are largely controlled by rainfall because young plants require moist surface soils over prolonged periods. Such events are rare over most of Namibia. Young trees are also often eaten by herbivores or killed by fires.
- Rates of growth are generally slow and limited by shortages of water, low winter temperatures and the low nutrient content of most soils. The majority of big trees are at least 100 years old.
- The highest diversity of trees is in the north-western highlands, in the dolomite hills near Otavi, Tsumeb and Grootfontein, in the Mukwe area along the Okavango River, and south-east of Katima Mulilo.
- The distributions of 80 species and subspecies of trees are largely confined to Namibia. Most of these endemics are concentrated in north-western Kunene.
- There are 15 plantations in Namibia, which cover about 300 hectares. Most were established as experimental plots of Eucalyptus trees. Yields have been poor.
- Namibia has few invasive trees, mainly because of its arid climate and poor soils in most areas. Most alien plants grow in riverbeds where the soils are deeper and richer in nutrients, and more water is available. Seeds are also dispersed and distributed by river water flows.

BENEFITS AND USES: more than wood

Forests and woodlands are important to people for many reasons. At a minimum, they yield wood for furniture, construction and firewood, but they also harbour hundreds of thousands of animal species that are valuable components of the natural environment. Many of these also provide food, pleasure and other resources to people. And in places where forest and woodland growth is luxuriant and dense, trees absorb large quantities of carbon dioxide thereby helping to keep the earth cool. There are countless other examples of the value and use of trees, many of which will be explored and assessed in the pages ahead.

Two principles are important in any assessment of the value of woodlands. The first is that the nature of use or value varies. Some resources are harvested or used *directly*, for instance firewood and fruit. Other resources have *indirect* benefits, for example the value of a forest in providing places for bees to produce honey, in adding nutrients to the soil, or in attracting tourism revenue that develops the national economy. Direct or indirect values are thus two major dimensions, and much of the material in this chapter is presented with this division in mind.

Almost two-thirds of all households use wood to cook their food, but how long will this tree last before it too is reduced to a pile of fuel?

Other dimensions concern whether woodland products are used in local homes (for domestic functions) or sold (for commercial purposes). Woodland products also have *option* values, which reflect potential benefits in deriving valuable products from trees at some time in the future. Such options relate to, but differ from *existence* values, which reflect the wish for people to see that forests and woodlands continue to exist. Many international donors and other philanthropists are prepared to contribute funds for the conservation of African woodlands, but they may never see or directly benefit from those habitats. Another dimension is between wood products and non-timber forest products (NTFP). The concept of non-timber forest products is a relatively new one, which helps emphasize the great variety of different values and uses of woodlands. The concept adds support to the development of community forests (see Chapter 4) in promoting possible commercial uses of non-timber forest products to improve the livelihoods of rural communities

The other principle is that values and uses depend much on context or setting. A grove of Mopane trees in one place may hardly be used because people build their homes or cook their food with other materials. But Mopanes elsewhere could have great value in supplying several such resources for domestic and commercial uses, for example. Likewise, the value of a single tree might not be high in well-wooded areas, but each of the few trees scattered across a desert landscape has extremely high value in providing shade, places for birds to nest, or fuel wood. The same tree species often has multiple uses. For example, Kiaat provides high quality wood for furniture, crafts and domestic implements, its latex yields red dye for basketry, while its powdered heartwood is used for stomach and eye ailments and as cosmetics by Ju|'hoansi women.[1]

The approach taken in this chapter is to focus on benefits clearly derived from trees and to leave aside uses that result more from an association with trees. The division between such uses is often blurred, and it is a matter of opinion as to what to include or exclude. However, we have chosen to exclude such other uses of plants and animals that occur in or are dependent on woodland habitats. Thatching grass and the hunting of wildlife are cases in point. It is simply beyond the scope of this book to describe all these other resources in any detail. This does not detract from their value, and we argue elsewhere (see page 78) that the potential of these resources should be recognized fully in assessing how woodland habitats are maintained.

People and their pre-human ancestors have been using woody plants for millions of years, and have therefore had lots of time to discover many benefits: food, fuel, cosmetics, construction materials, medicines, and others. And more uses of plants are being discovered as time goes by, to the extent that the majority of tree species in Namibia are put to some or other direct use. This is quite different from animal species, most of which are not used in the same utilitarian ways by people.

FUEL WOOD

More wood is used for fuel than for any other purpose in Namibia, as shown in the table below. To that conclusion can be added three others: most fuel wood is collected locally close to rural homes, largely for domestic cooking, and mostly from dead wood. By implication, little wood is used as industrial fuel and it is only around densely populated areas that living trees are killed and harvested for fuel. Energy from wood fuel makes up roughly 20% of all energy (which includes electricity, petrol and diesel) consumed per year in Namibia. This is slightly higher than the 14% of all energy that wood is estimated to provide worldwide.[2]

The Population and Housing Census held in 2001 provides much useful information on the use of wood, since it recorded the main fuels used for cooking, heating and lighting in all homes. Wood was used for cooking by over 213,000 or 62% of all households in Namibia. Many (42%) homes also use wood for heating, while 13% report using wood for lighting. However, the quantities of wood used for heating and lighting are much smaller than those used for cooking, and wood used for cooking often provides heating and lighting as well. Multiplying the total number of households using wood for cooking with an estimated daily consumption of 8 kilograms[3] means that Namibia uses about 1,700 tons of wood for cooking every day, equivalent to a pile of wood measuring 1 x 1 metre and over 2 kilometres metres high!

Over three-quarters of the 213,000 homes that reported using wood for cooking in 2001 were in Caprivi, Kavango, Ohangwena, Oshikoto, Oshana, Omusati and Kunene, and over 80% of households in these regions use wood for cooking (Figure 21).

Approximate quantities of indigenous wood (in cubic metres) used in Namibia each year.[4]

Use or product	Domestic, non-cash consumption	Commercial production
Fuel wood	983,000	100,000
Charcoal[a]	0	240,000
Household construction and fencing (local production)	316,000	0
Carvings	0	440
Mopane roots		1,000

[a] *About five kilograms of wood are required to produce each kilogram of charcoal, and so 240,000 cubic metres generate about 48,000 cubic metres of charcoal per year.*

Percentages of all homes using different fuels for cooking during 2001, in the whole country and in rural and urban areas.[5]

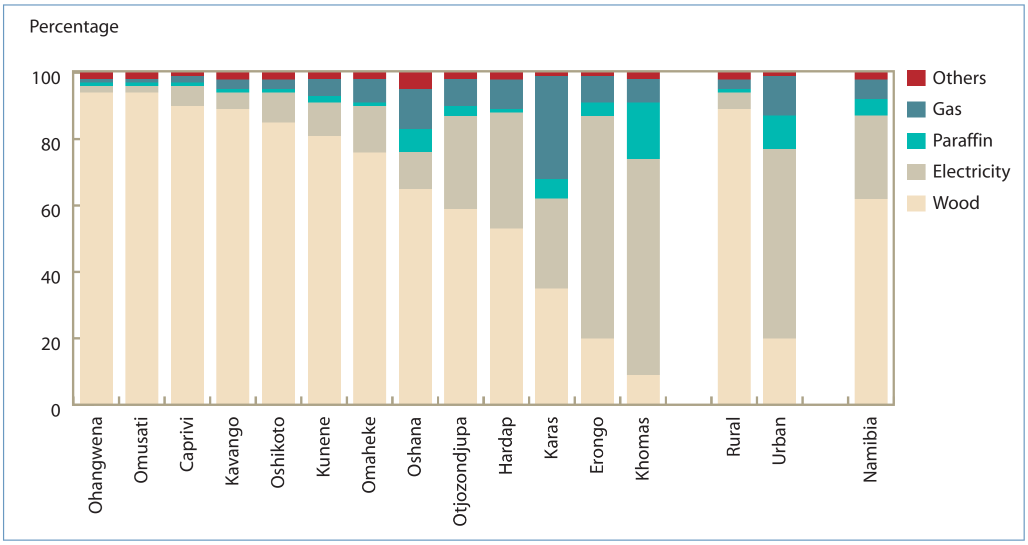
	Wood	Electricity	Paraffin	Gas	Other
Namibia (% of households)	62%	25%	5%	6%	2%
Namibia (number households)	213,526	86,187	17,105	22,344	7,293
Rural	89%	5%	1%	3%	2%
Urban	20%	56%	10%	12%	1%

These are all northern regions where wood is more available than further south (see page 49). But the high percentages also reflect the fact that the great majority of households in these areas are rural ones, in which many people are relatively poor and less able to afford alternative fuels. Indeed, wood is used for cooking by nine out of every 10 rural homes (89%), whereas only 20% of urban households use wood as the main cooking fuel.

Urban residents tend to be wealthier than rural people, and alternative fuels are more available and at lower cost than in more remote areas. Over half (57%) of all homes in towns use electricity for cooking, while about one tenth of households use gas or paraffin (kerosene) as a cooking fuel. About two-thirds of all houses in Khomas and Erongo use electricity for cooking, largely because most people that live in these regions live in Windhoek, Swakopmund, Walvis Bay, Usakos, Omaruru and Karibib. The availability of electricity in the larger towns of Oshakati and Ondangwa also explains why higher proportions of homes in Oshana (12%) cook with electricity than in Omusati and Ohangwena (2%). Both gas and paraffin are little used for cooking in the country as a whole, but gas is about equally as important as electricity and wood in Karas. The main fuels included in the category "Other" in the table above and Figure 21 are charcoal, dry livestock dung and solar power.

Changes in the use of wood for cooking can be assessed by comparing information from the 1991 and 2001 censuses. The number of homes using wood for cooking rose by about 26,000 between 1991 and 2001, an annual rate of increase of 1.3%.

Figure 21. The use of different fuels for cooking in 2001, showing the percentages of households in each region using each fuel as their main source of energy for cooking.[6]



The escalation is due to population growth, since the proportion of households using wood in fact dropped substantially from 73% in 1991 to 62% in 2001. Much of the decline can directly be attributed to the increased use of electricity and paraffin: respectively, about 40,000 and 15,000 more houses used these fuels in 2001 compared with 1991. More indirectly, the decline in wood use and increased use of modern fuels was due to urbanization. Town populations grew by about 5% per year over the past decade, and people now living in towns have better access to electricity and paraffin, and higher incomes to pay for these fuels. In addition, wood resources are scarce around most urban areas.

Another way of looking at changing energy uses is to consider what motivates people to change from wood to electricity use. One can assume that most people who have electricity also use electrical cookers or stoves. However, of all homes that had electrical lighting in 2001, only 75% used electricity for cooking. The remaining 25% was split between wood (12%), gas (10%) and paraf-

Most wood can be used for cooking and heating, but Camel Thorn, Mopane and Leadwood are often preferred because they are hard and burn for a long time. Both Camel Thorn and Leadwood are protected species (see page 99).

Percentages and numbers of households using wood for cooking in 1991 and 2001.[7]

Fuel	1991	2001	1991	2001
Wood	73%	62%	187,047	213,526
Electricity	18%	25%	46,648	86,187
Paraffin	1%	5%	2,096	17,105
Gas	7%	6%	18,139	22,344

Energy can be transported more easily as charcoal than as raw wood. About five kilograms of wood produce one kilogram of charcoal, and so most of the energy provided by a cumbersome bundle of wood is contained in a small load of charcoal.

fin (2%). Those who use gas are probably in a similar economic bracket to those using electricity, whereas households that still cook on wood are perhaps too poor to buy modern cookers or pay for electricity.

The region with the greatest use of paraffin is Khomas, largely because it is used by the majority of homes in the informal settlements or townships on the northern edge of Windhoek. The total number of households using paraffin in those areas rose from less than 100 in 1991 to about 9,700 in 2001. By contrast, the proportion of homes using wood for cooking in the whole city dropped from 7% in 1991 to 5% in 2001, again largely as a result of better access to other fuels and perhaps the reduced availability of wood around Windhoek.[8]

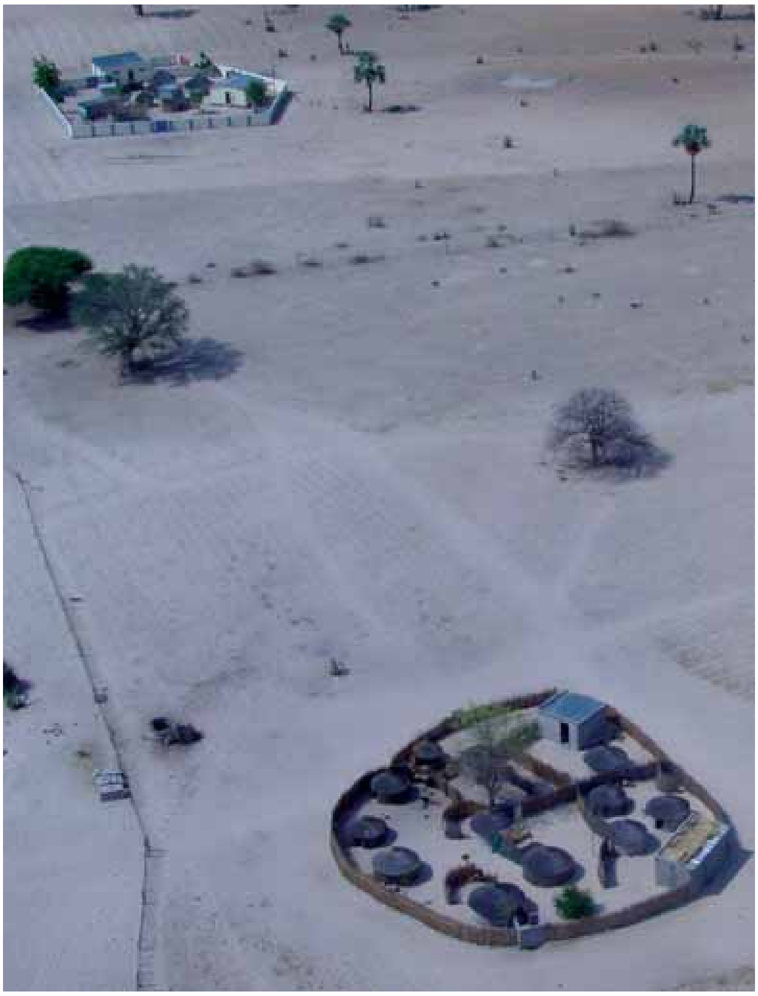
One might expect entrepreneurs to import and sell firewood to low-income groups in Windhoek. However, this appears to be happening to a very limited extent, perhaps because of the high costs of transporting wood from sources far to the north or east. Transport costs in northern Namibia would be lower, and there are indeed fairly large wood markets in many northern towns, which are surrounded by more abundant supplies of wood within 50 kilometers. One study found that households in Oshakati and Ongwediva bought and used about 26 bundles of wood per month, each bundle weighing an average of 7 kilograms and costing between N$6 and N$7.[9] This was in 2003, when prices had more than doubled from those charged in 1997. As more and more people settle in towns, especially in low-income housing, a greater trade in wood to towns might develop. Alternatively, more people might start to use paraffin, a possibility requiring research to investigate what factors encourage households to adopt alternative cooking methods. It is often argued that low-income households do not use charcoal because they prefer traditional wood fires and because they cannot afford stoves on which they can cook on charcoal. Both arguments are perhaps contradicted by the growing use of paraffin in Windhoek.

Namibia's annual production of charcoal in recent years has varied between about 40,000 and 50,000 tons. A few hundred tons are sold in Namibia, mainly for the barbeque or locally known *braaivleis* market, while the rest is exported, roughly three-quarters being sold in South Africa and one-quarter in the United Kingdom. The total value of the industry, which has grown rapidly over the past 15 years, was estimated to be about between N$75 and N$100 million in 2004. However, charcoal sales to Europe have dropped in recent years, especially to Germany where 40% of Namibia's charcoal exports were sold in the mid 1990s. The loss was largely due to poor quality control by producers, the stronger South African Rand and competition from other charcoal producing countries such as Argentina and Poland.[10]

Charcoal is largely produced from so-called invader bush, particularly those species – Black Thorn, Purple-pod Terminalia and Sickle-bush – that cause most bush encroachment (see page 112). The charcoal industry is thus often seen as an anwer to the problem of bush thickening. However, this solution only applies to a few small areas because the number of suitably large bushes harvested for charcoal is low compared to the extent of the bush encroachment problem. In addition, the roots of bushes and small trees cut for charcoal are often not killed and the plants then coppice again into bush. There are between 100 and 120 active charcoal producers in Namibia, most of whom are freehold farmers. In total, between 2,500 and 3,000 people are employed in the industry, which operates largely on freehold farms lying between the veterinary cordon fence in the north and Windhoek in the south. About 20 of the farms on which charcoal is produced carry Forest Stewardship Council (FSC) certification, one provision of which means that the bush is harvested on a sustainable basis.

CONSTRUCTION AND FENCING

Together with fuel wood, the other major use of indigenous wood in Namibia is for building homes and fencing. One estimate suggests that about 316,000 cubic metres of wood may be used each year for fencing and construction (see page 61). Most of this is in northern Namibia, while the majority of homes in the southern regions are structures of bricks, cement and corrugated iron. Wire fences supported by steel fence posts and droppers, or treated, imported droppers, also predominate in the south.



The use of wood for construction has dropped significantly as increasing numbers and proportions of rural households in the northern, communal areas are built of bricks, corrugated iron and other modern materials.

Building styles vary a great deal in the northern areas, where increasing numbers of modern homes are being constructed. Wealth is a major factor. Amongst traditional homes, it is the wealthiest households that have the biggest structures and that consist of the greatest amounts of wood. Poor homes, by contrast, are small and more often built from grass, reeds and long sticks. Housing styles also vary in relation to the availability of wood and traditional or cultural practice. The most impressive wooden homes are the large, traditional complexes of rooms and palisade walls built in former Owambo. Many of those homes are comprised of between 4,000 and 6,000 sizeable poles, mainly

Percentages of houses built using various materials for their outer walls in 1991 and 2001, and in urban and rural areas in 2001.[11]

Outer wall material	Namibia 1991	Namibia 2001	Urban 2001	Rural 2001
Wood poles and grass	40%	21%	3%	33%
Sticks, mud and cow dung	12%	8%	2%	12%
Cement blocks/bricks	34%	38%	66%	20%
Burnt bricks/face bricks	2%	15%	4%	22%
Corrugated iron sheets	9%	15%	21%	11%
Prefabricated materials	1%	2%	3%	1%
Other	1%	2%	2%	2%

of Mopane and Silver-leaf Terminalia because this wood is hard, resistant to pests and thus long-lasting. Large areas of woodland were deforested in north-central Namibia as a result.[12]

From the 2001 Population and Housing Census, about 21% of all homes in Namibia have outer walls constructed of wood, while another 8% are built of much thinner sticks that are often woven or platted and then plastered with mud and dung. The great majority of these traditional structures are in rural areas, whereas there are few such homes in urban areas. Thus, about 45% of rural households have outer walls of wood or sticks, plastered with mud and cow dung compared to only 5% in towns.

Housing construction has changed very substantially since 1991, as indicated by the figures in the table above. Far smaller proportions and numbers of homes are now built of traditional materials, while many more have been built using bricks, cement blocks or corrugated iron. For example, 52% of all houses had outer walls of poles, sticks, and mud and cow dung in 1991, compared to only 29% in 2001. The total number of these houses dropped from 132,105 in 1991 to 99,339 in 2001.

Much of this change is due to urbanization, people moving to towns replacing their traditional houses with ones built using modern materials. However, many rural homes in communal areas

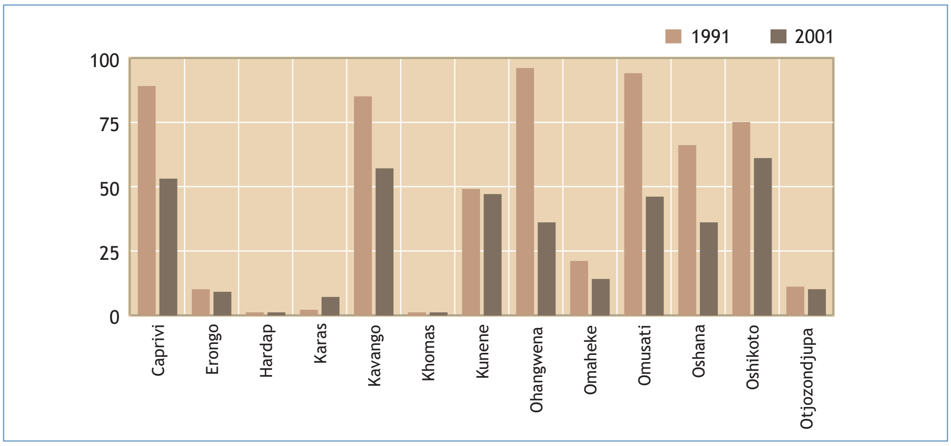
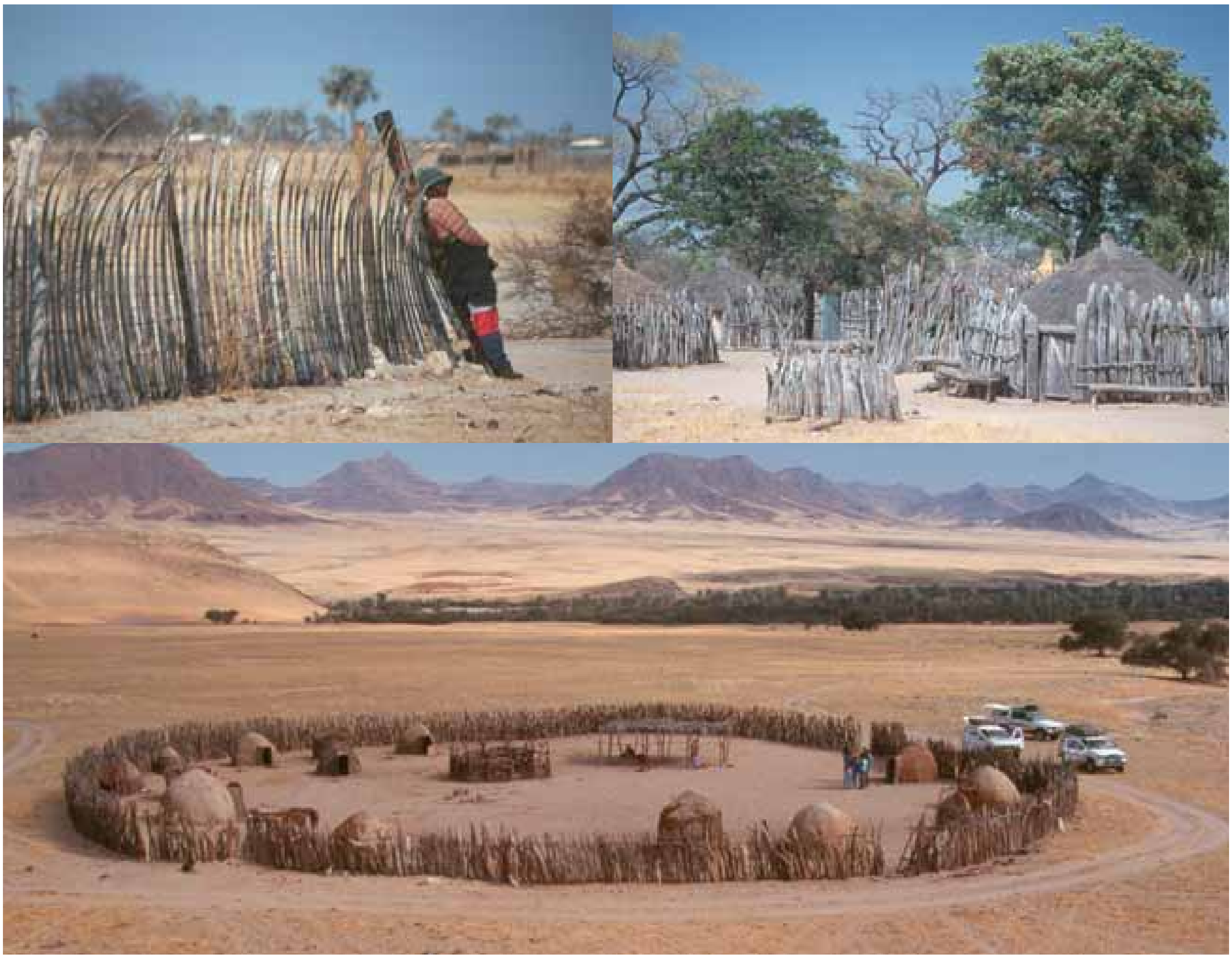


Figure 22. Percentages of houses built using poles, sticks, and mud and cow dung for the outer walls in 1991 compared with 2001.



are now also being built of bricks and other purchased materials. This is particularly the case in Oshana, Ohangwena, Oshikoto and Omusati where, for example, the percentage of houses with outer walls of poles dropped in Ohangwena from 88% in 1991 to 34% in 2001, and in Omusati from 92% to 34%, a decline of more than half in both areas (Figure 22). Several factors appear to have driven this change. First, many households in these areas now have reasonable – often very substantial incomes – which can be used to build improved homes. Second, and in parallel, lifestyles have changed. Western clothes are the vogue, many people carry cell phones, and having a modern home forms an integral part of a new style of living. Third, it is now difficult to replace old poles because of the scarcity of Mopane, Silver-leaf Terminalia and other suitable trees nearby. Harvesting and transporting such poles from more distant sources is furthermore an expensive undertaking. Fourth, permits required to harvest and transport poles have helped limit the cutting of trees. The introduction of the permit system was accompanied by extension campaigns, often broadcasted through public radio services, urging that the use of wood be reduced and that trees were not to be cut down. Finally, modern building materials are now readily available from building suppliers that have opened shops in many of the northern towns.

All manner of wood is used for fencing, ranging from thick poles cut from Camel Thorns and Mopanes, to Makalani Palm fronds, and waste, such as old car doors. Because Mopane coppices and quite rapidly produces branches or trunks suitable for fencing, it is regularly harvested from vast areas of shrubland in northern Namibia. Some farmers around Tsumeb now harvest and sell Purple-pod Terminalia for fence droppers.

Kiaat dominated the timber industry because it provided the best wood for furniture (top). The wood is hard and attractive, sizeable and straight planks can be harvested, and it has fewer knots and warps less than other indigenous woods. Following Kiaat, and in order of quality and preference, Zambezi Teak, Ushivi, Pod Mahogany, and Burkea (bottom) also produce useful timber.

Large quantities of wood are used for fencing but little information is available on the extent of this use. However, the use of wooden fencing poles is almost certainly declining as farmers increasingly use wire fencing and steel fence poles. Many wire fences on freehold farms in central and southern Namibia were erected using Camel Thorn and other hardwood fence posts. Some of the posts still stand, but steel pipes are normally used for new and replacement fence posts. Fencing in the communal areas generally uses more wood, the entire fence often consisting only of hundreds of thin poles erected and held in place with thin plaited sticks to create a dense lattice that keeps goats out of fields. Many fences around fields and livestock stockades in the north-central regions consist of thousands of Mopane poles. As in the case of housing, wealthy farmers tend to have bigger fields that are securely fenced, while poorer farmers use less wood because they have smaller fields, which are often not fenced at all. However, many richer farmers in communal areas now also erect wire fencing strung between steel poles supported with steel droppers.

TIMBER

Namibia's arid environment and sparse tree cover is only one of several reasons that the country's timber resources are small (see page 51). Most trees are not suited to timber production because they are small or the wood is too knotted or distorted, and this is also true for most trees in the north-eastern woodlands. Any tree with a diameter of less than 45 centimetres at breast height is usually not worth harvesting because it would yield only a few narrow planks. The wood of trees such as Zambezi Teak and Ushivi is also very hard, making the timber expensive to cut and plane. Additionally, most sizeable timber trees are scattered widely, often far from roads. Finding and reaching them, and then transporting the logs to sawmills is thus expensive. Finally, the Namibian market is small, and the cost of exporting small loads of timber to foreign destinations is high. As a result of these constraints, almost all timber used to build and furnish modern houses is now imported, mainly from South Africa. Much of this is pine or processed chip wood, which is much cheaper than indigenous timber. Namibia imported about 25,210 tons of wood products in 2003.[13]

Although timber production has always been rather limited, quite large volumes have been harvested at various times. For example, some 42,000 cubic metres were cut in 1926, and 28,000 cubic metres were harvested during the first nine months of 1972.[14] While much of the logging and timber production that occurred in northern Namibia happened legally and under permit, it is also often

Each mokoro *boat is produced from the trunk of a single, large tree.*

claimed that large-scale illegal harvesting occurred, and that Namibia's stocks of Kiaat and Zambezi Teak were severely depleted as a result. How true this is remains unknown to us.

Timber production evidently declined over the past 60 years to the extent that only small quantities were cut by the early 1990s. For example, only 3,100 cubic metres were cut in 1990, of which 1,200 cubic metres was exported. Three sawmills operated during the early in 1990's, one each at Rundu, Katima Mulilo and near Tsumkwe, and it was only in these north-eastern areas that any logging took place. The Ministry of Environment & Tourism stopped the cutting of timber for exports in 1996 and then stopped all timber production in Namibia in 2003. The main reason for these bans was to enable the country to take stock of its timber resources and to ensure that timber resources would remain in community forests (see page 93).

CRAFT AND DOMESTIC IMPLEMENTS

Although Namibia has a conspicuous and popular woodcraft industry, little solid information about it appears to be available. Items carved from wood form part of a rich array of craft which includes baskets, pottery, wire sculptures and plastic bangles. Relatively large numbers of people make their livelihoods, directly or indirectly, from harvesting, carving and selling craft, and most of these people are in, or originally lived in Kavango. This is also the region that supplies the Kiaat and Ushivi wood used for most carvings. Carvers pay N$400 per annum for a permit to harvest wood for commercial craft production. Other than roadside stalls between Rundu and Mururani gate, most woodcraft is sold at street markets in Swakopmund, Okahandja and Windhoek. The markets are aimed largely at tourists, and craft from Zimbabwe, Zambia, and East and West Africa is also sold there.

The only estimate – as far as we know – of wood volumes used for craft indicates an annual consumption of 440 tons.[15] The economic value of the whole industry has not been assessed but because of the value added to raw wood, it probably provides the highest returns of all uses in Namibia. It also provides more jobs per cubic metre than any other use of wood. These aspects should be born in

The massive and spectacular grain storage baskets made by Oshiwambo-speakers are largely fashioned from thin Mopane branches bound together with rope made from Mopane bark.

mind if the impact of the carving industry on Kiaat and Ushivi populations is evaluated. Additionally, far greater numbers of these trees are killed every year by fires (see page 107) than are cut for craft production.

Two other uses of wood are included here: implements for domestic and farming use, and the export of Mopane roots as ornaments. A variety of wooden objects are used in rural homes for preparing and storing food, and for eating (for example, bowls, mortars and pestles) and as farm implements (sleighs, yokes, axe handles and rope from bark, for instance).

There is also the use of trees for dug-out boats, usually known locally as *mokoros*, but relatively few boats appear to be made these days. Again, no information is available on the quantities or values of all these items.

FOOD, OILS AND BEVERAGES

People have been eating indigenous fruits, nuts and tubers for millennia, and these foods still form a high proportion of the diet of some people, especially in poorer households. These are people who have small fields, few or no livestock and little or no cash income. Much of what we now know of plant foods is based on traditional uses, and it is on this foundation that new efforts are being built to increase and market the value of indigenous plant foods.

Plant foods are amongst the most important non-timber forest products. There is, however, considerable variation in the abundance, availability and use of food plants, both from place to place and from time to time. Some foods are so important that they are collected, carried home and then eaten, stored, sold or further processed.

These are usually from plants bearing large fruits, whereas those with smaller, or less nutritious or tasty fruits are eaten in passing as snacks, such as the berries of several species of Raisin Bushes. More plant foods are available in northern and north-eastern Namibia, mainly because this is where most species that bear large fruit occur. Trees in more arid areas further south and west generally have small, inedible seeds. Of all tree species in Namibia, 157 species (35%) have been recorded as being used for food in one form or another.[16] This is across the country, but between 30 and 40 tree species normally provide food in any one area in north-eastern Namibia. Of those, there would be only a handful that supply food regularly and in substantial quantities, the most important of which are: Marula, Mangetti, three species of Monkey-oranges, Baobab, Bird Plum, Jackal Berry, Ushivi, Kalahari Podberry, Mobola Plum and Blue Sourplum.

Many indigenous fruits have very high nutritional value and thus provide more than just energy. For example, Baobab and Marula are particularly rich in protein and vitamins, Marula having four times more Vitamin C than oranges. Blue Sourplum fruits also contain Vitamin C in high concentrations, as well as potassium. The only species to be sold regularly in traditional markets are Monkey-oranges and dried Bird Plum fruit. Most other fruit does not remain fresh for long or is less abundant. Several tree species are being investigated as having potential for commercial production of nuts, fruit, jams and relishes, as listed in the table overleaf. There is a well-developed Marula jam industry in South Africa.

Oil from the seed kernels of Marula has long been used traditionally for cooking and cosmetic purposes. The oil is particularly stable, and thus does not oxidize as rapidly as many other oils used in cosmetics or for cooking. Both Marula oil and soap are now being sold, while products from several other species have the potential to be developed as commercial products. Many of these oils have special chemical properties that make them attractive as components in cosmetics, especially for skin and hair care and in make-up. The oils also have high nutritional values, mainly because of their high concentrations of unsaturated fatty acids. Essential oils extracted from leaves and flowers can be used as ingredients in perfumes.

Traditionally, men were not allowed to carry weapons during the Marula season because it was assumed that they would consume too much omaongo *wine and then engage in fights.*

The fruits of several trees are used for the production of juice, wine or spirits. Most are prepared for consumption at home, but some are sold sporadically at local informal markets. The main species from which beverages are produced are: Marula (juice called *oshinwa* and a wine known as *omaongo*), Baobab (spirits) Bird Plum (wine and spirits), Makalani Palm (spirits called *olambika* and a wine), Monkey-oranges (spirits), Jackal Berry (spirits and liqueur, Velvet Wild Medlars (spirits), Raisin Bushes (spirits), Buffalo Thorn (spirits) and Mangetti (spirits known as *kashipembe*). Marula has gained international fame as a component in a liqueur branded as Amarula and produced in South Africa, but Namibian Marula fruit are not used in its production. Monkey-oranges harvested in Kavango have been used to produce a liqueur which has been exported to South Africa. Other

Tree species and products being considered or investigated as having potential commercial uses. Only Marula oil and Monkey-orange liqueur has been developed to the point that it can be formally marketed.[17]

Species	Food	Beverages	Cosmetics or medicinal uses
Marula fruit and kernels	Jam	Fruit pulp/juice	Oils
Mangetti fruit and kernels		Spirits	Oils
Makalani Palm sap		Spirits	
Baobab fruit and kernels	Flavourant	Fruit juice	Oils
Blue Sourplum fruit and kernels	Fruit		Oils
Sausage Tree fruit			Cancer treatment
Mopane leaves			Perfume oils
Bird Plum fruit and kernels	Jam	Wine, spirits, liqueur	Oils
Monkey-orange fruit and kernels	Fruit	Liqueur	Oils
Jackal Berry fruit		Wine, spirits, liqueur	
Velvet Wild Medlar fruit		Liqueur	
Raisin Bush fruit		Spirits	
Buffalo Thorn fruit		Spirits	
Kalahari Podberry fruit	Fruit		
Ushivi kernels	Relish		Oils
Lekkerbreek kernels			Oils
Laventelbos leaves			Perfume oils
Silver-leaf Terminalia root bark			Anti-inflammatory agent
Commiphora species resin			Perfume fragrance

Oils extracted from Marula kernels collected in north-central Namibia are now bottled and also processed into soap for sale.

species being studied to see if they might produce beverages of commercial and export value are shown in the table above.

MEDICINAL PRODUCTS

Nearly a third (29%) of tree species in Namibia are recorded as having medicinal uses, and some are used to treat several different conditions. Almost all the uses are as traditional medicines, largely in rural households. More use is made of roots for medicines than leaves, fruits, flowers and bark. Unlike many more densely populated areas in Africa, Namibia does not have an extensive trade in medicinal tree products. The African White Protea is probably extinct in Namibia, perhaps as a result of the use of its roots for medicinal purposes. Potential commercial uses of plant products as components of modern medicines are being investigated for the roots of Silver-leaf Terminalia, as an anti-inflammatory agent in cosmetics, and Sausage Trees, as a treatment for skin cancer. About a quarter (23%) of Namibian trees are also said to have spiritual or symbolic values.

BROWSE

Trees provide many animals with much (and sometimes all) of their food and water. The focus here is on large mammals that eat leaves, fruit and pods, but it should be recalled that very large numbers of other animals (birds, small mammals, insects, etc) feed on trees as well. A total of 130 tree species have been recorded as being browsed by large mammals, this being 29% of all tree species in Namibia. Broadly speaking, large mammals can be divided into browsers that obtain all their food from woody plants – such as goats, giraffe, black rhino and kudu – and grazers. However, many grazers turn to leaves and flowers when pastures are depleted and when trees offer fresh, succulent leaves and flower buds. Browse is especially important in early summer when some trees produce fresh growth before the onset of the rains and growth of fresh grass, and during drought years.

Most large herbivores in the driest areas depend heavily on riverine woodlands growing along the ephemeral rivers. Pods of Camel Thorns and Ana Trees are particularly important sources of fodder along these rivers. No information is available on the economic value of browse for the Namibian livestock industry. Of course, goats obtain almost all their food from leaves and twigs nibbled off shrubs and smaller trees.

INDIRECT USES

Much of this chapter has dealt with benefits obtained directly from trees, largely by harvesting their wood, fruit, bark or roots. The section that follows explores less direct benefits. Some of these are obvious while others might be more surprising or less conspicuous. Of the several indirect benefits, two stand out as being far more valuable to Namibia than the others: the habitats that woodlands provide for so many other living organisms, and shade.

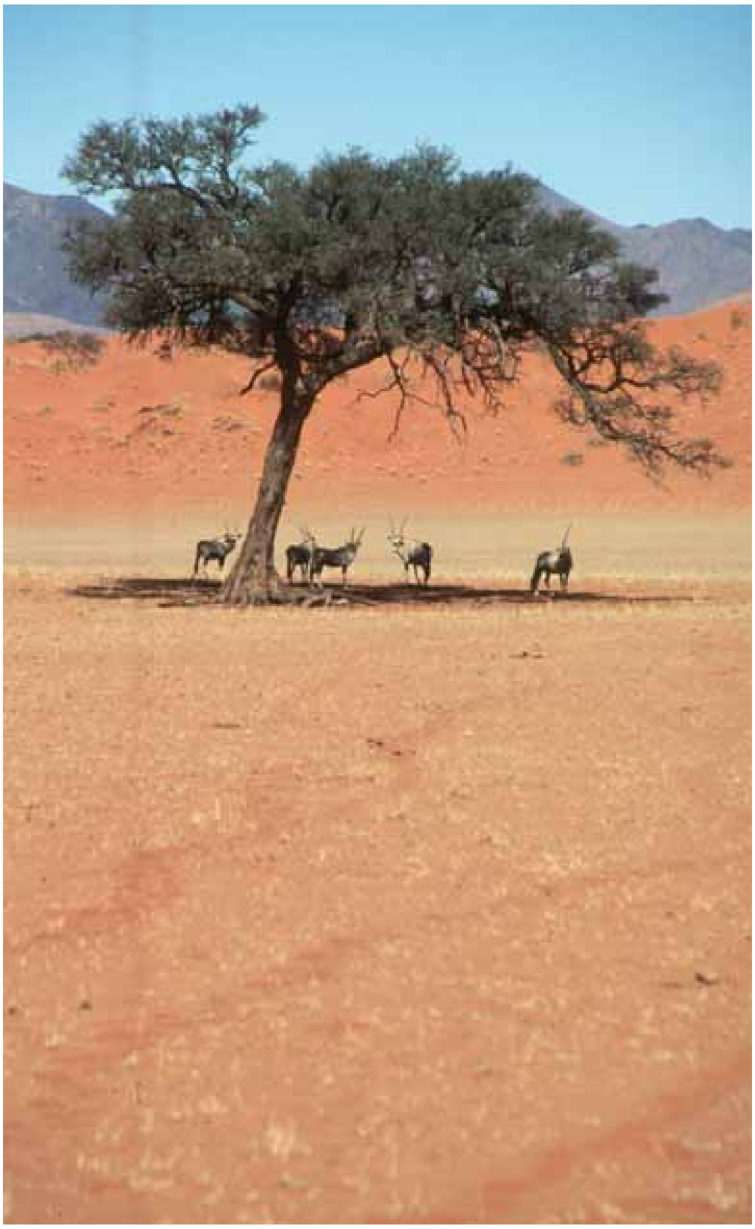
Pods of Camel Thorn and Sweet Thorn trees collected by women around Windhoek are offered for sale to livestock farmers along the road north of the city (top). Leaves and pods of trees are generally more nutritious than grass because of their high content of protein (bottom)

A habitat is a place in which organisms live: where they find water, food, places to nest, sleep or hide, for example. Quite simply, woodlands habitats provide just these kinds of resources – or services – to myriad animals and other plants. Perhaps the best way of visualizing the value of trees is to recognize that most organisms that depend on trees would simply disappear if they were removed. This is what has happened to many areas cleared for farming in northern Namibia. In modern jargon, forests and woodlands are said to be major contributors to biodiversity. The woody plants themselves add a diversity of species and then create conditions that enable diverse other species to live there as well. Birds provide a good example of this effect, and so many more bird species are found in areas with a high diversity of trees.





A small selection of tree users and uses (top left to bottom right): Namibia's famous Gobabis prawn or koringkriek; tree squirrel; Acacia silk moth from which silk now sells for about N$1,000 per kilogram; a makeshift garage mechanic; monkey-oranges; mopane worm; elephant; and sociable weaver nests.



Shade is literally a vital resource when it is hot, the air is dry and drinking water hard to find.

This is a general principle of ecology, and there are sound ecological reasons for conserving woodlands and forests, some of which are elaborated upon below. But the health and integrity of these habitats has direct socio-economic value for many Namibians as well. It is on these habitats that much of our wildlife depends. In turn, wildlife is a cornerstone of the tourism industry that employs many people and on which a sizeable part of the economy depends. Likewise, these are the habitats for many of the animals that we harvest for meat and trophies.

Shade is one of those obvious ecological resources or services that woodland habitats provide, but it is a feature worth highlighting in the context of the hot conditions that often occur in Namibia, which are often accompanied by very low humidity. In the absence of shade, many animals would either be altogether absent or would be much less productive. The cooler conditions provided by shade allow animals to use less water to cool themselves, and to expend less energy in producing metabolic water and panting. Many animals would also die if they were exposed to high temperatures for extended periods because proteins break down under conditions of extreme heat. The few animals that do not need shade all have special adaptations to keep them cool.

Shade is a major component of a whole suite of the decorative and aesthetic properties we value trees for. Indigenous woodlands and forests are attractive places, appealing to tourists and local Namibians alike. They add value to the experience of visiting game parks and provide pleasant settings for picnics or camps. Canopies of trees soften stark or harsh landscapes. Increasing numbers of people plant ornamental and shade trees in their gardens, and there is a growing demand on nurseries in rural areas to supply such trees. Exotic Neem trees are proving to be popular shade trees in north-central Namibia.

Forests and woodlands have several major effects on soils. First, roots help to stabilize the ground by holding and binding soil particles. This reduces erosion, especially on sloping ground. Second, by reducing surface flows, plants help retain rainwater in the soil, making more water available for plant growth over longer periods. This stabilizes river catchments. Third, trees help in the formation of soils. Most soil particles were originally part of rocks, and tiny rootlets help to break off rock crystals which then become soil particles. Fourth, trees add considerable quantities of nutrients to soil,

most usually in the form of compost or humus. Many trees that are legumes are so-called nitrogen fixers. Acacias are the best-known example in Namibia, but other prominent nitrogen fixers are Zambezi Teak, Burkea, Kiaat, Ana Tree and Ushivi. Bacteria living on the roots enable the trees to obtain, or fix, nitrogen from the atmosphere. Although the nitrogen is at first used by trees, much of it later finds its way into the soil through decomposition. Finally, many trees have roots that extend outwards up to seven times beyond the diameters of their crowns. Their roots thus draw in, and concentrate nutrients from surrounding areas. The effect of concentrating nutrients, together with the higher levels of soil moisture and shade under trees, creates microclimates in which other plants can grow. This is why many trees have a fairly dense growth of grasses, herbs and shrubs beneath them.

Plants require carbon dioxide during photosynthesis, the chemical process used to convert solar energy into metabolic energy for growth and reproduction. The carbon dioxide is absorbed from the atmosphere in big enough quantities that plants are said to be carbon 'sinks'. Atmospheric carbon dioxide is essentially sunk and stored in a process called carbon sequestration. Most carbon dioxide is eventually returned to the air through respiration and decomposition. The fraction that is retained is held in different places: in wood, in the bodies of animals that eat plant material, and as carbon in the soil, for example. While this has been known for many years, it is only recently that we have started to pay more attention to the value of plants as sinks. This is because of global warming, which has largely been caused by the increasing quantities of carbon dioxide produced by human activities. Carbon dioxide is one of several greenhouse gases,

The root system of a Black Thorn spreads over a large area, giving the tree access to nutrients but also helping to concentrate nutrients beneath the tree which other plants can use.

and it is thought to contribute to about 60% of global warming. Other significant greenhouse gases are methane, nitrous oxide, halocarbons, and soot particles from fires. Rising emissions of carbon dioxide and these other gases are estimated to have caused about half of the rise in global temperatures. The other half is due to a reduction of plant cover – and thus carbon sequestration – as a result of land being cleared for farming.

Carbon dioxide is absorbed in direct proportion to growth, and so areas with dense, tall plant growth are the most effective carbon sinks. Similarly, more carbon dioxide is absorbed during the summer growing period than in the dry winter months. Compared with many other places in the world, especially the tropical rainforests, Namibian trees absorb very little of all carbon dioxide surrounding the earth. But every little bit helps! Whatever the costs and disadvantages of bush encroachment (see page 112), it is likely that the additional plant biomass caused by bush thickening has led to an increase in quantities of carbon dioxide withdrawn each year from the global atmosphere. It is also possible that bush encroachment has been enhanced by the higher temperatures and greater carbon dioxide levels, both being conditions that promote growth.[18]

Finally, forests and woodlands offer options, much like investments and savings that give people more opportunities than those who have nothing to fall back on. Trees are just such investments, which will provide new kinds of foods, medicines and other benefits in the years to come. In short, the more forests and woodlands Namibia manages to preserve, the greater its options in the future.

PROMOTING BENEFITS

It is clear that forests and woodlands provide a whole package of uses and benefits, and much of this chapter has attempted to disentangle the parcel by describing the most important ones individually. Many of these benefits were only recognized and exploited during the past 15 years, and more people than before now see greater value in woodlands than simple trees. In addition, it should be clear that the healthier and more diverse the package is, the greater the range of benefits. Namibia faces two challenges: looking after the package – a topic addressed on page 98 – and getting more value out of forests and woodlands, a subject which we now address.

First, more should be done to recognize, promote and market indigenous plant products. Namibia has made good progress in these endeavours: the table on page 72 lists products from 19 tree species now being investigated for their potential in providing marketable medicines, cosmetics and food. Products from some other plants are also being developed, for example from Devil's Claw, Hoodia, Kalahari Melons and !Nara. All these developments are coordinated through the Indigenous Plant Task Team, a grouping of people and organizations working to promote supplies and demands for plant products. There are several challenges that members of this group seek to overcome. Namibia must do more to compete with others who may develop similar products. For example, Marula is being cultivated in Israel, and South Africa has already done much to market Marula products. Competing will not be easy, given the remoteness of many areas in Namibia in which useful plants can be harvested, the lack of experience in this kind of business, and the rather high costs of labour in Namibia.

Better connections between suppliers and consumers need to be created. Most potential consumers live in fairly demanding societies in Europe, North America and South Africa, far away from the suppliers in rural areas, who are often poorly educated and lack organizational systems to compete with suppliers elsewhere. Suppliers are also often ignorant of consumers' needs for high quality and reliable deliveries of raw materials that are competitively priced. Most connections between suppliers and markets are now created and run by organizations, such as the development agency CRIAA-SADC in Windhoek, but these need to be taken over by Namibian entrepreneurs and communities in the longer term.

Implied in all of this is the need to build better supply systems. One way of doing this is to culti-

vate and harvest plants growing in more controlled environments. All products now being developed are reaped from wild stocks, which are often dispersed and subject to variable growing conditions, pests and predators. Cultivation would also help increase populations of indigenous species, thus complementing (and perhaps later replacing) the current large-scale focus on growing exotic shade and fruit trees. Areas cleared for farming and now abandoned could be reforested with Marula, Bird Plum, Mangetti and other useful trees.

There is a need for more research, both to discover new uses and to broaden the range of products. Several key characteristics are needed for a product to be successful: it should have a long shelf life, be harvested easily, have characteristics that are exotic to consumers, high value, and a competitive advantage. These are not easy features to find, and so every effort should be made to make the search urgent and effective.

Several other aspects need to be enhanced in the quest to profit from indigenous plant products. Markets for the products need to be cultivated through aggressive advertising, negotiation and promotion. The maximum possible value should be added before products are exported, for example through local processing and packaging. Suppliers must be given appropriate tenure and ownership – and thus security – over the areas in which they harvest. Likewise, policies should encourage the harvesting and sale of indigenous plants, of course within sustainable limits. Efforts should be made to ease barriers to exports from Namibia and imports into other countries. Appropriate certification for plant products should be obtained, both to guarantee the quality to customers and to promote the special or unusual qualities of the plants. At least three different kinds of certification are now available: Forest Stewardship Council, Organic, and Fair Trade Certificates.

While more focus on individual plant products is necessary, there is also a need to broaden our overall perspectives on the values of forests and woodlands. Most people now promote direct uses of plants, but many of the indirect values are perhaps more important and profitable. Substantial income can be generated quickly, as has been shown in the example of conservancies (see page 96). Tourism and wildlife have been the main money-spinners for conservancies and, as indirect products of woodland habitats, they are high-value, non-timber forest commodities. High returns are also likely to encourage communities to manage woodlands more effectively than smaller incomes obtained, for example, from selling a few poles or bundles of firewood.

This is not to argue one resource against another, but the suite of resources and benefits inherent in woodlands should be widened beyond that which is usually granted by plant ecologists, botanists and foresters. People should benefit from all timber and non-timber forest products, selecting those in each patch of woodland that provide the greatest returns. These might be timber in some areas, elsewhere they may be honey, medicines, thatching grass or grazing. In other areas they will be wildlife to hunt, sell and attract tourists. And in places with few of these kinds of resources, it will be the whole environment: the rugged landscapes, rare and interesting plants and animals, scenery and solitude that help make the world a better place.

Finally, the implementation of policies and practices should be encouraged to limit the use of raw wood for fuel, building and fencing. This might counter the idea that the more resources are used, the more they are protected. However, these conservation measures probably only apply to trees that have very high values, for instance the Marula, Bird Plum and Mangetti trees that are protected and propagated because of their valuable fruit. One way to reduce the use of wood is to raise prices, which some people argue are too cheap in Namibia. This would also help stimulate the use of alternatives. Almost all charcoal, which is now harvested from unwelcome invader bush, is exported. This industry could surely expand to provide charcoal to low-income settlements in urban areas. The large number of people now using paraffin as a cooking fuel in squatter townships north of Windhoek shows that new technologies and fuels can be adopted. The use of paraffin for cooking is, itself, rather limited to these townships and a programme to encourage its use elsewhere as an alternative to firewood is to be recommended.

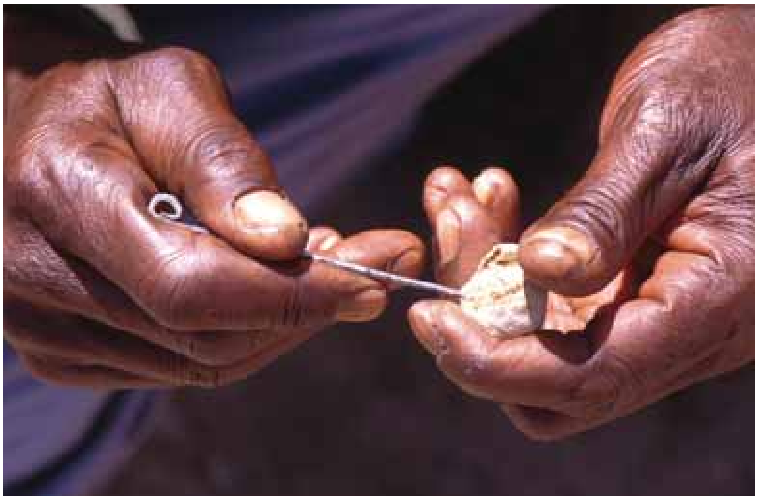
THE ECONOMICS OF WOODLANDS

Natural resources have economic values which derive from the kinds of uses described earlier. Values for resources used directly, such as for fuel and construction, are easier to estimate than those with indirect benefits, for example, shade and the provision of habitats for wildlife. However, even values for direct uses have not been well studied in Namibia, and much of the information that follows is thus preliminary. The Environmental Economics Unit of the Directorate of Environmental Affairs developed the estimates for this book using standard resource accounting methods.[19] The Unit is responsible for the compilation of accounts for natural assets (such as fish, forests, wildlife, water and minerals) that are consistent with conventional national economic accounts. These resources are not generally included in standard accounts since they are not man-made or owned. A consequence of their exclusion is that sound planning for sustainable development is not taken seriously.

What then is the value of woodlands and forests to the Namibian economy each year? Accounting figures in the table below begin to answer this by providing estimates for the use of fuel wood, poles for housing and fencing, and the use of such non-timber forest products (NTFPs) as craft, foods, medicines and cosmetics, and grass for thatch. An important point is that these are partial accounts because they do not include values for other values, such as livestock grazing and browse, shade, or the use of wild fauna in woodlands and savannas.

Wood fuel, construction and NTFP products directly add a total of just over N$1 billion to the national economy each year. The highest values come from wood fuel (N$610 million), followed by NTFPs (N$283 million) and poles for housing and fencing (N$157 million). Regions contributing the greatest proportions to these figures are Omusati, Ohangwena, Kavango, Oshikoto and Oshana because they have the greatest numbers of rural households that make most use of wood for fuel and construction.

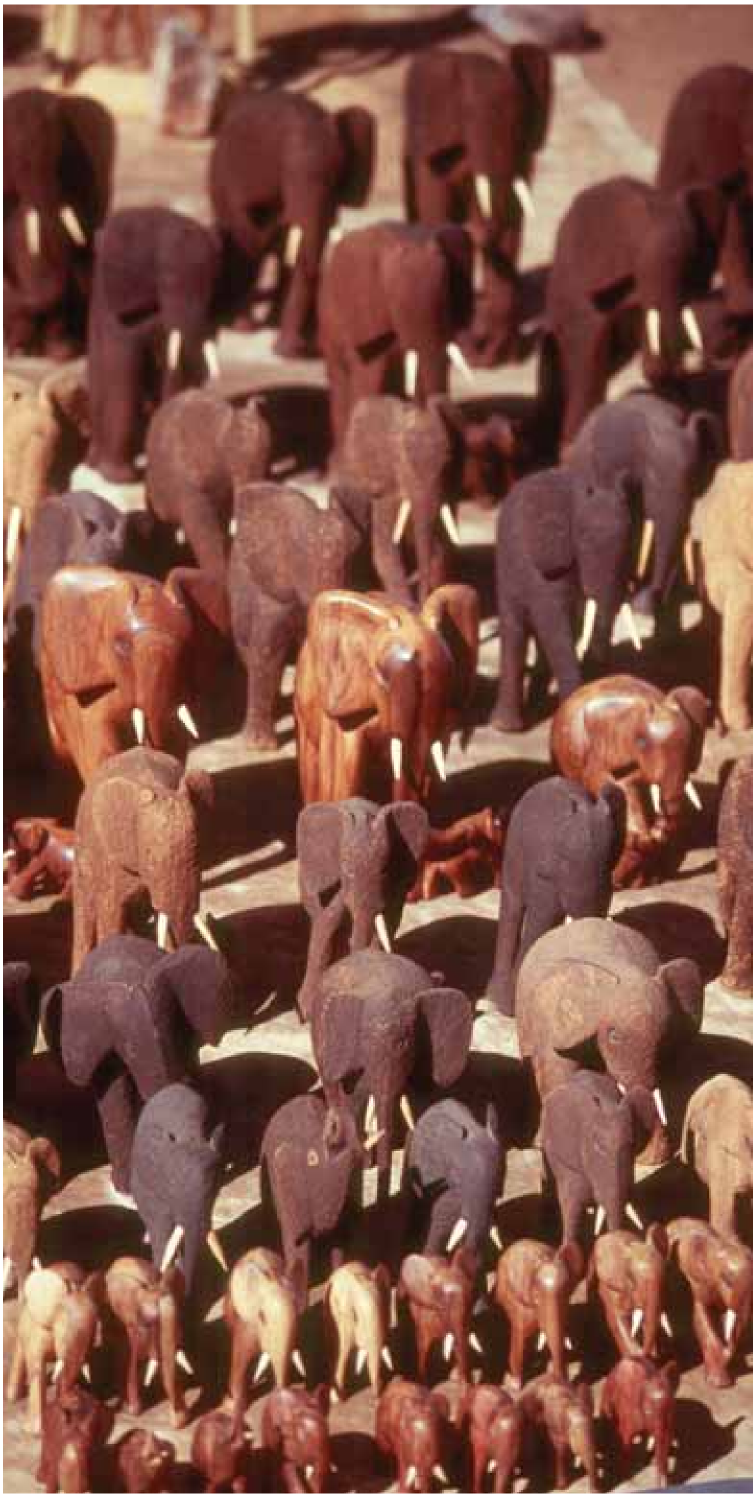
The direct contribution of about N$1 billion represents approximately 3% of the gross national product (GNP), a figure comparable to 4.6% for agriculture, 5% for fishing and some on



The use of fuel wood (previous page) and harvesting of non-timber forest products, such as Marula nuts (top), directly and respectively contribute about N$600 and N$300 million to the national economy each year.

Estimated annual contributions of the use of fuel wood, construction and fencing poles and non-timber forest products (NTFPs) to the Namibian economy in 2004.

	Fuel wood	Building and fencing poles	Non-timber forest products (NTFPs)	Total
Direct contribution to national product	$609,416,700	$157,440,900	$282,706,100	$1,049,563,800
Direct and indirect contribution to national economy	$965,990,300	$263,580,900	$619,459,000	$1,849,030,200



board fish processing, 6.8% for mining and 6% for tourism.[20] However, this direct contribution creates further activity in the broader economy through indirect multiplier and linkage effects.[21] For example, a woodcutting activity generates added value through income received for its labour and capital. The enterprise might also use inputs such as transport, and this generates further value in the transport sector, which might, in turn, buy inputs from other sectors, such as fuel, generating further value, and so on. These additional linkage effects amount to about N$0.8 for each N$1 generated directly. As a result, the total impact of fuel wood, construction and NTFPs rises to about N$1.8 billion in 2004, shown as the total direct and indirect contribution in the table. These figures are impressive but would be very much higher if we could add such other values as those derived from pollination, the effects of carbon sinks, contributions to animal and plant diversity, nutrient cycling, tourism, and livestock farming. Forests and woodlands are indeed rich assets.

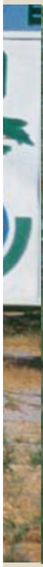
One of the best ways to conserve woodlands and forests is to add as much value as possible to the resources they provide. Indeed, elephants are now much more abundant than before (see page 116) because so many people appreciate their commercial and aesthetic value.

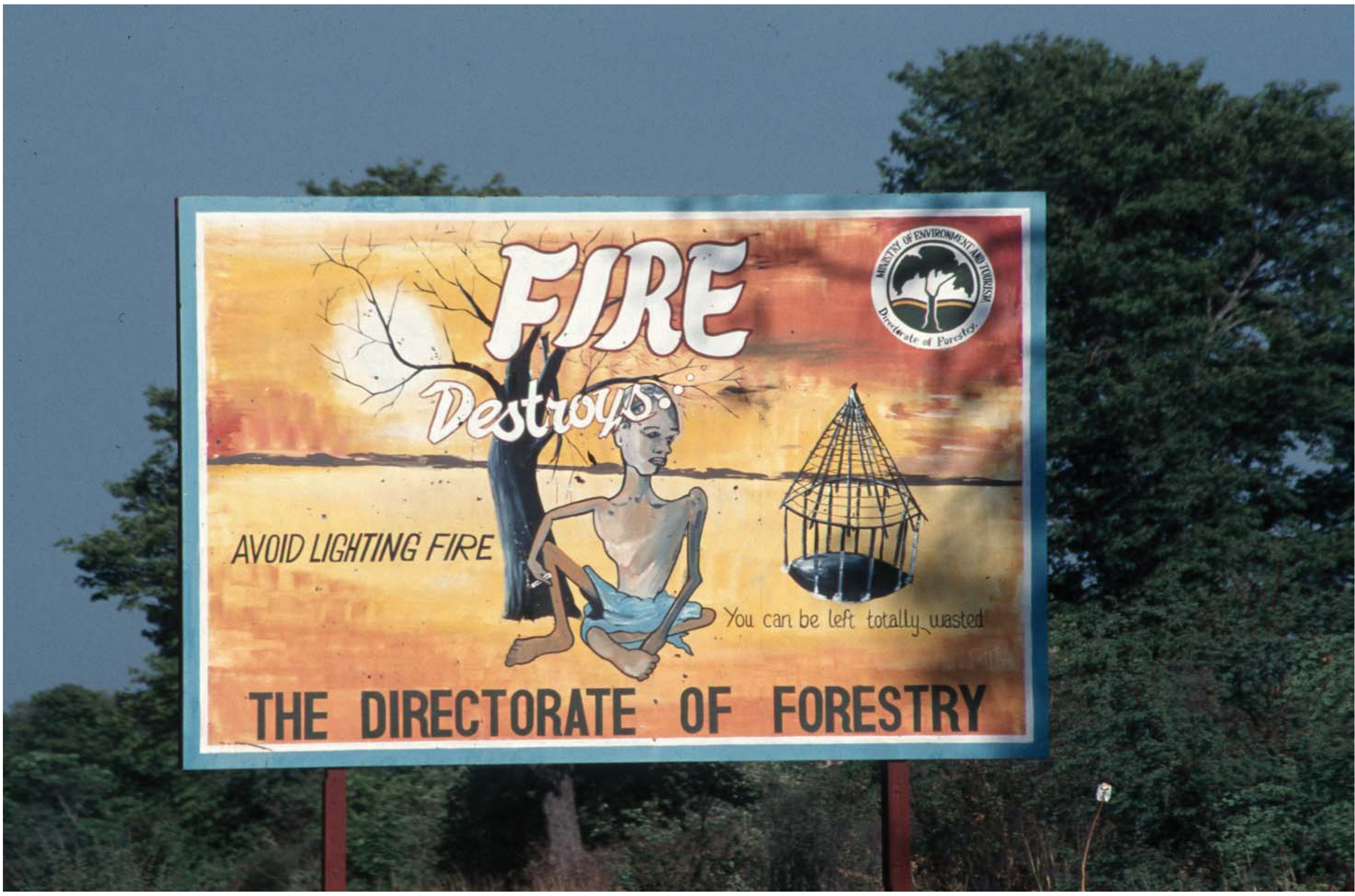
Key points:

- The many benefits of forests and woodlands are broadly divided into direct (fuel wood, timber, food *et cetera*) and indirect uses (shade, wildlife habitats, and the absorption of carbon dioxide, for example).
- More wood is used for fuel than for any other purpose, most of it for domestic cooking, and collected locally from dead trees close to rural homes.
- The use of wood for the construction of houses has declined substantially in recent decades, as increasing numbers of people have built homes from brick and cement, particularly in towns.
- The economic value of the woodcraft has not been assessed, but it is likely to provide amongst the highest returns of all wood uses in Namibia.
- Of all tree species in Namibia, 35% have been recorded as being used for food, 29% have medicinal uses, and 29% are known to be browsed by large mammals.
- Work is underway to develop medicines, foods, cosmetics and beverages from 19 tree species as potential commercial products.
- Among the most important indirect benefits of forests and woodlands are shade, habitats for wildlife, tourism, the formation and nutrification of soils, and absorption of carbon dioxide.
- There is a need to broaden perspectives on the value or woodland resources, especially in developing more commercial values and the importance of indirect benefits. The more Namibia does to preserve forests and woodlands, the greater its options in the years to come.


TREES FOR THE WO
ONDANGWA NURSERY ONDJONDJO
TEL/FAX 065 240939
E-MAIL.TREESOND@IAFRICA.COM.NA

CHANGING MANAGEMENT: conservation for use





Educational programmes, including many billboards placed along major roads in the north-east Namibia, have been used to alert Namibians to the dangers of bush fires.

The overall concept of forestry has changed a good deal in recent years, especially in developing countries such as Namibia. New policies and approaches are being adopted, and management processes are being adjusted in two main directions. The first is to move away from a concentration on silviculture, which is largely focussed on growing trees to yield poles or timber for furniture and building, to practices that give prominence to indigenous woodland habitats. Less emphasis is placed on *conventional forestry* and more on *environmental management.*

The second move is to place the management of forests and woodlands in the hands of the public, particularly in communal areas (see page 15). More broadly, this second approach seeks to promote the wise use, management and conservation of resources by people who use them. In this sense, conservation is designed to protect natural resources *for* use, rather than *from* use. This forms part of a wider trend termed community-based natural resource management, now often known as CBNRM. Other kinds of natural resources can be managed using CBNRM and much has been done to promote CBNRM for the management of rural water supplies and wildlife in Namibia. The key principles of CBNRM are that ownership and control over natural resources should lie with local people who have traditional rights to those resources, and that benefits from the use of natural resources should go to those people. These benefits should create incentives so that people take responsibility for managing the resources in a sustainable manner. CBNRM also often brings new sets of natural resources into production and the market place. Foresters introduced CBNRM concepts to woodland management as far back as the late 1970s, calling this approach community, social or participatory forestry.

Three factors stimulated the changes in Namibia. The first was the realization that conventional silviculture was at best a weak enterprise. Indigenous timber resources were clearly limited (see page 49), and since little information was available on what volumes could be cut on a sustainable basis, it seemed prudent not to harvest them. Also, it was clear that yields from plantations were so low that the prospects of developing productive plantations were poor (see page 54). In essence, alternative approaches to forestry were desirable.

Second, was the need to seek ways for forestry to help rural development, reduce poverty and redress imbalances caused by previous policies of racial segregation and discrimination. On the latter score, people were not allowed to own land in the so-called homelands and therefore did not have secure rights over resources in those areas. Although land ownership in communal areas is still not allowed, giving rural people rights to own and manage woodland resources through CBNRM practices was deemed an important step towards improving socio-economic conditions.

Third, came new thinking and approaches to forestry strongly influenced by foreign experience and technical advice, in particular the concept of community forestry that had been advocated and adopted by such organizations as the Food and Agriculture Organization (FAO). Since the first development projects started in 1991, there has been a succession of projects, programmes and advisors, many of which directly or indirectly helped encourage the changes.

The period of development really got going in the mid-1990s in Namibia, and much of the change can be grouped in three processes: (a) development of policy, strategy and legislation; (b) the institutional and staff development of the Directorate of Forestry, and (c) the introduction of community forestry. It was also in the mid-1990's, specifically in 1994, that the Directorate of Forestry joined the Ministry of Environment & Tourism after being part of the Ministry of Agriculture, Water & Rural Development. As this book was being completed, the government announced that the Directorate would move back to what would now be called the Ministry of Agriculture, Water and Forestry. This was to be effective from the 21st of March 2005.

PLANNING NEW SYSTEMS OF MANAGEMENT

The earliest policies were formulated in the *Namibia 1992 Forest Policy Statement*. Much of the emphasis in this document was on wood products, perhaps with too much optimism on how much wood could realistically be obtained from indigenous woodlands and plantations. But the policy also laid the basis for legislative control of forest products and land uses, the need for forestry to contribute to national and rural development, and the role of forestry in contributing to the maintenance of biodiversity.

The Directorate of Forestry released a second guiding document in 1996 in the form of *Namibia Forestry Strategic Plan: forest biodiversity for present and future generations*. It was this document that set the scene for the involvement of rural communities in forest management and the development of community forests. The *Strategic Plan* also introduced the need for Namibia to help limit climate change by stressing the importance of its woodlands as carbon sinks (see page 78).

A third major policy document was compiled and released in 2001 as the *Development Forestry Policy for Namibia*. It declared the mission of the Directorate for Forestry "to practise and promote the sustainable and participatory management of forest resources and other woody vegetation, and to enhance socio-economic development and environmental stability". It also moved towards actual implementation by declaring nine strategic objectives:

1. To implement forest policy and legislation, and to educate the public on these key documents.
2. To institutionalise the culture of strategic and forest management planning in the sector.
3. To implement the strategy of environmental forestry.

4. To implement the strategy for community involvement in forestry in the whole country.
5. To uphold the principles and practices of forest protection or conservation for national and global benefits.
6. To promote and implement afforestation and reforestation programmes.
7. To conduct forest research and provide information for forest management.
8. To institute a system for human resources development and organizational effectiveness.
9. To provide baseline data on, and promote forest products and forest-based industries.

The final stage in the phase of policy development also came in 2001 when the *Forest Act of 2001* was promulgated. The Act requires the parent Ministry and Directorate of Forestry to embark on several new activities. For example, the Minister is to appoint the Forestry Council to provide overall guidance on forestry policy and management. Five kinds of classified forest areas may be declared for purposes of conservation and management: State Forests, Regional Forests, Community Forests, Forest Management Areas, and Fire Management Areas. The Act stipulates that the Directorate has a management plan for every classified forest area. Interestingly, through its interpretation of natural resources to be used by community forests (see page 93) and the requirement that an inventory be maintained for every state, regional and community forest, the Act moves the concept of forest resources into a broad realm. Thus, each inventory must contain a record of the type and quantity of forest produce, which is defined as "anything which grows or is naturally found in a forest" and includes "any living organism or product of it" and "any inanimate object of mineral, historical, anthropological or cultural value".

THE DIRECTORATE OF FORESTRY

Although formal government forestry began some 120 years ago when the German government issued the first regulations to control the cutting of trees in 1894 (see page 16), it remained a tiny sector. By the time Namibia became independent in 1990, there was just a handful of foresters employed in different departments. Much has been done since then to develop the Directorate of Forestry into a very large organisation. At the end of 2004, its staff establishment consisted of 646 posts, of which 555 or 86% of positions were filled. The majority of posts are for unskilled work hands, labourers, forest guards and watchmen. Thirty-eight positions are for professional staff having a degree, 23 of these posts being filled at the end of 2004. Sixty-five of another 74 technical posts requiring a diploma in forestry or a related technical field were filled. One of the main achievements of the Namibia-Finland Forestry Programme (NFFP) has been to fund the training of many Namibians as foresters, both within the Directorate of Forestry and at Ogongo Agricultural College where most people study to obtain forestry diplomas. Other donors to have funded training include Australia, Britain, Canada and Luxembourg. As a result, the Directorate is very well staffed with qualified Namibians. In total, the NFFP sponsored the studies of five MSc, 11 BSc, three MBA, one MPPA, and 32 Forestry Diploma students between 2001 and 2004. Numerous other students have been funded to attend shorter, in-service courses.

The Director has two Deputy Directors in charge of Divisions of Forest Research and Forest Management. They and other head office staff are based in Windhoek, while most Forest Research staff work at research stations in Okahandja, Walvis Bay, Kanovlei and Hamoye, and for the National Remote Sensing Centre and National Forest Inventory in Windhoek. Most staff in the Forest Management division work at three regional offices, 12 district offices, 15 forest stations and 34 nurseries across Namibia, which is split into three regional sub-divisions: North-east, North-west and South Central (Figure 23). Each region is managed from a regional office, respectively at Rundu, Ongwediva and Windhoek. To these regional centres are attached district offices and forest stations. The Forest Management Division has a fourth sub-division responsible for Extension and Training.

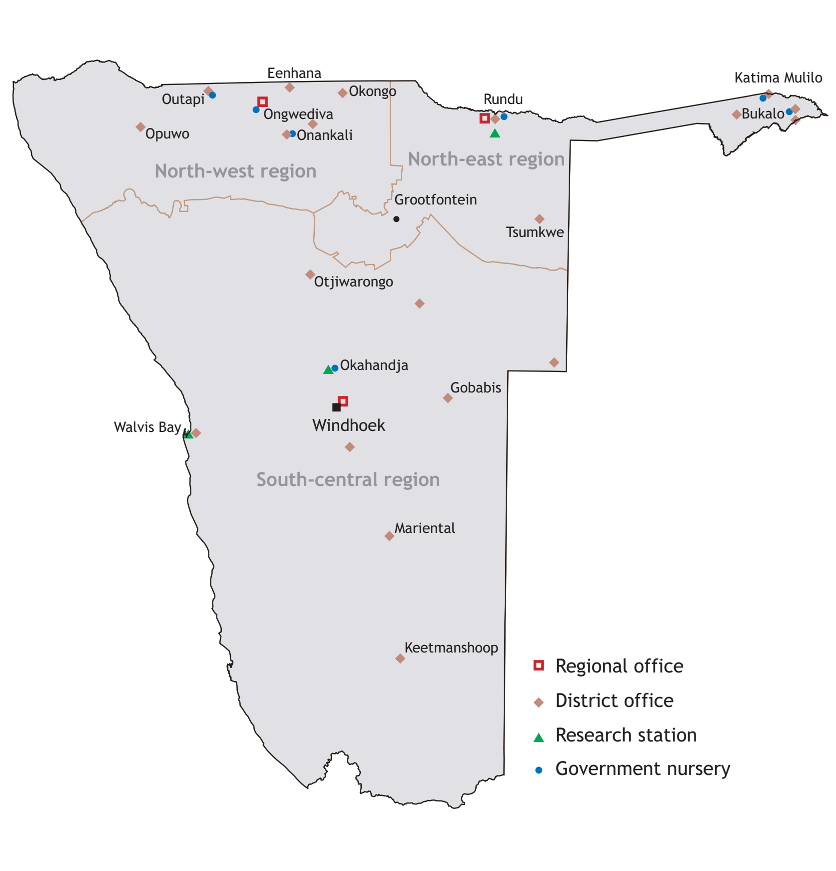


Figure 23.
The three regions in terms of which forestry is administered in Namibia, and the regional offices, district offices, research stations and nurseries.

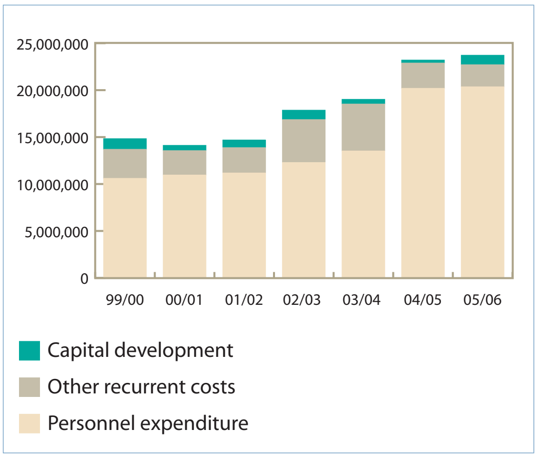


Figure 24.
Expenditure on forestry has increased rapidly between the 1999/2000 and 2005/20006 budget years. Most funds are now allocated to remuneration, leaving less available for other recurrent costs or capital developments.

The operational budget for forestry amounted to N$23,727,000 in the 2005/2006 financial year, having risen from N$14,839,000 in 1999/2000. Personnel expenditures rose from 72% of the budget in 1999/2000 to 86% in 2005/2006. Over the same period, other revenue and capital spending dropped respectively from 21 and 8% to 10 and 4% of the total forestry budget (Figure 24).

Over the past 10 years, much of the Directorate's work has been concentrated around the following activities:

Law enforcement Permits have been required for many years for the harvesting, transportation and marketing of wood products, including charcoal. The essence of the control system is that permits are needed whenever wood products are to be sold or transported in bulk. The only wood products exempt from the permit system are those used for domestic purposes in small quantities (filling less than the back of a light delivery vehicle or *bakkie*). In addition, the Directorate issues export permits for charcoal and transit permits for Angolan and Zambian timber to be exported en route to markets elsewhere, mainly in South Africa. A total of 9,479 permits was issued in 2003 for the harvesting, transport and marketing of wood products.[1] The Forestry Act of 2001 describes a great many legal provisions for the use and protection of woodlands and wood products, but specific regulations have yet to be gazetted for these controls.

Research The most important research in recent years has been the compilation of 31 forest inventories since 1996. Five inventories were for regions (Caprivi, Omusati, Oshana, Oshikoto and Otjozondjupa) while the others covered selected forest areas, many of which are planned to become community forests. The principal aim of the inventories was to provide estimates of woody biomass in these areas, especially for species of potential commercial value. Some of the results of this work are presented in the section on woody biomass (see page 49). Several studies have been started on growth (mainly on Mopane and Eucalypts) and propagation (Kiaat and fruit trees), but the results of most of these projects have yet to be finalised. An exception is the work on growth rings (see page 38).[2] Likewise the results of several studies conducted for degree purposes by staff of the Directorate of Forestry await publication. Most plantations were really established as experiments to investigate their viability, sometimes using different seed stocks, but maintenance of most of these trials stopped during the 1990s.[3]

Fire management The main response of the Directorate of Forestry to the problem of widespread and frequent bush fires (see page 107) has been to encourage the rural public in communal areas to prevent and control fires. Much of this work has been led and funded by the Namibia Finland Forestry Programme (NFFP). Fire Management Units in select villages have been established, members of the units being trained and given basic equipment to fight fires. Community members have also been paid to clear firebreaks, and a total of 2,118 kilometres of firebreaks were cleared in 2003. The Directorate, NFFP and the German-funded Community Forestry in North-east Namibia (CFNEN) projects paid for the clearing. In addition, posters, billboards and theatre plays have been produced to create awareness about fire hazards.

Farm or agro-forestry Even though the Directorate of Forestry left the Ministry of Agriculture, Water & Rural Development in 1994, it continued to play a major role in promoting horticulture (this function is likely to escalate now that the Directorate has re-joined the Ministry of Agriculture, Water and Forestry). The whole programme is based on Namibia's goal of improving rural livelihoods and the country's food security. Approximately 60,000 seedlings were distributed to the public and schools from 34 nurseries in 2003. Many of these were sold, earning a total of about N$280,000 in that year.[4] While most seedlings are fruit trees, large numbers of Eucalyptus, shade and ornamental trees were also germinated and distributed. Few indigenous trees are produced. The CFNEN project is also promoting the development of gardens for fruit and vegetables and private nurseries. By 2007, it is intended that about 150 fruit and vegetable gardens and eight private nurseries be established. Average potential profits for each garden are estimated to be N$30,000/year after five years, while each tree nursery could earn a profit of N$100,000/year after seven years of development.[5]

Community forestry The development of community forestry, as described in detail below, has perhaps represented the biggest change in forestry policy and practice. Most activities have been supported by the NFFP, CFNEN and Danish Community Forestry and Extension Development Project. The first Community Forestry Officer (CFO) was appointed as a staff member of the Directorate in 2004.

Education Activities to promote the value of trees are largely directed at schools, to which seedlings are donated to encourage the cultivation of trees. Competitions between schools are run annually, those schools having developed the best gardens and orchards being rewarded during ceremonies held on Arbor Day each year. The Directorate of Forestry has also promoted the production and distribution of posters to publicize a "Tree of the year" each Arbor Day. Other activities to promote awareness of trees and woodlands have been held during annual Environment Days.

These are now the main activities of the Directorate of Forestry. Implementing provisions of the *Forest Act of 2001* and the *Development Forestry Policy for Namibia of 2001* will, however, require the organisation to make considerable structural and positional changes. The shift of the Directorate to the new Ministry of Agriculture, Water and Forestry will bring about other changes. The point was made earlier that most of the changes are embodied in the idea of moving from *commercial forestry* to *environmental management*. The change also seeks to develop rural economies by giving people ownership of natural resources, and to increase yields of both wood and other commodities. To align the Directorate with these new approaches, proposals have been made to reorganise it around the following five programme areas. The proposals also take into account that some functions may become the responsibility of the 13 regional governments:

Policy, planning, regulation, monitoring and information are core functions of the Directorate to be implemented from the central head office. An ambitious range of indicators has been compiled to monitor performance of the forestry sector, and some of the indicators are to be provided through management information systems that must be designed and built.

Community Based Forest Management This is the programme for continued development and promotion of community forests. It is possible that regional governments will take responsibility for these areas, perhaps in collaboration with conservancies and the CBNRM sub-division of the Ministry of Environment & Tourism.

Tree planting and farm forestry The principal intention is to produce seedlings and support tree planting on both freehold and communal farmland. The activities are likely to be emphasized by the Ministry of Agriculture, Water and Forestry and run on a decentralized basis by the regional governments.

Forest conservation and protection Some functions will be retained at a central level, especially those relating to state forests, while issues concerned with regional and community forests, and fire management could be the responsibility of the 13 regions.

The Directorate of Forestry runs 34 nurseries across the country. Fruit, shade, timber and ornamental trees are propagated for sale to the public and for distribution to schools. Demands for trees in rural areas of northern Namibia have risen in recent years.

Forestry research Although studies should be relevant to regional concerns, research would be a core activity run from research stations operating under the guidance of head office.

Namibian forestry has enjoyed considerable technical and financial assistance from foreign sources over the years. The Finnish Government has provided more support, and over a longer period, than any other foreign source. The first phase of support began in 1991, while the fourth and final phase ended in April 2005. Management, institutional, policy and capacity development have been the major foci of Finnish support, both to the Directorate of Forestry and the Ogongo Agricultural College. Additional assistance has been given to research (largely through the development and implementation of forest inventories), the provision of buildings and vehicles, fire management, and community forest development.

FOREIGN ASSISTANCE PROJECTS TO THE FORESTRY SECTOR IN NAMIBIA SINCE 1991

Project	Donor	Budget N$	Period
National Remote Sensing Centre	Denmark	3,000,000	1993 - 1996
Vegetation mapping	Sweden	4,721,000	1993 - 1996
Public Sector Forestry Capacity Building	Finland	4,100,000	1991 - 1996
National forest inventory	Finland	3,300,000	1995 - 1996
Forest fire control	Finland	900,000	1996
Forest research and development	Britain	3,510,000	1994 - 1997
Kavango forest support	Luxembourg	1,692,000	1994 - 1997
Support to forestry sector	Australia	1,500,000	1995 - 1997
Community Forestry and Extension Development Project	Denmark	6,765,000	1997 - 1999
Volunteer services to forestry	Germany	1,050,000	1996 - 1998
Indigenous fruit tree promotion	FAO	190,000	2001 - 2003
Namibia-Finland Forestry Programme Phase I	Finland	50,480,000	1997 - 2001
Namibia-Finland Forestry Programme Phase II	Finland	45,678,000	2001 - 2005
Community Forestry in North-Eastern Namibia	Germany	22,864,000	2004 - 2007
Support to National Forest Programmes	FAO	382,000	2003 - 2005
National Tree Seed Centre (SADC programme)	Canada	2,800,000	1994 - 2000
Sustainable Management of Indigenous Forests with Community Participation (SADC programme)	Germany	4,078,000	1998 - 2006
Improvement and Strengthening of Forestry Colleges in the SADC Region (SADC programme)	Finland	1,935,000	1989 – 2002
Improvement and Strengthening of Forestry Research Institutions in the SADC Region (SADC programme)	Finland	640,000	1990 – 1992
TOTAL		159,585,000	

Donor funds converted to Namibian dollars using exchange rates of N$8/Euro and N$6 per US$. The table does not include projects which provided the services of volunteers from Sweden and Germany. Information on a project supported by the Netherlands was not available. The four projects listed last in the table formed part of regional projects for the Southern African Development Community (SADC); the figures are those allocated to Namibia. The Directorate of Forestry provided counterpart support to most projects.

The other major donor to the forestry sector is the German government. Its current project (Community Forestry in North-Eastern Namibia – CFEN) began with a pilot study in 2001 to assess the potential for community forestry development. Formal implementation began in 2003 and the project should last until 2011. The development of community forests is the major goal of this project, which aims at having 28 such areas gazetted in its first four years. This target is needed to demonstrate progress and maintain funding for the second four-year phase. The project also helps communities to establish fruit and vegetable gardens and privately-run nurseries.

Other assistance has come from a variety of agencies and countries. Research activities and projects have been supported by the British, Danish, Canadian, Dutch and Australian governments; mapping and remote sensing work has been funded by Sweden, Finland and Denmark; a beekeeping project received assistance from Britain; support to formulate forestry legislation came from the Food & Agriculture Organization (FAO), which has also helped fund a project aimed at domesticating indigenous fruit. Support for various activities in Kavango and north-central Namibia was provided by Luxembourg and Denmark, respectively.

Various donors have given financial and technical assistance to different components of a broad programme to develop the commercial value of indigenous plants. The programme is co-ordinated by the Indigenous Plant Task Force of what was the Ministry of Agriculture, Water & Rural Development, and brings together many people and organizations involved in testing and developing the potential of plant products. That Ministry has also funded components of this work. At the end of 2004, a total of 34 potential products were being considered tested and promoted (page 72).

COMMUNITY FORESTRY

Since the publication of the *Namibia Forestry Strategic Plan: forest biodiversity for present and future generations* in 1996, the development of community forestry has been centred very much on community forests, but three other programmes also contribute to the overall concept of community involvement and benefits. The first is farm forestry which promotes the planting of fruit and shade trees by rural people, and generally stimulates people to attach greater value to trees. A second programme encourages rural people in communal areas to manage and control bush fires, mainly by organising villagers into fire management and control units. Thirdly, many projects are working to develop non-timber forest products, especially those that can be harvested and marketed by poorer rural communities. These are the products mentioned above.

COMMUNITY FORESTS AS SHOWN IN FIGURE 25 AND APPROVED IN EARLY 2005

Region	Name	Size in hectares	Number of beneficiaries
Caprivi	Bukalo	5,341	4,000
Caprivi	Kwandu*	19,936	4,300
Caprivi	Lubuta	17,003	1,800
Caprivi	Masida	19,408	1,200
Caprivi	Sikanjabuka	4,186	850
Kavango	Hans Kanyinga	27,348	1,300
Kavango	Mbeyo	41,331	3,000
Kavango	Ncamagoro	25,687	3,500
Kavango	Ncaute	11,949	500
Kavango	Ncumcara	13,198	3,000
Ohangwena	Okongo	76,758	1,100
Omusati	Uukolonkadhi*	85,042	11,100
Otjozondjupa	M'Kata*	47,534	600
TOTAL		394,721	36,250

* *These community forests are also wholly or largely conservancies (see below).*

Active work to develop community forests began in 1995, and the Minister of Environment and Tourism approved the first 13 community forests early in 2005. These community forests are listed in the table above, together with another 16 areas being developed.

All community forests are in the northern communal areas of Namibia (Figure 25). Together they cover an area of almost 3,950 square kilometres and approximately 36,250 people living within them will share the benefits of these areas.

In terms of the Forest Act of 2001, the Minister of Environment and Tourism (now the Minister of Agriculture, Water and Forestry) proclaims each gazetted area to be administered for the purpose of a community forest. The Act stipulates that people living in a community forest area then have the rights "to manage and use forest produce and other natural resources of the forest, to graze animals and to authorize others to exercise those rights, and to collect and retain fees and impose conditions for the use of the forest produce or natural resources".

A pit-saw in operation, in this case mounted on stilts instead of in a pit in the ground. Cutting timber in this way is not easy, especially if straight planks with an even thickness are to be produced.

It is also clear from the Act that the beneficiaries are those people who have traditional rights over areas included in community forests.

The key points are management and use by local people. Management is led by a management committee with which the Minister enters into an agreement as part of the gazetting process. The agreement stipulates that the area be managed according to a management plan, and in the interests of those having rights to the area. It is also expected that there should be close linkages between the committee and local traditional authority whose consent is required before a community forest can be approved.

The agreement with the Minister of Agriculture, Water and Forestry is really a contract that the community forest be managed according to specific guidelines. Management practices focus on natural resources, including granting permissions and permits for the use of woodland products, the control of fires by clearing firebreaks, approving the burning of any areas (to clear new fields or stimulate new grass growth, for instance) and extinguishing wild fires. In addition to empowering communities, local management also reduces the government's responsibilities, usually filling a management vacuum because most community forest areas are remote and little has been done to manage their natural resources.

Perhaps the most important innovation brought about by community forests change is that now people have *exclusive commercial rights* over resources rather than mere *communal rights* to use resources that belong to the state. Exclusivity is of special importance in communal areas because it provides for control over natural resources and, indirectly, security of tenure over land. There are no formal deeds to land in communal areas, and there is a great risk of wealthy, influential individuals occupying large tracts of land and claiming all their resources. By 2001, at least a quarter of all communal land had already been occupied for the exclusive use of wealthy, large-scale farmers.[6]

Other than empowering people to manage and own woodland resources, the other major goal is to provide greater material and financial benefits. The management committee will decide how income from natural resources in a community forest is to be used, guided by the broad intention that funds be distributed and used equitably. Thus, income will go into a community fund to pay for developments (for example, new boreholes or school facilities), maintenance (fuel and repairs for water pumps, for instance) and operational expenses, including salaries for community forest staff.

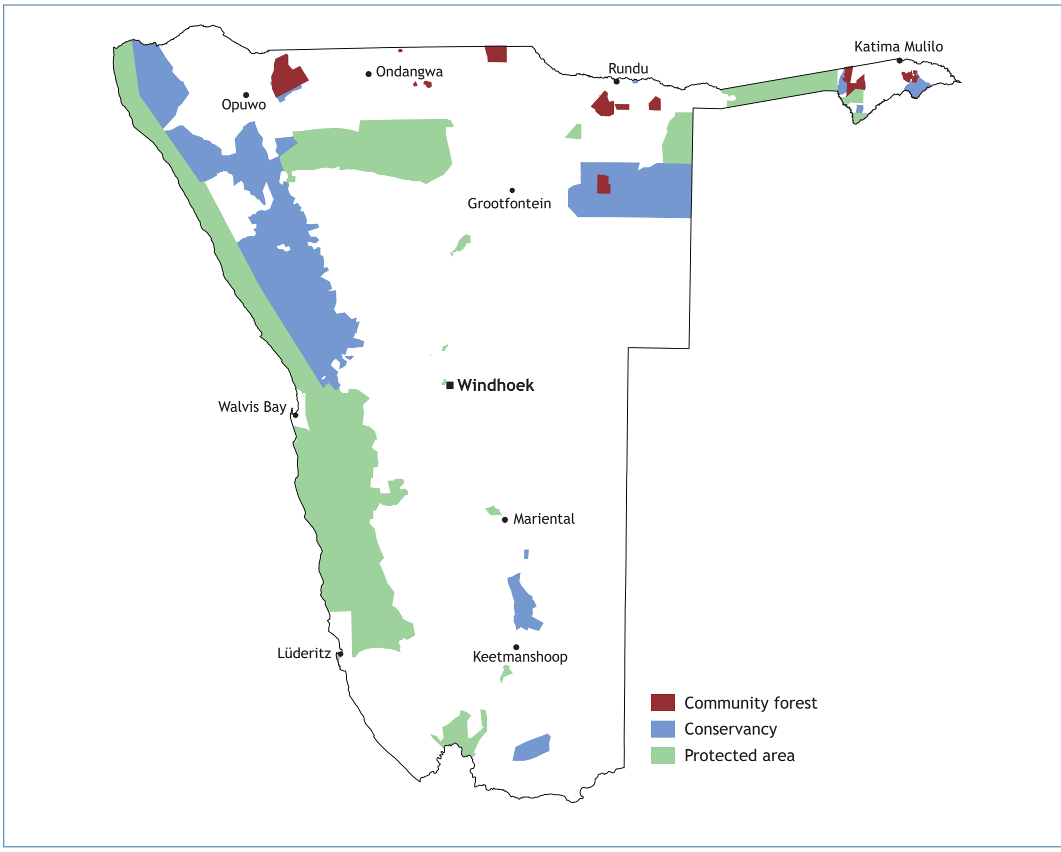
North-eastern Namibia is littered with large, dead trees killed by fire. Community forest members are now beginning to harvest timber from the carcasses.

The only study (to our knowledge) to estimate potential income was conducted in Kavango and Caprivi. The investigation found that most income is expected to come from the sales of timber, wood for craft production, poles for construction, firewood, grazing, honey, wild fruits, the clearing of firebreaks, permits and grazing fees (listed in order of value).[7] It is expected that produce will be harvested and sold by community members or sold to outsiders who wish to harvest for themselves. For example, merchants who sell firewood in towns may collect wood in a community forest. They would be charged for the wood and for permits to transport and sell the firewood. Permit sales will also give communities further authority and ownership over their resources.

This study suggested that annual profits for each community forest could rise to N$200,000 - N$250,000 after about eight years of development. The estimates seem high if community forests focus on the kinds of resources listed above. For example, M'kata community forest has more abundant timber resources than most others (see page 51), and yet the planned annual quota of 40 live Kiaat would be worth only about $10,000. The estimates are also based on the assumption that ready markets will be found. But finding buyers may prove difficult given the small population (and hence market) in Namibia. The costs of transporting goods over the considerable distances from most community forests to bigger urban markets would often be substantial. Finally, community forests with little woodland are unlikely to be able to sell much produce.

These cautionary comments are based on the assumption that plant products remain the focus of community forests. However, the provisions of the Forest Act allow a much broader range of products to be used to generate income, including wildlife and tourism, which are likely to bring much greater returns and benefits (see below).[8] There is also considerable potential from the harvesting and possible cultivation of some of the non-timber products described on pages 72, some of which are already earning substantial sums.

Figure 25.
Thirteen community forests have been proclaimed and another 16 are now being developed in Namibia, while 31 conservancies had been proclaimed by the end of 2004. Some community forests are also conservancies, while the boundaries of some others overlap to a greater or lesser degree.



The development of community forests has been a slow process. The first 13 community forests are to be gazetted some 10 years after the programme began. Much of the delay was due to two factors. First, the Ministry of Environment and Tourism was reluctant to gazette community forests in the absence of clear rules, since no regulations had been promulgated in terms of the Forest Act of 2001. Second, the development of each community forest entailed the preparation of exhaustive information and documentation since each application for approval had to be accompanied by a management plan based on an inventory of wood resources, a constitution and a monitoring system.

Consultations on community forest development were also complicated by the fact that the Ministry of Environment and Tourism was establishing conservancies at the same time, often in exactly the same areas. Conservancies (here limited to those in communal areas and thus different from those on freehold farms) were also designed to give rural communities rights over natural resources and the benefits to be gained from them. They thus serve purposes that are really identical to those of community forests.[9] The only difference is in the resources on which they focus: wildlife and tourism for conservancies, woodland and its products for community forests. The first conservancy was gazetted in 1998, and 31 conservancies had been declared and gazetted by the end of 2004, covering almost 80,000 square kilometres and containing about 100,000 residents (Figure 25). The 31 conservancies together earned about N$8.3 million during 2003, although the variation between them was great. Some newer conservancies had no income while several others rich in wildlife and attractive to tourists each earned over N$1 million in 2003. Most income has come in the form of salaries and cash levies from tourism establishments and trophy hunters with which the conservancies have joint venture agreements. Smaller sums were earned from meat harvests, craft and the sale of wildlife.

Conservancies grew under the overall umbrella of the Ministry of Environment and Tourism's CBNRM (Community Based Natural Resource Management) programme, which has gained international acclaim for its success. It also attracted substantial funding, and it is a pity that community forests developed independently without benefiting from the experience and standing provided by the CBNRM programme. Why should two systems with such similar aims have developed separately within the Ministry?

Much of the explanation has to do with the interests of people involved in the two programmes: different people took initiatives to develop different projects based on their own perspectives and expertise. Wildlife enthusiasts created conservancies, while foresters established community forests. The projects were then adopted by different donors and NGOs, and developed under different directorates in the same Ministry.

Different legislation was also developed for the two systems: the 1996 Amendment of the Nature Conservation Ordinance for conservancies and the Forest Act of 2001 for community forests. The legislation provides communities with similar rights: conservancies have rights over wildlife (which arguably include all plants and animals) and community forests have rights over the produce of woodlands and other natural resources of the forest (which include wildlife and grazing).

There were some differences in approach to the development of community forests and conservancies. The focus in conservancy development was to implement and register them quickly before detailed development planning started. Communities therefore began to get rights, benefits and incentives quite soon, whereas extensive planning and consultation took place before applications were made to declare community forests. Another aspect given emphasis in community forests is for the areas to be managed to provide resources for day-to-day subsistence use. Thus,

Some community forests and conservancies overlap geographically, such as in the Uukwaluudhi area shown in Figure 25 between Opuwo and Ondangwa. There are good reasons to promote the integration of these two community-based natural resource management programmes.

the areas should be managed to ensure adequate supplies of non-cash commodities, such as grazing, firewood and poles for the construction of rural homes. The management of community forests to achieve such varied goals is arguably more complex than in conservancies, which have concentrated on the clearer goals of obtaining high returns from wildlife and tourism. It will be interesting to see how community forests balance the need for subsistence resources against – or in conjunction – with potentially lucrative returns from using resources in other ways.

Despite these differences, the essence of the systems is the same: they give management and secure ownership over natural resources, and generate incomes from commodities that have seldom been marketed in communal areas. It is logical for conservancies and community forests to operate very closely, or preferably to be united into one system. The Ministries of Environment and Tourism and of Agriculture, Water and Forestry should collaborate to make this possible. All natural resources in an area should be pooled, and decisions left to those with rights to the resources to decide how best to manage them for their benefit. Of course, this should happen according to appropriate policies and guidelines that promote sustainability and the maintenance of a healthy environment. In many cases, high value incomes from wildlife and tourism will provide the greatest incentives for communities to manage and conserve their forest and woodland habitats.

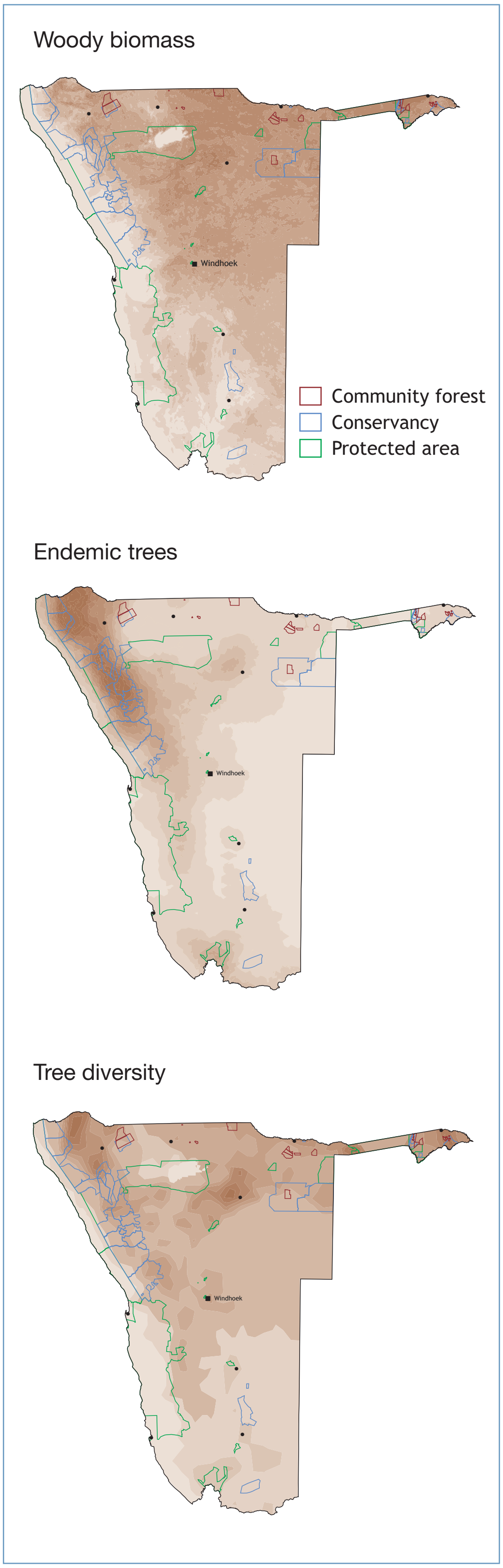


Figure 26.
The network of land that is managed directly or indirectly according to conservation principles in Namibia compared to indices of tree diversity and endemism (page 43) and woody biomass (page 51).

FOREST AND WOODLAND CONSERVATION

Woodlands and forests have been formally conserved in Namibia in several ways: in national parks and game reserves, through the banning of timber harvesting in 2003, permit controls on harvesting, transporting and selling wood products, and the declaration of 50 specially protected species (see the table opposite). Provisions in the Forest Act of 2001 allow the government to declare woodland and forest areas as conservation areas in several different forms (see page 88). The Act also states no one may cut, remove or destroy 'any living tree, bush of shrub growing within 100 metres of a river, stream or watercourse.[10]

The Caprivi State Forest was signposted as such, but never declared a legally protected area. The Directorate of Forestry intends to rectify this, in addition to proclaiming other state forests at Hamoye and Kanovlei. The state forests, national parks and game reserves are formally protected areas, land on which conservation is an explicit management goal. To these can be added community forests and conservancies, where conservation is part of the management objective. Many freehold farms are run as private nature reserves on which habitat conservation is important. Figure 26 shows that Namibia has an impressive network of areas set aside for conservation management. These maps also show how the distribution of conservation areas relates to indices of diversity, endemism and woody biomass. Not surprisingly, most community forest and proposed state forests are in the north-eastern parts of the country where rainfall, diversity and wood biomass is highest. Most endemic species, by contrast, are in north-western Namibia where they are better protected by communal area conservancies, national parks and game reserves.

FUTURE CONSIDERATIONS

The changes to the forestry sector have been substantial. Almost all staff have been appointed in the past several years, many of them newly trained. Its mandate is now quite different from before, guided by new policies and legislation that largely move the whole sector to the management and conservation of

Species of trees that are specially protected in terms of the Preservation of Trees and Forests Ordinance of 1952 and the Proclamation of the SWA Administration, No. 486 in 1972

Latin scientific name	Common name	Latin scientific name	Common name
Acacia erioloba	Camel Thorn	*Lannea discolor*	Omundjimune
Acacia haematoxylon	Grey Camel Thorn	*Maerua schinzii*	Ringwood Tree
Acacia monti-usti	Brandberg Acacia	*Ochna pulchra*	Lekkerbreek
Acacia robynsiana	Whip-stick Thorn	*Olea europaea*	Wild Olive
Acacia sieberiana	Paperbark Thorn	*Ozoroa crassinervia*	Namibian Resin Tree
Acanthosicyos horridus	!Nara	*Pappea capensis*	Jacket-plum
Adansonia digitata	Baobab	*Parkinsonia africana*	Wild Green-hair Tree
Albizia anthelmintica	Worm-bark False-thorn	*Peltophorum africanum*	Weeping Wattle
Baikiaea plurijuga	Zambezi Teak	*Philenoptera nelsii*	Kalahari Apple-leaf
Berchemia discolor	Bird Plum	*Philenoptera violacea*	Apple-leaf
Boscia albitrunca	Shepherd's Tree	*Pterocarpus angolensis*	Kiaat
Burkea africana	Burkea	*Rhus lancea*	Karee
Colophospermum mopane	Mopane	*Rhus pendulina*	White Karee
Combretum imberbe	Leadwood	*Salix mucronata*	Wild Willow
Elaedendron transvaalensis	Transvaal Saffron	*Schinziophyton rautanenii*	Mangetti
Entandrophragma spicatum	Owambo Mahogany	*Schotia afra*	Small-leaved Boer-bean
Erythrina decora	Namib Coral Tree	*Sclerocarya birrea*	Marula
Euclea pseudebenus	Ebony Tree	*Securidaca longepedunculata*	Violet Tree
Faidherbia albida	Ana Tree	*Spirostachys africana*	Tamboti
Ficas cordata	Namaqua Fig	*Sterculia africana*	African Star-chestnut
Ficus burkei	Common Wild Fig	*Sterculia quinqueloba*	Large-leaved Star-chestnut
Ficus sycomorus	Sycamore Fig	*Strychnos cocculoides*	Corky Monkey Orange
Guibourtia coleosperma	Ushivi	*Strychnos pungens*	Spine-leaved Monkey Orange
Gyrocarpus americanus	Propeller Tree	*Strychnos spinosa*	Spiny Monkey Orange
Kirkia acuminata	White Syringa	*Tamarix usneoides*	Wild Tamarisk

indigenous woodlands for the benefit of rural people and country as a whole. This is an encouraging and stimulating shift. But how does the theory match the practice, and what are the main challenges?

Perhaps it is too early to answer the question of how effectively new policies and legislation are being implemented, but there are clear signs that more progress is needed. For example, despite the Forestry Act being promulgated in 2001, by early 2005 the first Forest Council had not been appointed. Other than the 13 Community Forests, no other classified forests had been proclaimed. The Directorate also needs to confirm its presence and role in activities where it should be more actively engaged, two examples being the promotion of non-timber forest products and reforesting of areas that now lie fallow and unproductive. If natural resources and fire are mainly to be managed by rural people, forestry officials will have to spend more time (and other resources) supporting and encouraging these distant communities.

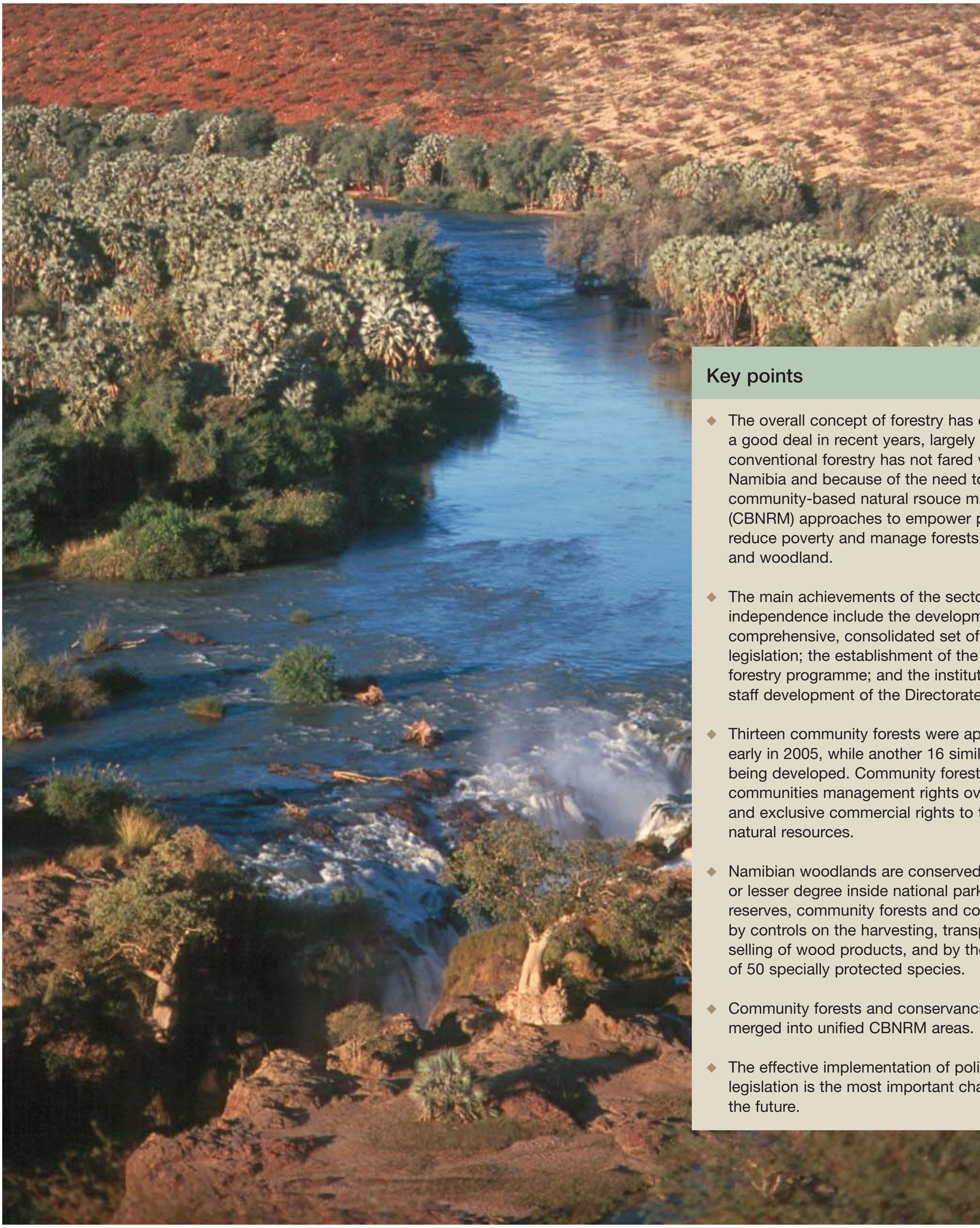
These concerns lead some people to ask if Namibia should have a discrete forestry sector. The sector's role is also confounded by the fact that the Directorate of Forestry has itself shifted attention to concentrate more fully on environmental management, rural development and the use of all plant and animal resources to be found in woodlands that cover over half the country (see page 11). A logical possibility would be to expand and transform the sector into one that manages all woodland resources under an umbrella of holistic, environmental management and conservation.

Wildlife conservation is a well-established and profitable concept, made popular by such flagship animals as rhinos, elephants and lions. Woodland or forest conservation is not widely embraced, partly so because it lacks the dramatic icons on which to sell the importance of conservation. There are no botanical rhinos, elephants or lions, although Quiver Trees, Welwitschia and Baobabs go some way towards raising the profile of trees. Namibian forests also do not compare with the impressive forests in equatorial regions of the world.

Another option is to broaden the role of forestry to focus on all vegetation, both woody and non-woody. One benefit in this would be to create much greater advocacy for plants and to have an organisation fully devoted to the study, management and conservation of plants indigenous to Namibia. Most so-called broad environmental management and conservation activities ride on the back of flagship species or concepts: desert elephants and rhinos, spectacular tourism attractions, rare species of birds or, indeed, plants such as Welwitschia. These are the icons for which many areas are managed – directly or indirectly – for conservation, both for the sake of preservation and the wise use of resources. Moreover, most conservation areas are declared because there are passionate protagonists who champion these favourite species, and it is usually due to their efforts that broader areas are conserved in which their 'icons' live. By contrast, few natural environments are managed for conservation in the absence of flagships and their advocates. Having an organisation that promotes the value of plants would help to raise the profile of these important organisms, regardless of whether they occur in forests, woodlands, shrub-lands or desert areas. The chances of having such an organization have, however, perhaps been reduced as a result of the Directorate's recent move to the Ministry of Agriculture, Water and Forestry. Indeed, the future will tell how the past 10 years' of development in an environmental setting will be carried forward in an organisation where agriculture is a priority.

Namibia now has three systems of community management of natural resources: commercial or freehold farm conservancies, communal area conservancies, and community forests. All three systems seek to promote the wise use and management of natural resources. The separate systems were designed to deal with different kinds of land tenure and natural resources. Distinctions between communal and freehold land are starting to blur as more people develop large farms in communal areas, and more previously disadvantaged people own or settle on freehold farms. Furthermore, differences in natural resource use and management between community forests and conservancies are ones of subtle emphasis. In time to come, one would hope that these borders and differences will be dismantled further and lead to a situation in which natural resources are managed effectively, profitably and sustainably by the people who own them, and with a minimum of sectoralism.

In summary, much has been achieved since independence in 1990 to formulate a new world of forestry in Namibia, a sector and enterprise that is much more in tune with the realities of available forest and woodland resources, and how they can best be used and managed. What remains is to turn these good intentions into worthwhile results for the benefit of Namibia's natural environment, its people and the broader globe.



Key points

- The overall concept of forestry has change
a good deal in recent years, largely becaus
conventional forestry has not fared well in
Namibia and because of the need to adopt
community-based natural rsouce managem
(CBNRM) approaches to empower people,
reduce poverty and manage forests
and woodland.

- The main achievements of the sector since
independence include the development of a
comprehensive, consolidated set of policies
legislation; the establishment of the commu
forestry programme; and the institutional ar
staff development of the Directorate of Fore

- Thirteen community forests were approved
early in 2005, while another 16 similar areas
being developed. Community forests give r
communities management rights over their
and exclusive commercial rights to the use
natural resources.

- Namibian woodlands are conserved to a gr
or lesser degree inside national parks and g
reserves, community forests and conservar
by controls on the harvesting, transportatio
selling of wood products, and by the declar
of 50 specially protected species.

- Community forests and conservancies shou
merged into unified CBNRM areas.

- The effective implementation of policies an
legislation is the most important challenge f
the future.

PROSPECTS: seeing the wood and the trees

A major difference between trees and grasses is that trees grow from the tips of their branches while grasses grow up from their roots. Trees thus grow from top to bottom, and any damage to their growing tips, for example from browsers, fire, or frost, impedes their growth.

Trees grow and die, each sapling adding to a forest or woodland. Every death is a loss, but also an opportunity for new growth. The push and pull between growth and death varies across the country, and from year to year. The result is a patchwork of richly varied habitats. These are the natural conditions of Namibia's woodland environments, the consequences of evolutionary selection over tens of millions of years. However, substantial changes to natural environments have occurred recently. These are changes bought about by people, particularly through their use of land for agriculture. Livestock farming was introduced to Namibia about 2,000 years ago, and the first land was probably cleared for crops roughly 1,100 years ago.[1] But conditions changed most radically during the last century when the number of people increased very greatly, largely as a result of modern medicine and better food production. The increased population has led to great demands for wood for fuel and the construction of houses. More land is used for crop farming, and more livestock ave led to and greater grazing and browsing pressures.

Namibia's woodland resources have suffered from these demands, and the detrimental impacts continue. It is on aspects of these influences that the chapter begins, describing the process and effects of woodland loss, especially those caused by the clearing of land for farming, and bush fires. The use of woodland resources has been non-sustainable because resources are removed from the landscape at a rate greater than the pace at which they grow or regenerate. This is foolhardy exploitation in the short-term at the expense of access to longer-term benefits. And so how can we begin to match greater demands on woodlands with better management to ensure that resources remain available for generations to come? And how can we derive additional benefits from these natural habitats to enhance the economy of Namibia? These are big questions for the people and government of Namibia.

Land clearing

Large areas of woodland and forest have been cleared for crop farming (Figure 27), particularly in northern Namibia where soils and rainfall are better suited to crops than in the more arid areas to the south. Cereals are produced on the majority of fields, the vast majority being dryland fields where crops depend on rainfall for moisture. About 70% of all areas cultivated for cereals are under pearl millet (locally known as *mahangu)* and sorghum, while maize and wheat make up 25% and 5% of production, respectively. Approximately 90% of cleared land belongs to subsistence farmers. Their fields are small, each farmer usually cultivating between one and five hectares. Fertilizers or manure are seldom applied, with the result that soil nutrients are generally depleted after several crop seasons. New fields are then cleared, especially in in Kavango and Caprivi. As a consequence, most areas cleared of trees now lie abandoned and much more land has been cleared (about 20,000 km^2) than is used for crops in any one year (3,000 km^2). In addition to fields from which nutrients have been exhausted, other fields were cleared following cycles of unusually high rainfall. These fields were then abandoned when conditions reverted to the more normal mix of good and bad years. About 18,500 km^2 of cleared woodland and forest is in communal areas, and the remaining 1,800 km^2 on freehold farms.

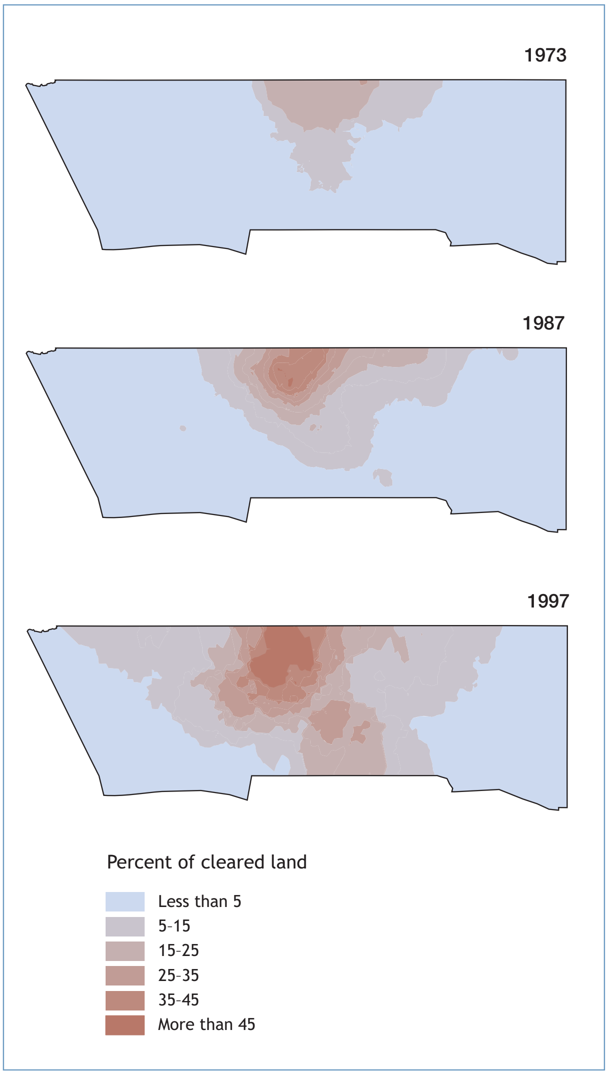
The Kalahari sands and woodlands that cover much of northern Namibia (see Figure 9 on page 31) are poorly suited to subsistence cultivation. As a result, fields have mostly been cleared in three localised landscapes within and around these sands. The first is on patches of more clayey soils along river courses, around pans and in linear valleys between sand dunes that formed during much drier periods. This is where most fields in Caprivi, Kavango, north-eastern Otjozondjupa and eastern Oshikoto and Ohangwena are located, and the majority of cleared trees are species that prefer such clayey soils. The second landscape is on raised patches of ground above the salty soils in the oshana drainage lines of the Cuvelai Drainage system in Omusati, Oshana and western Ohangwena and Oshikoto. Mopane and Silver-leaf Terminalia are the main species to have been cleared. However, in both landscapes farmers have often left standing larger, valuable fruit and shade species, such as Marula, Bird Plum, Mangetti and Jackal Berry.

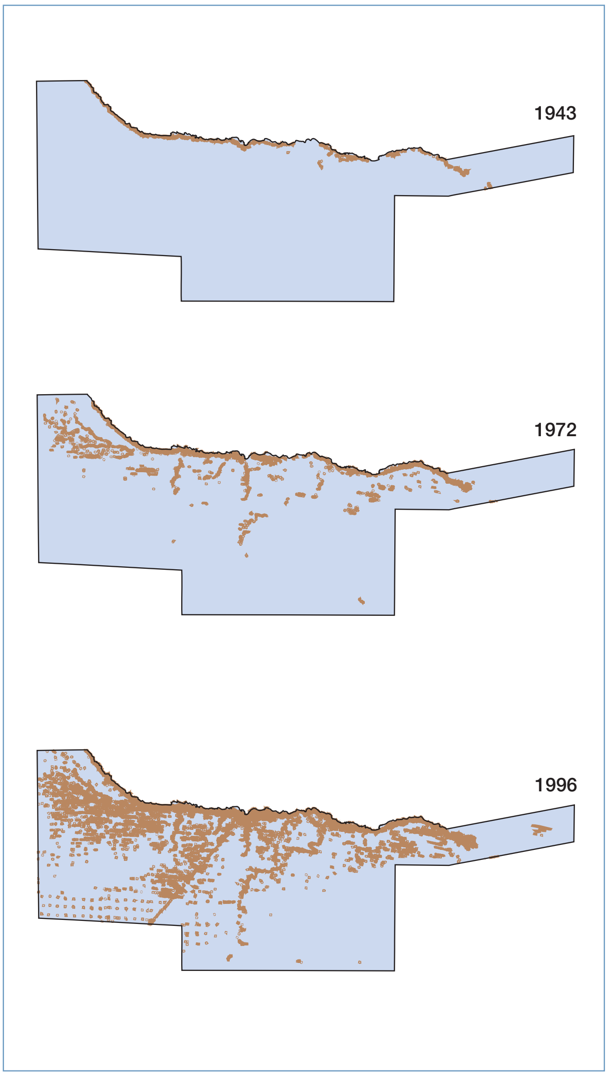
Huge areas of woodland and forest have been cleared for crop production. Most of these areas now lie fallow, abandoned as scrubby, shrubby patches devoid of large trees.

The third landscape is on loamy soils in valleys that surround the Otavi-Grootfontein-Tsumeb mountains. This is Namibia's so-called maize triangle, where large-scale, freehold farmers mainly grow maize, wheat, sunflowers and cotton, often in fields that are irrigated. The most prominent trees cleared off these relatively large fields are Tamboti, Purple-pod Terminalia, Peter's Fig and various Acacias. Many of the fields have been abandoned over the years and are now dense thickets of Sicklebush and Purple-pod Terminalia.

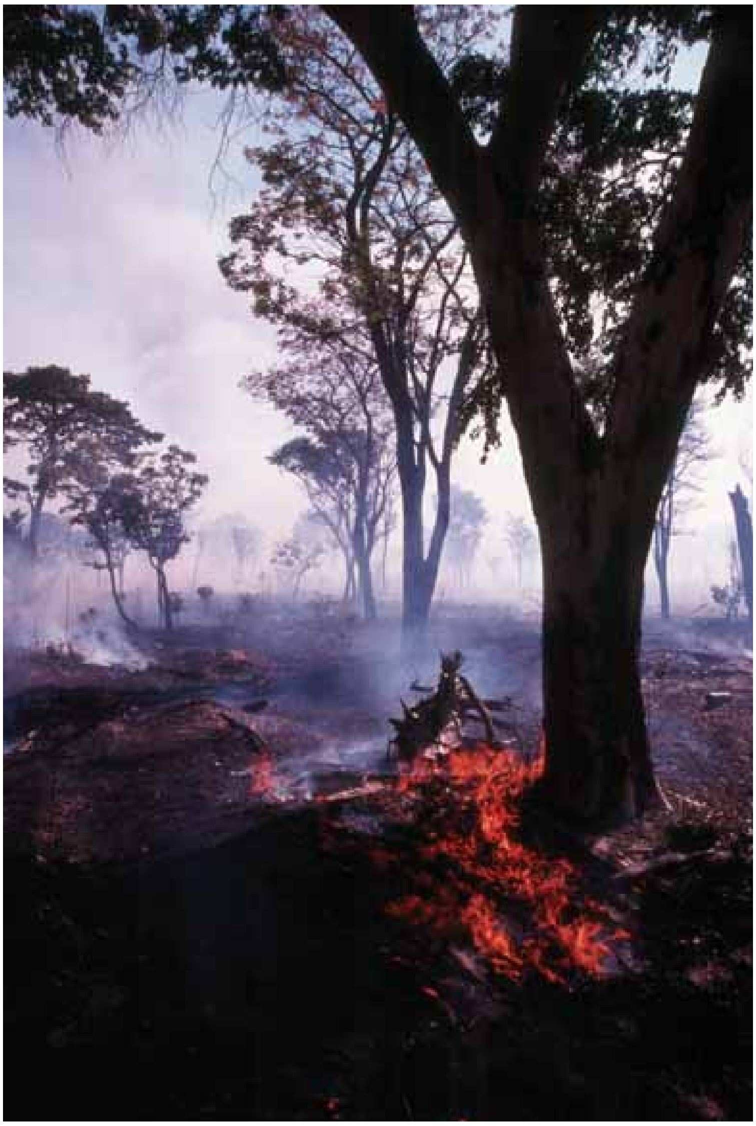
Expanses of woodland cleared for crops have increased a great deal in recent decades. Examples are given for two areas in Figure 27, one being in Kavango and the other the former Owambo region. In both regions, zones of cleared land expanded away from core areas. In Kavango, the

Figure 27. Large areas of woodland have been cleared for crop farming in north-central Namibia and in Kavango. The maps of former Owamboland (below left) show percentages of different areas cleared for crops in 1973, 1987 and 1997, while the three maps of Kavango (below right) show areas that had been cleared in 1943, 1972 and 1996. Approximately 4% of additional land was cleared each year between 1943 and 1996 in Kavango, while rates of clearing in former Owambo varied between 2% in the most densely populated areas and 9% in more outlying, unoccupied zones.[2]





core was along the Okavango River where the only cultivation was practiced in 1943. By 1972, scattered fields had been cleared along many of the fossil river valleys (or *omurambas*) and inter-dune valleys, mostly within 50 kilometres of the river. The extent of clearing then spread further south between 1972 and 1996. While much of the land was cleared as the number of people increased over this period, a large part of the clearing was also due to farmers clearing new fields when their old ones became less productive. By 1996, a total of about 4% of the region had been cleared for cultivation. Figure 27 shows how woodlands cleared for farming also expanded in former Owambo from a core area along the Angolan border. The proportion of land cleared in this region rose from 2.1% in 1973, to 5.2% in 1987 and 10.4% in 1997.



About 17% of Africa south of the Sahara burns every year, creating great palls of smoke that hang over the continent's savannas. Over one-third of north-eastern Namibia is burnt annually.

Scorched woodlands and forests

It is widely agreed that fires have been a feature of the African landscape for millions of years, and it is well known that fires occur more widely and frequently in Africa than on any other continent. Africa is a 'burning continent' for three reasons. The first is that well-defined wet and dry seasons occur in many areas, and regular fires only occur in areas with extended wet and dry periods. The growth of trees and grass is stimulated and sustained when it rains, and then dry season cut the plants back. Secondly, most grasses have low nutritional value because of the relatively poor nutrient quality of soils. The grasses are little grazed and therefore remain standing as fuel for bush fires. Thirdly, the prevalence of fires might be due to the abundance of savannas in Africa, since the layer of grass provides a carpet of fuel for fires to spread widely and wildly. That savannas burn often is clear, but it is also likely that savannas were themselves moulded by repeated burning, the fires maintaining the mix of tree and pasture growth.[3]

Fires vary greatly in intensity, depending on the quantity of combustible material, wind strength, and dryness of the fuel. The more fuel, the more intense and high the fire, and the greater the chance that trees will be burnt. What is important about the quantity of fuel is its density (biomass/hectare), since fuel that is sparsely distributed does not burn easily. For example, dry leaves in a tree canopy do not burn as readily as compacted layers of dry grass. There is also a clear relationship in African woodlands between rainfall and fire intensity. The higher the rainfall, the more grass and thus the hotter the fire. Of course, the frequency and intensity of burning diminishes in areas where rainfall is either very high or low.

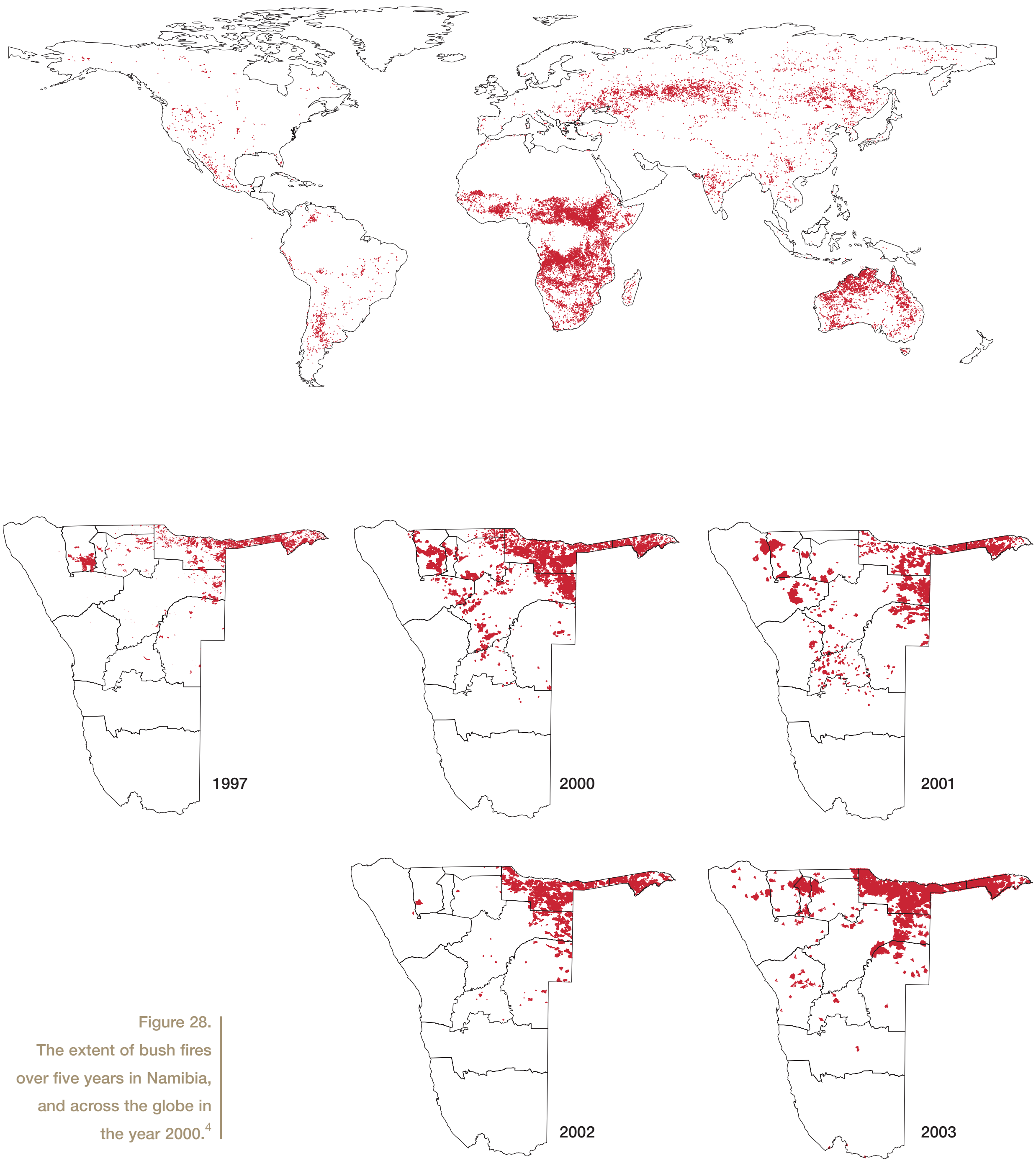


Figure 28.
The extent of bush fires over five years in Namibia, and across the globe in the year 2000.[4]

An estimated 168 million hectares or 17% of the area south of the Equator in Africa burns each year.[5] Much less of Namibia burns than this because there is so little grass in the extensive arid areas of the country. However, a high percentage of the north-east is burnt each year. For example, an average of 43% of Caprivi and 34% of Kavango burnt each year during the five years shown in Figure 28.

While large areas of the north-east burn each year, the southern parts of the country only burn when there is an abundance of dry grass following wetter summers. This was the case in 2000 when fires covered 6% of the Khomas region, and there were many more individual fires than in 1997, a relatively dry year.

People start the great majority of bush fires, usually to encourage the growth of new grass for their livestock or to attract wild animals (the flushes of growth are due to the release of nutrients caused by the combustion of dry plant material). Other fires are set to clear new fields or to remove old growth from existing fields. Fires set to clear dry grass beneath Ushivi trees are said to be a major cause of widespread burning in the Caprivi Strip (once the cover has been cleared, people can easily collect fallen Ushivi seeds which they eat as a cooked relish). Many fires run out of control, especially during the windy months between August and September (Figure 29). A fire started with a single match may spread to burn thousands of square kilometres of woodland and pasture.

Percentages of Kavango and Caprivi that burnt between 1989 and 2002. Over half of these two regions burnt during 5 or more of these 13 years.[6]

11% of the area never burnt
16% of the area burnt in 1 or 2 years
19% of the area burnt in 3 or 4 years
23% of the area burnt in 5 or 6 years
17% of the area burnt in 7 or 8 years
14% of the area burnt during 9 to 13 years

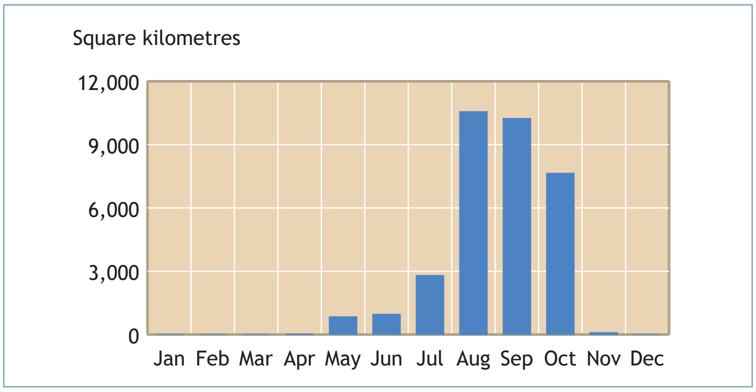


Figure 29.
Most fires in Namibia burn in the late winter and autumn months. Fires may then spread wildly because these are the windiest months and the grass is driest. The graph shows the total area burnt during each month of 2003.[7]

It is true that fires were commonplace in Africa long before people started to have a major impact on its savannas. However, the key change in recent decades is that woodlands now burn much more frequently than before because there are many more farmers who clear land and keep livestock. Indeed, much of north-eastern Namibia burns every one or two years, as shown by the figures given in the table below. The burning of the same areas year after year has several undesirable impacts on woodlands. First, many mature trees - including valuable timber trees - are killed, with the result that tens of thousands of dead trees are now scattered across north-eastern Namibia. The best place to see this is along the road from Divundu to Kongola across the Caprivi Strip. Another area that is burnt excessively is the Caprivi State Forest, where the forest inventory found that 53% of all Burkeas, 37% of Kiaats, 15% of Zambezi Teak and 15% of Ushivi were dead, mainly as a result of fire.[8]

Second, the recruitment of trees is limited. Young seedlings are killed by fire, while saplings need several years free of fire to grow tall enough to escape the effects of burning. Many areas are characterised by the presence of small, bushy trees that have coppiced repeatedly, each bout of sprouting following a fire that has burnt away their stems, branches and leaves. Repeated fires therefore prevent or slow down the emergence of mature trees to replace those that have been killed. Third, frequent fires accelerate the rate at which soil nutrients are lost, thus reducing soil fertility. The effect happens in




two ways: carbon, nitrogen and sulphur are lost to the atmosphere in volatile molecules, and fires increase the rate at which nutrients are bought to the surface from where they can escape through burning. This is the simple result of roots tapping nutrients from below the surface, and putting them into leaves, twigs or wood. These later fall to the ground as dead material and many of the constituent nutrients are lost through subsequent burning. There is usually a more even distribution of nutrients in the soil profile in places that seldom burn, whereas nutrients are concentrated near the surface in areas exposed to regular fires.

These are all effects on woodlands, but fires have other impacts. The most obvious is the loss of grazing, which must be substantial if an average of over one third of Kavango and Caprivi burn each year. Wildlife, livestock and people are killed, and homes and other property are destroyed from time to time. Frequent, extensive fires also release pollutant gases into the atmosphere, particularly methane and nitrous oxide. It is sometimes claimed that the emissions add significantly to the effects of global warming caused by the greenhouse effect. However, a recent analysis found that the volumes of greenhouse gases produced annually by Namibian fires are considerably lower than the amounts absorbed by plants in the country. Thus, about 54,000 metric tons of methane and 2,000 metric tons of nitrous oxide are released by bush fires per year, but in carbon dioxide equivalents these emissions amount to only about 4% of the carbon dioxide absorbed by bush-encroached areas alone.[9]

The maps in Figure 28 show fire scars in each of five years but also reveal three areas that seldom burn. The biggest is the western and southern deserts and semi-deserts where there is hardly any grass to burn. The second consists of places that are densely populated by small-scale farmers, especially along the Okavango River and in the Cuvelai Drainage system. The high density of livestock and grazing pressures in these areas leave little grass to burn. The third zone is the freehold faming area in eastern Namibia, largely in Omaheke and Otjozondjupa. The absence of fires here is due to much of this being cattle ranching

Most trees die as a result of successive burns over a number of years. The problem begins with an accumulation of leaf litter on the lee side of a tree trunk, usually on the south-west because of north-easterly prevailing winds. The burning litter forms a small scar in the trunk, which then fills with even more litter during the next dry season. The next fire burns deeper into the tree trunk, killing off more wood. The cycle of increasing litter accumulation and burning into the wood continues until the tree eventually dies (left). The skeletons of large Burkeas, Zambezi Teak and Kiaat are prominent features in the Caprivi Game Park and Caprivi State Forest (below). These areas are little grazed because there are few livestock. Intense fires thus sweep across the protected areas in most years.

country where fires are strictly controlled to avoid the loss of grazing. Tellingly, most of these farms are so heavily encroached by bush that there is little grass to burn, and it is to this problem that the chapter moves.

THE PLOT THICKENS: BUSH ENCROACHMENT

Anyone driving between Otjiwarongo and Otavi will see extensive tracts of very dense bush alongside the road. Over the last few decades the thickets have replaced savanna woodland characterized by tall trees, scattered bushes and a carpet of pasture for cattle and wildlife. Bush encroachment is to be seen in many places. Its main features are an increase in woody plant biomass, a reduction in grass cover, and a change in the kinds of uses and benefits of land, both for people and other organisms. Farmers now keep fewer livestock and produce less meat. Contributions to the Namibian economy from farming are reduced, perhaps by as much as N$700 million per year.[10] There is also a loss of biological diversity, since grass and any wildlife and other animals that depend on grass are largely absent from highly encroached areas.

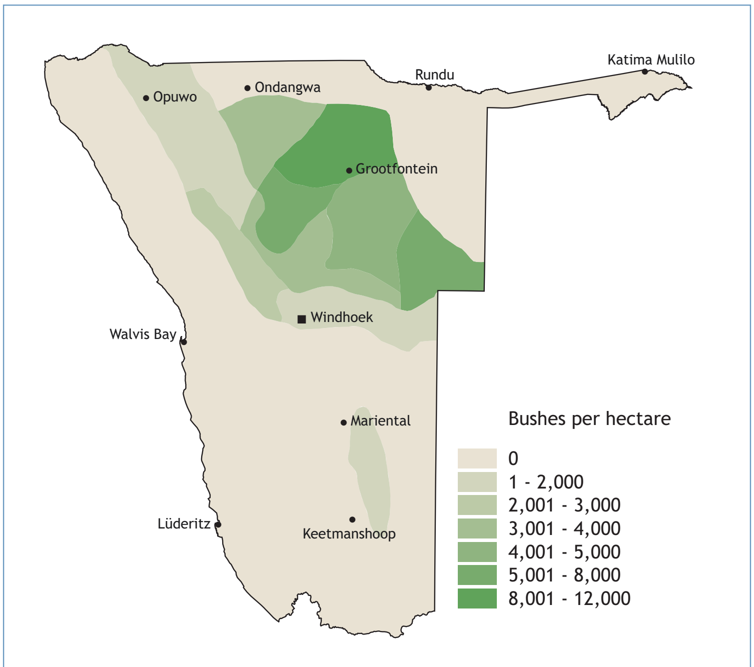


Figure 30. Roughly one third of Namibia is considered badly affected by bush encroachment. Each area shown in the map is characterized by different invasive species at the approximate densities of bushes shown in the legend.[11]

Losses in grass production are not compensated by increased wood biomass. Most invasive or encroaching species are not palatable to browsers because they are thorny or have high tannin levels in their leaves. The invasive trees are generally bushy and produce little wood of value. Most stems and branches are too thin for charcoal production, never mind other timber products. Bush encroachment furthermore leads to a loss of soil moisture as a result increased run-off and the fact that bushes transpire much more water than grass.

Nine species are generally considered to cause most bush encroachment: Yellow-bark Acacia, Sandveld Acacia, Black Thorn, Purple-pod Terminalia, Silver-leaf Terminalia, Driedoring, Mopane, Rooihaak and Sickle-bush. The only estimate of areas affected by bush encroachment amounts to about 260,000 square kilometres, or about one-third of Namibia (Figure 30). However, bush densities in encroached areas vary considerably and some areas with very high densities in north-eastern Namibia are not shown in Figure 30. The map is, however, correct in illustrating the order of magnitude of the problem. It is important to recognize that bush encroachment is a relative condition, and one that changes as bush densities increase and grass cover declines. Any addition of bush and simultaneous reduction in grass production amounts to encroachment. Farmland considered free of encroachment typically supports several hundred woody plants per hectare, whereas heavily thickened areas have more than 3,000 bushes per hectare. The most encroached areas have densities ranging from 10,000 to 24,000 bushes/hectare.

A variety of factors are thought to cause bush encroachment, and the reader is referred to a recent review on bush encroachment for a thorough discussion of these.[12] The relevance and importance of the different causes appears to vary across the country, and four conditions probably explain most encroachment. Firstly, the thickening of bush is strongly related to rainfall (Figure 31). This is largely due to the growth of trees being highly dependant on an adequate supply of water, and even small changes in rainfall are associated with rather large differences in numbers of bushes. A few years of higher than normal rainfall therefore probably result in substantial increases in the germination and survival of bushes.

Second, encroachment is closely linked to modern farming practices, both here in Namibia and in other parts of the world. Most bush encroachment has developed on cattle ranches, and very dense thickets of Sickle-bush and Purple-pod Terminalia have developed on abandoned fields around Tsumeb, Otavi and Grootfontein. Many sheep farms in the south-eastern regions suffer from invasive Driedoring.

Thirdly, bush encroachment is associated with over-grazing and a loss of grass. This is explained using the two-layer hypothesis, which suggests the following mechanism. Grasses draw moisture from the top layer of soil, thus limiting water availability to the roots of bushes that extend to a deeper layer. Woody plants boom once grass has been removed because they then have greater access to soil moisture. The idea is logical and simple, but it does not explain encroachment in areas where there is only a single, shallow layer of soil and in places where grazing pressures are light.

The loss of grass cover has another effect, which leads to the fourth cause of encroachment. This is the absence of fires. Bush fires just can't burn if grass fuel is lacking, either as a result of over-grazing or a thick cover of bush. Most Namibian grasses do not grow well in shade, so there is seldom enough grass beneath trees and bushes to fuel a fire hot enough to kill invasive bushes. A variety of experimental and circumstantial evidence indicates that woody plants flourish in the absence of fires, and it is indeed fire that maintains savanna as a mix of trees and grass. In the absence of fires, most savannas would become forests. Many people endorse the value and use of fire as a tool to manage pastures for this reason.

Many farms in the most encroached areas in eastern and north-eastern Namibia have not seen a hot fire for decades, and there is a striking correspondence between the most encroached areas

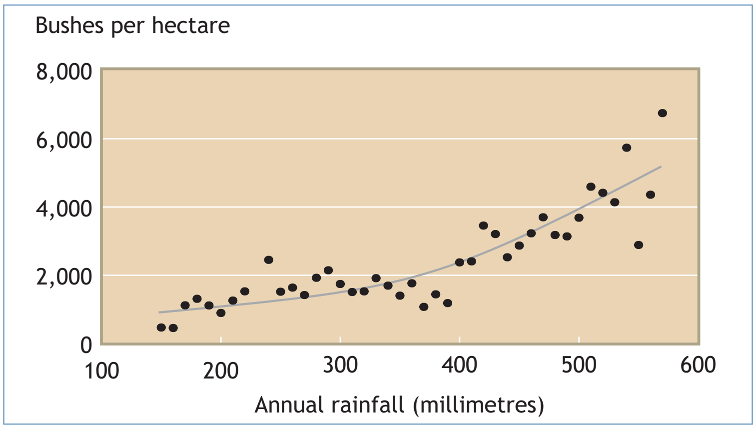


Figure 31.
Bush encroachment is much greater in higher than lower rainfall areas. These figures come from samples of bush density taken from west to east across the central half of Namibia.[13]

Sickle-bush flowers resemble delicate lanterns, images of beauty giving lie to their role in causing much of the bush encroachment problem in many areas of Namibia.

Fungal infections cause Black Thorn trees to curl over and die. The infections occur in patches, but have had little impact in helping to curb bush encroachment.

shown in Figure 30 and the absence of fires in eastern Namibia, as shown in Figure 28. The role of fire in limiting woody growth is also evident on several farms protected from frequent burns in the north-eastern woodlands. Examples are the Sachinga Livestock Research Station in Caprivi and the Mangetti farms in southern Kavango, where bush densities are very much higher than in the surrounding areas.

It is ironic that Namibia suffers from too many fires in the north-eastern communal areas but too few on the eastern freehold farms. Ever since freehold cattle ranching was started there has been opposition towards bush fires because of the obvious loss of grazing. Even controlled fires are generally loathed since there is always the possibility of them raging out of control on to neighbouring farms. These views were embodied in law in the Soil Conservation Act of 1952. Provisions in the Act banned the setting of bush fires unless the special permission of the Minister of Agriculture was obtained.

In summary, most encroachment in Namibia is probably due to the following combination of events. Dense stocking rates of cattle lead to over-grazing, which together with fire controls, lead to the elimination of bush fires. Bush growth flourishes in the absence of fires, especially following years of above average rainfall. Growth rates are probably enhanced by less competition for water and nutrients from grass. These conditions most likely apply to the eastern and central cattle ranches. In the north-eastern communal areas, patches of bush encroachment are probably due to an absence of fire. The south-eastern areas are so arid that fires are unlikely to play any role in limiting bush growth, and so encroachment in these areas is probably due to over-grazing by sheep.

Two main methods of getting rid of bush are used in Namibia: herbicide poisons sprayed from aeroplanes or applied manually to each plant, or mechanical destruction by cutting and uprooting each bush. The methods share one feature – high cost – and few farmers have therefore attempted to clear bush on a large scale. In addition, ground from which bush has been removed requires after-care management to prevent the invasive problem from recurring. Hopes have been raised that encroachment might be controlled naturally by fungal infections, especially by fungi belonging to the genus *Phoma*. The infections have killed or retarded the growth of large numbers of Black Thorn in certain areas, but there is no evidence to suggest that the fungi will help reverse the problem of bush encroachments. Research to find ways of increasing the infections to combat bush encroachment has not been successful.

Are there any benefits to bush encroachment? Some people have taken the opportunity of clearing bush mechanically to produce charcoal, which is marketed as an environmentally friendly product made from invader bush. The whole charcoal industry has grown considerably in recent years (see page 64), but most charcoal is now produced from selected plants with thicker stems and branches. Smaller bushes are left and even those that have been cut later sprout to generate new growth, making this more of a harvest than a solution to encroachment. Some non-invasive trees are also harvested. Methods of producing wood chips from invasive bush and compressing them into blocks of fuel have been developed recently. Production costs appear high and it is not known if market demand will be strong enough to sustain the enterprise.

Finally, here is a surprising potential benefit. Namibia's expanses of dense bush probably absorb carbon dioxide to such an extent that they represent a significant carbon sink which helps reduce the effects of global warming. Any measures or resources that remove greenhouse gases qualify to be traded as credits in terms of the Clean Development Mechanism of the Kyoto Protocol, but countries or individuals intending to sell carbon credits must meet three conditions. First, activities qualifying as credits should be shown to have a net benefit to the atmosphere, which is true for bush encroachment. Second, they should have been developed deliberately to reduce emissions or reach certain greenhouse gas targets. This is not the case for bush encroachment. Third, the activities must be sustainable in the sense of not incurring environmental or economic costs. This, too, may not hold for bush encroachment, since it can be argued that encroachment leads to reduced biodiversity and lower economic returns as a result of lost grazing. This is the theory behind trading carbon credits. Some of the reasons for not trading bush encroachment could fall to legal argument, and Namibia may earn credits for its 'carbon farms' at some point in the future. For the time being, however, government policy supports measures that aim to restore encroached areas to savanna woodland.

ADDITIONAL CHALLENGES

Several other processes increase pressures on Namibia's woody resources. Ephemeral and fossil rivers are lined by margins of denser, taller trees than those in the surrounding more arid areas. These linear oases supply a range of resources. In the most arid areas, the riverine woodlands provide the only available shade, fodder, fuel wood and nest sites for birds, for example. The germination and growth of many of the trees depends on occasional flows of water after heavy falls of rain in upstream catchments, since the flows recharge aquifers in the sands that fill the river valleys. However, two activities have an impact on those water resources. First, water is pumped from the aquifers to supply farms and towns, especially the coastal towns of Lüderitz, Walvis Bay and Swakopmund. Pumping rates are often greater than the rate at which the aquifers recharge, with the result that the growth of trees has probably slowed and rates of mortality have increased. Ana Trees along the lower Kuiseb River appear particularly vulnerable to the depletion of aquifers due to water abstraction for Walvis Bay and Swakopmund.

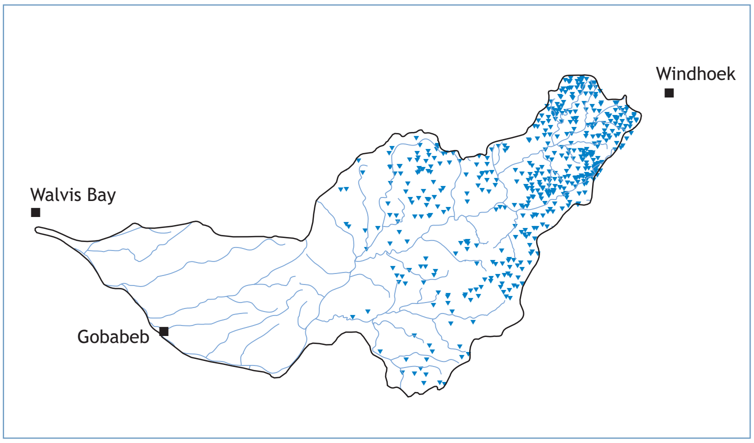


Figure 32.
Thousands of dams have been built over the years along Namibia's ephemeral rivers and their tributaries. The catchment of the Kuiseb River stretches over about 250 kilometres from east to west and covers approximately 14,850 square kilometres. However, it is only in the hilly eastern areas that rain falls sufficiently often and heavily enough for water to flow and be dammed. [15]

Downstream water flows are also affected by the damming of upstream tributaries. The Kuiseb River is again an example. To supply their livestock with water, farmers have built approximately over 5400 dams in its catchment (Figure 32). Many of the smaller impoundments remain dry for much of the time and cover less than a hectare. However, it is easy to imagine the cumulative effects of so many dams withholding water from the roots of riverine trees downstream. These effects are probably greatest in seasons with low or average rainfall, whereas the dams fill and overflow when above average rains fall.[14]

Unluckily for trees, elephants are largely browsers, and large browsers at that! Huge quantities of foliage are eaten each day. The animals also often tear down branches or whole trees to reach fresh leaves and fruit. This is not a problem in woodlands where there are few elephants, but conserva-

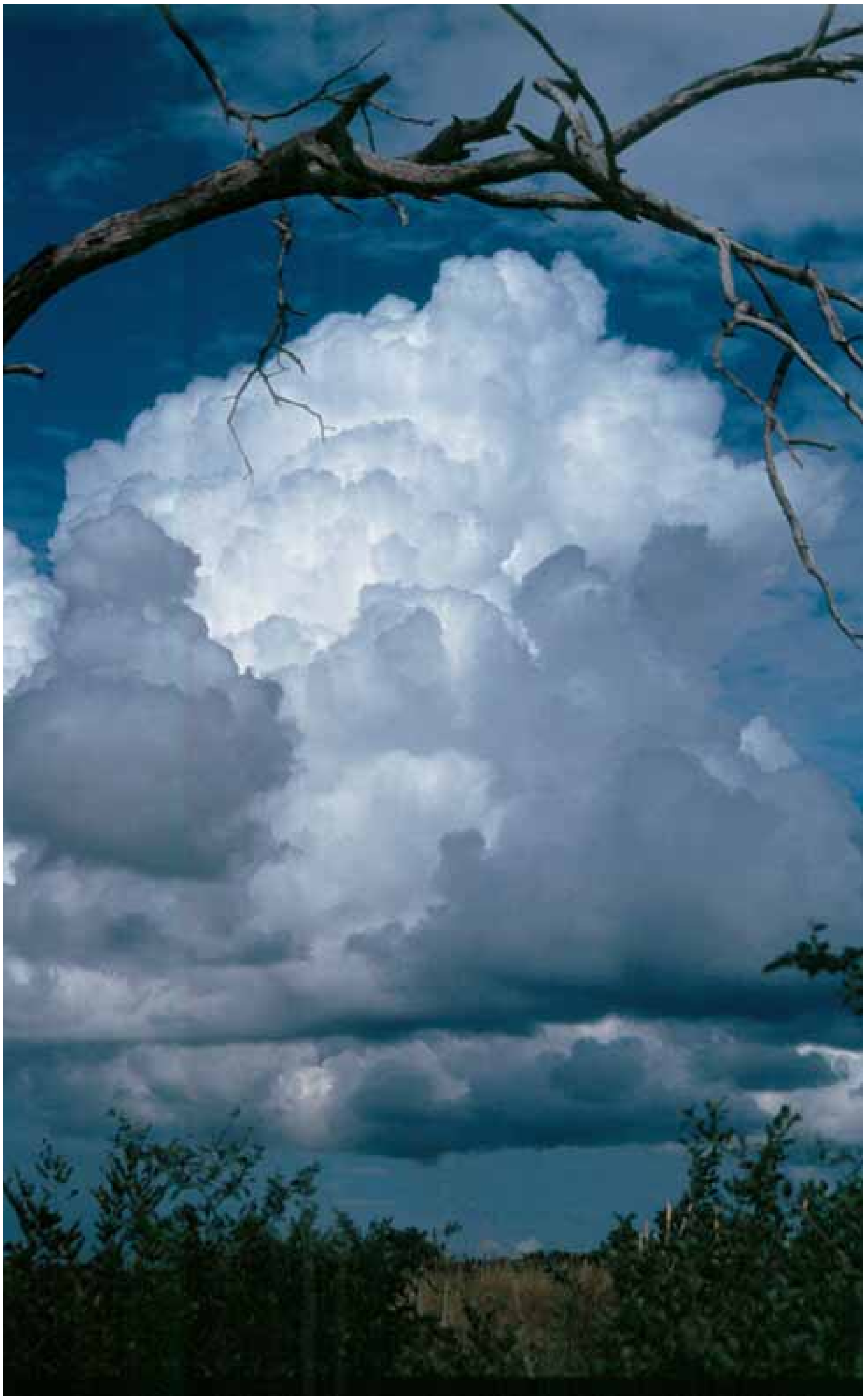
Much of the thick riverine forest in the Mahangu Game Reserve has been lost as a result of damage caused by elephants. In this case, the trunk of a Baobab has been badly scarred (left). The number of elephants in Namibia will probably double 15 years from now, and very much greater losses of trees are then expected. Water held in a typical dam nestling in a valley of an ephemeral river is not available to downstream woodlands growing along the river's banks (right).

tion programmes in Namibia and neighbouring Botswana and Zimbabwe have been so successful that elephant populations are now skyrocketing.[15] Thus, the total population of elephants in Namibia is estimated to have increased from less than 1,000 in the 1960s to about 18,000 in 2004. The animals are concentrated in and around several conservation areas: about 800 in Kunene, 2,500 in Etosha National Park, 5,000 in Khaudum Game Reserve and north-eastern Otjozondjupa, and approximately 9,000 elephants in eastern Kavango and Caprivi. It is in the north-eastern areas where damage to woodlands is most evident, especially along the Okavango River in the Mahangu Game Reserve and Kwando River in Caprivi. Large numbers of elephants congregate here in winter when water is not available in the surrounding woodlands.

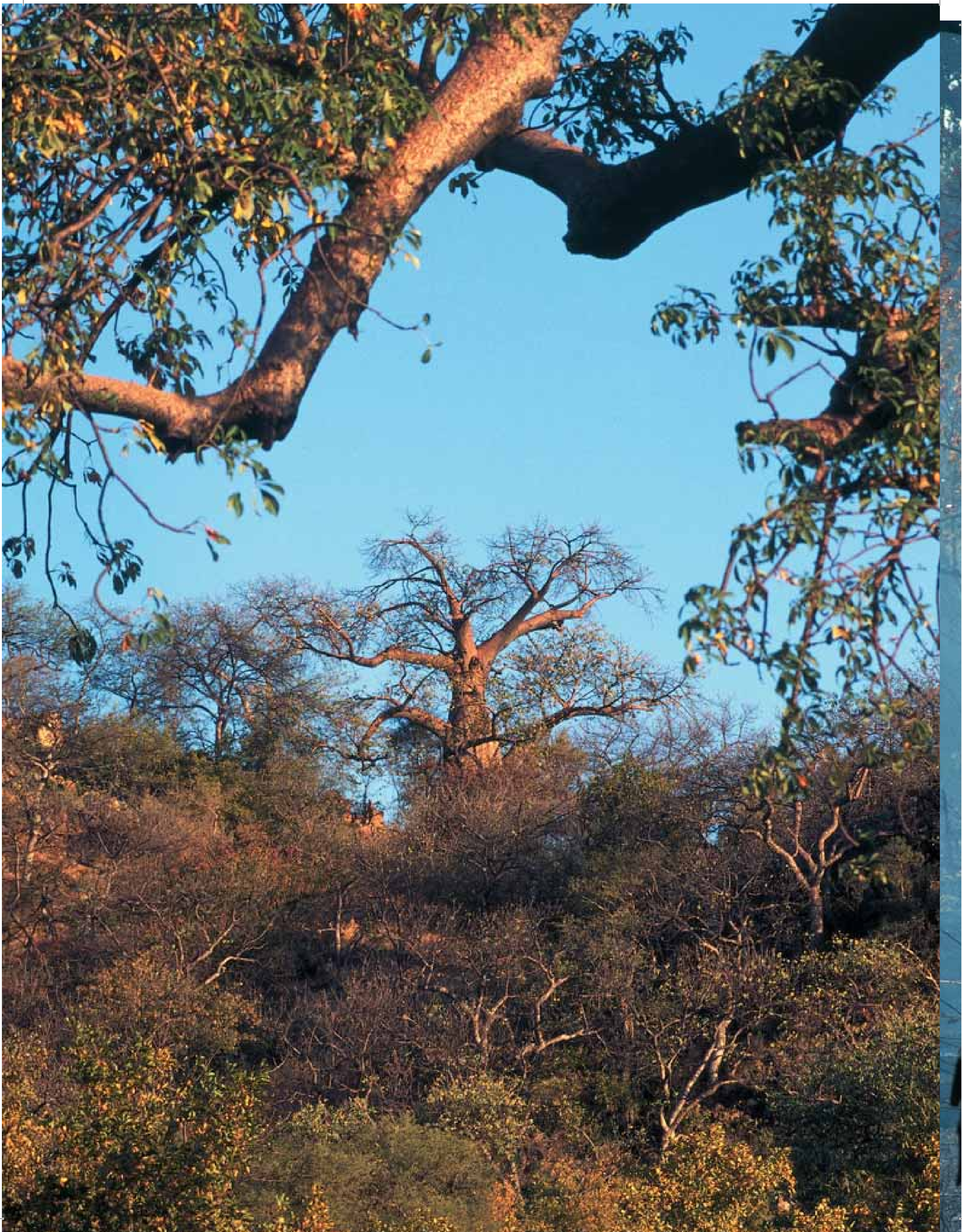
The growth in Namibia's population of elephants is largely due to the better survival of adults. But numbers have also increased as a result of immigration, mainly from northern Botswana and Zimbabwe. Botswana's elephant population has increased at over 6% per year over the past four decades to reach the astounding figure of over 140,000 animals. All forecasts suggest that populations in Namibia and Botswana will continue to boom, perhaps doubling in less than 15 years. Their distributions will also expand and damage to trees will escalate. A troubling aspect is that neither the Namibian nor the Botswana governments have clear plans to control elephants.

One of the latest environmental concerns to sweep the world is climate change, a process that now generates great discussion and considerable speculative hot air. But several aspects are now well established. It is clear that the atmosphere is becoming hotter and that the warming will continue for at least several more decades; for example, average temperatures in Windhoek are now 1.2°C higher than in 1920. The heating is due to two factors: increased greenhouse gases in the atmosphere and a reduction in the capacity of the earth to absorb carbon dioxide because of reduced forest and woodland cover, caused mainly by clearing for agriculture. It is further agreed that all these changes are primarily due to human activities, but scientists and politicians do not always agree on how the changes can be turned around.

It is also generally accepted that temperature changes will affect global circulation and pat-



Such thunderstorms may be less frequent in the future as a result of climatic change caused by increased concentrations of greenhouse gases and global warming. As a consequence, water availability for forest and woodland growth might be reduced in Namibia.



Much of the thick riverine forest in the Mahangu Game Reserve has been lost as a result of damage caused by elephants. In this case, the trunk of a Baobab has been badly scarred.

terns of rainfall. Many studies on the effects of global warming attempt to model how rainfall will change and what that might mean for aspects of life that are themselves affected by rain, such features as flooding, water supply and, of course, forests and woodlands. Just such an assessment has recently been completed for Namibian vegetation, and it draws the following conclusions.[17] Our climate will probably become increasingly arid during this century and that will have impacts on the structure, functioning and distribution of woodlands. Desert and shrub-land should expand, savanna woodlands and grasslands will shrink, and overall plant production should decline. These bleak trends are, however, confounded and possibly compensated by enhanced plant growth due to higher levels of carbon dioxide. Species that cause bush encroachment are then expected to spread and grow more rapidly.

Namibia probably absorbs more greenhouse gases than it produces, and it thus contributes little to global warming.[17] Other than adding to the international lobby for the implementation of international conventions on climate change, such as the Kyoto Protocol, Namibia's ability to reverse the process is limited. However, we can help to reduce forest and woodland losses caused by changing atmospheric conditions. For example, more could be done to protect plants most vulnerable to increasing aridity, perhaps by reducing grazing pressures or the frequency of fires.

CHANGING VALUES, RESPONSIBILITIES AND ACTION

A good deal of this book has been devoted to the values of forests and woodlands. Many of the values are particularly high because of the relative scarcity of these habitats in Namibia's dry environment. Each tree counts because there are so few of them! Values also vary greatly from place to place. A grove of Prosopis growing in the very arid south of the country is extremely precious to a poor household nearby. The same trees in a river in the centre of the country are viewed as invasive aliens, with all the contempt implied by the label.

Values applied to other natural resources vary even more arbitrarily. Much of the world jumps up and down if an elephant or a rhino is killed, but daily massacres of forests and woodlands raise much less concern. Why is so much attention focused on wildlife while trees are frequently neglected? Ironically, it was a botanist who initiated the idea of formal nature conservation in southern Africa. Ludwig Pappe was concerned about deforestation and habitat degradation in the Cape Colony, and his views were translated into the first forest law in 1846. The annual celebration of trees – Arbor Day – began way back in 1872 in the USA. Notwithstanding these early initiatives, it is wildlife preservation that has dominated conservation motives over the past century.

But views on forests and woodlands have increased a great deal over the years, especially in the recognition of many more different values. Thirty years ago, most people would have dismissed the idea of special programmes for non-timber forest products. Estimating the economic value of woodlands as part of the nation's national accounts would have been thought absurd. Emphases have shifted, and nowhere clearer than in Namibia. German colonial government efforts focused on growing trees to supply wood to freehold farmers, whereas the South African government devoted most of its forestry interests to the harvesting of timber from Kiaat and Zambezi Teak. During its first 15 years, the Namibian government has embraced the importance of broad management and conservation of forests and woodlands as a priority, often to enhance rural livelihoods. Much of this was done under the auspices of the Ministry of Environment & Tourism, but emphasis could now be given to agro-forestry after the recent move of the Directorate of Forestry to the Ministry of Agriculture, Water and Forestry.

While perceived values have risen, they remain grossly under-priced. We take some care of the resource, but more remains to be done. What are the most urgent and useful measures Namibia can take to manage and benefit from its forests and woodlands? Three broad categories of activity are required: more protection of these habitats, greater promotion of their importance, and increasing the benefits through wise use and management.

Protection

Fire and the clearing of land destroy far more forest and woodland annually than any other activity. Almost all of this happens in communal areas in the north of the country (Figure 33), where management of the land is the responsibility of rural communities (see Figure 3, page 15). It is the members of these communities who decide to clear land and to set fires. Judging from the number of fields cleared and individual fires lit each year, both practices are common and important to many people. The government has largely withdrawn itself from measures to control fires, hoping instead that community based forest management and education programmes that highlight the dangers of fires will reduce the extent of burning. This is too little to stay the destruction of what is rapidly becoming a non-renewable resource. The hope further rests on assumptions that the interests of the common good will prevail over those of people who set fires, that communities will perceive and receive greater benefits from controlling than allowing fires, that individuals who want to set fires will bow to community opinion, and that communities will put in place actual mechanisms to control fire. Even if these assumptions hold good, they will only be implemented in the few small areas covered by community forests (see page 93).

Most people would agree to the need for rural farmers to clear forests and woodlands to plant crops. The whole practice appears justified by policies to reduce poverty, promote rural development, achieve food security and redress past discrimination that kept people in tribal areas. However, there is also need for care in promoting the clearing of natural vegetation for crop production. We offer four arguments in support of caution.[19] First, subsistence crop farming is characteristically a low input, low output production system. This is a consequence of infertile soils, unreliable rainfall, small investments of labour, fertilizers and manure, and a high potential of crop failure due to drought, disease and pests. Farming is a high-risk business, and efforts to produce decent yields are often lacking. Fields are frequently cleared but soon abandoned, and not because the soils have lost their fertility. Farmers that have access to other more lucrative and reliable incomes lack incentives to invest more seriously in growing crops. All these constraints make it hard to shift a system into producing higher outputs which would better justify the loss of natural habitats.

Second, the many wealthy people having other incomes that far surpass the value of food from their crops generally have much larger fields than those of poorer households. Most of these fields are really luxuries cleared at the expense of resources now lost to everyone, including nearby poverty-stricken households. Third, it is often possible or likely that woodlands would provide greater socio-economic benefits if they were used for purposes other than small-scale crop farming. Tourism is an example of such an alternative. Finally, many agricultural development projects are based on the partial assumption that farmers will be able to sell surpluses. However, marketing is often difficult for small scale farmers because of the low population (and thus market demand) in rural areas, the distances and costs of transporting goods to concentrations of customers in more distant towns, the need for packaging and storage of products, and the difficulty of competing with cheaper products delivered more reliably from wholesalers elsewhere.

There is an urgent need for the Directorate of Forestry to lead a determined campaign to reduce losses due to both fire and clearing creative and coordinated. The campaign should be implemented in conjunction with agronomists and all local leadership structures, rather than concentrating on community forests. All fires should be banned in eastern Kavango and Caprivi, and stiff penalties imposed on those who disregard this. Such an embargo would not stop all burning, and fires would still occur frequently enough to maintain the open savanna landscapes.

Likewise, the Directorate should develop policies for the clearing of forests and woodlands for crops. The guidelines should be translated into controls that local leaders can implement to ensure that natural habitats are only cleared when absolutely necessary. Furthermore, interventions to reduce burning and clearing should become part of a broad agro-forestry programme. Agro-forestry normally concentrates on the cultivation of trees, but this could be widened into a programme that encourages rural farmers to plant and *protect* trees.

Large fruit and shade trees, such as Marula, Bird Plum Jackal Berry trees, have been protected in most small, fenced farms in northern Namibia. These good practices and new efforts to encourage the planting of indigenous trees may lead to the re-foresting of many areas in the north.

In terms of the Forest Act of 2001, State Forests and Regional Forests can be proclaimed as legally protected areas. However, no areas have been set aside in terms of this legislation. The Caprivi State Forest also has no legal status and it is not managed as a state forest, since much of it burns every year with the result that a high proportion of its trees are now dead (see page 109).

Farmers from local villages graze their cattle, set most of the fires and harvest wood in the Caprivi State Forest. In essence, there is a need to take the protection of this and other forest and woodland areas seriously.

Promoting forests and woodlands

At the risk of repetition, why should State or Regional Forests be treated less seriously than those set aside for wildlife? Why are housing and lodge developments along the coast seen as serious environmental issues that demand intensive impact assessments (EIAs), and yet no one assesses the impacts of clearing or burning forests and woodlands? There is no need to repeat the answer, only to stress again the importance of promoting the value of woodland habitats as discussed elsewhere (see page 78).

One aspect to be discussed here, though, is the need for a vigorous programme of research and investigation, one that delivers more product and far less process. Results are needed, and their implications need to be documented and widely disseminated. Three areas of research are needed urgently. First, far too little is known about growth, production and recruitment rates, especially as

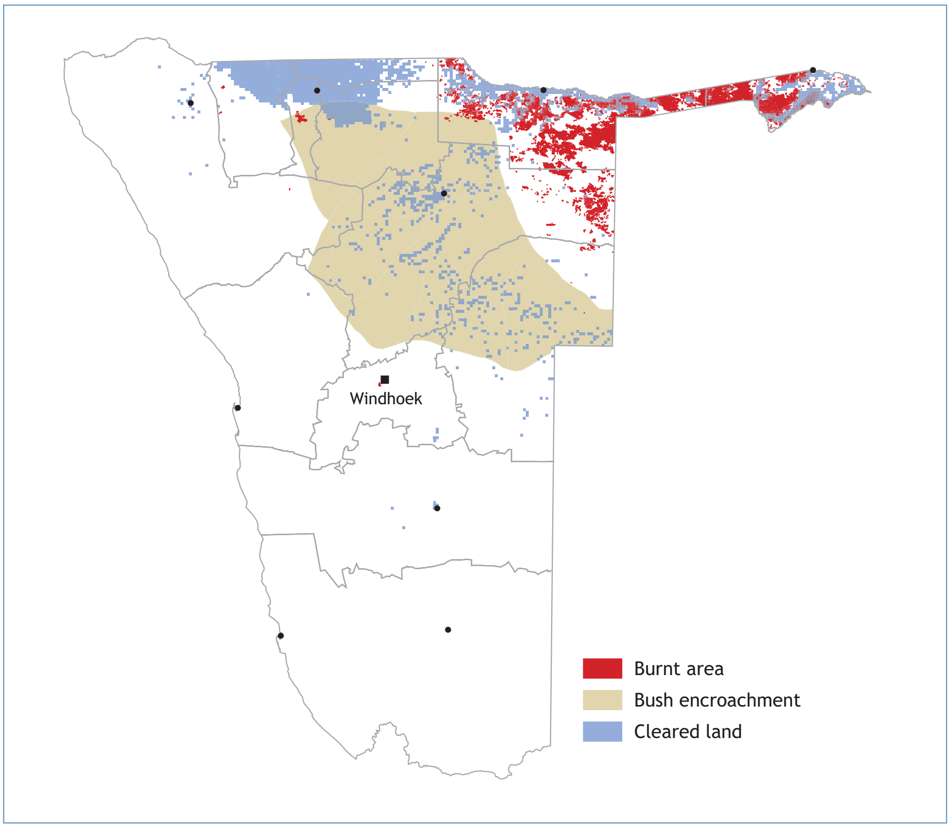


Figure 33. A composite of major impacts on forests and woodlands derived from the percentage of land cleared for crops, the frequency of bush fires and density of bushes.[20]

they relate to the potential harvesting of timber trees. In addition to factual information, a good understanding must be developed of these processes, especially so in the context of Namibia's semi-arid environment where rainfall varies greatly from year to year. If, for example, most significant germination and early growth only occurs during years of good rain, tree production may be much more tenuous than assumed. We don't know this for sure, hence the need to find out. Likewise, agro-forestry initiatives to plant indigenous trees in north-central Namibia will be more successful if they are based on a good grasp of growth and production rates. It might be pointless trying to plant large numbers of trees of certain species if useful production can't be attained in a reasonable time. This must be tested.

Secondly, a much greater understanding of the effects of fire must be assembled. For example, in areas burnt most often (Caprivi State Forest, Caprivi Game Park, and eastern Kavango), our observations suggest that there is almost no annual increment of wood to be harvested from sizeable trees. Instead, there seems to be a net loss, which means a growing loss of Namibia's stock of wood. Although there are many small trees in these areas, most appear to have coppiced as a result of being burnt down in most years. Perhaps this conclusion will be proved wrong once the matter is investigated.

Thirdly, there is the whole issue of bush encroachment. If the idea is correct that most encroachment is caused by a lack of fire and over-grazing, then the only ways of reversing the problem will remain expensive manual or herbicide treatment. Even if grazing is stopped, there is too little grass to fuel fires hot enough to kill the woody plants. The problem is then a compounding one: too much bush → too little grass → less chance of fire →

more bush growth → less grass and less fire, and so on. This is not a happy conclusion, and studies are needed to find alternative solutions.

The focus here has been on issues that have practical implications on the health of forests and woodlands. There are many other topics that require study, and research should not be limited to questions having practical value. Much more basic investigation, sometimes and unfairly called esoteric research, is also needed to add to the store of information available, and to improve our understanding of the processes and principles that govern forest and woodland environments.

The production of seeds by Candle-pod Acacias is the first step in the generation of new trees. Later survival and growth and is a tenuous process, particularly in the relatively harsh Namibian environment. As much as we reap the benefits of trees, so too should we keep additional hazards induced by people to a minimum.

More benefits

During the past 15 years, Namibia has made substantial progress towards enhancing the value of benefits from forests and woodlands, especially by developing indigenous plant products (see page 72) and community forests (see page 93). What more can be done, however? It should be clear that forests and woodlands have many potential values of which we know nothing. Indeed, many of the indigenous plant products now being tested for their commercial potential were unknown until recently. Vigorous, creative exploration and investigation is certain to yield many more products that have similar, or perhaps quite different uses. The more we search and think about possible benefits, the more will be found, both as direct uses and as added values. The many indirect values of forests and woodlands – shade, wildlife habitats, browse and the absorption of carbon dioxide, for example – need to be publicly promoted as well. Too many people know too little of these benefits.

The most important innovation of the community forest programme is the creation of opportunities for rural people to own, manage and derive greater benefits from woodland habitats. Values and ownership go hand in hand. There is now a need to accelerate the programme and to declare as many community forests as possible. Enthusiastic determination in the Directorate of Forestry should lead the process. The greatest values from forests and woodlands are likely to come from wildlife and tourism, and a much stronger linkage – preferably amalgamation – with conservancies is desirable. These more lucrative enterprises, which bring additional income through multiplier effects and job creation, will do more to alleviate poverty than small incomes from the sale of a few bundles of firewood, for example. They will also provide more sustainable incentives for communities to manage and conserve forests and woodlands. Furthermore, local empowerment should be strengthened by providing legal rights, institutional arrangements, procedures, and management and monitoring tools which are robust and easy for communities to use.

Forestry is not an activity indigenous to Namibia, but much has been achieved by building systems and policies to take better care, and make greater use of our forests and woodlands. Of course, much more has to be achieved, both in the short and long term. Recall that Namibian trees are slow growers, often taking one or two hundred years to reach sizes where they provide useful shade, timber or other fruit. We can easily remove and harvest trees, but we can't replace them rapidly. A tall Camel Thorn, Ushivi or Zambezi Teak killed today will only be replaced by an equally large tree one or two centuries from now. Only then, several generations later, will people to whom we bequeath Namibia's forests and woodlands enjoy the same shade, timber and fruit.

Key points

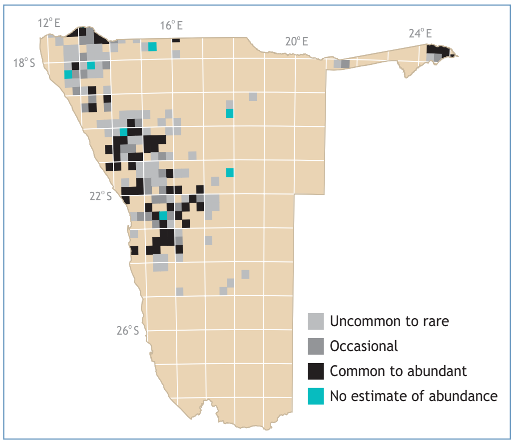
- Three processes induced by people have led to the biggest losses of large areas of woodlands and forests: the clearing of land for crop cultivation, the frequent burning and killing of trees in the north-east, and bush encroachment in the central and eastern regions.
- Other significant damage to forest and woodland habitats has been caused by the damming of tributaries of ephemeral rivers, water abstraction from aquifers and large populations of elephants.
- Global warming and climate change may lead to lower rainfall and a loss of trees, but it is also possible that increased carbon dioxide in the atmosphere could promote plant growth.
- Namibia should offer greater protection to forest and woodland habitats, promote the importance of these habitats, and increase benefits derived through the wise use and management of woodlands and forests
- Most valuable, indigenous trees grow very slowly in Namibia. Those killed today by farming practices or bush fires will only be replaced by trees offering equivalent benefits and uses a century or more from now.


TWENTY Namibian trees

ANA TREE

Faidherbia albida

Other names: Anabaum, Anaboom, Anas, Mbunga, Omue, Winter Thorn



The Ana Tree is protected in Namibia and belongs to the pea family, Fabaceae. Most individual trees are 10 to 20 metres in height, but the spreading crowns of the tallest trees reach up 30 metres above ground. The young trees are usually thin or spindly, and have a relatively smooth, light coloured bark that later becomes rough and greyish-brown. Young twigs are almost white and bear light coloured thorns of about 2 centimetres in length. The flowers are creamy-white, very small and clustered in spikes, and appear before the onset of the rainy season or during winter. The leaves are also borne during winter, and these unusual features are possibly due to the roots being deprived of oxygen during the summer when rivers are in flood. The fruit are large, curled, orange-brown pods, which sometimes look like dried apple-rings.

The species occurs widely in the drier areas of tropical and sub-tropical Africa, and extends into the Middle East. The trees are most abundant on alluvial soils along rivers, especially along the western ephemeral rivers of Namibia. Ana Trees may survive several months of flooding but are reputed to be sensitive to frost.

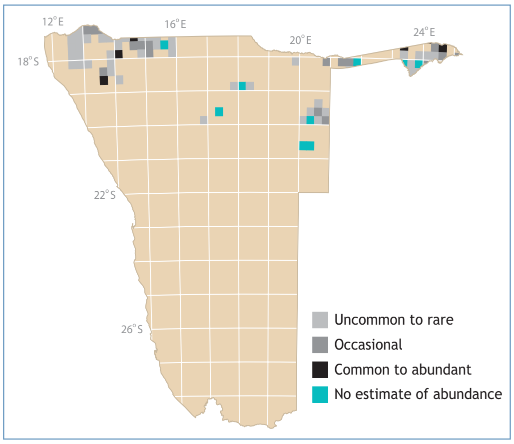
The fruit is attractive to herbivores, which disperse the seeds in their droppings. Germination is aided by the herbivores' digestive juices. Young trees can grow quite rapidly, their height increasing by 1.5 metres and more per year, and their roots growing up to 13 millimetres per day. Damaged roots may coppice, thus producing new trees vegetatively.

The pods are valuable fodder, especially in western Namibia and when other food is scarce in winter. Farmers frequently collect and grind up the pods to improve the digestibility of seeds that would usually pass undamaged through cattle, thus increasing the animals' intake of energy and protein. Other important benefits are provided by shade in reducing the evaporation of soil moisture beneath the crown, and in creating cool resting places for animals and people. The trees add nutrients to the soil as a result of nitrogen fixation by their roots and the decomposition of fallen leaves and twigs. Dung and urine produced by animals resting in the shade further improve soil quality. The wood is coarse-grained, rather light, and is not suited for furniture.

BAOBAB

Adansonia digitata

Other names: Affenbrotbaum, Divuyu, Dorsboom, Kremetartboom, Monkey-bread Tree, Mubuyu, Mukura, Omukwa, Uyu



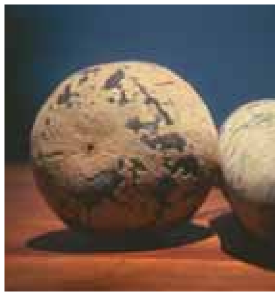
Of all trees in Africa, the Baobab – with its characteristic and peculiar shape – must rank as the best known. It is also one of the largest trees in the world, and often associated with legends and superstitions. There are nine species of Baobabs: one in Africa, seven in Madagascar and one in Australia. The trees belong to the family Bombacaceae. The Baobab is a protected species in Namibia.

Baobabs occur singly or in loose groves throughout drier woodland areas south of the Sahara, being absent from the wettest, driest and highest areas. Populations are clumped in five areas in northern Namibia. Most trees grow on well-drained soils in places free of frost. The tallest trees rarely exceed 25 metres in height, and the biggest trunks can be up to 12 metres in diameter. The bark is normally greyish and smooth, but often deeply folded. Both the bark and wood are relatively soft and fibrous.

The fruit is oval, with a hard woody shell covered in short velvety hairs. The large white flowers have an unpleasant scent, and are probably pollinated at night by bats. Flowering occurs at the end of the dry season, while the fruit develop late in summer.

Seedling and sapling growth is very rapid. Under optimal conditions, young trees may grow to heights of 3 metres within two years.

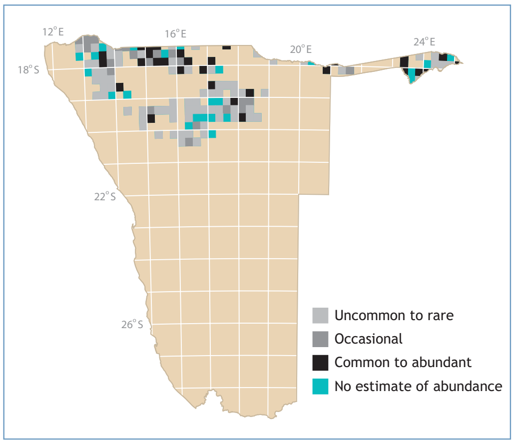
Baobabs provide food to people and a wide range of animals. They are also considered a good source of water during the driest conditions. The leaves are rich in vitamin C and sugars, and are often cooked as spinach. Young roots are cooked as well. Many animals eat the leaves and flowers. The fruit pulp also contains lots of vitamin C and is used to prepare a drink. Elephants chew the soft wood, especially at the end of the dry season when water is in short supply. The fibrous bark is often twisted into fibre or rope to fashion baskets, floor-mats and other items. Hollow trunks are frequently used to store water and provide shelter. Some of the biggest trees have provided cavities for toilets, homes, post offices, bars and prisons! The leaves, roots and pulp are used as traditional treatments for urinary disorders, diarrhoea and fever. Recent chemical analyses have shown that the pulp has significant anti-inflammatory and analgesic properties.



BIRD PLUM

Berchemia discolor

Other names: Bruinivoor, Eembe, Mukalu, Mukerete, Muzinzila, Ombe, Omuve, Wilde Dattel



The Bird Plum is widely distributed in Africa, extending from the Sudan to South Africa, and growing in a variety of woodland and forest habitats. In drier areas, its growth is often in association with termite mounds. The tree is most abundant in Caprivi and in the Cuvelai Drainage in north-central Namibia, but nowhere is it a common species. Despite its socio-economic importance, relatively little appears to the known about the Bird Plum in Namibia. It belongs to the family Rhamnaceae.

This is a medium-sized deciduous tree, which usually reaches a height of between 7 and 20 metres. The crown is rounded, the bark dark grey, rough, fissured, and flaky on older trees. The wood is yellow to brown, hard and has an attractive grain suited to furniture. However, its commercial value for timber is limited because few trees have stems long enough to produce usable planks. The oval to oblong leaves are dark green above, much paler below and their herring-bone veins are a diagnostic feature. Small greenish to yellow flowers are borne between October and January. The fruit is a small drupe that turns yellow when ripe. It is easy to propagate from seed and the species may produce root suckers. Once established, however, the tree is reputed to be rather slow growing.

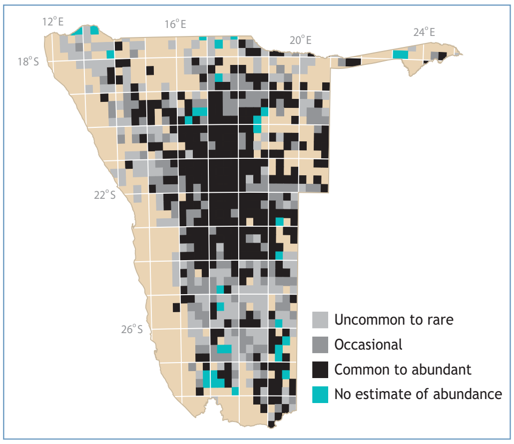
The tasty fruit are rich in vitamin C, and are often collected and eaten as snacks. They also have a high sugar content making them suitable for the production of alcohol known as *ombike*. Dried fruit are often sold at informal markets in north-central Namibia. Birds and other animals are attracted to the fruit. An extract of the inner bark is frequently used to produce a dye to colour palm fibre for weaving. The potential production of liqueurs and jelly from fruit for commercial purposes is now being investigated.

Various traditional healing properties are associated with the tree. The phloem, found directly under the bark, is pounded and boiled to treat nausea, vomiting and diarrhoea, while the leaves are used to make poultices for the treatment of wounds. As a result of all these uses the Bird Plum is of substantial value to people in many rural areas where the trees are usually protected. It has also been legally protected in Namibia since 1975. However, the harvesting of bark for dyes sometimes results in trees being killed.

BLACK THORN

Acacia mellifera

Other names: !Noes, Hakiesbos, Kankata, Omungondo, Omusaona, Omutukahere, Swarthaak



Black Thorns are widespread in Namibia and elsewhere in Africa, where they occur south from Egypt to South Africa, and also on the Arabian Peninsula. Two distinct subspecies are present in Namibia: *Acacia mellifera detinens*, which is most widely distributed, and *Acacia mellifera mellifera* in the far north-west. They grow in a variety of soils, aspects, elevations and habitats in Namibia, but are generally absent from sandy and saline soils, and from the most arid western and southern areas. In many places, the species forms almost pure, dense, impenetrable, even-aged thickets. This is especially the case in the central parts of the country, where the growth of Black Thorns has led to problems of bush encroachment (see page 112). Densities of 10,000 and more Black Thorns per hectare have been recorded. Taxonomically, they belong to the family Fabaceae.

Growth forms vary between multi-stemmed shrubs or small to medium sized trees. The dark grey bark is initially smooth, but roughens as the tree ages. The sapwood is light in colour while the heartwood is dark brown. Small hooked sharp thorns grow in pairs along the branches. The leaflets are characteristically rounded rather than elongated, and grey-green in colour, drying to yellow. The creamy white flowers have a pleasant scent, and are said to be highly attractive to bees. Flowering usually occurs before the rainy season in August and September, and the fruit mature over the following two or three months. The pale brown pods hold two or three seeds, and are very thin and papery, properties that allow them to be dispersed by wind.

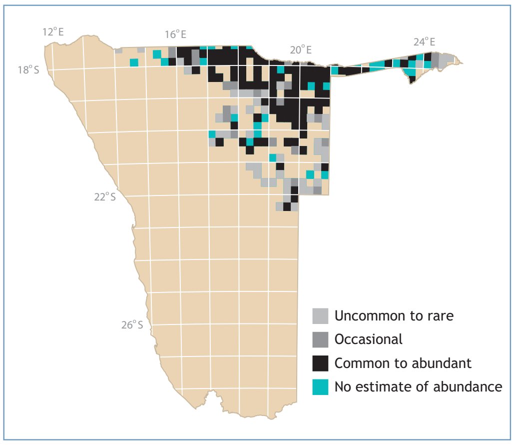
This is a hardy species that can withstand long periods of low rainfall. The seeds germinate readily, and Black Thorns also coppice easily. As a result, a new cover of shrubs rapidly develops in areas where invasive bushes have been cut, but not killed by herbicides or other means. The fungus *Phoma glomerata* has killed fairly large patches of Black Thorns in certain parts of the country (see page 114).

Flowers, leaves, twigs and pods of Black Thorns are considered valuable fodder for cattle, goats and game. The bark of the tree is traditionally used for treating colds. Charcoal is now produced on many farms where the species has caused bush encroachment.

BURKEA

Burkea africana

Other names: Omutundungu, Muhehe, Musheshe, Red Syringa, Sandsering, Wildesering, Wild Syringa,



This is the most abundant and conspicuous large tree growing on Kalahari sands in the north-eastern woodlands, where it forms almost pure stands over large areas. It is particularly abundant in Kavango and eastern Ohangwena. Elsewhere in Africa, Burkeas are widely distributed in dry savannas from Nigeria southward to north-eastern South Africa. The species belongs to the family Fabaceae. It is a deciduous tree growing up to 12 metres tall, and very vaguely resembles a Syringa. It has a characteristic long, thin trunk, which divides into several large branches that support a loose canopy. The bark is dark grey and has a tendency to flake, thus being rough to the touch. The wood is a pale yellow to reddish-brown, hard and heavy. Unfortunately the wood is frequently attacked by woodborers which, together with the generally thin trunks of most trees, means that it has little use as timber for furniture production. However, the wood is often used for building huts, and for pestles and mortars. It serves moderately well as firewood.

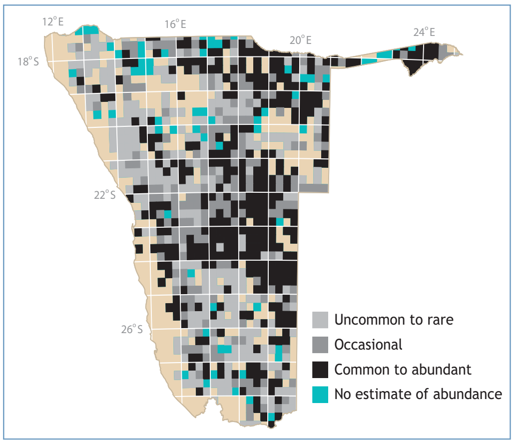
Burkeas are the last large trees in the north-east to lose their leaves during the dry season when they produce a splendid show of autumn colours. Flowering is between September and November before the flush of new leaves. The flower spikes are unspectacular creamy-white to green. Each fruit is a flat pod bearing one seed. The pods hang in conspicuous clusters and may remain on the tree throughout the dry season. Flowering is possibly halted for several years after severe fires. Seedlings appear to establish themselves more vigorously under a tree canopy than in the open. Growth above ground is initially slow as the root system develops, but they grow more rapidly once they reach sapling-size. Most large trees are at least 100 years old.

Their leaf-litter adds significant amounts of nitrogen to the soil. Two species of edible caterpillars feed on the leaves, and these may form a valuable source of supplementary protein for people. An extract from the bark and pods can be used for tanning, while the bark may be chewed and used as a poultice on septic sores. Infusions from the roots are used to treat toothaches and stomach pains. Some hunters believe that smoke from fresh roots make their prey drowsy. Ash from charred roots is rubbed into the skin to ensure a successful hunt.

CAMEL THORN

Acacia erioloba

Other names: _ganab, Kameeldoring, Kameldornbaum, Muhoto, Muntu, Omumbonde, Omuonde, Omuthiya



Camel Thorns must rank as the best-known, most popular, and perhaps most widespread tree in Namibia. They vary in structure and size, growing as shrubs or medium-sized trees up to 20 metres in height, and with typical umbrella-shaped, flat-topped crowns. The rough bark is dark grey to blackish brown and deeply furrowed. The wood is dark red, extremely hard and reputed to be termite-proof. Like other Acacias, Camel Thorns belong to the pea family (Fabaceae) and were proclaimed a protected species in 1952.

The branchlets have a characteristic zigzag growth, and bear straight, paired thorns that are swollen at the base. The leaves are dark green, relatively hard and feathery., and carried almost year-round since old leaves fall late in the dry season just before the new ones emerge. Clusters of bright yellow, strongly and sweetly scented flowers are also produced before the first rains between August and November. The pale grey, half-moon shaped pods grow to a maximum length of about 13 centimetres; this makes them the largest Acacia pods. The number of flowers and pods produced varies greatly between individual trees and from year to year.

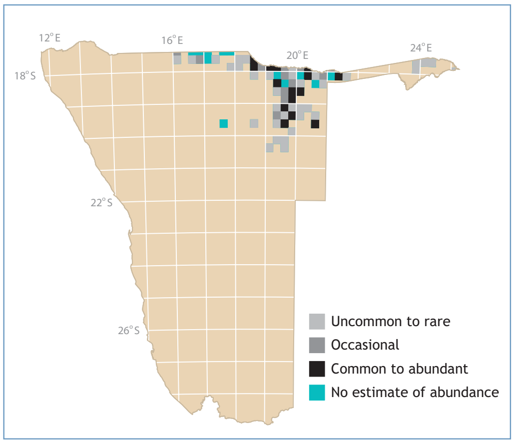
Other than in the most arid areas along the Namib coast, Camel Thorns are conspicuous throughout Namibia. However, they only grow in places where they can sink their deep roots to water far below the ground. It is those roots and water sources that allow them to grow on dunes in the Namib and Kalahari, and in other areas that receive very little rain. Elsewhere, Camel Thorns are found throughout Botswana and Zimbabwe, northern South Africa, southern Angola and Zambia.

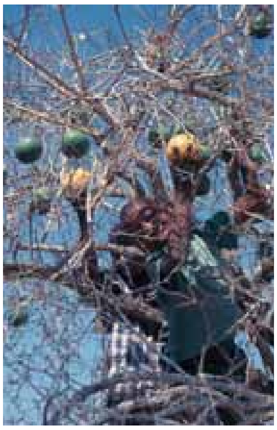
Camel Thorns are slow growers, and most large trees in Namibia are probably at least 200 years old (see page 39). Their hard wood is popular for firewood (even though they were proclaimed a protected species in 1952), and stems and thicker branches have been used extensively for fence posts. Traditional medicines are produced from the roots (chewed to relieve pain or treat coughs) and the bark (burnt and ground to a powder as a cure for headaches). Cattle and game animals browse pods, flowers and foliage, and the pods are said to stimulate milk production by cows. The extensive crowns of Camel Thorns often provide the only available shade in the hot Namib and Kalahari Deserts.

CORKY MONKEY-ORANGE

Strychnos cocculoides

Other names: Omauni, Maguni, geelklapper, muhuluhulu





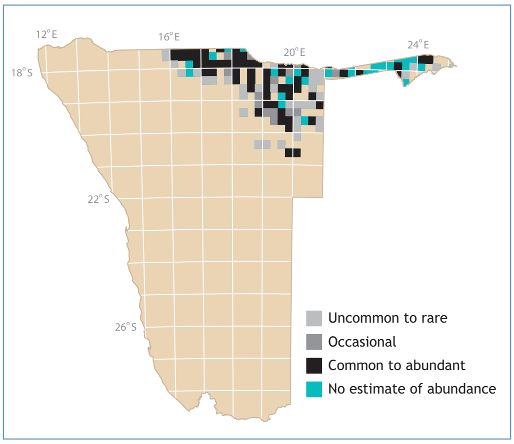
Corky Monkey-oranges are mostly found on deep sand in north-eastern Namibia, elsewhere occurring in northern South Africa, Zimbabwe, Zambia and Angola. These small trees with their dense, rounded crowns normally grow to a height of 2 to 8 metres. Their bark is characteristically corky, pale brown to creamy coloured with deep longitudinal ridging. The wood is white and fairly tough. Paired, slightly curved, strong spines arm the branches and twigs, each of which generally ends in a spine. The young leaves are very hairy, becoming rather smooth and dark green later. Small greenish white flowers are produced in September to November. All species of monkey-oranges belong to the Strychnaceae family; strychnine poison is derived from the seeds of some species in this family.

The fruit of this species and those of Spine-leaved and Spiny Monkey-oranges are popular in north-eastern Namibia, and are frequently sold along the road between Rundu and Grootfontein and in informal markets in towns and villages. The fruit ripen between April and August, and are about the size of oranges. However, sizes vary from one area to another. Corky Monkey-orange fruit have hard, woody shells that are dark green and speckled with white while young, while those of Spiny Monkey-oranges lack the white speckles, and Spine-leaved Monkey-orange fruit have a distinctive bluish green colour. The fruit of all these species, however, turn yellow when ripening. Seeds are embedded in a pulp that gradually liquefies as the fruit ripen. In fact, the green fruit are often harvested and buried in the sand until the pulp has liquefied. A hole is then made in the shell and the liquid is drunk directly. Jam and spirits may also be produced and a bottled liqueur from monkey-orange fruit has been made and sold. Other commercial prospects include the production of oils and more widespread marketing of fresh monkey-orange fruit. The wood is used to make handles for implements.

KIAAT

Pterocarpus angolensis

Other names: Bloodwood, Dolf, Ghughuwa, Mukwa, Uguva



Kiaat grow in warm, frost-free areas in South Africa, Zimbabwe, northern Botswana, Mozambique, Angola, Namibia, and north into Tanzania. Namibian Kiaats are strictly limited to sandy soils in areas where rainfall exceeds 400 millimetres per year. Mature trees normally reach a height of 10-12 metres, and have characteristic flat-topped crowns, giving the trees an umbrella-shape. The bark is grey-brown, deeply creviced with a slightly corky feel. The flowers are yellow to orange, and the distinctive bristled and winged pods give the genus its name: *pter* meaning wing and *carpus* for fruit in Greek; literally winged-fruit. The Kiaat belongs to the Fabaceae family.

Fire apparently stimulates germination, and seedlings are generally only found in open areas cleared by fire or human activity, so that the young trees have less competition from other woody plants for water or light. Growth rates vary, probably according to rainfall, soil fertility and other environmental conditions, but the trees normally grow slowly and most large trees are therefore between 100 and 150 years old (see page 39). Kiaat only start flowering at an age of about 20 years. New flowers and leaves usually appear in September and October before the onset of the first rains.

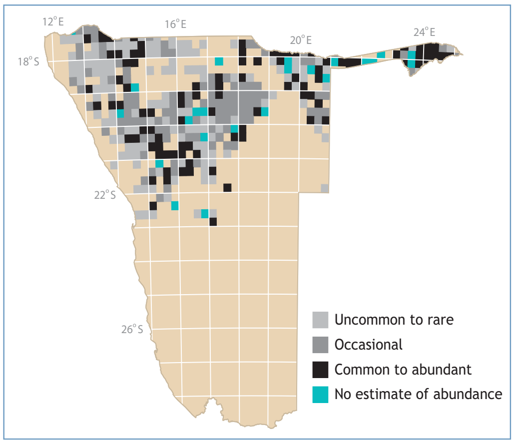
Cut stems and large branches exude a dark-red sap which gives the tree its alterative name of Bloodwood. The sapwood is pale yellow, while the heartwood is dark, reddish brown, attractive and relatively hard. These qualities, the long, straight stems, and the fact that the wood is seldom knotted and easier to plane and cut than other local hardwood species, make Kiaat the most valuable tree for timber and furniture production in Namibia. Very large numbers of the biggest trees were harvested between the 1940s and the 1990s in Kavango and Caprivi.

Kiaat trees are also the mainstay of the woodcraft industry, while whole tree trunks may be used to produce *mokoro* dugout boats. As a traditional medicine, the sap is used to treat coughs, and stomach and eye problems, and is also processed into a paste for skin care. The latex can be used to produce a red dye used to colour baskets.

LEADWOOD

Combretum imberbe

Other names: Ahnenbaum, Hardekool, Munyondo, Muzwili, Omukuku, Omumborombonga



Leadwoods are highly respected for their spiritual and cultural value in representing the ancestry of people and animals; Herero folklore tells how the first humans emerged from a hole in the trunk of the tree, followed by their cattle and wild animals. The tree generally grows to a height of between 7 and 15 metres, but very tall ones can reach 20 metres. The bark is usually light grey and fissured, forming an irregular pattern of small squares. Leadwoods belong to the family Combretaceae, together with the many other Combretum species. The species is protected in Namibia.

The wood is dark and extremely heavy or dense, giving it durability (for example, as fence posts) and making it amongst the best firewood in Namibia. Dead trees may remain standing for decades. Even fallen branches do not decay for a very long time. The leaves are grey-green and the flowers are creamy to yellow and sweetly scented. They bloom between November and March. The small four-winged pods seldom exceed 15 millimetres in diameter. The Leadwood is the largest of all the Combretums but has the smallest pods. These are borne in large numbers, giving the trees a yellowish appearance.

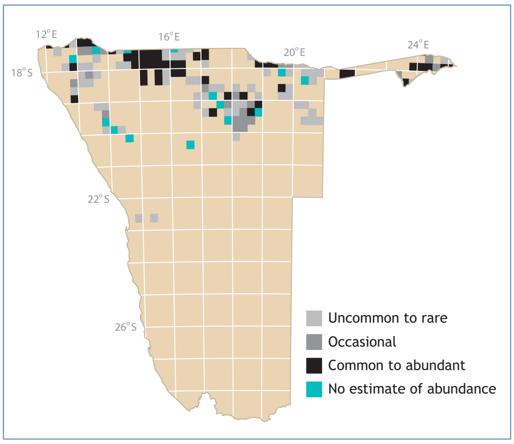
The species is very widely distributed, occurring over much of northern and eastern South Africa, Swaziland, Botswana, Namibia, Angola and north into East Africa. They are most abundant in eastern Caprivi. Although widely spread across the rest of northern Namibia, Leadwoods are generally and locally limited to alluvial clay soils on the edges of rivers, dry water courses, inter-dune valleys and isolated pans. Their absence further south might be due to sensitivity to frost. Leadwoods are very slow growing, and the largest trees in Namibia must be extremely old.

Leadwood ash has been used as a toothpaste, or, when mixed with milk, as a whitewash paint. A variety of large mammals and cattle eat the foliage. As a traditional medicine for bad colds, smoke from the leaves is inhaled or the leaves are chewed.

MAKALANI PALM

Hyphaene petersiana

Other names: Omurunga, Fan Palm, Epokola, Mbare



Makalani Palms are common along many of the ephemeral rivers in north-western Namibia, but they are a really prominent feature of the oshana landscape of channels in Omusati, Oshana and western Oshikoto. They grow here as tall single trees or in copses on clay soils which is their preferred substrate in most parts of their range. In Kavango and Caprivi, however, most plants are much smaller and more bushy than those near the Cuvelai Drainage. Outside Namibia, the species is broadly distributed in tropical and sub-tropical areas from northern South Africa up to Tanzania and west across into the Congo Basin. Some trees have one slender trunk but most have multiple stems that are fused at the base. Often the stems have a bulge along the middle of the trunk. The leaves are fan-shaped, usually dark green to greyish green, and carried on thorny stalks in a dense cluster at the top of the stem. Makalanis are protected in Namibia, and belong to the Arecaceae or palm family.

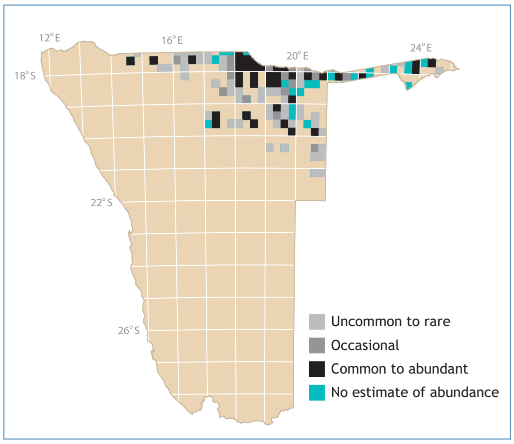
Male and female flowers are produced on separate trees during September and October. The rounded fruit with reddish-brown shells are borne in large bunches. Fibrous tissue inside the shell surrounds a relatively hard core. New plants can grow vegetatively from suckers produced by the roots. During the first seven years or so, young plants concentrate their growth on the development of underground stems, which are probably used to store water until the tap roots have grown long enough to reach water sources far below the surface. The palms also have extensive shallow roots, perhaps to anchor and stabilise the tall plants with their thin stems, and to take up water during rains and flooding.

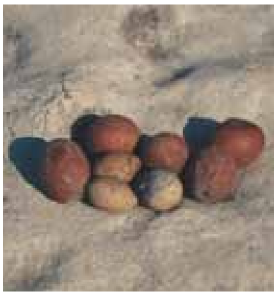
The leaves provide fibre to weave mats, hats and baskets for domestic uses and the craft industry, while leaf stalks are often used for fencing (see page 67). The nuts are very hard, but may be processed and eaten. Often called vegetable ivory, the nuts are nowadays often carved into small ornaments and trinkets to adorn key rings, necklaces or charms. The core of the trunk is relatively soft and may be extracted and eaten as a vegetable. Palm wine is produced from sap collected from the growing tip, but this often results in the death of the plant. Elephants sometimes bump the trees to dislodge bunches of fruit.

MANGETTI

Schinziophyton rautanenii

Other names: Manketti, Mugongo, Omunkete, Ugongo





The Mangetti is a medium to large deciduous tree growing to a height of 12 metres. Although the tree has a fairly characteristic shape, the form of the crown varies, apparently in relation to the density of trees. Isolated trees have rounded crowns while those in denser stands have crowns with flatter tops. The bark of mature trees is very thick, yellow-grey to golden in colour and relatively smooth, sometimes flaking off. The pale yellow wood is light, sometimes being used to produce carvings and small pieces of furniture. Five to seven leaves are arranged spirally around a single point, a formation known as digitate. The sexes are separate on different individual trees. Yellow flowers, each about 10 millimetres in diameter, are borne in slender sprays in October and November. Mangettis belong to the Euphorbiaceae family, and were declared a protected species in Namibia in 1952.

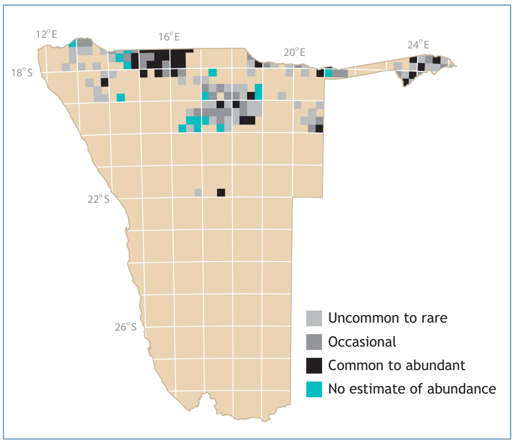
Mangetti trees are patchily distributed across northern Namibia, growing on deep Kalahari sands. Elsewhere, the species only occurs in a narrow belt extending across southern Angola, northern Botswana and Zimbabwe, and over much of Zambia, Malawi and Mozambique. The trees have long taproots to draw water from deep, saturated sands. In some areas, such as in western Kavango, they are locally dominant and abundant. The groves may extend over thousands of hectares, and are valuable resources to nearby rural communities who harvest the fruit. Each fruit contains one or two nuts surrounded by an extremely hard shell. Kernels extracted from the nuts are roasted or pulped. Oil is obtained from the boiled pulp and the remaining pulp is eaten. A potent alcoholic drink, known as *kashipembe*, is derived from the fruit. The possibility is being investigated of producing nuts, liquor and oil for commercial markets.

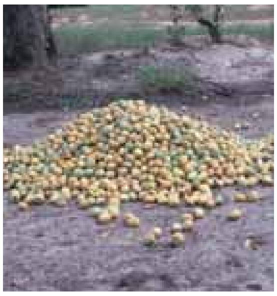
Fruit production varies from year to year, apparently in relation to rainfall. In years after good rains, female trees may produce a thousand or so fruit. About 2,000 tons of fruit were exported each year during the early 1900's, perhaps making Mangetti to be the first indigenous fruit exported from Namibia.

MARULA

Sclerocarya birrea

Other names: Malula, Maroela Omugongo, Omungongo, Uwongo





The Marula is a medium-sized deciduous tree, usually growing to a height of 10 to 20 metres. The crown is rounded and somewhat spreading, topping a trunk that may grow to a diameter of 1 metre and more at its base. The bark is dark grey, but flakes that peel off reveal a lighter under-layer, giving the trunk a mottled appearance. The wood is very pale with a pinkish tinge, and relatively light in weight.

Male and female flowers may be borne on the same tree but are usually carried on separate trees. Flowering is between September and November, and fruit mature between February and June. The egg-shaped fruit remain green while on the tree, but turn yellow and ripen once they fall to the ground. Each fruit contains a single stone that is surrounded by a fleshy edible pulp. The stones themselves contain two or three seeds that are rich in protein.

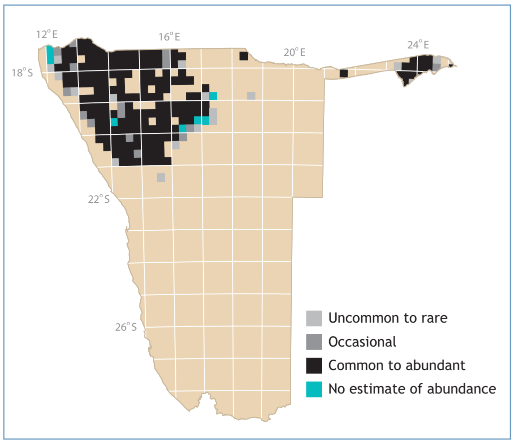
Marulas are widely, but patchily distributed in northern Namibia. They are absent from the Kalahari sands. The species is most abundant and conspicuous in the Cuvelai Drainage where the trees have been nurtured, protected and perhaps propagated by small-scale farmers over several hundred years. Along with Bird Plum and Jackal Berry trees, they are the only large trees that remain in many parts of the Cuvelai. Marulas occur widely elsewhere in Africa: from Namibia, Botswana and South Africa north to Angola, Zambia, Ethiopia and Sudan, and through the savannas north of the tropics to West Africa.

Fruit are collected at the end of the rainy season and processed into a variety of products. The pulp is rich in Vitamin C and is often eaten directly. However, it may also be used to produce juices, jelly or alcoholic beverages, such as marula wine, known as *oshinwa.* Kernels extracted from the hard shells are either eaten unprocessed or boiled to extract their oil, which can be used for cosmetic purposes. The oil is also used for cooking or processed into soap (see page 72). The nutritious fruit are favoured by elephants and many other animals. The bark has been used to treat dysentery and diarrhoea and is believed to prevent malaria.

MOPANE

Colophospermum mopane

Other names: Gais, Mupanyi, Omusati, Omutati, Pana, Tsaurahais



Mopane trees provide many resources to rural communities lucky to live near populations of this species in and around Omusati and Oshana, and in eastern Caprivi. Livestock browse the trees and shrubs; stems and longer branches provide poles for construction and fencing; and the wood makes excellent firewood. Rope and twine can be made from the bark, which is also used for tanning. Many of the uses derive from the fact that Mopane wood is extremely hard and resistant to decay. Moreover, bushes or trees that have been harvested produce new coppiced growth quite rapidly. The largest trees in Namibia are probably 150 and more years old. Mopane is a protected species. Roots are sand blasted and sold as ornaments in Europe, supporting a small local export industry. Many people value Mopane worms as a delicacy. They are the larvae of emperor moths that feed on the leaves (see page 75).

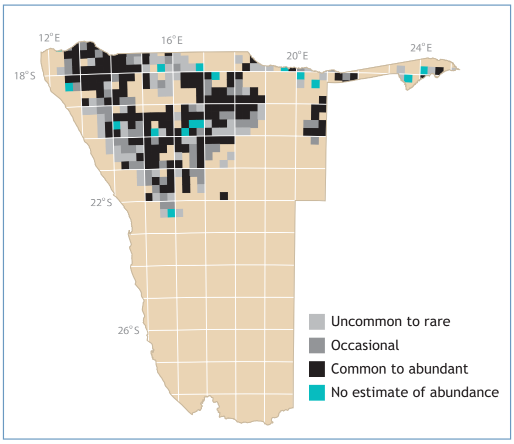
Mopane belong to the Caesalpinioideae, one of three subfamilies of the pea family Fabaceae. The species is locally abundant and may dominate the vegetation, often forming pure stands. In some areas, they grow as relatively tall trees (up to 10 metres), while in other areas (especially in central Omusati) Mopane forms continuous stands of shrubs that average 1 or 2 metres in height. What determines these very different growth forms appears unknown, but soil conditions, water availability, and perhaps frost, are likely to play a role. Throughout its localised, patchy range in Namibia and elsewhere in Angola, South Africa, Mozambique, Botswana, Zimbabwe, Zambia and Malawi, the species is limited to clayey, alluvial soils in dry, hot and low lying areas.

Each plant normally has several stems. The bark is grey, deeply fissured and flaked on larger trees. The heavy wood is reddish brown in colour. Each leaf consists of two distinctive leaflets joined at the base, looking like a butterfly or the hoof print of an antelope. Small, green flowers are borne in slender sprays from November to January, but individual plants may not flower for several years. A single seed is contained in each flat, kidney-shaped pod. The pods are distributed by wind or by sticking to the hooves of animals. The name *Colophospermum*, which means oily seed in Greek, was given because of the high content of sticky resin found in the seeds.

PURPLE-POD TERMINALIA

Terminalia prunioides

Other names: Blutfruchtbaum, Deurmekaarbos, Heras, Muhama, Omuhama



The Purple-pod Terminalia is usually a shrub or tree growing to height of 3 to 10 metres, although some much taller trees grow to 15 metres. Its rounded, untidy crown is formed by the jumbled growth of the branches, most appropriately reflected in the Afrikaans name *Deurmekaarbos.* The bark is grey to brownish and stringy on young branches, while the wood is yellow and hard. The fruit are characteristically dark red or purple, each consisting of a single kernel surrounded by two wings. Fruit often remain hanging on the tree until the next flowering season, when old fruit and flowers may be seen together on the same tree. Its colourful display of purple fruit makes this an attractive ornamental garden plant. The flowers are small and cream coloured and emit an unpleasant odour. Fresh leaves appear in distinctive clusters on the tips of branchlets in the beginning of November, before the first flowers appear. Flowers are produced following rain, and a tree may flower more than once in a season. Purple-pod Terminalias belong to the Combretaceae family.

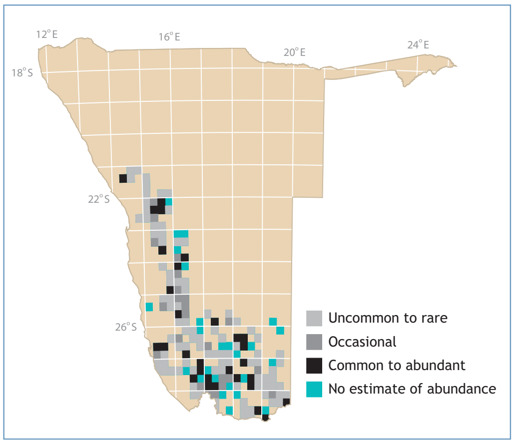
The species grows in a variety of habitats, ranging from dense woodland and rocky hills to dry watercourses or flat grassy plains, and often on poor soil. However, they are absent from the Kalahari sands, and those Purple-pod Terminalias in north-eastern Namibia are all found on patches of more clayey or other soils. In some areas of the country, especially around the Otavi-Grootfontein-Tsumeb hills, the species has become an invasive problem associated with bush encroachment.

The hard wood of this species is very useful for firewood, charcoal, implement handles, hut construction and fence posts. Its fresh fruit and leaves are sometimes used to prepare tea, but no medicinal properties seem to be attributed to the brew. Pulverised rotten heartwood of the tree is sometimes used as a fragrant cosmetic. Giraffe browse the flowers and young shoots while antelope are reported to eat the leaves and small shoots during the dry season. Young buds form an important source of food for Rüppell's parrot at the Waterberg.

QUIVER TREE

Aloe dichotoma

Other names: ||Garas, Kokerboom, Köcherbaum



This and the Giant Quiver Tree are amongst the largest aloes in the world. Along with other aloes, they belong to the family Aloaceae. Quiver Trees are prominent features of many desert or semi-desert areas in southern Namibia, occurring elsewhere only in the Namaqualand and Bushmanland regions of western South Africa. Their range extends from northern Erongo southwards along the escarpment above the Namib, and then across the whole of the southern quarter of the country. In all these areas, they grow mainly on rocky hills. A high proportion of dead trees are found throughout their distribution, but more so in their northern range than in South Africa. One possible explanation is that this is an effect of global warming. Quiver Trees are a protected species in Namibia.

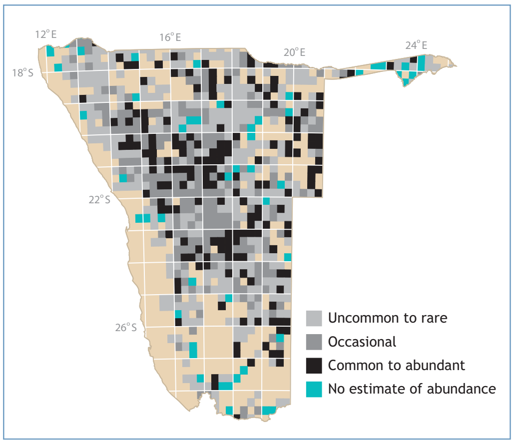
Quiver Trees usually reach a height of 3 to 8 metres, and have a rounded, dense crown that is characterised by repeated, dichotomous branching. The comparatively compact trunk may attain a diameter of up to 1 metre at ground level. The bark is white, yellow or golden, smooth and flaky, but often also folded, giving the appearance of molten wax. The large fleshy leaves are dark green and have a row of brown serrations or 'teeth' along their margins. The flower heads are up to 30 centimetres in length, and carry bright yellow flowers in June and July. Seeds germinate readily but rates of germination improve if the seeds are left lying in the sun for a day before planting. The growth of trees is extremely slow.

Little or no direct current use has been reported for the species. The common name is derived from the fact that San hunters formerly used the bark to make quivers for their arrows. Young flower buds may be eaten, while dead tree-trunks have been hollowed out and used as natural fridges. Sociable weavers frequently build their spectacular on Quiver Trees, and baboons are reported to eat the flowers to benefit from the sweet nectar. The Quiver Tree Forest near Keetmanshoop is an important local tourist attraction. The aloes are also popular garden plants.

SHEPHERD'S TREE

Boscia albitrunca

Other names: /Hunib, Omunghudi, Omutendereti, Weissstamm, Witgat



The Shepherd's Tree is one of the hardiest trees in Namibia, surviving in extremely dry and hot conditions and withstanding severe frost. Although the species grows on a variety of substrates, their deep rooting system suits them well to arid, sandy areas. They often grow on or close to termite mounds in the central regions, and frequently grow up inside other trees of different species, which offer them protection from browsers. The Shepherd's Tree belongs to the caper family Capparaceae, and is widely distributed both in southern Africa and Namibia, where it is most abundant in the centre of the country. It is a specially protected species.

This is a small tree, most individual trees ranging between 3 and 5 metres in height. The tallest ones may reach 7 metres. Many trees have a distinct browse line beneath their small, shapeless canopies, reflecting the reach of browsing cattle, game or goats. The bark is generally smooth and pale-grey although it is often pitted and can be quite dark. The wood is yellow, heavy and tough, and only considered suitable for the carving of household utensils.

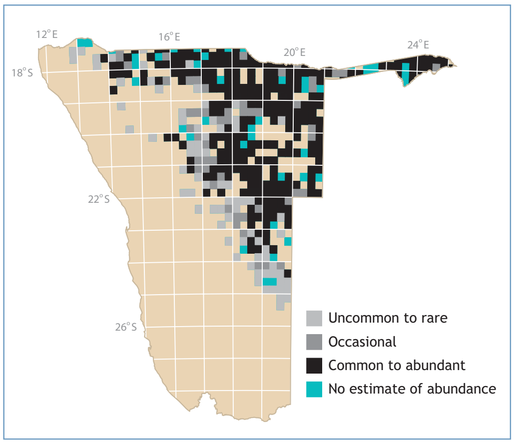
The leaves are grey-green and have a leathery texture. Even though the tree is evergreen, many of the leaves are lost when the tree flowers, which is usually between August and October, and before the first rains. The small, green flowers are borne in dense clusters, but the tree does not produce flowers every year. Round, berry-like fruit ripen between October and December. Seeds germinate readily, but the subsequent growth of seedlings is tenuous. Birds often eat the fruit, which probably helps to disperse the seed.

The greatest value of the tree is during very dry periods when the leaves and branchlets provide valuable fodder for livestock and wildlife. Goats are known to nibble and strip off bark when there is little else to eat. A number of medicinal uses have been recorded, including the use of a decoction from the roots to treat haemorrhoids and an infusion of leaves to treat inflamed eyes of cattle. The roasted roots are used as a substitute for coffee, while pounded roots can be used to make porridge. The fruits are also edible, and flower buds can be pickled as capers. In the most arid, desolate parts of Namibia, it is the shade of the Shepherd's Tree that provides welcome, cool relief to many animals.

SILVER-LEAF TERMINALIA

Terminalia sericea

Other names: Gaab, Geelhout, Gelbholtz, Ghushosho, Mugoro, Muhorono, Omuseasetu, Silver Cluster-leaf, Sandgeelhout, Vaalbos



The Silver-leaf Terminalia is an extremely abundant tree or bush in northern and eastern Namibia, in many places dominating all other woody species. Its vigorous, pioneering growth also means that it is one of those invasive species associated with bush encroachment (see page 112). The trees are generally found on deep sandy soils, preferring open areas but also growing in open woodland as bushes under other trees. They are deciduous shrubs or trees, usually reaching heights of 3 to 15 metres. Most of those in Caprivi are much taller than trees to the south and west, perhaps because of higher rainfall in the north-east.

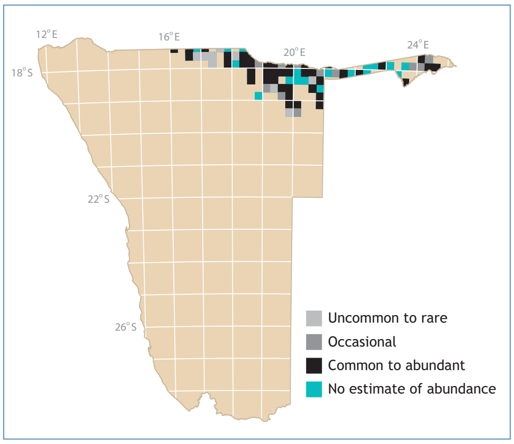
The crown of the tree is slightly rounded and layered. Younger trees have smooth brown bark, which turns grey-brown and fissured as they age. The wood is distinctively yellow, fine-grained, hard and durable. Dense hairs cover the leaves, giving them the silver appearance for which the tree is named. The leaves are clustered on the tips of small branchlets, and take on a distinctive reddish-brown colour when dry. Flowers are small spikes that appear before the first rains in September and October. Fruit are pale red, pinkish or flesh-coloured, with two wings, one on either side of a single kernel. The fruit may hang on the tree throughout the dry season. Plants damaged by fire or cutting coppice readily. This is particularly true of smaller, younger individuals. In a study of growth rings, no trees older than 100 years were found (see page 39).

The leaves are eaten by various wild and domestic animals, as well as by a caterpillar which some people collect and eat. It is said that the silver hairs from the leaves are used to glaze pottery. Domestic implements for cooking, such as spoons and pestles, are made from the wood. Rough furniture is also produced. Stems and thicker branches are commonly used as poles for the construction of huts and for fences. Twine is made from the outer covering of the roots, and a host of traditional medicinal uses have been recorded for the roots themselves. These include decoctions to treat headaches, wounds, persistent colds, diarrhoea, skin problems and colic. Pharmaceutical companies are now showing an interest in producing an anti-inflammatory agent from the roots. The agent could be used in cosmetics.

USHIVI

Guibourtia coleosperma

Other common names: Bastermopanie, False Mopane, Ghushi, Msivi, Muzauli, Omusii, Rosewood



Ushivi trees are strictly limited to deep Kalahari sands in north-eastern Namibia, from where their range extends north into Angola and Zambia, and east into Zimbabwe. They often grow in association with Kiaat and Burkea trees, but their abundance varies locally. For example, Ushivi are much commoner in Kavango than in Caprivi. The species belongs to the Caesalpinioideae subfamily of the pea family, Fabaceae.

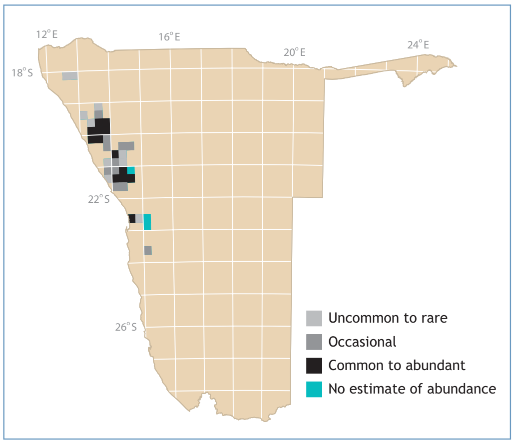
The evergreen trees are medium to large, growing to between 6 and 20 metres in height. Many of them are prominent features along the tar road south of Rundu. The main trunk usually forks fairly low down, above which there is a large, rounded crown with drooping branches. A variety of colours give the bark a patchy appearance of pale brown or cream, sometimes tinged with pink and frequently with dark brown or black blotches. A reddish tinge and beautiful fine grain characterizes the very hard wood. The leaves are dark green, and somewhat resemble the leaves of Mopane. Small, creamy white flowers appear between December and March. The fruit is woody, splitting open down one side while still on the tree and then exposing a bean-like seed that dangles on a short stalk from the open pod. The seed is covered by a bright scarlet aril.

In the past few years, Ushivi wood has been used increasingly for carving crafts for sale and for furniture, especially as bar counters now seen in many lodges and hotels in Namibia. Most thicker stems and branches curve and twist, with the result that it is seldom possible to cut long, straight planks suited for more conventional furniture. Traditional knife-handles and sheaths are made from the wood in some areas. The seed and aril that covers it are valuable sources of food. The seeds are soaked in water until the moistened arils come away from the seeds. Soups or other drinks are then prepared from the arils, while the remaining seeds are roasted in hot ash to be eaten whole or ground up and mixed with water and Mangetti nuts. It is believed that wounds heal more rapidly if pounded bark is applied to them.

WELWITSCHIA

Welwitschia mirabilis

Other names: !Kharos, N'tumbo, Onyanga, Tweeblaarkanniedood



This is perhaps Namibia's most famous plant, attracting the interest of lay people and scientists because of its rarity, peculiar growth form, its harsh environment, and the fact that it shares features of the gymnosperms (pines) and angiosperms (flowering plants). It is the only species in the family Welwitschiaceae. In addition to being a protected species, the Welwitschia enjoys international protection from the CITES convention that prohibits the plant from being traded. Welwitchias are endemic to the Namib Desert, almost their entire range being confined to narrow zone stretching from the Kuiseb River about 1,000 kilometres north into southern Angola.

The Welwitschia is really a stunted tree. The apical growing point dies off early, and the plant then only grows laterally. There are no branches on the very short trunk, which can expand to about 1 metre in diameter. A shallow concave depression forms as the trunk ages. Each plant normally has only two leaves, which grow continuously from opposite sides of the stem. Damage caused by wind, herbivores and other agents breaks up the outer points of the leaves, giving them a scraggly appearance. The longest leaves reach over 6 metres.

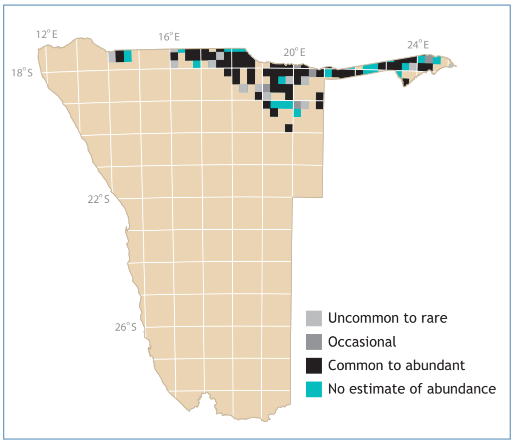
The plants grow on gravely soils, largely in a zone 30 to 50 kilometres from the coast. Rainfall in the zone is minimal but fog occurs regularly. Fog water is absorbed through stomata on the leaves, while ground water and nutrients are drawn up through a network of fibrous roots that go down between 1 and 3 metres and extend around the plant in a radius of up to 15 metres. The stomata are closed during extreme heat and periods of very dry weather to conserve water.

Male and female plants are separate. Males secrete a liquid that attracts pollinating insects to their flowers. Females carry seed in cones, which are borne on inflorescences growing from the rim of the stem cup. The seed are very light and have a translucent, papery wing for dispersal by wind. Each female can produce between 10,000 and 20,000 seeds per year. Some very large Welwitschias are reputed to be between 2,000 and 3,000 years old, but these ages have not been confirmed.

ZAMBEZI TEAK

Baikiaea plurijuga

Other names: G!òà, Mukusi, Mukutji, Omupapa, Uhahe



The Zambezi Teak belongs to the pea family Fabaceae, and has been a protected species in Namibia since 1952. The tree occurs broadly in north-eastern Namibia, but its abundance varies substantially. Patches where it is extremely common include the Caprivi State Forest, north-western Kavango and eastern Ohangwena, and on old sand dunes in central Kavango and to the west of the Kwando River. Its entire range outside Namibia is limited to south-eastern Angola, south-western Zambia, western Zimbabwe and northern Botswana. In all these areas, the Zambezi Teak is very much a species of deep Kalahari sands.

This is a large evergreen tree growing to a height of 20 metres and a stem diameter of up to 75 centimetres. It has a dense spreading crown. The bark is pale and relatively smooth on younger trees, becoming darker with age. The wood is very hard and red-brown; again, as timber, the wood colour darkens over time. Showy, purple-pink flowers held above the canopy normally appear between December and March. The fruit are flattened pods covered with dark, golden-brown brown hairs that give them a velvety texture. The dry pods split and scatter their seeds from June to September. These germinate readily, but rates of survival among seedlings in their first year are low as a result of inadequate water, browsing and fire. The young plants concentrate growth in their roots to develop deep roots that can reach moist, sub-surface soils. Later growth is very slow and large trees in Namibia are old. Those with stems having diameters of 45 centimetres or more are at least 150 years (see page 39).

The greatest direct value of Zambezi Teak is in its timber. The wood is termite proof and is popular for flooring, furniture and canoes. It has also been used for props by the mining industry and as railway sleepers. San people often thread the seeds onto necklaces to be sold to as craft. The biggest threats to Zambezi Teak populations come from fires, the clearing of land for farming and timber logging, although this has now stopped in Namibia.

SOURCES AND NOTES

Introduction: context and early beginnings

1. Curtis, B.A. & Mannheimer, C.A. 2005. *Tree Atlas of Namibia.* National Botanical Research Institute, Windhoek.
2. The FAO defines Other Wooded Land as "Land not classified as forest, spanning more than 0.5 hectares; with trees higher than 5 metres and a canopy cover of 5-10%, or trees able to reach these thresholds, or with a combined cover of shrubs, bushes and trees above 10%."
3. Derived from a comparison between an analysis of average annual green vegetation production produced by the Ministry of Agriculture, Water and Forestry from NDVI data provided by NOAA satellite images and an analysis of tree cover for selected regions, as reported in Verlinden, A. & Laamanen, R. 2002. *The role of remote sensing in monitoring woody vegetation resources in Northern Namibia.* Namibia Finland Forestry Programme, Directorate of Forestry, Windhoek. Data for Africa were obtained from www. glcf.umiacs.umd.edu/tree cover.
4. From Mendelsohn, J.M., Jarvis, A.M., Roberts, C.S. & Robertson, T. 2002. *Atlas of Namibia.* David Philip, Cape Town.
5. Same as Note 4.
6. Erkkilä, A. & Siiskonen, H. 1992. *Forestry in Namibia, 1850-1990.* Silva Carelica 20. University of Joensuu, Finland.
7. Breitenbach, Von, F. 1968. *Long-term plan of forestry development in the Eastern Caprivi Zipfel.* Department of Forestry, George; Geldenhuys, C.J. 1975. *Stock enumeration and management planning of the woodlands of Kavango.* Saasveld Forestry Research Centre, George; Geldenhuys, C.J. 1977. *Woodland management plan for Nakabunze Reserve, Eastern Caprivi.* Report. Division of Forest Science & Technology, CSIR, Pretoria.

Ecology: the life of trees

1. From Mendelsohn, J.M., Jarvis, A.M., Roberts, C.S. & Robertson, T. 2002. *Atlas of Namibia.* David Philip, Cape Town. The co-efficient of variation is the standard deviation of annual rainfall divided by average rainfall and then multiplied by 100.
2. Timberlake, J. 1996. A review of the ecology and management of Mopane *Colophospermum mopane.* In Flower, C, Wardell-Thompson, G. & Jamieson, A. (editors). *Management of Mopane in Southern Africa.* Directorate of Forestry, Windhoek.
3. From data supplied by the Namibian Meteorological Services.
4. From Mendelsohn, J.M., Jarvis, A.M., Roberts, C.S. & Robertson, T. 2002. *Atlas of Namibia.* David Philip, Cape Town.
5. Tropical and sub-tropical soils are relatively rich in iron and aluminium oxides with which phosphorus readily forms complexes. Phosphorous is not available to plants once it is bound into such a complex. Other limitations on the availability of phosphorous result from the formation of calcium phosphate in alkaline soils and the binding of phosphorous onto the surface of clay particles. The main problem for plant growth is the limited availability of phosphorous to nitrogen-fixing bacteria. The bacteria use an enzyme which requires phosphorous for nitrogen fixation. With limited phosphorous, the bacteria are unable to fix large amounts of nitrogen, resulting in low rates of nitrogen production. The bacteria are hosted in nodules in roots, where they feed off sugars supplied by the host plants. Up to 50% of the energy produced by some plants is spent on feeding sugars to the bacteria. Nitrogen fixation is the most important way in which savanna soils are enriched by nitrogen, but soils in most areas are too low in phosphorous for nitrogen to be produced faster than it is lost to the atmosphere. Nitrogen is also deposited as fall-out from the atmosphere, but at low levels. Unlike some nutrients, phosphorous is not cycled through the atmosphere, but remains 'locked' in the ground: in the parent rock, in plants and animals, or chemically bound with other elements, usually iron or calcium.
6. Adapted from information supplied by the Ministry of Agriculture, Water and Forestry.
7. Bond, W.J., Midgley, G.F. & Woodward, F.I. 2003. What controls South African vegetation – climate or fire? *South African Journal of Botany.* 69: 79-91.
8. Based on data supplied by Spatial Data Services & Mapping, Namibia and National Air & Space Administration (NASA) Shuttle Radar Topography Mission (SRTM).
9. Bond, W.J., Midgley, G.F. & Woodward, F.I. 2003. The importance of low atmospheric CO_2 and fire in promoting the spread of grasslands and savannas. *Global Change Biology* 9: 973-982.
10. Hoffman, M.T., Cowling, R.M., Douie, S. & Pierce, S.M. 1989. Seed predation and germination of *Acacia erioloba* in the Kuiseb River Valley, Namib Desert. *South African Journal of Botany* 55: 103-106.
11. Jacobson, P. J., Jacobson, K.M. & Seely, M.K. 1995. *Ephemeral rivers and their catchments: sustaining people and development in western Namibia.* Desert Research Foundation of Namibia,

Windhoek; and Petra Moser (personal communication).
12. Petra Moser, Desert Research Foundation of Namibia (personal communication).
13. Based on data collected and reported by the forest inventories conducted by the Directorate of Forestry.
14. Analysis of data collected and reported by Worbes. M. 1999. *Growth of trees from Namibia - A dendrochronological study*. Report for Namibia-Finland Forestry Project, Windhoek.
15. Steenkamp. C.J., Vogel, J.C., van Rooyen, M.W. & van Rooyen, N. Submitted. Age determination of *Acacia erioloba* trees. *Forest Ecology and Management*; Walter, H. 1940. Die Jahresringe der Bäume als Mittel zur Feststellung der Niedersch lagsverhältnisse in der Vergangenheit, inbesondere in Deutsch-Südwestafrika. *Die Naturwissenschaften* 38: 607-612; and Henschel JR. & Seely M.K. 2000. Long-term growth patterns of *Welwitschia mirabilis*, a long-lived plant of the Namib Desert (including a bibliography). *Plant Ecology* 150: 7-26.
16. Vogel, J.C. 2003. The age of dead trees at Sossusvlei and Tsondabvlei, Namib Desert, Namibia. *Cimbebasia* 18: 247-251.
17. Adapted from Mendelsohn, J.M., Jarvis, A.M., Roberts, C.S. & Robertson, T. 2002. *Atlas of Namibia*. David Philip, Cape Town.
18. Based on an interpolation of data collected per quarter degree by the Namibian Tree Atlas project.
19. Endemic trees: same as Note 18; endemic birds: same as Note 17.
20. Curtis, B.A. & Mannheimer, C.A. 2005. *Trees Atlas of Namibia*. National Botanical Research Institute, Windhoek.
21. The list was kindly compiled by Pat Craven.
22. Based on an interpolation of data collected per quarter degree by the Namibian Tree Atlas project.
23. From data collected and reported by the forest inventories conducted by the Directorate of Forestry.
24. Derived from a comparison between forest inventory data (published in reports by the Directorate of Forestry), an analysis of average annual green vegetation production produced by the Ministry of Agriculture, Water and Forestry from NDVI data provided by NOAA satellite images, and an analysis of tree cover for selected regions, as reported in Verlinden, A. & Laamanen, R. 2002. *The role of remote sensing in monitoring woody vegetation resources in Northern Namibia*. Namibia Finland Forestry Programme, Directorate of Forestry, Windhoek.
25. Based on data collected and reported by the forest inventories conducted by the Directorate of Forestry.
26. From data supplied by Alex Verlinden, collected under the auspices of the Namibia-Finland Forestry Project and reported in Verlinden, A. & Laamanen, R. Submitted. Modeling woody vegetation resources using Landsat TM imagery in Northern Namibia.
27. From the Namibia Forestry Strategic Plan of the Directorate of Forestry. See also Hines, C.J., Viitanen, J. & Tuomasjukka, T. 2003. *Environmental Forestry in Namibia: preliminary site descriptions of strategic forests*. Report for Directorate of Forestry, Namibia-Finland Forestry Programme.
28. From Department of Water Affairs; Ward, J.D & Breen, C.M. 1983. Drought stress, and the demise of *Acacia albida* along the lower Kuiseb River, central Namib Desert: preliminary findings. *South African Journal of Science* 79: 444-447; and Carole Roberts (personal communication).
29. Pieters, I. & Laamanen, R. 2002. *Inventory Report for Rehoboth Acacia Park*. Namibia-Finland Forestry Programme, Directorate of Forestry, Windhoek.
30. Plantations have been established at Ngoma (Caprivi), Musese, Ndiyona, Kaisosi, Mile 37 and Kehemu (Kavango), Onuno (Ohangwena), Onankali (Oshikoto), Osire (Otjozondjupa), Drimiopsis (Omaheke), and Aranos, Mariental and Kalkrand (Hardap). In addition, almost 9,000 trees were planted between 2002 and 2005 in an area of 30 hectares in the *ombuga* grasslands south of Oshakati. Most of these trees are indigenous to Namibia.
31. From Forest Inventory Reports of the Directorate of Forestry, Windhoek.
32. Kobus Theron, personal communication.
33. Geldenhuys, C. J. 1996. Past, present and future forest management in the southern African region with special emphasis on the northern regions of Namibia. *Forestry Publication No. 5*, Directorate of Forestry, Windhoek; and Erkkilä, A. 2002. *Development of forest research networking system: A report prepared for the Namibia-Finland Forestry Programme*. Namibia-Finland Forestry Programme, Directorate of Forestry, Windhoek.
34. Bethune, S., Griffin, M. & Joubert, D. 2004. *National Review of Invasive Alien Species – Namibia*. Final Report to SABSP. Directorate of Environmental Affairs Discussion Document. Windhoek.

Benefits: more than wood

1. Leffers, A. 2003. *Gemsbok bean and Kalahari truffle: traditional plant use by Ju|'hoansi in north-eastern Namibia*. Gamsberg Macmillan, Windhoek.

2. Klaus Endresen (personal communication) and www.fao.org.
3. Wood fuel consumption measures are variable and so an average was taken from the results of 16 studies in and around southern Africa. Four of the studies were in Namibia: Wamukonya. L. 1997. *Study on energy consumption patterns of rural and peri-urban households in Namibia*. University of California, Berkeley; Klaeboe, J. & Omwami, R. 1997. *Forest Policy for Sustainable Utilization of the Woodlands and Savannas of Namibia. A study on consumption patterns of major wood and wood products in Namibia.* Directorate of Forestry, Windhoek; Negumbo, H.M.T. 2004. *Fuelwood consumption in Namibia: a case study on fuelwood consumption in Oshana Region*. University of Wales, Bangor; Ollikainen, T. 1991. *Study on wood consumption in Namibia*. Directorate of Forestry, Windhoek. Each cubic metre was taken as equivalent to 0.8 metric tons.
4. Fuel wood estimates are based on approximately 213,000 households that mainly cooked with wood in 2001, with each household consuming 4.6 cubic metres per year (see Note 3). Estimates on construction and fencing wood use are based on about 72,000 households using 4.37 cubic metres of poles per year (see Note 19 below). Estimates for craft, commercial firewood and Mopane are extrapolated increases from Klaeboe, J. and Omwami, R. 1997. *Forest Policy for Sustainable Utilisation of the Woodlands and Savannas of Namibia. A study on consumption patterns of major wood and wood products in Namibia.* Directorate of Forestry, Windhoek. Figures on wood imports are for 2003 and were supplied by the National Planning Commission to the Directorate of Forestry. Ian Galloway provided estimates on charcoal production.
5. From analyses of data collected in the Population and Housing Census held in 2001 by the Central Bureau of Statistics, National Planning Commission.
6. Same as Note 5.
7. Same as Note 5.
8. Same as Note 5.
9. Negumbo, H.M.T. 2004. *Fuel wood consumption in Namibia: a case study on fuel wood consumption in Oshana Region*. University of Wales, Bangor.
10. Based on information supplied by Ian Galloway and Aigams Professional Services. 1997. *Charcoal production in Namibia*. Report for the Development Fund of Namibia, Windhoek.
11. From analyses of data collected in the Population and Housing Census held in 1991 and 2001 by the Central Bureau of Statistics, National Planning Commission.
12. Mendelsohn, J.M., el Obeid, S. & Roberts, C.S. 2000. *A profile of north-central Namibia*. Gamsberg Macmillan, Windhoek.; Erkkilä, A. 2001. *Living on the land: change in forest cover in north-central Namibia 1943-1996*. Silva Carelica 37. University of Joensuu, Finland.
13. Information supplied by the Directorate of Forestry, Windhoek.
14. Erkkilä, A. & Siiskonen, H. 1992. *Forestry in Namibia, 1850-1990*. Silva Carelica 20. University of Joensuu, Finland.
15. Klaeboe, J. & Omwami, R. 1997. *Forest Policy for Sustainable Utilization of the Woodlands and Savannas of Namibia. A study on consumption patterns of major wood and wood products in Namibia.* Directorate of Forestry, Windhoek.
16. From data collected by the Tree Atlas Project and kindly supplied by Barbara Curtis.
17. Based largely on du Plessis, P. 2002. *Promoting indigenous fruit in Namibia (PIF).* Indigenous Plant Task Team Report, Ministry of Agriculture, Water & Rural Development.
18. Bond, W.J., Midgley, G.F. & Woodward, F.I. 2003. The importance of low atmospheric CO^2 and fire in promoting the spread of grasslands and savannas. *Global Change Biology* 9: 973-982.
19. See Barnes, J.I., Nhuleipo, O., Macgregor, J. & Muteyauli, P.I. 2005. *Preliminary development of wildlife and woodland asset accounts in Namibia*. Research Discussion Paper, Directorate of Environmental Affairs, Windhoek.
20. CBS. 2004. *Republic of Namibia national accounts: 1995-2003.* Central Bureau of Statistics, National Planning Commission, Windhoek, Namibia; and Note 19.
21. Lange, G., Schade, K., Ashipala, J. & Haimbodi, N. 2004. A social accounting matrix for Namibia 2002: a tool for analyzing economic growth, income distribution and poverty. *NEPRU Working Paper 97.* Namibia Economic Policy Research Unit, Windhoek, 47pp

Changing management: conservation for use

1. Directorate of Forestry Annual Report for 2003.
2. Worbes. M. 1999. *Growth of trees from Namibia - A dendrochronological study*. Unpublished report for Namibia-Finland Forestry Project, Windhoek.
3. Erkkilä, A. 2002. *Development of forest research networking system: A report prepared for the Namibia-Finland Forestry Programme*. Namibia-Finland Forestry Programme, Directorate of Forestry, Windhoek.
4. Figures supplied by the Directorate of Forestry.

5. Görgen, M. & Gsänger, J. 2002. *Gemeindewaldbewirtschaftung im Nordosten Namibias: Studie zur Wirtschaftlichkeit der Projektmaßnahmen.* Report for Community Forestry Project in North-eastern Namibia, Directorate of Forestry, Windhoek.
6. Based on data in Mendelsohn, J.M., Jarvis, A.M., Roberts, C.S. & Robertson, T. 2002. *Atlas of Namibia.* David Philip, Cape Town.
7. Görgen, M. & Gsänger, J. 2002. *Gemeindewaldbewirtschaftung im Nordosten Namibias: Studie zur Wirtschaftlichkeit der Projektmaßnahmen.* Report for Community Forestry Project in North-eastern Namibia, Directorate of Forestry, Windhoek.
8. NACSO. 2004. *Namibia's communal conservancies: a review of progress and challenges.* NACSO, Windhoek.
9. Same as Note 8.
10. This provision does not apply to surveyed plots in local authority areas.

Prospects: seeing the wood and the trees

1. Robbins, L.H. & Murphy, M.L. 1998. The Early and Middle Stone Age. In Lane, P., Reid, A. & Segobye, A. (eds). *Ditswa Mmung: The archaeology of Botswana.* Pula Press & The Botswana Society, Gaberone. The earliest evidence of crop farming in Namibia comes in the form of pottery made in about 850 AD at Kapako west of Rundu. The pots were used to store grain.
2. From Le Roux, J. 2000. *Expansion of subsistence agriculture in north-central Namibia*; Mendelsohn, J.M., el Obeid, S & Roberts, C.S. 2000. *A profile of north-central Namibia.* Gamsberg Macmillan, Windhoek; and Mendelsohn, J.M. & el Obeid, S. 2003. *Sand and Water, A profile of the Kavango region of Namibia.* Struik, Cape Town.
3. Bond, W.J., Midgley, G.F. & Woodward, F.I. 2003. What controls South African vegetation – climate or fire? *South African Journal of Botany.* 69: 79-91.
4. These are maps of areas that have been burnt, as detected from NOAA and MODIS satellite images. The interpretation of these satellite images and the mapping of burnt areas were done by Simon Trigg (1997), Johan le Roux (2000 and 2001), the National Remote Sensing Centre (2002, and David Roy (2003 - see http://edcdaac.usgs.gov/order.asp). The global map shows areas burnt in 2000, as provided by the Global Burned Area 2000 initiative (see Grégoire, J-M., Tansey, K. & Silva, J.M.N. 2003. Developing a global burned area database from SPOT-VEGETATION imagery. *International Journal of Remote Sensing.* 24: 1369-1376.
5. An excellent overall reference on fires in Africa is provided by Goldhammer, J.G. & de Ronde, C. (editors). 2004. *Wildland fire management handbook for southern Africa.* Global Fire Monitoring Centre.
6. Analyses of data reported in Verlinden, A. 2002. *A local operational tool for fire monitoring and management for the Kavango and Caprivi Regions.* Report for Lux-Development S.A. (Agence Luxembourgeoise pour la Coôperation au Développement), and National Remote Sensing Centre, Directorate of Forestry.
7. Based on data for 2003 provided by David Roy (see http://edcdaac.usgs.gov/order.asp).
8. Chakanga, M., Selänniemi, T. & Korhonen, K. 1999. *Forest inventory report of Caprivi State Forest.* Namibia Finland Forestry Programme, Directorate of Forestry, Windhoek.
9. Scholes, R.J., van der Merwe. M.R, Landmann, T, Venter, G. Basson, J., de Klerk, N. du Plessis, P. & Burke, A. 2005. *Review of Greenhouse Gas Emission Factors for Namibia.* Ministry of Environment & Tourism, Windhoek. The following figures come from this report. Methane and nitrous oxide have global warming potentials of 21 and 310 times that of CO_2. Multiplying those potentials by the 54,000 tons of methane and 2,000 metric means that bush fires produce total emissions equivalent to 1,754,000 tons of CO_2. A total of 12,400,000 tons of carbon, equivalent to 45,400,000 tons of CO_2 as a green house gas is estimated to be taken up each year in bush encroached areas.
10. De Klerk, N. 2004. *Bush encroachment in Namibia.* Ministry of Environment & Tourism.
11. Adapted from Bester, F.V 1999. Major problem: bush species and bush densities in Namibia. *Agricola* 10: 1-3.
12. Same as Note 10.
13. Adapted from data analysed for De Klerk, N. 2004. *Bush encroachment in Namibia.* Ministry of Environment & Tourism.
14. Braune, E. 1991. *Hydrology of the Lower Kuiseb River.* Department of Water Affairs, Windhoek.
15. Dams were mapped and kindly supplied by Carole Roberts.
16. Martin. R.K. 2005. *Elephants: Background study for the Transboundary Species Project.* Ministry of Environment & Tourism, Windhoek.
17. Midgley, G. Hughes, G. Thuiller, W., Drew, G. & Foden, W. 2005. *Assessment of potential climate change impacts on Namibia's floristic diversity, ecosystem structure and fu*nction. Report for Namibian National Biodiversity Programme. Directorate of Environmental Affairs, Ministry of Environment & Tourism.

18. Scholes, R.J., van der Merwe. M.R, Landmann, T, Venter, G. Basson, J., de Klerk, N. du Plessis, P. & Burke, A. 2005. *Review of Greenhouse Gas Emission Factors for Namibia.* Ministry of Environment & Tourism, Windhoek.
19. For cleared land, these are 5x5 kilometre blocks in which more than 5% of the block was cleared for crops, as derived from Mendelsohn, J.M., Jarvis, A.M., Roberts, C.S. & Robertson, T. 2002. *Atlas of Namibia.* David Philip, Cape Town; burnt areas are those that burnt in three or more of the five years shown in Figure 28; bush encroached areas those with more than 3,000 bushes per hectare as provided by Bester, F.V 1999. Major problem: bush species and bush densities in Namibia. *Agricola* 10: 1-3.
20. The arguments are based on analyses of farming systems in north-central Namibia, north-eastern Otjozondjupa and Kavango, as reported in Mendelsohn, J.M., el Obeid, S. & Roberts, C.S. 2000. *A profile of north-central Namibia.* Gamsberg Macmillan, Windhoek; Mendelsohn, J.M. & el Obeid. S. 2002. *The communal lands of eastern Namibia.* RAISON, Windhoek; Mendelsohn, J.M. & el Obeid, S. 2003. *Sand and Water, A profile of the Kavango region of Namibia.* Struik, Cape Town.

Sources of photographs

Cover: Helga Burger / page 1: RAISON / p2: Helge Denker / p4: Peter Reiner (left), Peter Tarr (right), RAISON (middle) / p5: Helge Denker (right), Peter Tarr (left) / p6: Helge Denker / p8: Helge Denker / p9: Helge Denker (right), Peter Tarr (left) / p10: Helga Burger / p12: Helge Denker (right), Hentie Burger (bottom), Tony Cunningham (left & middle) / p13: Helge Denker (top & middle), RAISON (bottom) / p16: Helge Denker / p17: National Archives of Namibia / p18: National Archives of Namibia / p19: Maria Fisch (bottom), National Archives of Namibia (top) / p21: Luise Hoffmann / p22: Helga Burger / p23: Peter Reiner (right), Peter Tarr (left) / p24: RAISON / p28: Barbara Curtis (top), RAISON (left & bottom) / p32: RAISON / p33: Helge Denker / p34: RAISON / p35: RAISON / p39: Carol Steenkamp(top), Peter Tarr (bottom) / p41: Antje Burke / p42: Roger Swart / p44: Helge Denker (top & right), Shirly Bethune (left) / p45: Helge Denker (bottom left), RAISON (top, bottom right & bottom middle) / p46: Hentie Burger (top left), Peter Reiner (top right), RAISON (bottom) / p47: Helge Denker (bottom), RAISON (top left & right), p54: RAISON / p55: RAISON / p56: Helge Denker (top), RAISON (bottom) / p57: Helge Denker / p58: Peter Reiner (left), Tony Cunningham (right) / p59: Helge Denker (right), RAISON (left) / p60: Peter Reiner / p63: Helge Denker (left), Peter Reiner (bottom), RAISON (top) / p64: RAISON / p65: Peter Tarr / p67: NACOPTA (Helge Denker, bottom), RAISON (left & right) / p68: RAISON (top & bottom) / p69: Peter Reiner / p70: RAISON / p71: RAISON / p72: Helge Denker / p73: Helge Denker (bottom), RAISON (top) / p74: Helge Denker (bottom), Peter Reiner (top left & top right), Peter Tarr (middle right), RAISON (middle left) / p75: Dave Cole (top left), Helge Denker (bottom), RAISON (top right) / p76: Helge Denker / p77: Nico Smit / p79: RAISON / p81: Tony Cunningham / p82: RAISON / p83: RAISON / p84 RAISON / p85: Peter Reiner (right), RAISON (left & middle) / p86: Peter Reiner / p91: Peter Reiner / p94: Peter Reiner / p95: Peter Reiner / p97: RAISON / p100: RAISON / p101: Helga Burger / p102: Helga Burger / p103: Peter Reiner (left), Peter Tarr (right) / p104: Peter Reiner / p105: Helge Denker / p107: NBRI (Chris Hines) / p110: RAISON / p113: Peter Tarr (left), RAISON (right) / p114: RAISON / p116: RAISON / p117: RAISON / p118: Peter Tarr / p119 Helge Denker / p122: RAISON / p124: Helge Denker / p125: Luise Hoffmann / p126: Helge Denker (right), Peter Reiner (left) / p127: Helge Denker (right), RAISON (left) / p128: Luise Hoffmann (top), RAISON (bottom) / p129: Peter Tarr (top), RAISON (bottom) / p130: Barbara Curtis (top), RAISON (middle), Tony Cunningham (bottom) / p131: Barbara Curtis (top), Barbara Curtis (middle & bottom) / p132: Barbara Curtis (all) / p133: Helge Denker (top), Peter Tarr (bottom) / p134: Peter Reiner (bottom), RAISON (top) / p135: Helga Burger (bottom), RAISON (top) / p136: Luise Hoffmann / p137: RAISON (all) / p138: Peter Reiner (all) / p139: Helge Denker (top), Peter Reiner (bottom) / p140: Helga Burger (all) / p141: RAISON (all) / p142: Helge Denker (top), Luise Hoffmann (bottom) / p143: Helge Denker / p144: Luise Hoffmann (top), RAISON (bottom) / p145: Peter Reiner (top left), RAISON (top right), Tony Cunningham (bottom) / p146: Peter Tarr / p147: Helga Burger (all) / back cover: Helge Denker (top right and top left), Peter Reiner (top middle), Peter Tarr (bottom) / back flap: Helge Denker (top & 2nd from top), Luise Hoffmann (bottom), RAISON (3rd & 4th from top).