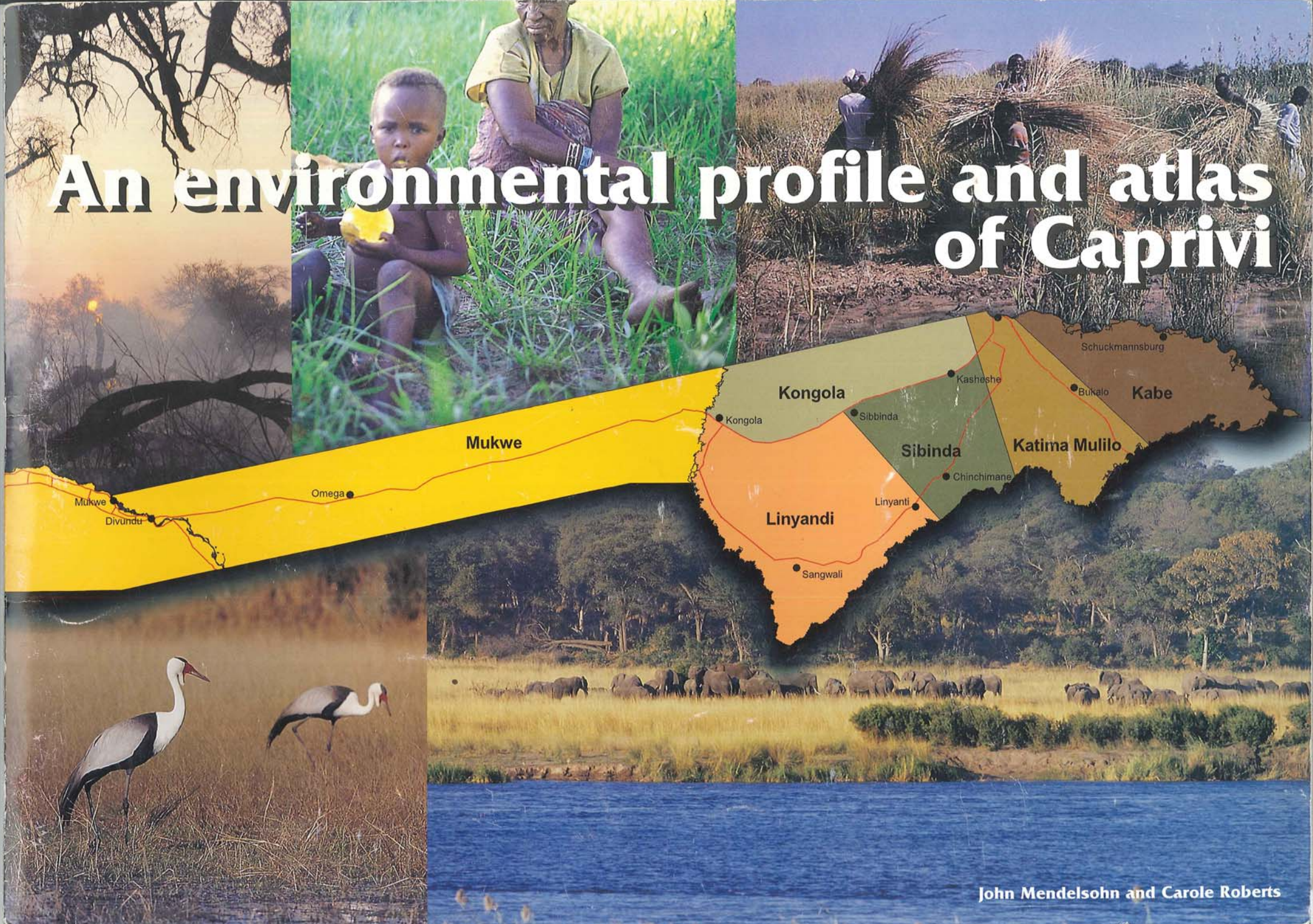
An environmental profile and atlas of Caprivi



John Mendelsohn and Carole Roberts

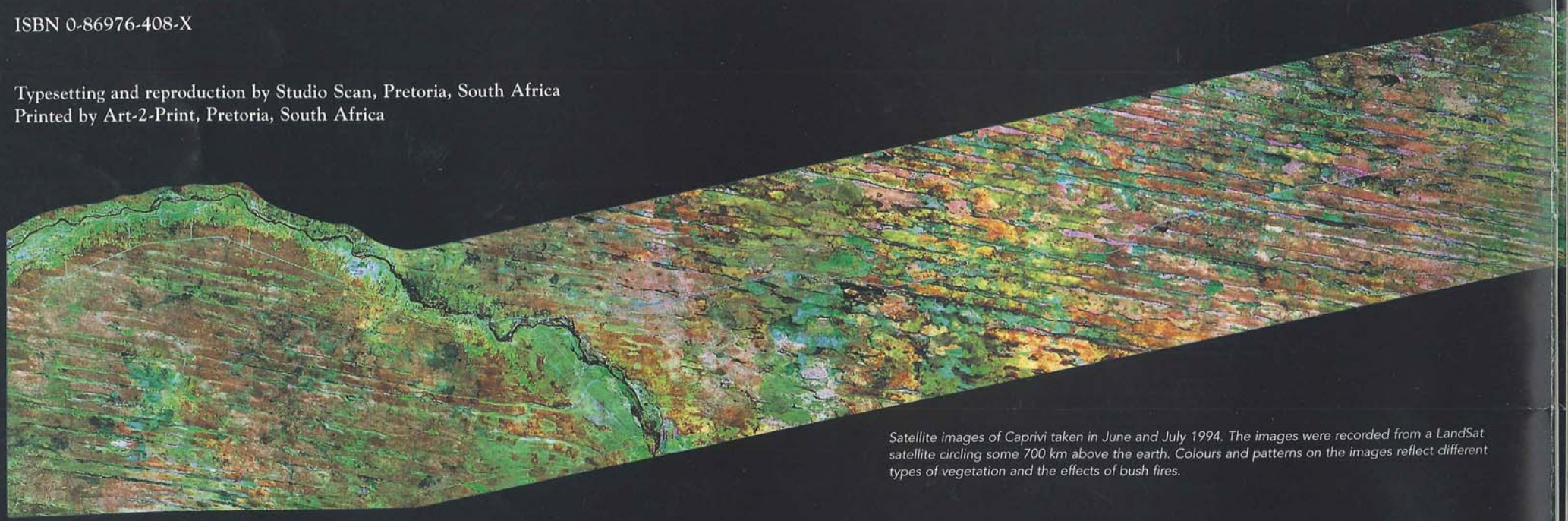
Environmental Profiles Project
Directorate of Environmental Affairs
Ministry of Environment and Tourism
Private Bag 13306
Windhoek
Namibia

The project and production of this book was funded by the generous support of the Kingdom of the Netherlands

Published in Namibia

ISBN 0-86976-408-X

Typesetting and reproduction by Studio Scan, Pretoria, South Africa
Printed by Art-2-Print, Pretoria, South Africa



Satellite images of Caprivi taken in June and July 1994. The images were recorded from a LandSat satellite circling some 700 km above the earth. Colours and patterns on the images reflect different types of vegetation and the effects of bush fires.

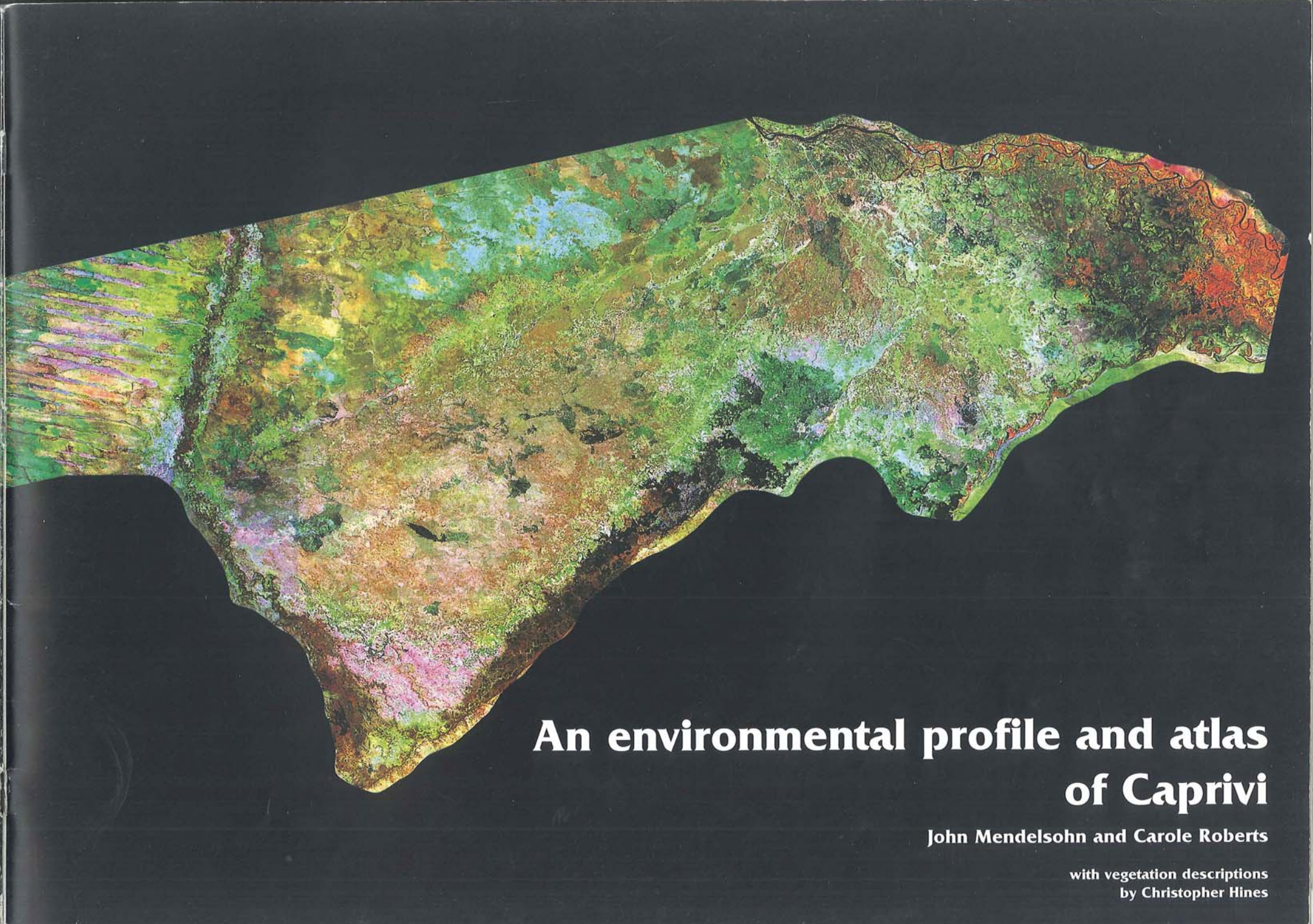
Acknowledgements

Work done in compiling this environmental profile has benefited from help given by many people and organizations. Most of the funding was generously provided by the Kingdom of the Netherlands and, Désiré Bonis, Chargé d'Affaires in Windhoek, gave great support. Chris Brown got the project going and gave his energy, advice and encouragement throughout. The International Institute for Aerospace Survey and Earth Sciences (ITC), Enschede, helped in several ways, mainly through the efforts of Bert Toxopeus who became a good friend. Several people worked for extended periods to collect and analyse key sets of information, and we are specially grateful to Kathi Damon, Chris Hines, Chris La Franchi, Marie Mott-Adams, Fiona Trewby, Simon Trigg, and staff at the National Remote Sensing Centre. Funds for the project were efficiently administered by the Namibia Nature Foundation.

We are also extremely grateful to the following individuals and organizations:

Aircraft Operating Company; Chief Directorate of Surveys and Land Information, South Africa; other directorates within the Ministry of Environment and Tourism; the Ministry of Agriculture, Water and Rural Development (Department of Water Affairs, Directorate of Veterinary Services and Directorate of Planning); the Namibian, Botswanan and Zambian weather bureaux; Lund Consulting Engineers; Likwama Farmers Union; Studio Scan; and Art-2-Print.

C Ashley, J Barnes, S Bethune, F Binzouli, M Brenzinger, S Brown, A Burke, A Chilinda, S Christensen, M Coetzee, D Cownie, C Craig, S Crerar, A Cunningham, C Daffin, P de Bruyn, L de Klerk , K Dower, H du Plessis, A Eggers, A Erkkilä, M Fowler, M Gericke, D Gibbon, J Harrison, G Hoffmann, J Hoffmann, D Holme, J Irish, R Isaacs, A Jarvis, B Jones, M Jurvélius, H Kisting, H Koch, A Kooiman, K Korhonen, P Lieske, B Limulunga, M Lindeque, P Lindeque, E Louw, R Makandawire, T Marwick, H Matsert, S Mayes, M McArthur, C Mendelsohn, R Mothupi, T Mufeti, M Muloho, B Mutti, H Myburgh, P Namfua, Major Namupala, P Nghileendele, I Ngishoondele, U Noells, A Norval, F Paats, G Parodi, R Paskin, C and M Paxton, G and M Prettejohn, G Pritzen, M Rice, P Ries, K Roberts, T Robertson, T Rodwell, L Scheepers, K Schmidt, B Slinger, I Smith, R Soeters, C Stephanus, R Swart, A Symonds, J Tagg, P Tarr, E Taylor, J Timberlake, S Turner, P Tyldsley, L Underhill, T Uprichard, H van Gils, G van Langenhove, I van Ryhn, C van Waegeningh, L and R Vincent, J Visser, W Volkmann, G Walters, R Ward, C Weaver, B Weekley, G Wolters and R Wooding.



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John Mendelsohn and Carole Roberts

with vegetation descriptions
by Christopher Hines

Photograph: PT

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List of abbreviations and symbols

°	degrees
'	minutes
"	seconds
°C	degrees Celsius
AIDS	Acquired Immune Deficiency Syndrome
CSO	Central Statistics Organization
DWA	Department of Water Affairs
E	east
GIS	Geographic Information System
GPS	Global Positioning System
ha	hectare(s)
HDI	Human Development Index
HIV	Human Immunodeficiency Virus
ITC	International Institute for Aerospace Survey and Earth Sciences (ITC)
kg	kilogram(s)
km	kilometre(s)
km^2	square kilometre(s) (1 km^2 = 100 ha)
LIFE	Living in a Finite Environment, programme of WWF in Namibia
m	metre(s)
m^3	cubic metre(s)
m^3/s	cubic metre(s) per second
MAWRD	Ministry of Agriculture, Water and Rural Development
mm	millimetre(s)
NDC	Namibian Development Corporation
NOAA	National Oceanic and Atmospheric Administration (USA)
NOLIDEP	Northern Livestock Development Programme
S	south
SARCCUS	Southern African Regional Commission for the Conservation and Utilization of Soils
SD	Standard deviation
SIAPAC	Social Impact Assessment and Policy Analysis Corporation (Pty) Ltd.
sp.	species (singular)
SPOT	Systeme Probatoire d'Observation de la Terre
spp.	species (plural)
SSD	Social Sciences Division (University of Namibia)
TDS	Total Dissolved Solids
TM	Thematic Mapper
UNDP	United Nations Development Programme
WWF	World Wildlife Fund

Chapter 1
Introduction

(PT)

About 100 years ago there were probably about six thousand people living in the area we now call Caprivi. People lived off the land, farming, hunting, fishing, and using wood to build their homes and cook their food. The quality of their lives depended on having ready access to good natural resources, and demands for food, water and fuel could easily be met by what the natural environment could supply. With 6 000 people in an area about 20 000 km^2 in size, each person had access to more than three square kilometres of land, on average, and all the resources that were available on that piece of land.

Now, 100 years later, people still largely depend on what the land has to offer. However, Caprivi now has a population about 18 times higher than it was then. Very simply, each person lives off 18 times less land than he or she would have 100 years ago. And the number of people keeps growing! In a perfect dream we would have hoped for the land to keep growing, but the amount of land and what it offers has not been maintained – instead, it has shrunk. Repeated and frequent bush fires have burnt away woodlands; land has been cleared, farmed and abandoned to become fields of thickets and weeds; game has been killed and driven away; and fish numbers have dwindled.

Many may argue that this description is too bleak. Large areas in Caprivi remain unsettled and unused by people, and some areas are still home to large numbers of game. All of this is true, and certainly Caprivi is no wasteland. But Caprivi can expect to have more people as time passes, and more people will need more land. Parts of Caprivi are also no longer available for subsistence farming, with competing uses for game parks, forest management, tourism and commercial farming. How can these competing interests be accommodated and how can we hope for Caprivians of the future to have access to the resources they need?

This publication does not pretend to answer all these questions, but it does present information and comment that people should consider if such questions are of any value at all. It attempts to bring together information on key issues and processes that affect the health of both the physical and social environment in the Caprivi. It has been written with a broad audience in mind, ranging from key leaders and politicians who need to make bold and wise decisions, to men and women who should know more about their region, to the youth who might face a sad future if these questions are not posed in this, the last decade of this century.

Much of the publication explores the relationship between the quality and distribution of natural resources and the spread of people who depend on these resources. Water is needed, both for domestic uses and livestock. The majority of homes obtain most of their income from subsistence farming, planting crops that need good soils and tending cattle that do best on healthy pastures. Most homes are constructed from wood, so timber is required to build them, especially from those types of trees which provide more durable timber. Most homes have thatched roofs which require certain kinds of grasses and reeds. With almost all households using wood fuel for cooking, firewood is another critical resource. For communities living close to rivers, fish are an important source of food and may be sold to generate cash. Other natural resources of direct benefit to Caprivians are indigenous fruits and other foods, and materials for the crafting of utensils and items for sale.

In compiling this publication, we have sought to emphasize the most important issues and processes that drive and affect the environment in Caprivi. The choice of what to highlight has been ours, but was guided by two workshops — one in Katima Mulilo, the other in Windhoek. Participants highlighted issues, constraints and problems of an environmental nature that we have taken up in assembling the profile. The contents of the publication have also been influenced by current events and climatic patterns. Recent years have been relatively dry compared to rainfalls in the 1960s and 1970s, and the rivers now run low. New political structures and aspirations have been introduced, and the tensions of the past 25 years have faded. New ways of conserving the environment are being tried, new entrepreneurs are emerging, and old ways are being scrutinized.

This publication, a product of the Environmental Profiles Project of the Ministry of Environment and Tourism, is a step towards their goal of having information on important environmental issues and processes in Namibia accessible to everyone. Work done to compile the profile was largely funded by the Kingdom of the Netherlands as part of their on-going commitment to enhancing environmental awareness throughout the world. This particular project has aimed to provide two products: this publication, and a range of information that was collected during the process. Our hope is that a variety of people will pick up this information, analyse it further, add to it, and generally use the information for whatever good purpose it may serve.

This is a publication intended for a wide readership. Within that frame, however, two groups of readers are perhaps more important than others. The first is Caprivi's new Regional Government, a body that needs to gain structure and stature to administer and lead Caprivi forward to a productive future. It is a modest hope that information presented here will aid the members of this body in their task. The second group consists of the many Caprivians who have been badgered by researchers and students collecting information. Too often one hears that nothing comes of these studies and no feedback is given. Again, it is our hope that information compiled here will provide some reward for sharing their knowledge so generously.

Aerial view of the Linyanti Swamps with Kalahari woodlands in Botswana in the background

Information compiled by the Environmental Profiles Project

The Environmental Profiles Project assembled several sets of data which are available from the Directorate of Environmental Affairs in the Ministry of Environment and Tourism. Those compiled by the project are freely available and those derived from other sources can be used with permission from the relevant organizations. The information is freely available in the spirit that human development is stimulated by the unrestricted flow of information.

Aerial photographs	prints of 1:20 000 photographs taken in 1996 and 1997 of the whole region; prints of certain areas taken in 1943, 1972, 1990, 1993 and 1995; and a list of other aerial photographs taken of Caprivi
Birds	records of species occurring in each quarter-degree square
Boreholes	co-ordinates, rest water levels, yields and total dissolved solids for several hundred boreholes
Climate	rainfall, temperature, humidity and evaporation data for weather stations in and around (Zambia and Botswana) Caprivi
Cultivation	areas cleared for cultivation in the whole of Caprivi in 1996, and of sample areas in 1943 and 1972 have been mapped; the data is available digitally
Fire	images showing active fires and fire scars derived from an interpretation of NOAA images taken in 1996
Infrastructure	positions of schools, health facilities, air strips, police posts, roads, telephone lines, power supplies and tourist facilities
Literature	lists and copies of publications relating to Caprivi
Mammals	point co-ordinates of game counted in the 1994 and 1995 aerial surveys
River levels and volumes	data on river flows at Katima Mulilo, Mukwe, Kongola, Victoria Falls, Ngoma and several other gauge stations
Satellite images	LandSat images of the whole region taken in 1994, and of the eastern floodplains taken in 1989
Settlements	co-ordinates of all settlements, the numbers of households and estimated numbers of people in 1996, and the numbers of households in sample areas in 1943 and 1972
Stock numbers	co-ordinates of crushpens and stock counts in 1995 and 1996
Vegetation units	mapped vegetation types, with associated information on species composition, soils and ratings for potential land uses

Key publications on Caprivi

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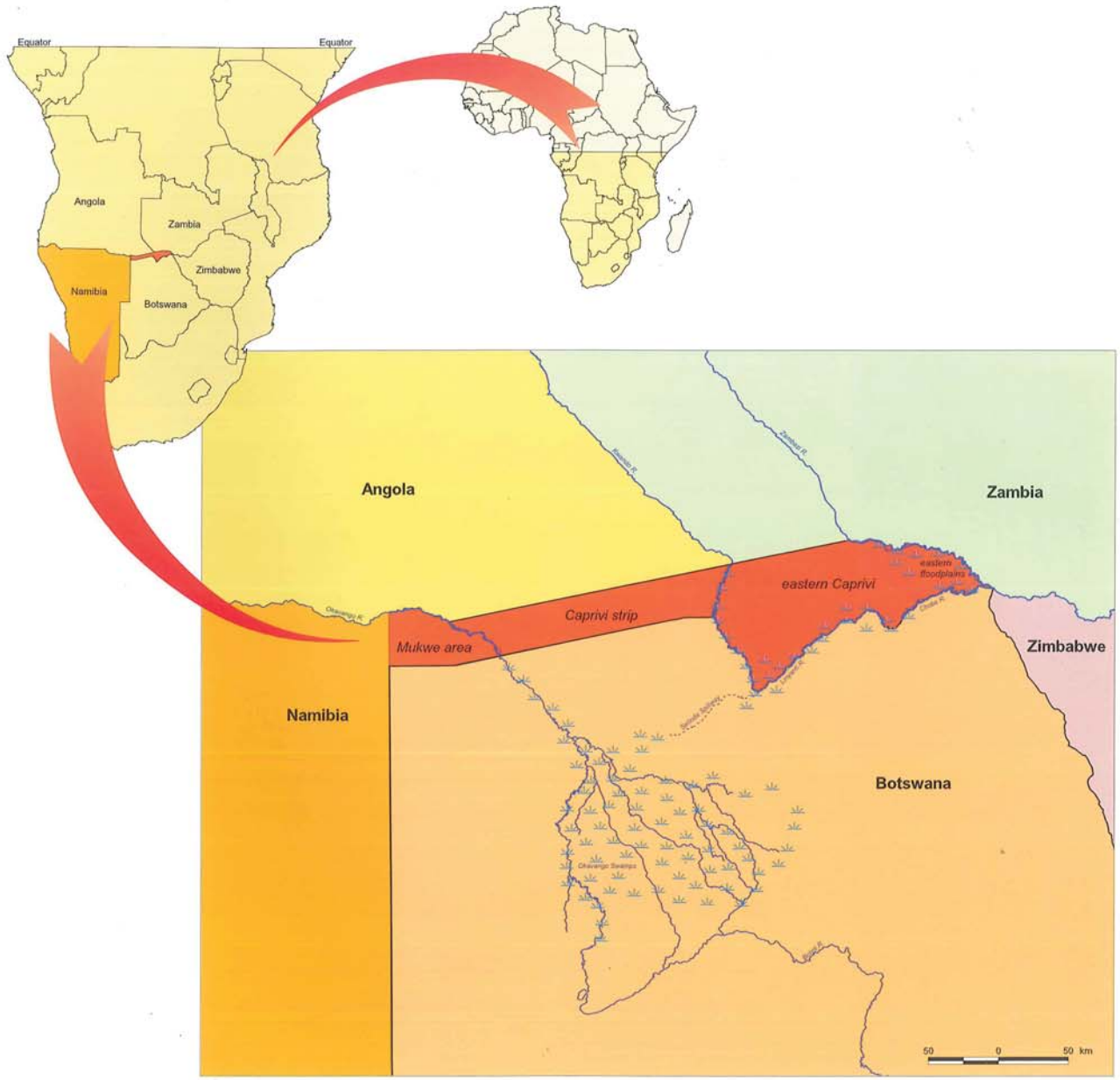
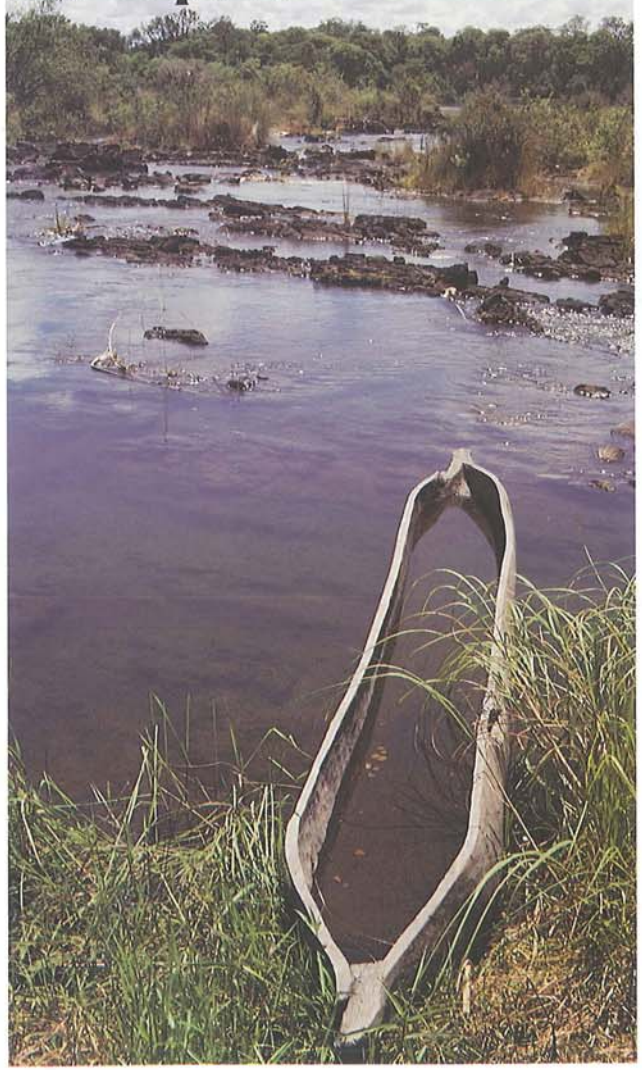


Caprivi's position in southern Africa

Projecting eastwards from Namibia, Caprivi lies in the centre of southern Africa. It is bounded by four other countries. Three perennial rivers cross Caprivi, making it a unique area in the otherwise arid Namibia.

Chapter 2
General description of Caprivi



Caprivi, one of the 13 regions of Namibia, forms the country's finger-like projection in the north-east which extends Namibia's borders into the centre of southern Africa (see map on page 3). The region lies about half-way between the equator and the southern tip of the continent and midway between the Atlantic and Indian oceans. Attached to the rest of Namibia only along a short border, Caprivi is bounded by four other countries: Botswana to the south, Angola and Zambia to the north and Zimbabwe to the east. The inclusion of this area into Namibia is the result of negotiations between Germany and other colonial governments at the end of the 19th Century. It was agreed at the Berlin Conference that it would be added to German South West Africa as an extension, allowing the German colony to gain access to the Zambezi River. It is to the chief German negotiator at this conference, Count von Caprivi, that the region owes its name.

In broad terms, the Caprivi stretches 450 kilometres from east to west and ranges between 32 and 100 kilometres in width from north to south. Our calculations indicate that it covers an area of about 20 000 km^2. The region is divided into three distinct areas by the Kwando and Okavango rivers (see map on page 3):

- eastern Caprivi, that area east of the Kwando River,
- Mukwe area, the triangle of land west of the Okavango River, and
- the Caprivi strip, the narrow strip of land between the two.

Like many other borders in Africa, Caprivi's boundaries either follow the midstream of rivers or run along straight lines[1]. A number of disputes about the precise positions of these boundaries have arisen over the years. Most recently Botswana and Namibia have been at odds over the ownership of Kasikili, or Sudundu, Island in the Chobe River in the south-east, not far from its confluence with the Zambezi. The straight-line borders are delimited by cut-lines, many of which have become overgrown.

What is important about these borders is that they do not follow any distinct environmental or cultural boundaries. Environmentally, most of Caprivi is really part of a broader landscape of Kalahari woodlands, and plants and animals found in the Caprivi are to be found in adjoining areas of Angola, Zambia, Zimbabwe and Botswana. Many of the larger mammals in this semi-arid and dry sub-humid environment depend on being able to move freely around this broader landscape. They cannot be restricted to relatively small areas demarcated by borders cutting arbitrarily through their ranges and habitats.

Landscapes and land types

Topographically, Caprivi is particularly flat without a single feature recognizable as a hill. From the highest areas in the extreme west (about 1 100 m above sea level) elevations gradually drop to 930 m near Impalila Island in the east. There are slight local changes in elevation in the river valleys and between the vegetated dunes and dune valleys in the Mukwe area and Caprivi strip, but these are seldom more than 30 m.

The area is covered in thick deposits of Kalahari sands, with very little of the underlying geology exposed, except along certain sections of the river courses and on Impalila Island. The extensive Kalahari sands and the rivers with their associated floodplains, channels and deposits are the two major features which shape the landscape. The processes associated with these features have created six major land types:

- The Okavango, Kwando, Linyanti, Chobe and Zambezi rivers and their deeper channels make up areas of **open water**.
- The **floodplains** associated with the rivers are flat areas dominated by grasslands and old river channels. River waters flood over these areas when good rains cause river levels to rise.
- **Riverine woodlands** in the Okavango and Kwando river valleys and in the Maningimanzi area on the Zambezi River east of Katima Mulilo are characterized by a high diversity of tall trees.
- **Mopane woodlands** lie in an area of old river drainage lines which are being covered by wind-blown sand deposits.
- **Kalahari woodlands** cover the largest area, and are dominated by sand dunes and interdunes in the Mukwe area and Caprivi strip and extensive sandy plains in eastern Caprivi.
- **Impalila woodlands** covering the island make up a small but unique area from the rest of Caprivi. They are based on basalt rocks rather than wind-blown sands or river systems.

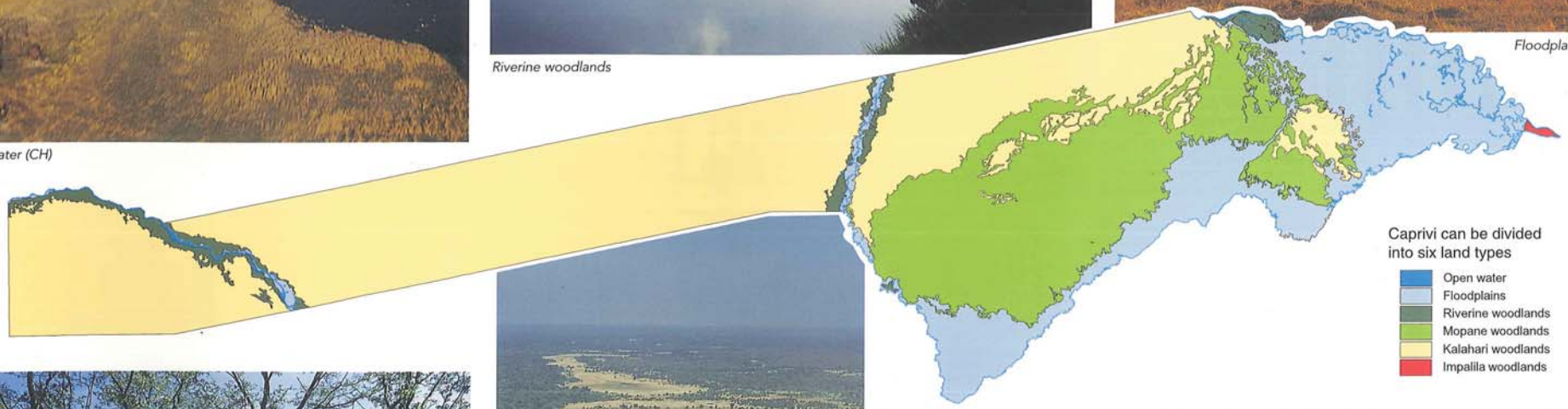
Land type	Area (km^2)	%
Open water	166	0.8
Floodplains	3 762	18.8
Riverine woodlands	511	2.6
Mopane woodlands	4 613	23.0
Kalahari woodlands	10 939	54.7
Impalila woodlands	18	0.1
TOTAL	20 009	100.0

Six land types in Caprivi, the areas they cover and their relative sizes

Open water (CH)

Riverine woodlands

Floodplains (CW)



Mopane woodlands

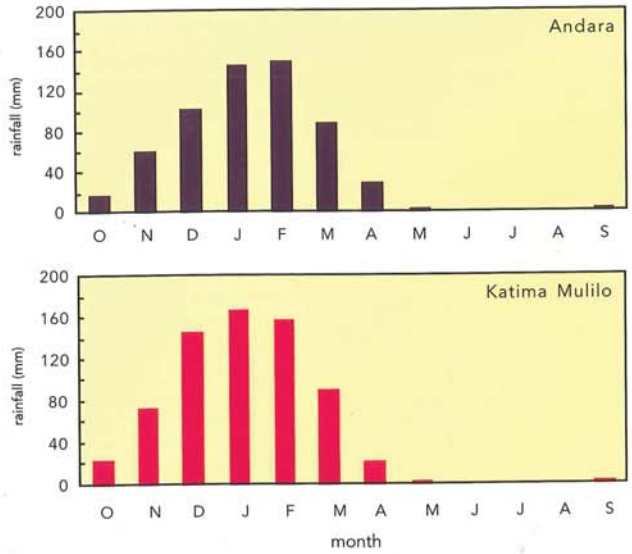
Kalahari woodlands

Exposed basalt forms the Mambova Falls on the Zambezi (foreground) and the basis of the Impalila woodlands

Climate

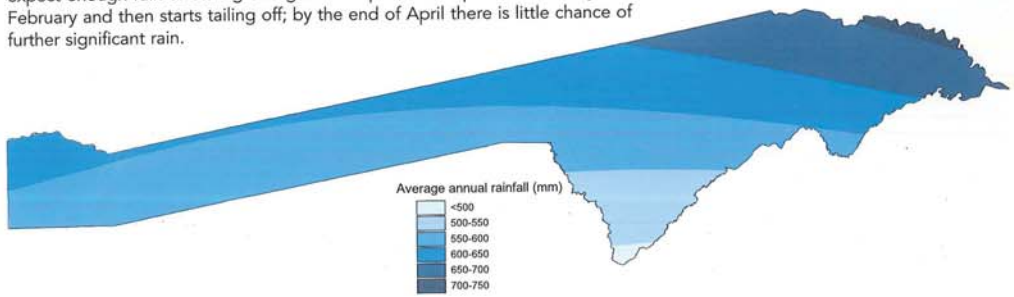
In a country often characterized as hot and dry, Caprivi is distinctly more tropical than any of the other regions. It enjoys a higher rainfall, less evaporation and a warmer winter than the rest of Namibia, providing a home to many tropical plants that are unable to suvive elsewhere in Namibia.

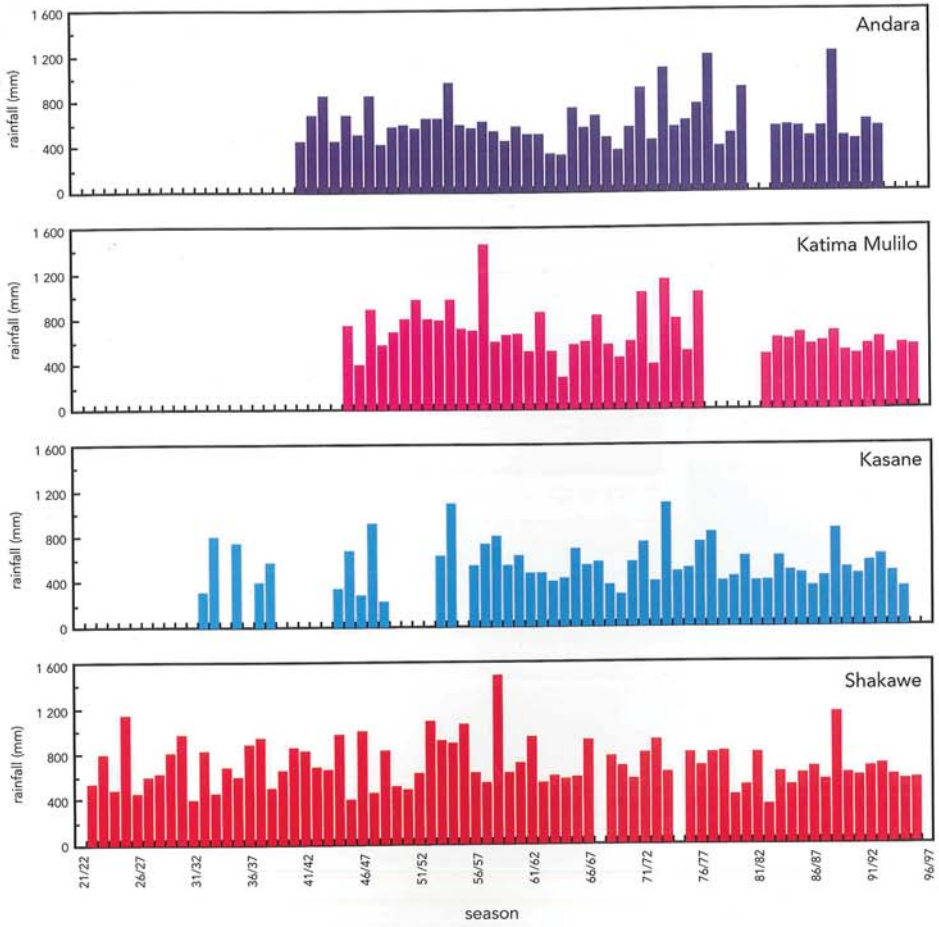
Even though Caprivi sees the highest rainfalls in Namibia, it is still plagued by rain that is highly variable from year to year and from one place to another, and experiences serious droughts from time to time. At these times the livelihoods of many farmers are placed in jeopardy.



▲ **Average rainfall at Andara and Katima Mulilo for each month of the year**

Almost all of Caprivi's rain falls during the summer months. Small falls may occur in October or even September, but it is only in November that farmers can expect enough rain to start growing their crops. Rainfall peaks in January and February and then starts tailing off; by the end of April there is little chance of further significant rain.





◀ **Total rainfall measured each season at four places in, or close to, Caprivi**

Only seasons with complete rainfall records are shown in the graphs. Seasons with no or incomplete records have been left blank — they should not be interpeted as seasons with no rain.

One place may have a bumper year while another may have below average rainfall in the same season. Similarly, rainfall can double from one season to the next, at the same place.

As in other regions of Namibia, rainfall has generally been lower in recent years, although lower totals have been recorded in previous years. The 1988/89 rain season was an exception. Shakawe, Kasane and Andara recorded very high rainfalls of close to or above 1 000 mm, although Katima Mulilo missed these above normal rains. This illustrates the irregular and un-predictable way in which rain falls in Caprivi. For each of these places, the maximum amount of rain ever recorded in one season was about four times greater than the lowest amount of rain ever recorded.

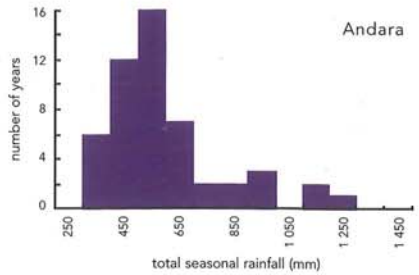
Rain falls mainly in the form of thunder showers (PT)

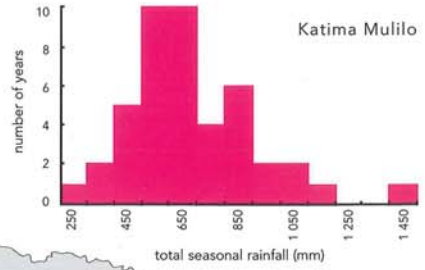
◀ **Average rainfall and variation in rainfall**

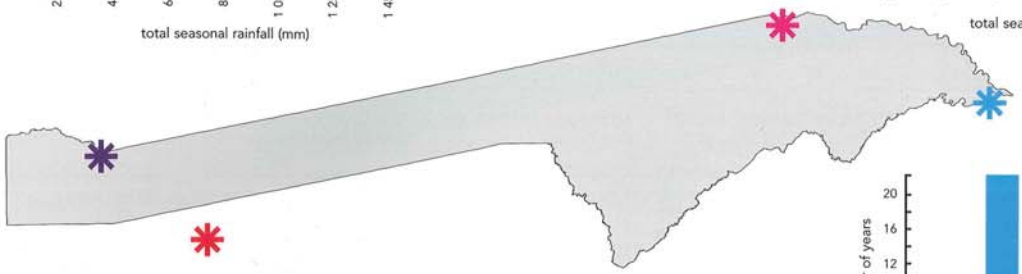
Despite highly variable rainfall figures, certain trends are apparent. An analysis of rainfall figures from a number of places in Namibia, Botswana and Zambia[2] shows that there is a general decline in rainfall from north to south and slightly so from east to west across Caprivi. In the north-east around Katima Mulilo, average total rainfall amounts to just under 700 mm and modal values are about 550 mm per year. In the southern-most parts of the region, averages are about 500 mm and modal totals are about 400 mm. In the west, around Mukwe, average rainfall is about 600 mm and modal rainfall is about 550 mm.

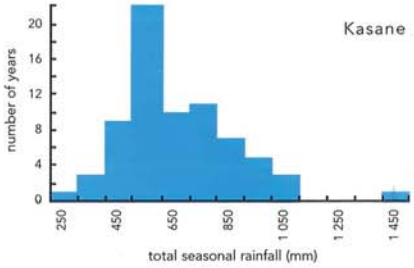
Variation in rainfall

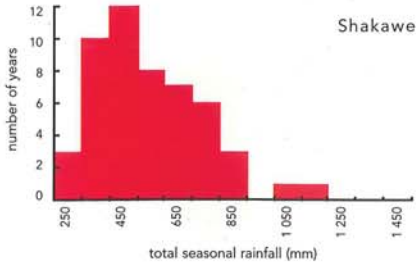
The degree of variation in rainfall from year to year also changes across Caprivi. As a proportion of the amount of rain that falls on average, rainfall is more variable in the southern-most parts of the region and most predictable in the eastern areas.







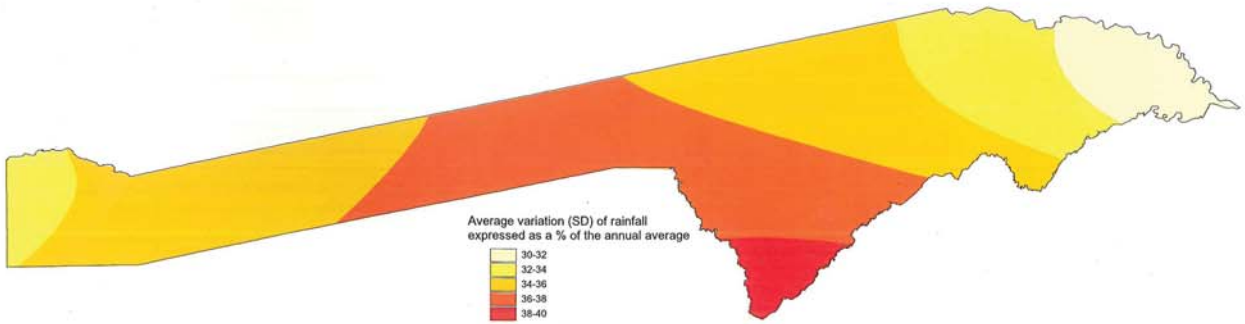


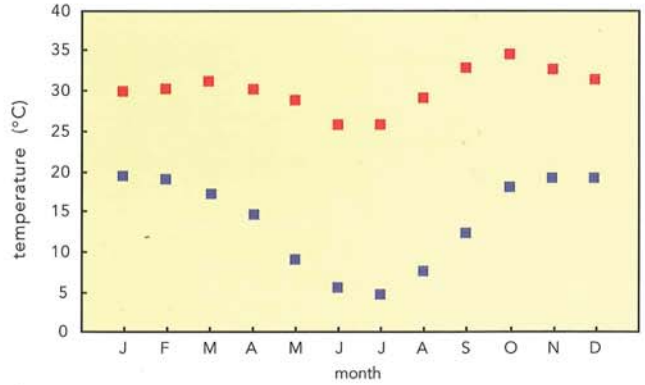


	Seasonal rainfall (mm)	
	mode	average
Andara	550	603
Kasane	550	666
Katima Mulilo	600	683
Shakawe	450	550

How often can Caprivi expect average or good rainfalls?

Due to the high variability in rainfall, average rainfall figures tend to give an exaggerated view of how much rain normally falls. For example, the average rainfall for Andara over the last half century has been 603 mm. However, this average is distorted by some very high falls during those years when over 1 000 mm fell in each of three seasons. Another way to express the amount of rainfall that a place "normally" receives is through modal values. Modes are perhaps the best measures of usual rainfall because they reflect the amounts of rain that fall most often. So, for Andara the modal value for total annual rainfall is 550 mm. Graphs for Andara and Katima Mulilo in Caprivi and for Kasane and Shakawe in Botswana show how total annual rainfalls are more often in the low end of the range of totals recorded.

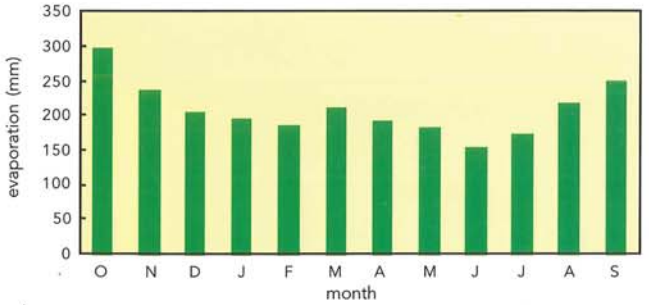




▲ **Average monthly minimum ■ and maximum ■ temperatures at Katima Mulilo**

Summer days are often cloudy, becoming progressively so during the day as clouds build up between the morning and afternoon. The effect of these clouds is to keep temperatures fairly low, especially during the middle and late summer months. In fact the highest temperatures are felt in September, October and November when there is often little cloud cover. The sun's radiation is then high, and average daily maximums are between 32° C and 35° C.

Average daily minimum temperatures vary between about 20° C in summer and about 5° C in winter. Frost is unusual, but may occur in some years in low-lying river valleys, especially in the western parts of the region. Clear skies during the winter months result in fairly high average maximum temperatures, but they also allow daytime heat to escape during the night. The range of temperatures during winter is thus greater than in summer.

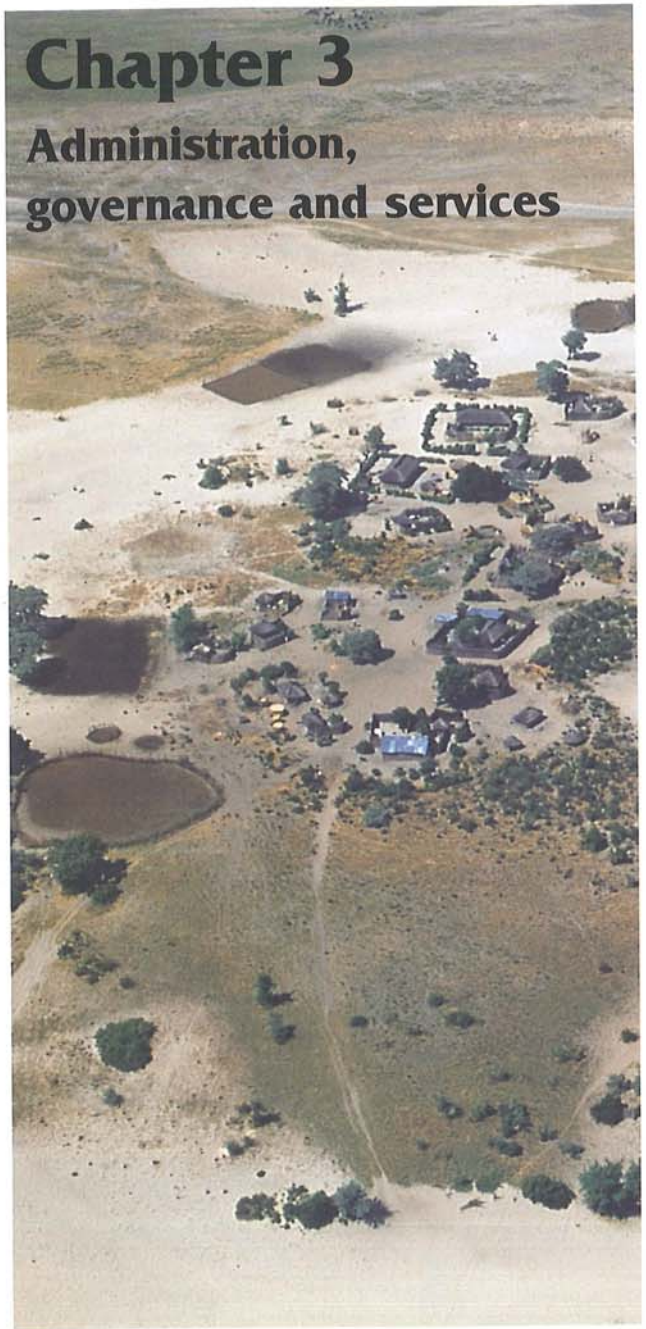


▲ **Average monthly rates of evaporation at Katima Mulilo**

The rate at which water evaporates into the atmosphere varies during the year, from the highest rates in September and October when it is hot and dry and clouds are sparse, to the lowest rates in the coldest mid-winter months. About 2 500 mm or 2.5 m of water evaporates in an average year, which is over four times the volume of water normally provided by rain. Evaporation rates are higher than usual in dry years when temperatures are high and cloud cover is sparse; plants and crops then suffer both from lower rainfalls and greater losses of water into the air.

Chapter 3

Administration, governance and services



Land-use types

The 20 009 km² of land making up Caprivi is either under state or communal administration. State controlled areas make up a total of about 8 770 km². They consist primarily of game reserves and national parks, the state forest, and diverse agricultural projects administered by various ministries and the National Development Corporation (NDC).

Land generally regarded as communal covers an area of about 11 239 km². The dominant form of land use in these areas is subsistence farming. In addition, several other commercial uses are made of these areas, including tourist lodges, and hunting concessions authorized by the Ministry of Environment and Tourism. This ministry is also in the process of supporting the establishment of conservancies by rural communities.

One major characteristic of land in many parts of Caprivi is the fact that uses allocated to land are often uncertain, uncontrolled or arbitrary in nature. For example, the state forest has never been proclaimed as a state reserve. Some people assume that it is proclaimed and respect that status, while others have settled and cleared land in the reserve. The Caprivi Game Park is another disputed area, although in this case it is legally proclaimed as a game reserve. Some people living in the Caprivi Game Reserve have been living there for decades and have become accepted inhabitants, but the establishment of new settlements and farms by other people is less accepted. The triangular area between the Caprivi Game Park and the Kwando River is thought to be a conservation area by many people and this status is generally upheld. While it presently enjoys no such formal protection, the Ministry of Environment and Tourism is motivating for its proclamation. In many communal areas, control over land occurs in arbitrary ways. Some people need special permission and permits to set up certain commercial enterprises, but none of these controls are required for other people who now use large areas for commercial farming.

Recent history of administration

Caprivi has seen a multitude of administrative changes during the last 100 years. It has been subject to three colonial governments (Germany, Britain and South Africa) and was administered through three separate countries before 1992: Botswana, South Africa and what was then South West Africa.

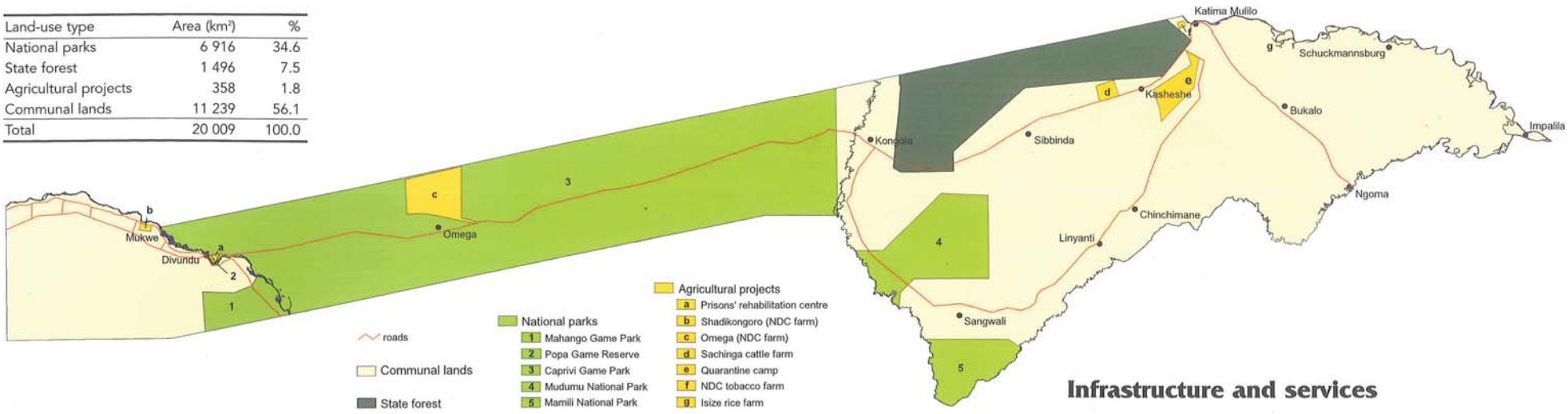
1600s and 1700s	First Lozi Empire
1820s–1864	Kololo Empire
1864–1890	Second Lozi Empire
1890	Caprivi is added to German South West Africa as a result of negotiations at the Berlin Conference
1914–1918	Along with the rest of German South West Africa, Caprivi is placed under British military rule
1921–1929	Administered as part of British Bechuanaland
1929–1939	Administration is allocated to the South West African Administration in Windhoek
1940–1981	Administered by South Africa from Pretoria
1981–1990	Under the Administration for Caprivians as part of the South West Africa Administration
1990–1992	Transitional period following Namibian Independence
1992	Caprivi becomes one of the 13 political regions in Namibia with its own regional governor and six councillors

Before 1992, the Okavango River formed the western boundary of Caprivi. In 1992, the boundary was moved west, adding the Mukwe area between the Okavango River and the line of longitude running along 21° East.

Traditional authorities

Within communal areas there are several levels of traditional authority. In eastern Caprivi, each village has a head who is the most senior male member. He advises the senior headman who represents a number of villages, or a ward. The senior headmen act as local representatives on the tribal council, or *kuta*, which is presided over by the *ngambela* (chief councillor). The *kuta* is the highest legislative, administrative and judicial body in the tribal area. The *ngambela*, who is appointed by the tribal head or chief, communicates the wishes of the chief to the tribe through the headmen, and vice versa. In western Caprivi, traditional authorities are less structured, but are similar in that authorities range from local village headmen to a chief who presides over a large area. Not surprisingly, the boundaries and zones of influence are often the subject of considerable competition and dispute.

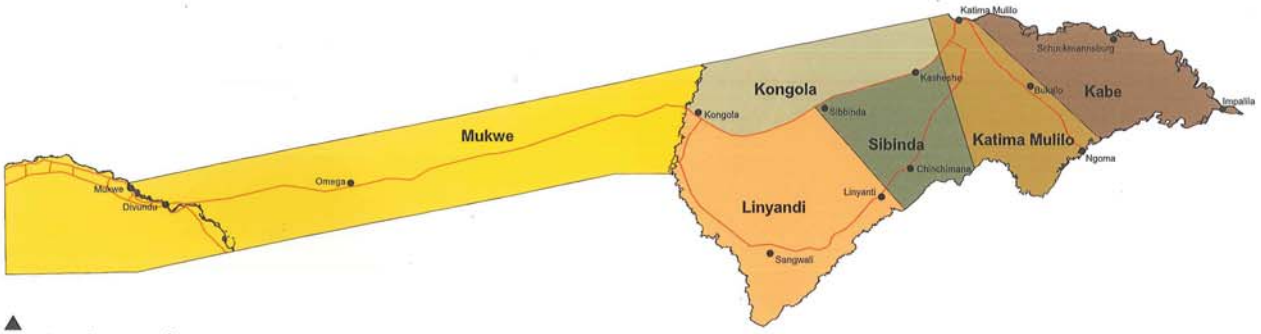
Land-use type	Area (km²)	%
National parks	6 916	34.6
State forest	1 496	7.5
Agricultural projects	358	1.8
Communal lands	11 239	56.1
Total	20 009	100.0



▲

Land administration

Land in Caprivi is either under state or communal administration. The status of some of the state areas is equivocal. Consideration is being given to changing the status of the Caprivi Game Park and designating some of it as a multiple use area. This would resolve the apparent contradictions that have arisen as a result of agricultural and other activities now occurring within the proclaimed nature reserve. Other areas in the Caprivi Game Park would be zoned as core conservation areas. The status of the state forest is also unclear since legislation has not been passed to designate this as a protected reserve. Timber was harvested extensively for many years, but formal or commercial logging is no longer allowed.



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Local and regional government

There are six constituencies in Caprivi. They were described in 1992[1] when the Namibian Government introduced a system of regional and local government for each of the 13 regions. Regional government is headed by an elected governor, while local representation is through six elected councillors, each of which represents a constituency. Note that the spellings of the constituencies are those used in the Government Gazette and in the case of Kabe, Sibinda and Linyandi differ from spellings commonly used for the villages after which they were named.

Constituency	Area (km²)
Kabe	2 113
Katima Mulilo	1 960
Kongola	2 024
Sibinda	1 726
Mukwe	8 519
Linyandi	3 667

Infrastructure and services

Katima Mulilo is Caprivi's capital and administrative centre. Some public services for the Mukwe area are still run from Rundu (Kavango's main centre), since that area used to belong to the Kavango Region. Prior to the establishment of Katima Mulilo as an administrative centre in 1935, Schuckmannsburg had served that purpose since 1903. As the capital centre in Caprivi, Katima Mulilo not only serves as the seat for the regional government and ministerial offices, but is the only commercial centre in the region. Small retail outlets can be found in other centres, but Katima Mulilo is the only centre in Caprivi which provides banking, postal and other commercial services. A map showing infrastructure, services and the larger villages follows on pages 10 and 11.

Health services

There are two hospitals, one at Katima Mulilo and the other at Andara, and three health centres equipped with some beds at Sibbinda, Chinchimane and Bukalo. Clinics and primary health care facilities are found at 34 other places throughout Caprivi. Outreach or mobile health teams are based at Andara and Katima Mulilo from where they serve outlying villages.

Education facilities

There is a considerable network of schools in the region — 70 primary schools, 22 secondary schools, and 52 combined schools which offer some primary and some secondary grades. Not all primary schools offer Grades 1–7 and not all secondary schools offer Grades 8–12. In addition, there is a vocational college and a teachers' training college in Katima Mulilo. About 37 000 students (over one third of Caprivi's population) attended these institutions in 1996, where they were served by about 1 500 teachers.

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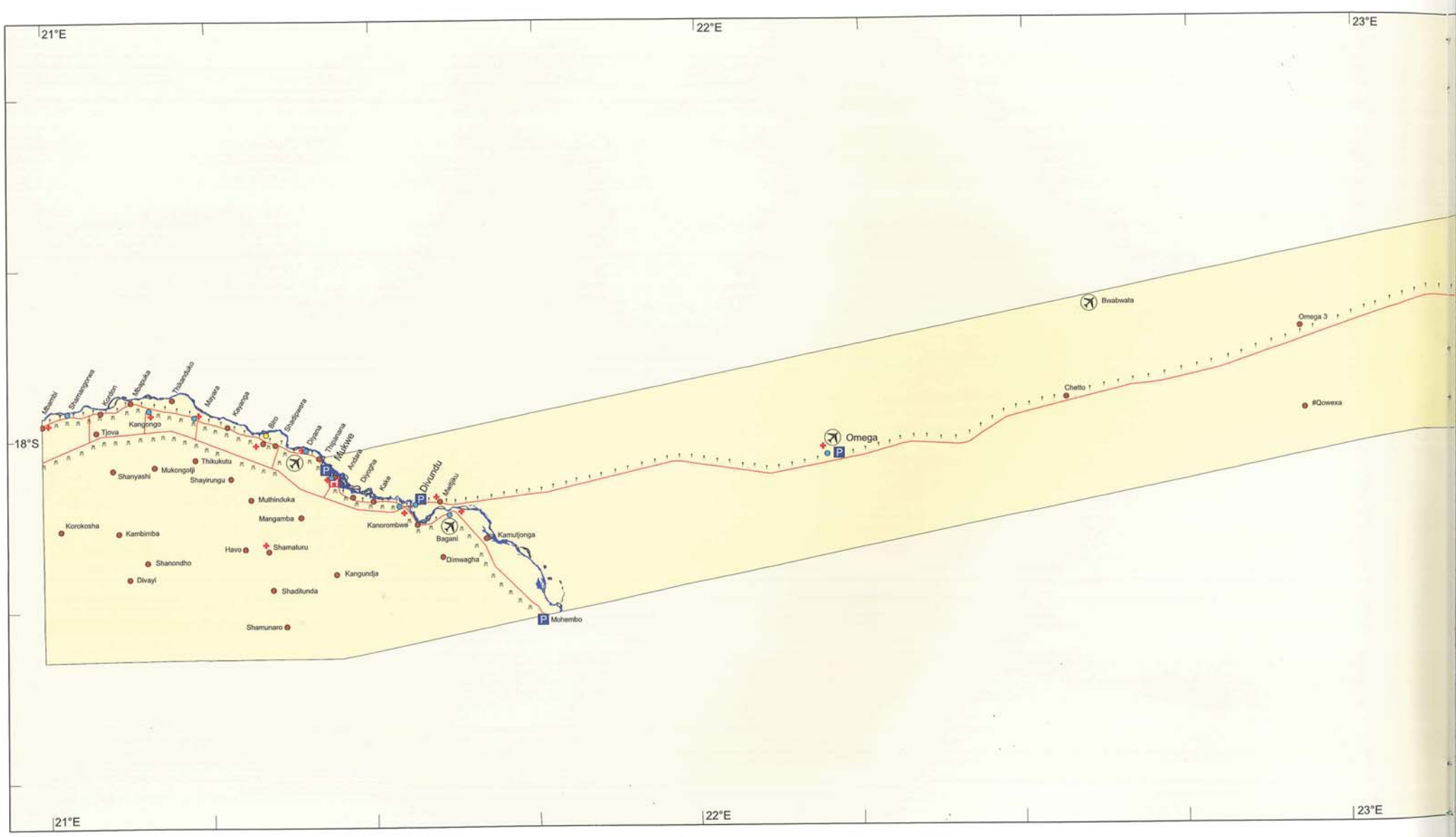
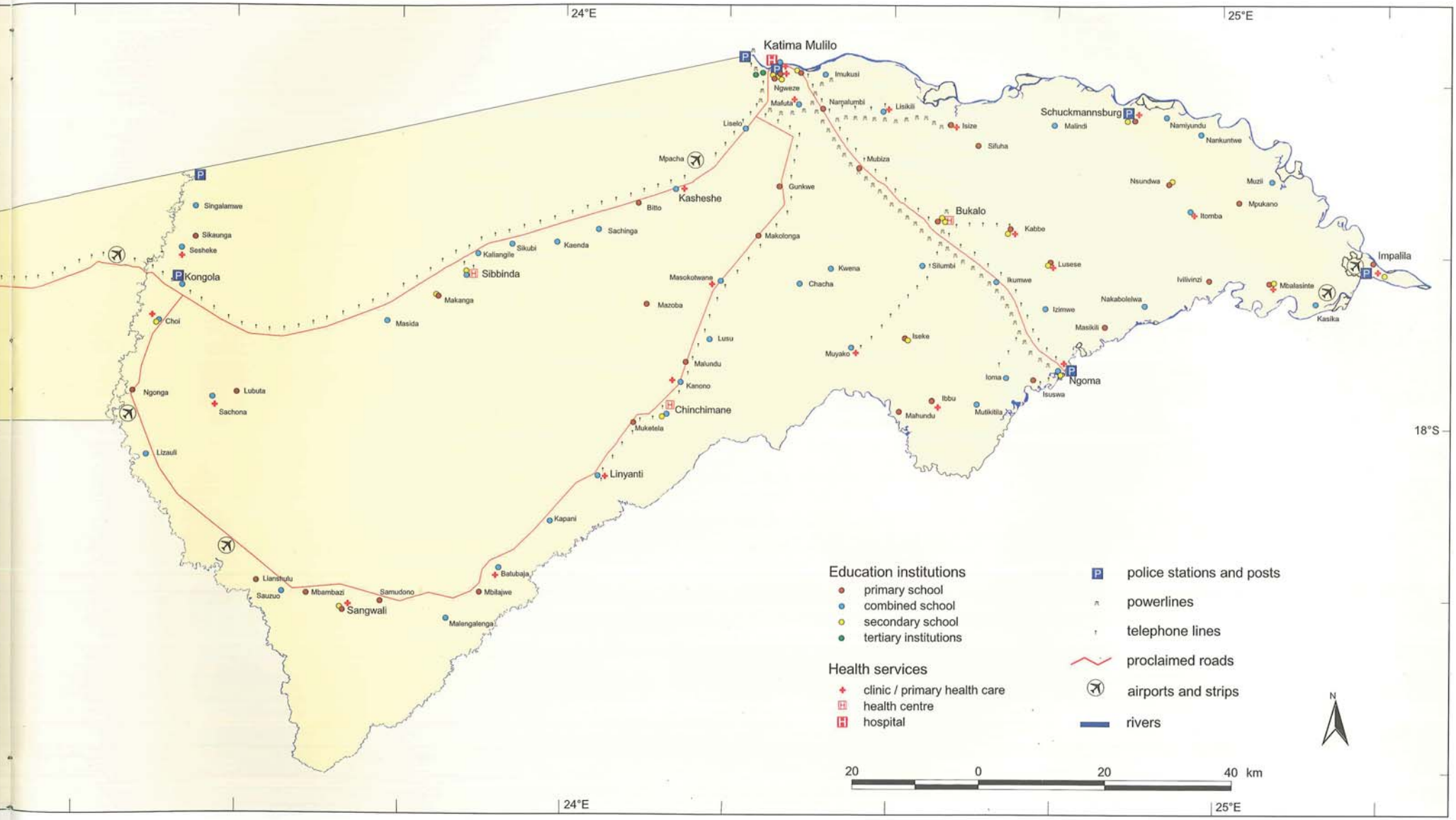


Infrastructure and services


24°E
25°E
18°S
Katima Mulilo
Imukusi
Ngweze
Maluta
Namalumbi
Lisikili
Schuckmannsburg
Malindi
Isize
Siluha
Namiyundu
Nankuntwe
Liselo
Mpacha
Mubiza
Nsundwa
Muzii
Mpukano
Itomba
Gunkwe
Kasheshe
Bitto
Bukalo
Kabbe
Singalamwe
Sikaunga
Sesheke
Kongola
Sachinga
Sikubi
Kaenda
Kaliangile
Sibbinda
Makolonga
Kwena
Silumbi
Lusese
Impalila
Ivilivinzi
Mbalasinte
Kasika
Nakabolelwa
Izimwe
Masikili
Masokotwane
Chacha
Ikumwe
Makanga
Mazoba
Masida
Choi
Lusu
Iseke
Muyako
Malundu
Kanono
Ioma
Ngoma
Isuswa
Ngonga
Lubuta
Sachona
Chinchimane
Ibbu
Mahundu
Mutikitila
Muketela
Lizauli
Linyanti
Kapani
Batubaja
Lianshulu
Sauzuo
Mbambazi
Samudono
Mbilajwe
Sangwali
Malengalenga
Education institutions
primary school
combined school
secondary school
tertiary institutions
Health services
clinic / primary health care
health centre
hospital
police stations and posts
powerlines
telephone lines
proclaimed roads
airports and strips
rivers
N
20
0
20
40 km

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Communication and electricity

Only a small area of the region has access to telephone and electricity supply services, and very few households there are connected to them. Expansions to these services are constrained both by the availability of distribution lines and the ability of households to pay usage fees. There are now about 1 000 telephone subscribers in the region and only 5% of all households had an electricity supply in 1991.

Telephone services to the Mukwe area and Caprivi strip are through the exchange in Rundu, while eastern Caprivi is served by an exchange in Katima Mulilo. Electricity to the Mukwe area comes off the Namibian grid system, while most power to eastern Caprivi is imported from Zambia. A generator in Katima Mulilo provides some additional electricity.

The main roads through Caprivi, from Ngoma to Katima Mulilo and from Katima eastwards through to Kavango are currently being upgraded and tarred. This route will form the Trans-Caprivi Highway and will be an important trade link between Namibia and the other southern African countries. Cargo traffic will increase and the area will also become more accessible to tourists, especially those travelling in sedan cars. In addition, there are some gravel-surfaced roads and a large number of small roads and tracks. There are no rail links serving Caprivi.

The only regular, commercial air service to Caprivi lands at Mpacha Airport outside Katima Mulilo. There are a number of other airstrips throughout Caprivi which vary in size and quality.

Police, customs and immigration services

Immigration services are available at Mpacha Airport, on the Botswana border at Ngoma and Mohembo and on the Zambian border at Katima Mulilo. Elsewhere, there are police stations or posts at Impalila, Schuckmannsburg, Singalamwe, Kongola, Divundu, Omega and Mukwe.

The market in Katima Mulilo. Katima Mulilo is the only commercial centre in Caprivi.

Tourism

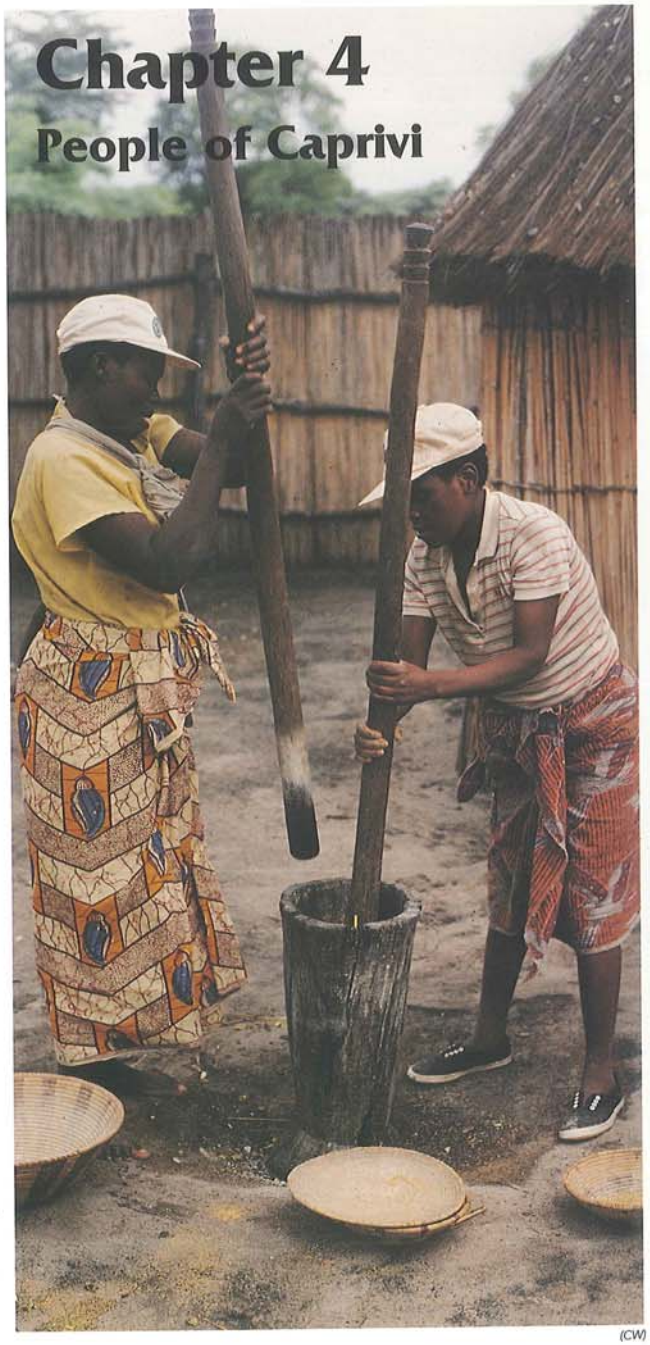
Caprivi is a popular destination for visitors, and provides links to attractions in Botswana, Zambia and Zimbabwe. On average, each tourist spends three nights in Caprivi and is usually on a trip that includes more than one destination. Tourism to Caprivi generates substantial earnings for Namibia. An estimated 30 to 35 thousand tourists visited the region in 1996, this being about 9% of all visitors to Namibia[2]. The numbers of tourists have grown at a substantial rate (over 20%) during the past three years, which is faster than the growth rate of tourism to Namibia as a whole.

▲

Accommodation and the main areas visited by tourists

In 1996 there were 12 facilities offering accommodation, between them having 127 rooms and 295 beds. Almost all tourism is centred on the southern sections of the Okavango and Kwando rivers, Impalila Island, and Katima Mulilo eastwards along the Zambezi River.

Chapter 4
People of Caprivi

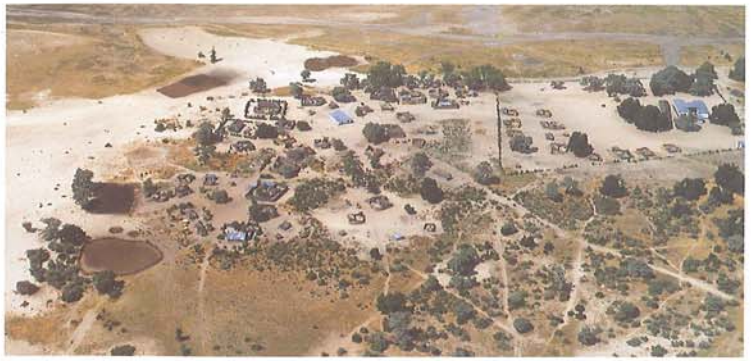


(CW)

Population size and distribution

The total population in 1991 amounted to 90 422 people, as reported in the 1991 Population and Housing Census. The most recent estimate from the 1996 Demographic Survey puts the population at about 107 900 people, while our estimates from aerial counts of households suggests a total population of about 110 700 in 1996.

To obtain information on the distribution of people in Caprivi, households were counted and mapped using aerial photographs[1]. The number of people was estimated by multiplying the number of households by the average household size in each area.



Aerial view of a typical village on the eastern floodplains

Area	Households	Estimated population
Eastern Caprivi	13 993	73 982
Caprivi strip	1 336	6 548
Mukwe area	4 287	30 174
Constituency		
Kabe	3 023	16 991
Katima Mulilo	5 313	28 163
Kongola	638	3 198
Linyandi	3 024	15 039
Mukwe	5 623	36 722
Sibinda	1 995	10 591
Total	19 616	110 704

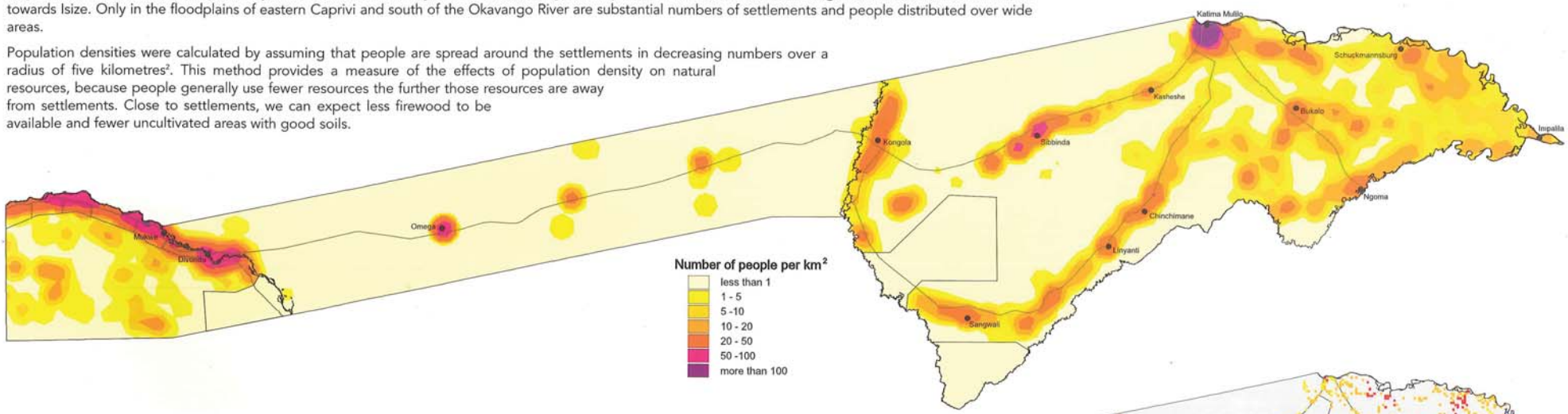
Estimated population of Caprivi (1996)[1] ▲

About 67% of the population lives in eastern Caprivi, 27% in the Mukwe area and 6% in the Caprivi strip. The Mukwe and Katima Mulilo constituencies have the largest populations, and Sibinda and Kongola have the smallest. A total of 2 655 households was counted in the town of Katima Mulilo, with an estimated population of 13 448.

Population densities ▼

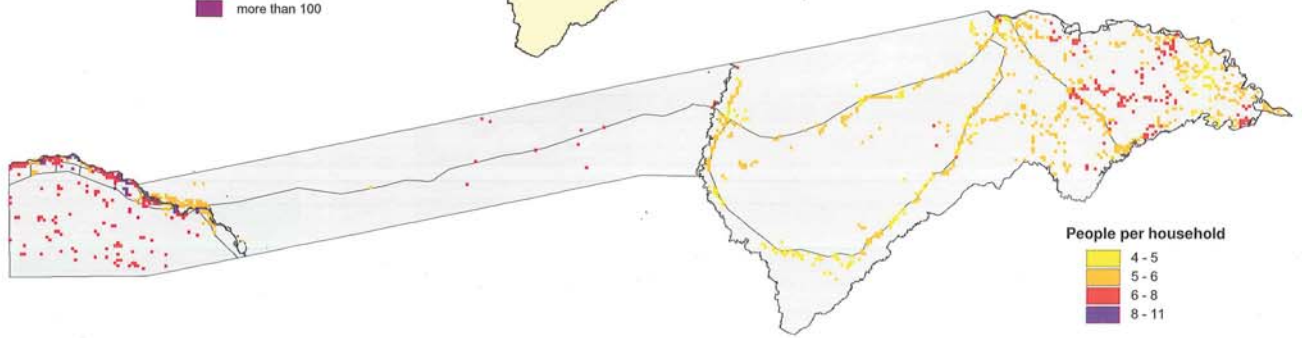
The average population density in 1996 was 5.5 people/km². However, most of the region is sparsely populated, with about 61% of the total area having a density of less than one person per square kilometre. Other than Katima Mulilo, the highest densities are along the Okavango River, north of Kongola along the eastern edge of the Kwando River, along the major roads around the villages of Sibbinda, Sangwali, Linyanti, Chinchimane, Bukalo and Ngoma, and east of Katima Mulilo towards Isize. Only in the floodplains of eastern Caprivi and south of the Okavango River are substantial numbers of settlements and people distributed over wide areas.

Population densities were calculated by assuming that people are spread around the settlements in decreasing numbers over a radius of five kilometres[2]. This method provides a measure of the effects of population density on natural resources, because people generally use fewer resources the further those resources are away from settlements. Close to settlements, we can expect less firewood to be available and fewer uncultivated areas with good soils.



Average numbers of people per household ▶

Household sizes vary from area to area, being largest along and south of the Okavango River and in certain areas on the eastern floodplains[6]. Average household sizes were reported to be 4.8 people per household in the 1991 Population and Housing Census[3]. However, the 1993/94 Income and Expenditure Survey reported a figure of 5.4 people per household[4] which is considered more representative, and the 1994/95 Agricultural Census gave a figure of 6.1 people for farming households in rural areas[5].



Population structure and human development

Results from the 1991 Population and Housing Census[3] showed that there were only slightly fewer males than females in Caprivi. This proportion of females (51.2%) is similar to that recorded for the whole of Namibia, and indicates that most men remain in the Caprivi, rather than moving away as migrant labourers. The 1991 census also showed that:

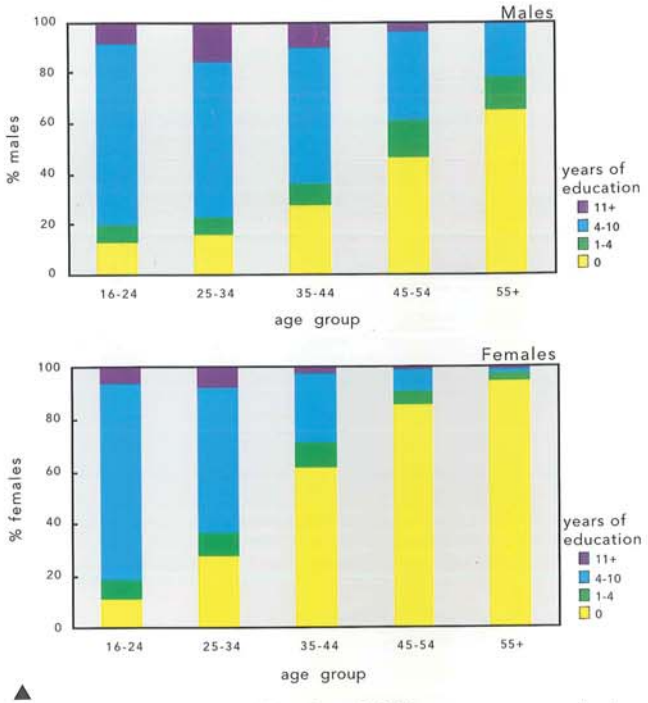
- Of the total population, 13 377 or 15% then lived in the region's only urban area — Katima Mulilo — while the remaining 85% lived in rural areas.
- Namibians made up 94% of the population, the remaining 6% being nationals of other countries.
- The main languages spoken there were Caprivian languages (the mother tongue of 70% of people), Rukavango languages (24%, mainly Thimbukushu), and Bushman languages (4%, primarily Kxoe).

Sixty-one percent of households are headed by men, while 39% have women as household-heads. Those headed by men are generally wealthier, average yearly consumption levels in 1993/94 being about 20% higher (N$5 893 vs N$4 917) than in homes where women are heads[4].

The Caprivi is particularly poor in terms of general human development. The Human Development Index (HDI) provides an index of human development by measuring the combined effects of life expectancy, literacy, enrolment rates at school and income. Comparing Caprivi with the other 13 regions in Namibia, Caprivi rates only slightly higher than the Ohangwena Region which has the worst HDI value in Namibia[7,8].

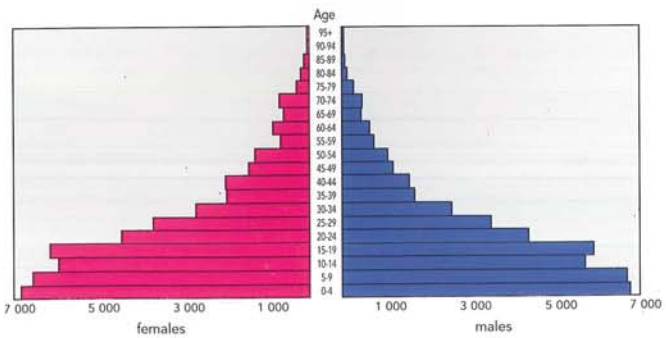
A low life expectancy in Caprivi is the most important factor contributing to Caprivi's poor Human Development Index. The life expectancy of men in 1991 was 51.4 years and that of women was 54.5 years (compared with the highest expected life spans of 69 years for women in the Khomas region). Child mortality rates are high, with 106 infant deaths per 1 000 infants born, and 132 per 1 000 of children under the age of five years[7]. The population of the region is dominated by young people with the average number of children born to a woman in Caprivi being 6.7[3].

Low life spans are largely due to the high rates of disease which affect Caprivians from birth. The infant and early childhood mortality rates are 50% higher than the national average. Diarrhoea and measles cause a high proportion of infant deaths, while 55% of school children suffer from goitre and 42% are physically stunted. Among older people, malaria, tuberculosis and HIV take an increasing toll. About one out of every four pregnant women attending clinics has been found to be HIV positive[8].



▲ **Proportions of males and females of different age groups having completed various levels of education** (from the 1991 Population and Housing Census)

Literacy rates among adults in Caprivi are relatively high at an estimated 75%, largely as a result of increased school attendance in recent years. An estimated 95% of 7–18 year-olds are at school, the total number of learners at school in 1996 being about 37 000. While levels of education among adults have improved over the years, many people aged 55 and above, especially women, have had little schooling. Rates of school attendance by men were higher than by women up until about ten years ago.



▶ **Age pyramid**

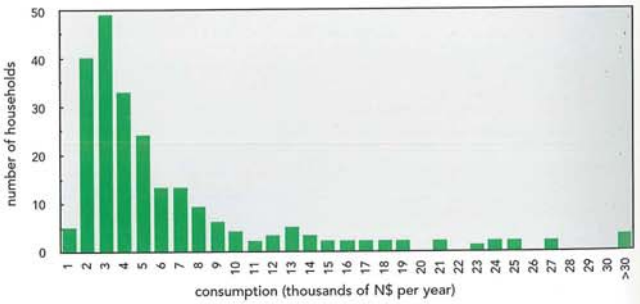
The population of Caprivi is dominated by young people — characteristic of a fast growing population. Those younger than 15 years make up 43% of the total number of people.

Income and expenditure

Caprivi's economy and that of most households is predominantly rural and subsistence in nature. Most people are thus directly dependent on natural resources, especially those occurring around their homes.

A survey of agricultural practices conducted in 1994/95 showed that 59% of all households in rural areas depend on subsistence farming to provide their main source of income[5]. Other rural households obtain most of their income from salaries (17%), pensions (16%), businesses (5%) or cash remittances (2% of all rural households). These households with other sources of income may also obtain additional income from subsistence farming.

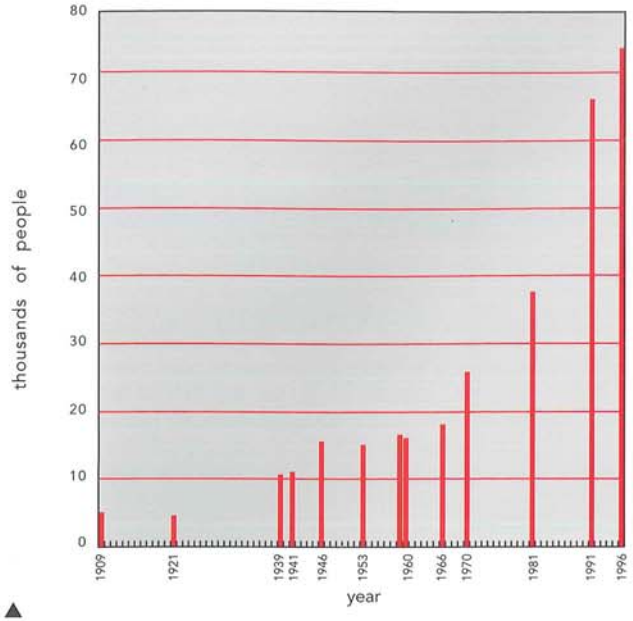
The 1993/94 Income and Expenditure Survey estimated that there were about 49 500 people aged 15 and older in Caprivi. Of this total, 18 000 were not economically active and therefore were not considered to be part of the labour force — most of these people were students (61%), homemakers (29%) or retired (11%). The economically-active part of the population, or labour force, consisted of about 28 300 people who were employed or self-employed and about 3 200 people who were unemployed. About 90% of the labour force was therefore employed while 10% remained unemployed[4].



▲ **Numbers of households with different rates of annual consumption**

From the 1993/94 survey of income and expenditure, total income for all private households in the region was estimated to be N$122 million per year. The survey also studied consumption levels, which provide an indication of wealth, since richer households spend and consume more than poorer ones. Average total consumption or expenditure per household was N$5 844 each year. This figure includes consumption of "in-kind" goods, such as food harvested from fields. As an average it hides the great degree of variation between households, as shown above — the majority of households have consumption levels of between N$1 500 and N$4 000 per year. Just a small number of households spend more than N$10 000 per year.

Population growth



▲ **Numbers of people in eastern Caprivi, as reported in various censuses between 1909 and 1996[2]**

Populations in Caprivi have grown rapidly over the past few decades as shown by the results of various population censuses and estimates for the eastern Caprivi — similar information is not available for the rest of the region. Starting with the earliest estimate of a total population of about 5 000 people in 1909, estimates from aerial photograph counts in 1996 put the total population in the eastern Caprivi at about 74 000, giving an overall growth rate of about 3.3% over 90 years. However, population growth rates have been higher in recent years. Taking population figures over the past three decades only, growth rates have been over 4%.

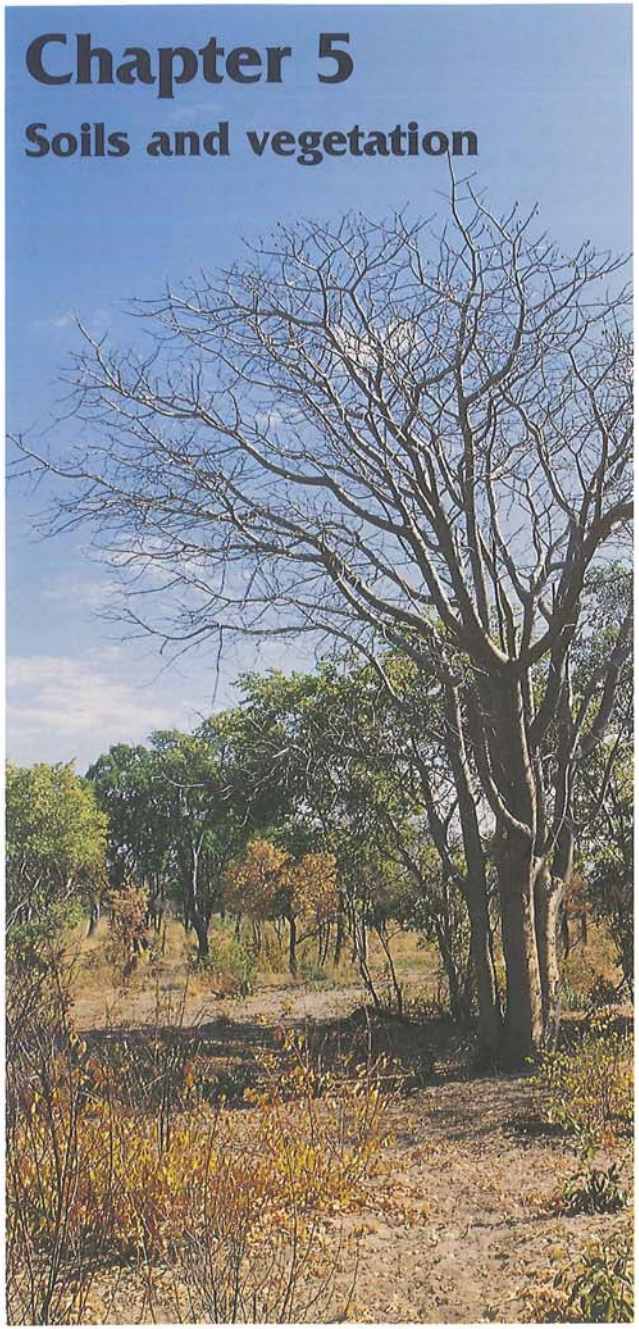
(CW)

The numbers of households in five areas in Caprivi in 1943 and 1996[1] ▲

Another estimate of population growth is available by comparing counts of households in aerial photographs in five areas taken in 1943 with those counted in 1996. In total there were 986 households visible in the five areas in 1943, and this number increased almost seven times to a total of 6 782 in 1996. The rate of increase over these 53 years is about 3.7%, and was fastest in the Mukwe area and slowest on the eastern floodplains.

Chapter 5

Soils and vegetation



Vegetation in Caprivi is influenced by three main factors: soils, flooding and fire. Soil texture, depth, nutrient content, the concentrations of salts, and the ability to hold water affect the kinds of plants found, their vigour and size. The Kalahari sands have distinct communities characterized by *Baikiaea plurijuga* (teak), *Burkea africana*, *Pterocarpus angolensis* (kiaat), *Ricinodendron rautanenii* (mangetti) and *Guibourtia coleosperma* (false mopane). *Acacia erioloba* (camelthorn), *Combretum imberbe* (leadwood) and *Acacia nigrescens* (knob-thorn) trees are common in areas with light clay soils, while *Colophospermum mopane* (mopane) dominates heavy and poorly drained clay soils. Water drains through sand easily, washing nutrients away and leaving both the sands and many grasses low in nutrients. Floods restrict the growth of most woody plants because they cannot withstand having their roots inundated. For this reason, areas subject to flooding are dominated by grasslands, with different species growing in areas subject to different frequencies of flooding. Reeds and sedges predominate in the wettest areas, while coarse grasses grow on leached sands. The effects of fire may be dramatic. Frequent hot fires can kill large trees, prevent the growth of young trees, and often lead to the development of uniform thickets of a few fire-resistant species.

Soils

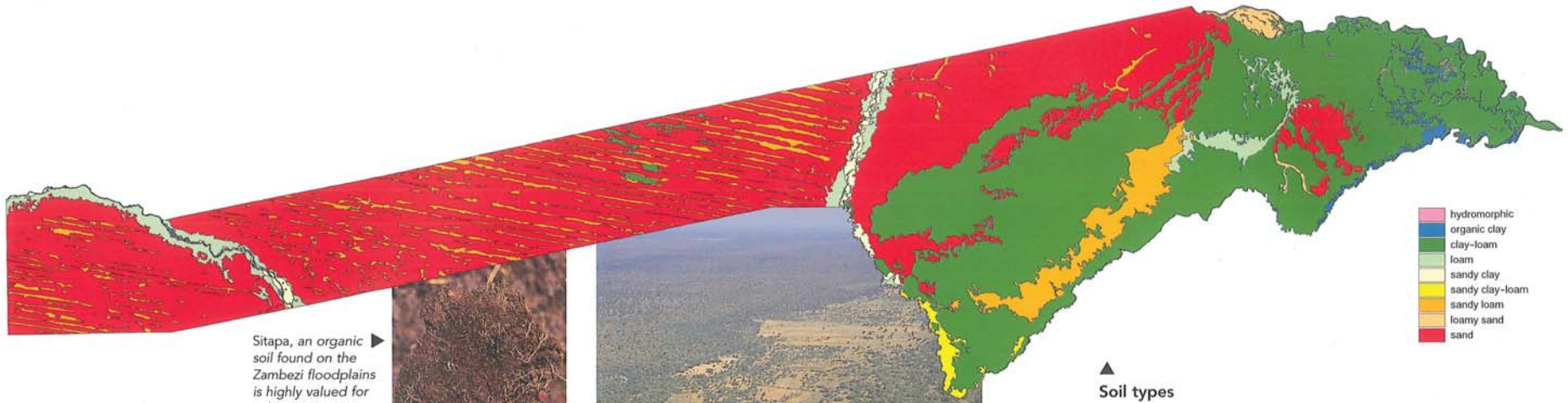
Caprivi is part of the Kalahari Basin, a vast inland depression that formed some 130–180 million years ago. Much of the Kalahari consists of sand shaped by wind into dunes. Heavier soils have formed where water has washed down finer particles which accumulate in depressions and between the dunes. Elsewhere, rivers have carved their way through the sands, depositing heavier soils washed down from their catchments. Thus, soils in the valleys of rivers in the Caprivi have largely been carried down from drainage areas in Angola and Zambia. These or different rivers also flowed through other areas in the Caprivi, thousands or hundreds of thousands of years ago, leaving behind fossil drainage lines that can still be seen today. Many of these old drainage lines (known as *omuramba* (singular) or *omurimba* (plural)) are in the form of characteristic meanders and contain soils that are typically deposited by river systems.

Soil types in the Caprivi were classified largely on the basis of their textures, with soils consisting of varying amounts of sand and clay having different textures. At one end of the spectrum are the heaviest soils with a high content of clay in areas which are regularly flooded, i.e. the hydromorphic and organic clay soils. Water does not penetrate or drain away easily because the clay is so dense. Areas flooded most frequently hold water for the longest periods, and often have a high content of organic material derived from decomposed reeds, sedges and other plants that grow in the water. In some areas, such as the Linyanti Swamps and around Lake Liambezi, these soils have developed into large deposits of peat. Depressions that are flooded infrequently often have clays with high concentrations of salts which are left behind as the water evaporates. On the other end of the spectrum are the pure sands. These deep soils do not hold moisture for long, so plants with shallow roots grow only once good rains have fallen. Large trees that grow on sands overcome this problem generally by having deep roots that extend into moist soils far below.

Between these two extremes is a range of intermediate soils (loams, clay-loams, sandy clays, etc.) consisting of varying proportions of sand, clay and organic material. The proportions of these components depend on the degree to which the clays and sands have been mixed and re-worked by the action of water and wind over the years, and the decomposition of plant material into nutrients held in the soil. Such intermediate soils also offer the best opportunities for cultivating crops because they retain water to some degree and have fairly high levels of nutrients. On the eastern floodplains, old drainage meanders within the large zone of clay-loam provide rich soils, known as *sitapa*, on which much of the maize in Caprivi is grown.

Soil type	Area (km²)
Hydromorphic	166
Organic clay	137
Clay-loam	6 939
Loam	647
Sandy clay	182
Sandy clay-loam	121
Sandy loam	1 735
Loamy sand	107
Sand	9 975
Potential for crops	
Best	3 137
Moderate	2 851
Poor	14 021

Different soil types and potentials for crops, and the areas they cover



Sitapa, *an organic soil found on the Zambezi floodplains is highly valued for cultivating maize (CH)*

▼ *Aerial view of crops planted in dry oxbows on the floodplain*

◀ *Local farmers take advantage of the relatively good soils found along the dune valleys*

▲

Soil types

The map of soils provides a general picture of where different soils are distributed. There is a great deal of small scale or local variation, especially in the large zone of clay-loam in eastern Caprivi where there are many old or fossil drainage lines and depressions. Caprivi as a whole is dominated by clay-loam soils (about 35% of the area) and sand (about 50%).

▲

Potential values of soils for crop cultivation

An assessment of the potential of different areas for crop cultivation is given. Areas are rated best, moderate or poor. This is an overall rating based on production potential, flooding frequency, levels of salts in the soil, and how easy it is to work different soils for various crops. The ratings are relative to the soils available in Caprivi. It provides a general indication of the suitability of soils for cultivation, but does not take into account the fact that different crops respond in various ways to particular types of soils.

Vegetation

The six land types in Caprivi form six broad vegetation communities (see Chapter 2): open water, floodplains, riverine woodlands, mopane woodlands, Kalahari woodlands and Impalila woodlands. While all of Caprivi could have been described in terms of the six land types, there is considerable variation within these categories, such that certain plants are abundant and provide important resources in some areas but are absent in others. Also, the same trees may be tall and well grown in one area, but small and shrubby in another. All of these and more variables could be recorded and described, but the amount of detail would make it hard to use. The particular balance between broad and detailed vegetation units shown here, is an attempt to achieve two goals. The first, to describe and map units which other people will recognize as real and relevant in the region. The second, to have units which reflect patterns and differences in the availability of important plant resources.

A total of 36 different units are described and mapped from satellite imagery, and aerial and ground surveys to provide an overview of the dominant plant species and communities[1]. In addition to the information presented here, more is available in the databases described on page 2. Descriptions of characteristic plants and other features are given below, those in each land type being treated together. More detailed descriptive information is provided in the Appendix. Unfortunately, many units have to be described using their scientific Latin names which are obscure for most people. However, common or colloquial names are used for species where they cannot be confused: mopane (*Colophospermum mopane*), teak (*Baikiaea plurijuga*), camelthorn (*Acacia erioloba*), leadwood (*Combretum imberbe*), knob-thorn (*Acacia nigrescens*), Burkea (*Burkea africana*), kiaat (*Pterocarpus angolensis*), false mopane (*Guibourtia coleosperma*) and mangetti (*Ricinodendron rautanenii*).

Some of the few remaining riverine woodlands along the Okavango are found on the islands near Andara

Vegetation units in the Caprivi

The table lists each vegetation unit and provides an assessment of their potential values (+ = lowest; ++ = medium; +++ = highest) for crop cultivation, livestock farming, conservation, and other non-agricultural subsistence values of plant resources. The soil type of each unit, the area covered, and the percentage that has been cleared for crops is also given.

Vegetation unit	Potential value for:				Soil type	Total area covered (km²)	% of area cleared
	cultivation	livestock	other resources	conservation			
Open water	+	+	++	+++	hydromorphic	166	4.8
Floodplains							
Bukalo–Liambezi grassland	+++	++	+	++	loam	223	32.6
Chobe grassland–hummock mosaic	++	++	+	+	clay-loam	295	32.7
Chobe Swamp grassland	++	++	+	+	clay-loam	177	37.1
Chobe wetland	+	+	++	++	organic clay	73	50.4
Dry Mamili grassland	++	++	+	++	clay-loam	339	10.9
Kwando–Linyanti grassland	+++	+++	+	++	sandy clay-loam	121	1.8
Liambezi–Linyanti grassland	+++	++	+	++	clay-loam	617	32.4
Okavango–Kwando grassland	++	+++	+++	+++	sandy clay	182	3.6
Wet Mamili grassland	++	++	+	++	clay-loam	95	0
Zambezi floodplain channels	+	+	++	++	organic clay	64	22.4
Zambezi floodplain grassland	++	++	+	+	clay-loam	1 168	9.5
Zambezi transition grassland	++	++	+	+	clay-loam	308	8.4
Zambezi woodland	++	+	+++	+++	clay-loam	100	6.0
Riverine woodlands							
Maningimanzi woodland and channels	++	++	++	+++	loamy sand	88	7.2
Okavango–Kwando valley woodland	+++	+++	+++	+++	loam	236	20.5
Okavango valley fields and shrubland	+++	++	+	+	loam	187	87.2
Mopane woodlands							
Gunkwe *mulapos*	+	++	+	++	clay-loam	148	10.3
Linyanti woodland	+++	+++	+++	+++	sandy loam	623	31.8
Mopane–*Aristida* woodland	+	++	+++	+	clay-loam	2 374	7.5
Mopane–*Burkea* woodland	+	++	+++	++	clay-loam	845	0.5
Mopane–*Terminalia* woodland	+	++	+++	+	clay-loam	375	7.2
Mudumu *Mulapo* woodland	+	+	+	+	sand	229	5.4
Salambala camelthorn woodland	++	+++	+++	+++	loamy sand	20	6.7
Kalahari woodlands							
Burkea–*Combretum* woodland	+	++	++	++	sand	2 717	2.3
Burkea–kiaat–false mopane woodland	+	++	++	++	sand	1 143	7.4
Burkea shrubland	+	+	+	+	sand	393	2.4
Burkea–teak woodland	+	++	+++	++	sand	1 038	0.1
Burkea–*Terminalia* woodland	+	++	++	+	sand	242	8.2
Omuramba fringe woodland	+++	++	++	+++	sandy loam	258	1.4
Omuramba grassland	+++	+++	+	++	sandy loam	855	10.6
Open camelthorn woodland	++	+++	++	++	clay-loam	80	0
Teak savanna	+	+	+	++	sand	945	0.2
Teak shrubland	+	+	+	+	sand	1 530	4.7
Teak woodland	+	+	+++	++	sand	1 741	2.1
Impalila woodlands	+++	++	+++	+++	clay-loam	18	22.4

Vegetation units in the Caprivi

Open water

Apart from the obvious rivers, the unit also covers permanent water channels on the Zambezi, Chobe, Kwando and Okavango floodplains. Plants on the edges of these waters are *Phragmites australis*, *Cyperus papyrus*, *Salvinia molesta*, *Nymphaea* spp., *Polygonum* spp. and many sedge species. The unit varies in size, as flood waters rise and fall.

Floodplains

Bukalo–Liambezi grassland is an extensive network of drainage lines running off the Zambezi floodplain, down the Bukalo Channel and into the upper areas of Lake Liambezi. Wetter soils are dominated by extensive *Cynodon dactylon* lawns, and drier slopes are generally sandy with coarse, unpalatable species such as *Hyperthelia dissoluta*, *Hyparrhenia hirta*, *Trachypogon spicatus* and *Eragrostis* spp. Soils are heavily cultivated, particularly in the lower Bukalo Channel and in Liambezi.

Chobe grassland–hummock mosaic is a series of sandy plains and hummocks along the Chobe River, where higher areas and hummocks are well wooded by tall camelthorns, *Lonchocarpus capassa*, *Kigelia africana* and *Diospyros mespiliformis*. Grasslands are dominated by coarse perennials such as *Hyparrhenia hirta*, *Loudetia simplex*, *Aristida stipitata* and *Hyperthelia dissoluta*.

Chobe Swamp grassland is the unit of tall grasslands in the Chobe Swamps east of Lake Liambezi. *Hyperthelia dissoluta*, *Hyparrhenia hirta*, *Setaria sphacelata* and *Loudetia simplex* are all characteristic. Woody species are rare, except for widely distributed, small dense hummocks of *Diospyros lycioides*.

Chobe wetland is a unit along the banks of the Chobe River from Ngoma towards Impalila Island. Various aquatic grasses and reeds dominate the vegetation, with *Cyperus papyrus* forming large floating rafts. Woody species are rare and normally only found along well developed banks.

Dry Mamili grassland is the unit of tall grasslands in the northern section of the Mamili National Park on soils that are seldom flooded. Wooded hummocks are largely absent and trees are limited mostly to short, isolated leadwoods and *Terminalia sericea*. The area is predominantly a mosaic of coarse tall grasses such as *Hyparrhenia hirta*, *Cymbopogon excavatus*, *Andropogon schirensis* and *Setaria sphacelata*, with extensive lawns of *Cynodon dactylon*.

Kwando–Linyanti grassland is the unit of tall, flooded grasslands on the seasonally inundated margins of the Kwando River where it enters the Linyanti swamps. Generally, *Miscanthus junceus* forms dense stands together with *Vetiveria nigritana*. *Echinochloa stagnina* forms floating mats in areas of extended flooding, and there are dense *Phragmites australis* reed beds.

Liambezi–Linyanti grassland forms the extensive grasslands of the Liambezi basin and the fringe of grasslands north of the Linyanti River. Soils are organic forms, rich in peat, or loamy clays, and most are heavily used for cultivation. Principal grass species include *Eragrostis cf. lappula*, *Imperata cylindrica*, *Loudetia simplex*, *Hemarthria altissima* and extensive lawns of *Cynodon dactylon*.

Okavango–Kwando grassland is the unit of tall open grasslands and wetlands along the margins of the Okavango and Kwando rivers. The area is seasonally flooded and an important grazing resource for wildlife and livestock. There are few woody species. *Echinochloa stagnina*, *E. pyramidalis* and *Vossia cuspidata* form extensive mats, and there are lawns of *Cynodon dactylon*. The wettest areas are often covered by reeds.

Wet Mamili grassland in the southern section of the Mamili National Park is periodically subjected to extended periods of flooding. The clay loams or peat-rich organic deposits remain wet long after flooding has receded. Grasses are predominantly water tolerant species, such as *Imperata cylindrica* and *Hemarthria altissima*, and channels are dominated by a variety of sedges and reeds. Small hummocks form islands of large trees.

Zambezi floodplain channels are similar to open water habitats and rivers except that trees and shrubs are often present. These wetlands are characterized by often tall and dense marsh vegetation, with shorter grass species on the "drier" margins. The wetlands dry out regularly and the highly organic soils (*sitapa*) are cultivated for maize production.

Zambezi floodplain grassland is a mosaic of wet and dry habitats on the eastern floodplains. Much of the area is grassland with small islands of woody species. Wettest areas are dominated by sedges. Moist slopes to the channels are dominated by several grasses, most importantly by *Cynodon dactylon* lawns, which are a valuable grazing resource. The large, dry sandy areas are dominated by *Eragrostis pallens*, *Tristachya superba* and *Hyparrhenia* spp., which are poor for grazing. Maize is grown on organic soils deposits (*sitapa*) in the channels.

Zambezi transition grassland is tall and open grassland between the eastern floodplain and higher, Kalahari sands to the West. Proportions of different grass species vary, depending on soils, frequency of flooding and soil drainage conditions. Characteristic species are *Vetiveria nigritana*, *Hyperthelia dissoluta*, *Tristachya superba*, *Aristida stipitata*, *Loudetia simplex*, *Andropogon schirensis*, *Setaria sphacelata*, *Eragrostis rotifer*, *Imperata cylindrica* and *Cynodon dactylon*. The grasslands are generally of poor quality and are not heavily used by local stock owners.

Zambezi woodland consists of wooded "islands" in an area of transitional grasslands between the western uplands and the eastern floodplains. Tall trees consist largely of *Parinari curatellifolia*, *Kigelia africana*, *Diospyros mespiliformis*, *Trichilia emetica*, *Acacia sieberana*, *Lonchocarpus capassa* and *Afzelia quanzensis*. Soils are generally heavier clay-rich loams, and local farmers value the grazing resources. These "islands" have considerable conservation value as centres of high diversity.

Riverine woodlands

The **Maningimanzi woodland and channels** east of Katima Mulilo, is a broad sandy plain of old river sandbars and deep river channels. This broken landscape floods regularly and vegetation consists of two distinct units. Sandy areas are covered predominantly by high *Terminalia sericea* woodlands, while the river channels have margins of reeds and dense stands of *Syzygium guineense*, *Rhus quartiniana*, *Trichilia emetica*, *Garcinia livingstonei* and *Kigelia africana* up on the drier margins.

Okavango–Kwando valley woodland consists of high, open woodlands along the Okavango and Kwando Rivers, perhaps showing what much of the next unit used to be like. Trees along the rivers are tall and diverse in species composition. The loamy soils represent some of the best potential for growing crops, while the area supports the greatest diversity of animals and plants in Caprivi. The wetlands are heavily utilized by wildlife and livestock and are probably one of the most threatened habitats in the region.

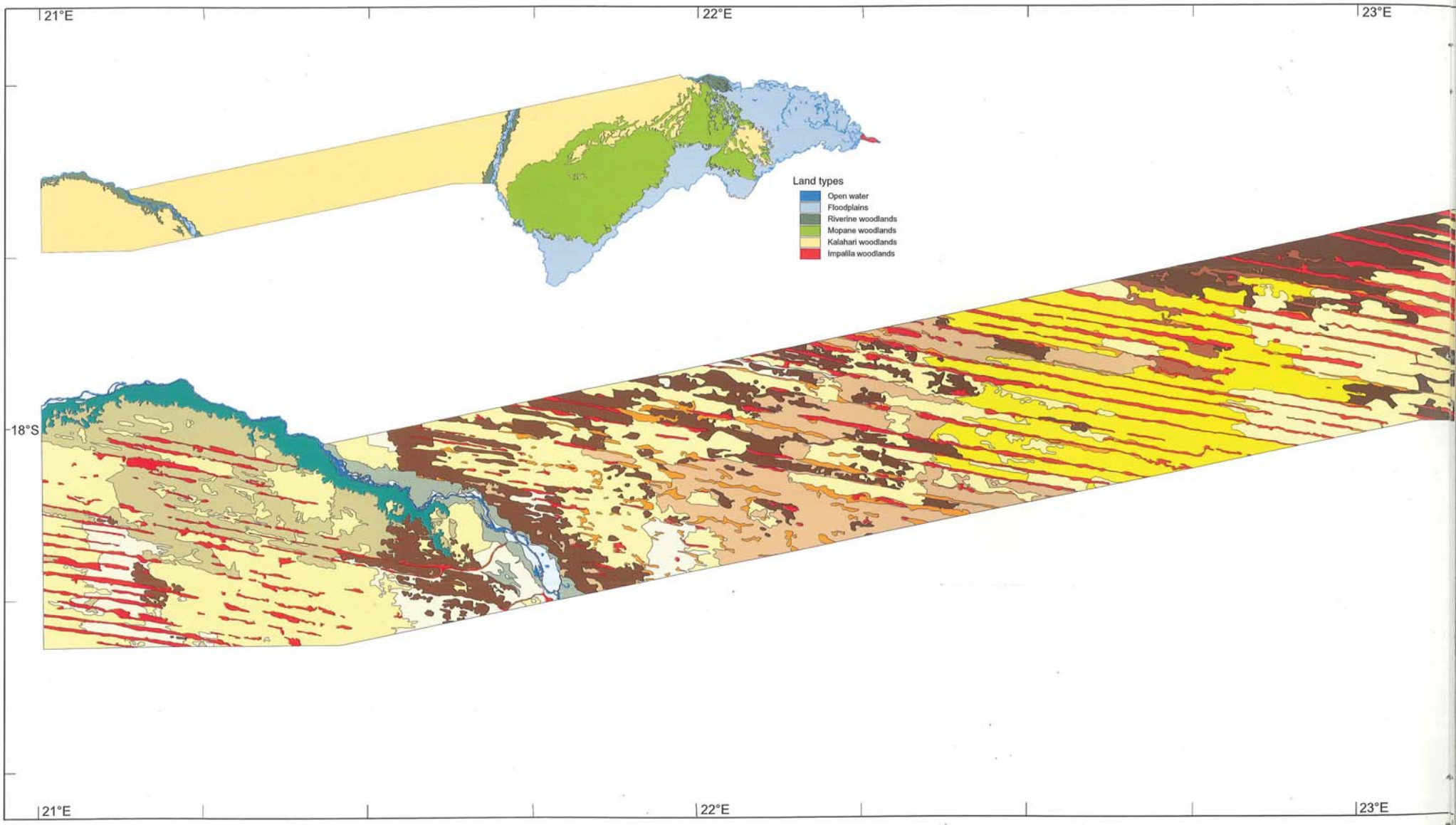
The **Okavango valley fields and shrubland** unit maps the heavily exploited valley of the Okavango River, where it is now difficult to assess the original vegetation types. Old fields are rapidly encroached by *Dichrostachys cinerea*, *Maytenus heterophylla* and a variety of weeds and pioneer species. Annual grasses, such as *Urochloa brachyura* and *Dactyloctenium giganteum*, often occur in dense stands.

Mopane woodlands

Gunkwe *mulapos* are grasslands in the braided system of drainage lines (*mulapos*) running through Kalahari sands south-west from Katima Mulilo. The loamy clays are poorly drained, with some areas flooded for long periods in the wet season. Other than *Cynodon dactylon* lawns these grasslands are generally poor and the soils are not suitable for arable agriculture.

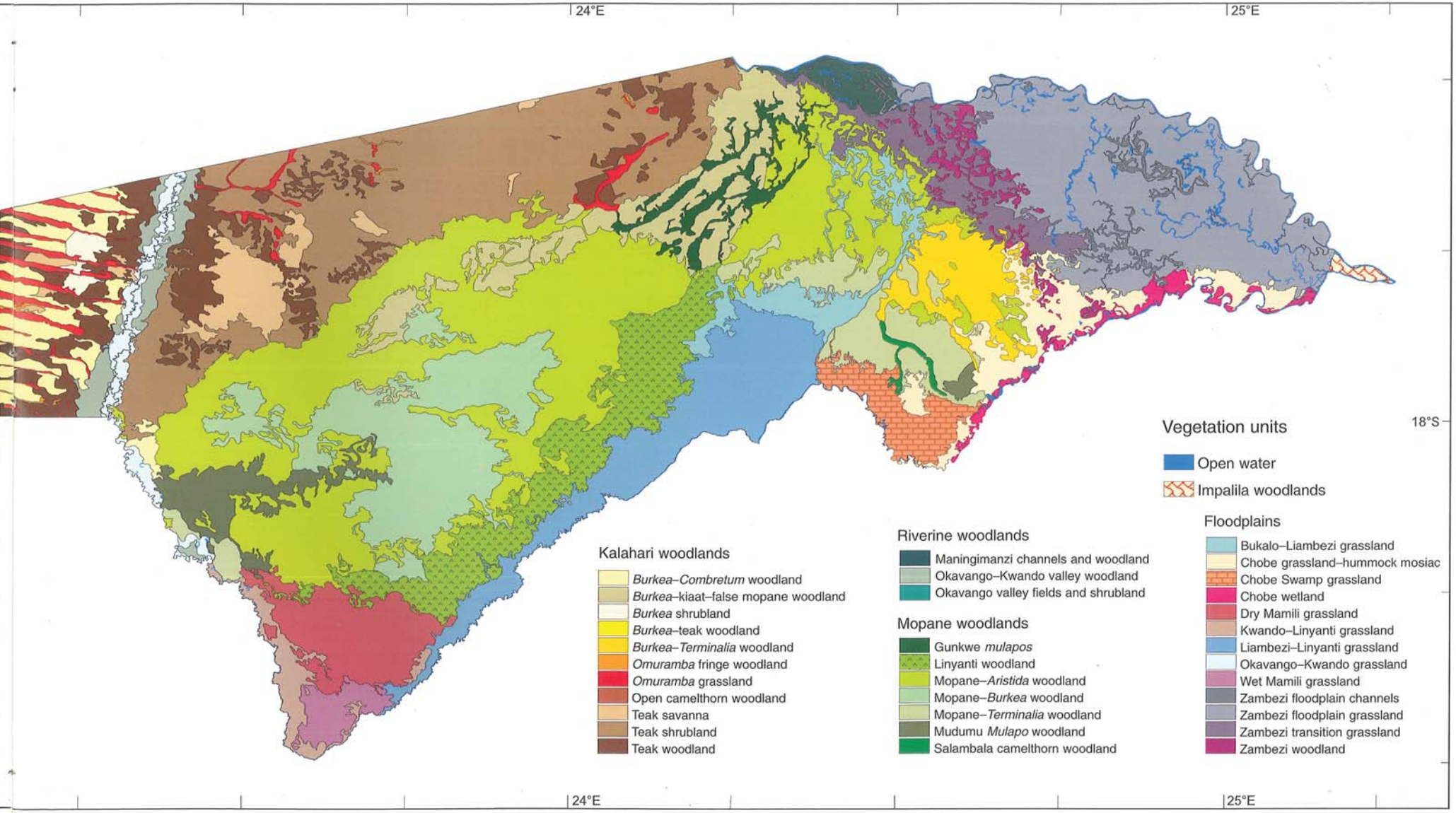
Linyanti woodland is a broad belt of woodlands between the Linyanti Swamps and the extensive mopane area in the central eastern Caprivi. The area is heavily settled and much of the land has been cleared. Soils are predominantly sandy loams. Camelthorn and *Lonchocarpus capassa* form a distinctive layer of tall trees. *Terminalia sericea* occurs throughout the area, usually as a large tree. Perennial grasses are

continued on page 22



Vegetation units in Caprivi

Descriptions of these units are given on pages 19 and 22


24°E
25°E
18°S
Vegetation units
Open water
Impalila woodlands
Kalahari woodlands
Burkea–Combretum woodland
Burkea–kiaat–false mopane woodland
Burkea shrubland
Burkea–teak woodland
Burkea–Terminalia woodland
Omuramba fringe woodland
Omuramba grassland
Open camelthorn woodland
Teak savanna
Teak shrubland
Teak woodland
Riverine woodlands
Maningimanzi channels and woodland
Okavango–Kwando valley woodland
Okavango valley fields and shrubland
Mopane woodlands
Gunkwe mulapos
Linyanti woodland
Mopane–Aristida woodland
Mopane–Burkea woodland
Mopane–Terminalia woodland
Mudumu Mulapo woodland
Salambala camelthorn woodland
Floodplains
Bukalo–Liambezi grassland
Chobe grassland–hummock mosiac
Chobe Swamp grassland
Chobe wetland
Dry Mamili grassland
Kwando–Linyanti grassland
Liambezi–Linyanti grassland
Okavango–Kwando grassland
Wet Mamili grassland
Zambezi floodplain channels
Zambezi floodplain grassland
Zambezi transition grassland
Zambezi woodland

continued from page 19

characteristic, although in many areas they have been overgrazed.

Mopane–*Aristida* woodland is a large unit of generally heavy clay loams which are often unsuitable for cultivation because of the accumulation of salts. Grazing quality is poor. Mopane is often the only large tree. Camelthorn, knob-thorn and *Albizia harveyi* may be found where soils are better drained. Shrubs are usually found on termite mounds. Grasses are dominated by coarse, unpalatable annuals. *Terminalia sericea* may occur sparsely on small pockets of reworked alluvial sands.

Mopane–*Burkea* woodland is a mosaic of heavy clay loam soils and pockets of deep sands, giving a mix of plants not normally found together. Mopane shrubs dominate the landscape but develop into trees around small pans. Kalahari sand species, such as *Burkea*, *Erythrophleum africanum* and *Combretum collinum* are characteristic on pockets of sands. Grasses are of variable quality, species varying according to soil type.

Mopane–*Terminalia* woodland is another mosaic of Kalahari sands and heavier clays, with the highly leached, white sands (dominated by *Terminalia sericea*) are interrupted by patches of clay loams (where mopane dominates). Grass cover is sparse and consists generally of unpalatable species.

Mudumu *Mulapo* woodland is found in the Mudumu *Mulapo*, east of the Kwando River, as well as in a smaller area west of Ngoma, near Ioma. The Kalahari sands have been reworked by water, resulting in highly leached sands, and isolated small pockets of clay loams. Vegetation on sands is dominated by large *Terminalia sericea*. Grasses are dominated by coarse species. Pockets of heavier soils carry short mopane. The unit has very low values for agriculture, conservation and biodiversity.

Salambala camelthorn woodland is a fossil drainage system in the Salambala area where tall camelthorn trees are abundant. Other large trees include *Lonchocarpus capassa*, *Afzelia quanzensis*, *Combretum collinum*, *Berchemia discolor* and knob-thorns. Soils are fine grained sands and sandy loams which are well drained. Although most grasses are annuals it is an important grazing resource for cattle.

Kalahari woodlands

***Burkea–Combretum* woodland** is a unit typically dominated by high *Burkea* at varying densities, with kiaat, false mopane and mangetti occurring less frequently. The structure is more open than *Burkea*–kiaat–false mopane woodland. *Terminalia sericea* dominates the low tree layer, and the shrub layer is quite open with *Baphia massaiensis*, *Bauhinia petersiana* and *Grewia retinervis* giving most of the cover. *Diospyros chamaethamnus*, a mat-forming woody species is common in areas burnt often. Grass cover is generally low. Soils are deep sands on dune slopes and sandy plains, with little value for crop farming.

***Burkea*–kiaat–false mopane woodland** occurs in two widely separated areas. West of the Okavango River it is widespread, mostly on undulating sandy plains. There is also a broad band west and south of Katima Mulilo where it occurs on sands which have been extensively reworked by flooding. *Burkea* dominates the tall (13–15 m) tree layer which, with false mopane, kiaat and mangetti trees, provides a dense woodland. Grasses are predominantly perennials with species such as *Schmidtia pappophoroides*, *Stipagrostis uniplumis*, *Aristida stipitata* and *Digitaria eriantha* characteristic at low cover.

***Burkea* shrubland** has little agricultural value, either as an arable resource or for grazing purposes. Trees over four metres high are rare. The shrub layer is generally characterized by *Terminalia sericea*, *Lonchocarpus nelsii*, *Bauhinia petersiana*, *Baphia massaiensis*, *Burkea* and *Grewia retinervis*. The shrub layer can cover as much as 50% in areas badly damaged by fires.

***Burkea*–teak woodland** is a unit on well developed dunes in the central Caprivi strip. There is a tall tree layer made up largely of *Burkea*, teak, false mopane, kiaat and mangetti. A second layer of trees, six to eight metres high, is present. The shrub cover is low, and grasses are predominantly annuals.

***Burkea–Terminalia* woodland** occurs on a large sandy ridge running south and east of Bukalo towards Ngoma which has been extensively reworked by the flow of water. There is a resulting mosaic of large sand deposits and heavy clays on which mopane grows. Transition areas between the sands and heavy clays are favoured for cultivation. *Terminalia sericea* occurs commonly in the low tree layer. Most grasses are annuals and of poor quality, and the perennials are generally woody and unpalatable.

The ***Omuramba* fringe woodland** unit forms a distinct fringe along the slopes of dunes and *omuramba* margins in the Caprivi strip. Camelthorn, leadwood and knob-thorn trees form a distinct layer 10–15 m high covering a substantial area. The vegetation is characteristic of both heavy soils and Kalahari sands. The unit provides important grazing habitat for wildlife, and has potential for arable agriculture.

***Omuramba* grassland** is found in the *omuramba* valleys throughout the Kalahari sand areas. The grass *Imperata cylindrica* dominates the wetter areas while a variety of palatable species grow in the drier areas, such as *Schmidtia pappophoroides*, *Brachiaria nigropedata*, *Digitaria eriantha* and *Anthephora pubescens*. These are some of the best grazing resources in the Kalahari sand areas, and the sandy loam soils are extensively cultivated in the Mukwe area and at Omega.

Open camelthorn woodland is limited to a small area in the eastern half of the Caprivi strip on clay loam soils. Camelthorns are well distributed and tall (15 m), and there is a distinct understory of low trees. Perennial grasses are well represented, so this area is presumed to have high value as a grazing resource.

Teak savanna is widely distributed in the Caprivi strip and in eastern Caprivi. It occurs in areas of deflated dunes where the landscape consists of gently rolling sandy plains. Tall teak trees are prominent but occur at moderate densities, giving the landscape a savanna-like appearance. The layer of shrubs is fairly sparse, with a relatively high proportion of perennial grasses.

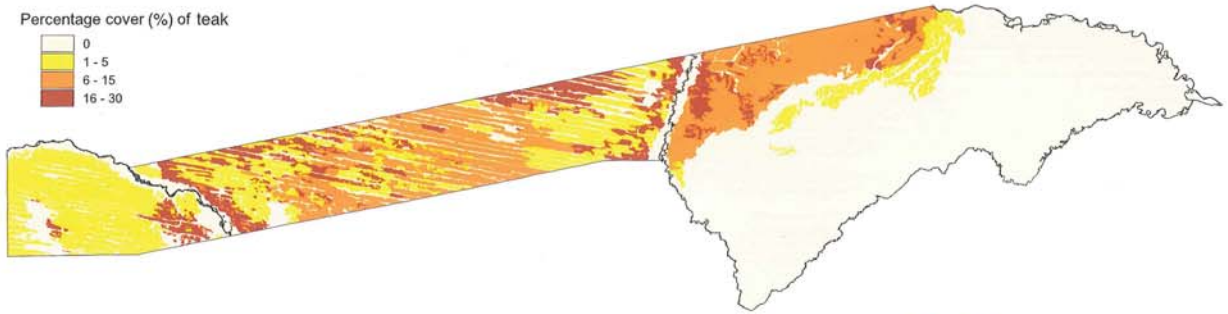
Teak shrubland is badly degraded teak woodland, where forests have been extensively logged in the past, and the logging probably also opened up the woodlands to allow fire to have a major effect on the structure of the woodland. A few large teak and camelthorn trees are present together with a distinct, dense layer of shrubs and small trees. The relatively sparse cover of grasses consists largely of annual species.

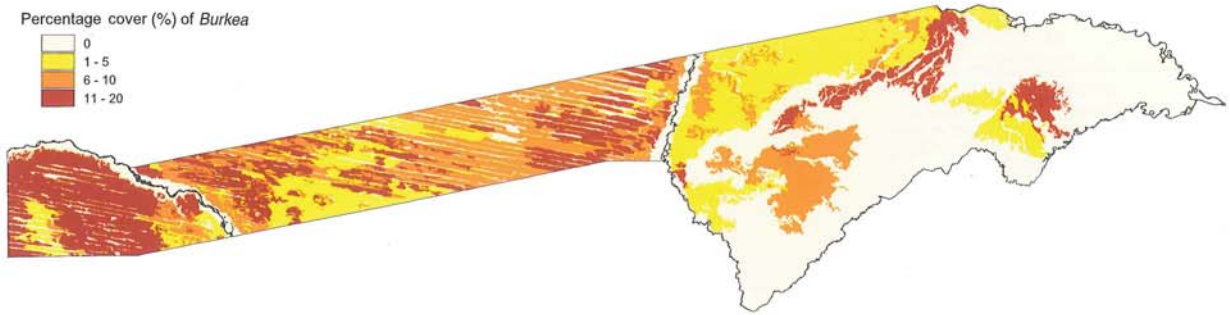
Teak woodland is tall, often fairly dense and widely distributed on deep, well drained sandy plains and dunes. A very dense layer of shrubs may be present. Their potential for grazing and cultivation is poor, but they have high value as a timber resource. Teak habitats have been badly damaged by commercial timber exploitation and fire.

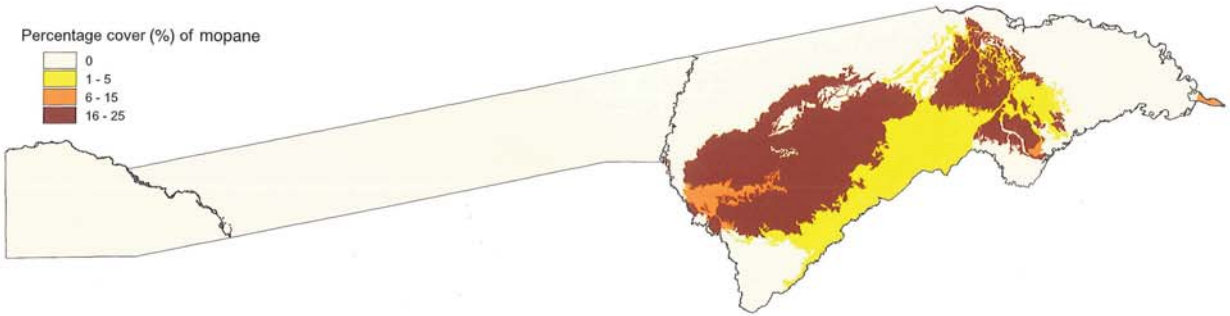
Impalila woodlands

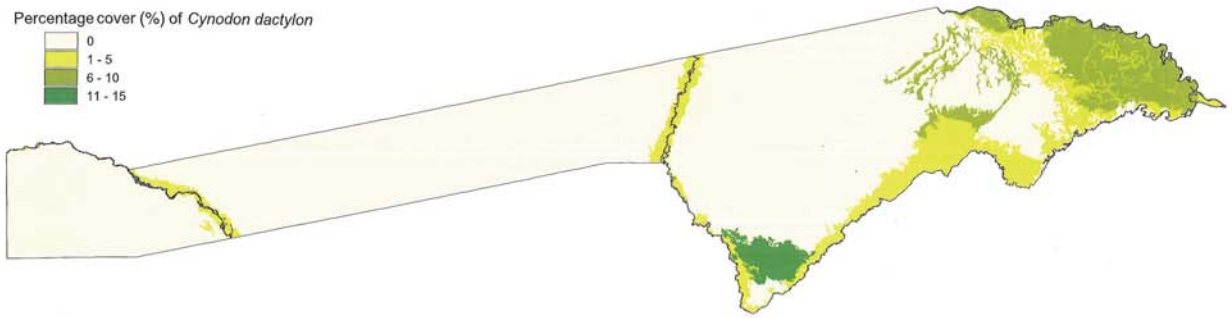
Rich soils, surface basalt rocks and a mosaic of wetland and dryland habitats contributes to a diverse vegetation. Many plant species found here occur nowhere else in Namibia. Drier areas are dominated by mopane, but with many other species present. Margins of the island have species typical of river levees, such as *Diospyros mespiliformis*, *Lonchocarpus capassa*, *Ficus sycomorus*, *Cassine transvaalensis*, *Kigelia africana* and *Syzygium guineense*. Because cattle numbers are high the grass layer is denuded and extensive patches of unpalatable species are common.

Fields in the Okavango valley — only trees valued for their resources have not been removed (CH)









Collecting grass for thatching (CH)

Terminalia sericea, *resistant to wood-borers and light in weight, makes a suitable roofing structure*

◀ Four important plant species — distribution and percentage cover

In compiling maps of different vegetation types, information was collected on the main species in each unit and the relative area covered by those species. These measures of cover provide an index of abundance, so the higher the cover provided by a species the more abundant it is. Maps for four species are presented here. Teak is a valuable timber species, although most large trees have already been cut and those remaining are often unsuitable for timber production. Pockets of denser, taller teak are scattered throughout the Kalahari sands. *Burkea* is a very common tree on Kalahari sands, varying in abundance and height in different vegetation units. In many areas it is the dominant tree. Mopane is a highly valued source of construction poles for the building of houses, especially in areas where the tree trunks are long and straight. The grass, *Cynodon dactylon*, is a valuable grazing resource and occurs as extensive lawns, mainly on wetter soils in floodplain areas.

Uses of vegetation resources

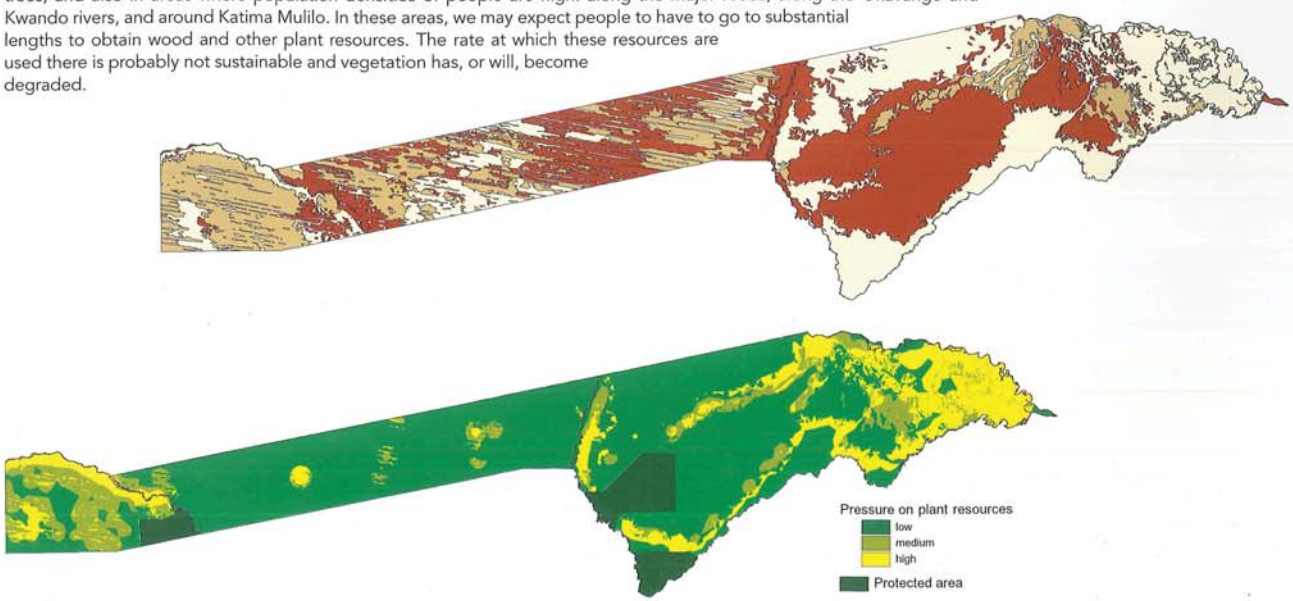
Caprivi's natural vegetation provides people with many resources. Agricultural uses are considered in Chapter 6, but many other resources are of value. Some are substantial and vital since they are used by the majority of households. For example, 88% of all homes are constructed from wood, 78% of homes are thatched with grasses or reeds, and 96% of all households use firewood for cooking[2]. Other resources are used less frequently or by smaller numbers of people, for example, many kinds of wild fruits, nuts (especially mangetti) and waterlily bulbs are used for food; a variety of plants are used for medicinal purposes; wood and palm leaves are used for making utensils and craft for sale; and thatching grass, construction poles and reeds are sold commercially in some places[3].

The degree to which these resources are used depends on their supply or availability and the demands put on them. For example, people living near tall mopane woodlands have little difficulty obtaining suitable construction poles because mopane provides the best timber for construction, cut trees regenerate readily, and they are seldom damaged by fire. By contrast, people living out on the eastern floodplains must either pay large sums to buy and transport suitable construction poles, or must build their houses using inferior materials. The last option is the only one available to many poorer households not having surplus cash, so tremendous pressure is put on the relatively few trees that remain on the floodplains. Supplies and demands for firewood present similar kinds of problems, both for people and for natural vegetation. Where firewood is in short supply, living trees may be cut or other fuels such as cattle dung are used. The efforts people make to collect fuel wood may be substantial, women spending long periods (up to half a day every few days) collecting wood, or men using oxen to cart wood from long distances to those households fortunate to have access to oxen[3].

The value of vegetation in providing resources and an assessment of the degree of pressure exerted on them[4] ▼

The top map gives a broad assessment of the values of vegetation in providing people with subsistence needs for construction and fuel wood, thatching grass, and plants used for food and medicinal purposes. The values exclude agricultural uses for crop cultivation and grazing. Amongst the most valuable areas are those with high numbers of tall mopane, those with lots of mangetti trees, and those with a high diversity of fruit bearing plants. Areas with low values are those with little timber or fuel wood.

Comparing the distribution of these values with population densities shows those areas where vegetation is under varying degrees of pressure[4]. The ratings are based on the assumption that in areas with few useful plants (lowest resources) there will be significant pressure put on the few trees if there are reasonable numbers of people, and that pressures will increase as population densities become greater. It is also assumed that people exert little direct pressure on vegetation in the three protected areas. Areas showing probable high pressures on vegetation are largely in the eastern floodplains and other areas where there are few remaining trees, and also in areas where population densities of people are high: along the major roads, along the Okavango and Kwando rivers, and around Katima Mulilo. In these areas, we may expect people to have to go to substantial lengths to obtain wood and other plant resources. The rate at which these resources are used there is probably not sustainable and vegetation has, or will, become degraded.



(CH)

Fire

"Caprivi's burning" "All of Caprivi burnt last year"

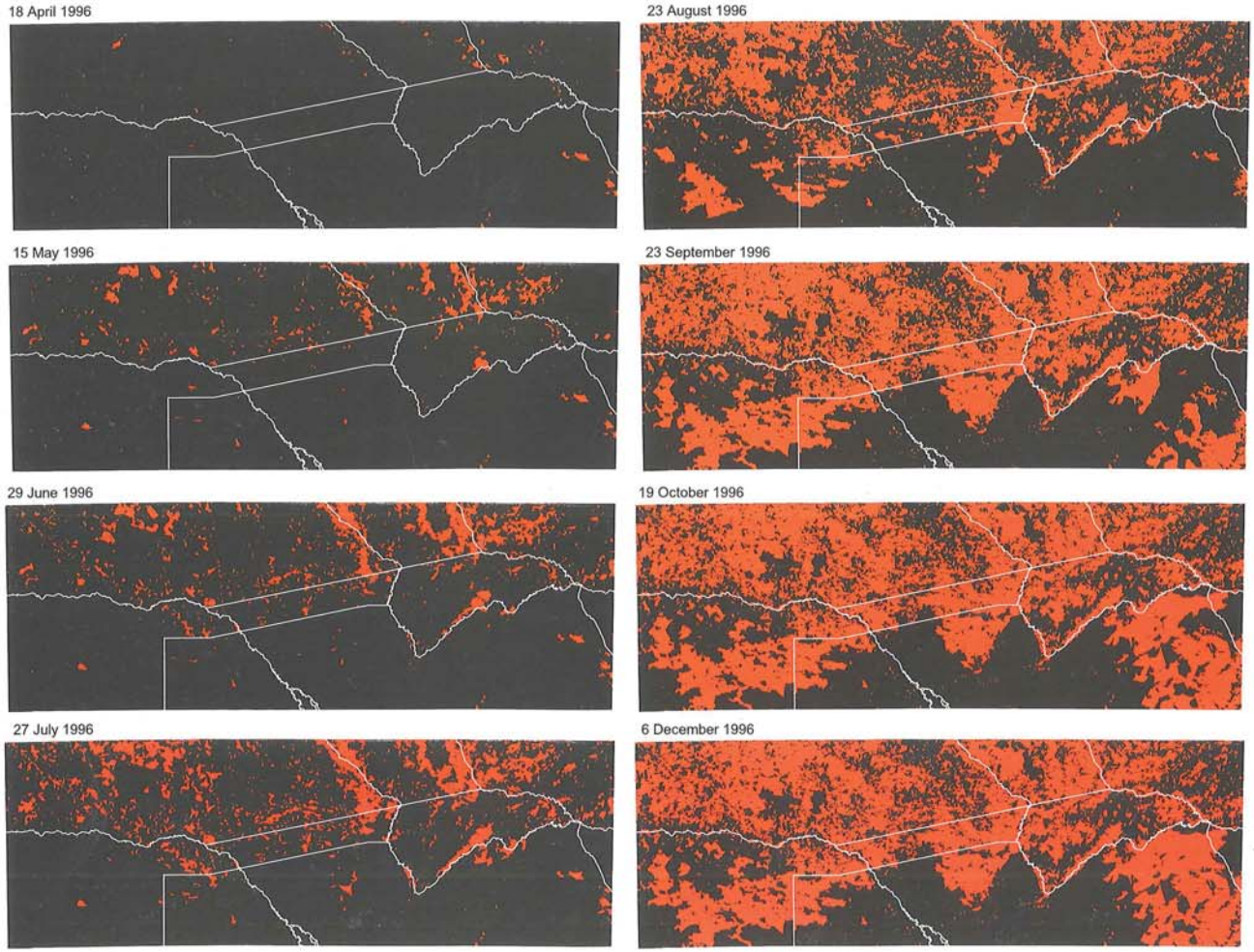
Such statements are heard often, and carry with them a good deal of truth. Fires have always been an important and natural process, and many people argue that they have important benefits to plant communities. However, what has changed in recent years is that the number of fires set each year has increased as human populations have grown, so areas get burnt much more frequently. Man-made fires also often burn at times of the year when they have damaging effects. The only natural burns in Caprivi occur from October to December when lightning may cause fires, and these are often closely followed by rain.

People set fires for many reasons: to stimulate the growth of fresh grass for cattle and to attract game, to flush out game that can then be hunted, to clear out vegetation around waterholes, and to clear land for cultivation. Many fires are also started accidentally. What is true for almost all fires is that they can spread, uncontrolled wherever the wind blows them and where there is enough dry material left to burn. The few rivers, wide channels and roads are the only barriers to fires, and the network of firebreaks previously cut to control and manage fires is no longer maintained.

Damage caused by fires occurs in a number of ways, but it is the frequency of burning that probably leads to most damage. Young trees are killed and, with repeated fires, it is now impossible to find young teak, kiaat and other valued plants in many areas. Large trees are also killed by frequent burning, the fires eating away at the base, year by year, and also burning into and up the trunks. Many areas of dense woodland have thus been converted to open grasslands and shrublands, the older large trees killed and no young trees to replace them. In fact, large areas of Caprivi are now bush-encroached. Dense thickets of *Terminalia sericea*, *Combretum* spp., *Dichrostachys cinerea* and other shrubs cover the ground, leaving little or no space for grass growth. The large areas of *Burkea* shrubland, teak shrubland and teak savanna were probably formed as a result of repeated burning.

People in Caprivi often complain because timber resources for the construction of houses have been burnt away by repeated fires. Similarly, large areas of grazing pastures are lost every year, forcing farmers to move their herds to other areas. Cattle may be killed and houses burnt in occasional accidents. One hundred and seventy buffalo were trapped and killed in a fire near Malengalenga in 1996. The same fire burnt away large areas of peat, as often happens in other peat areas. Fires also contribute to the loss of nutrients, both in smoke and as fine particles of material blown away once layers of grass protecting the soil surface have burnt away. Finally, and on a more global scale, the high rate of burning of African woodlands and grasslands adds significantly to the concentration of carbon dioxide and dust in the atmosphere, contributing to global warming and other climate changes.

Dense growths of shrubs form after repeated burning (CH)

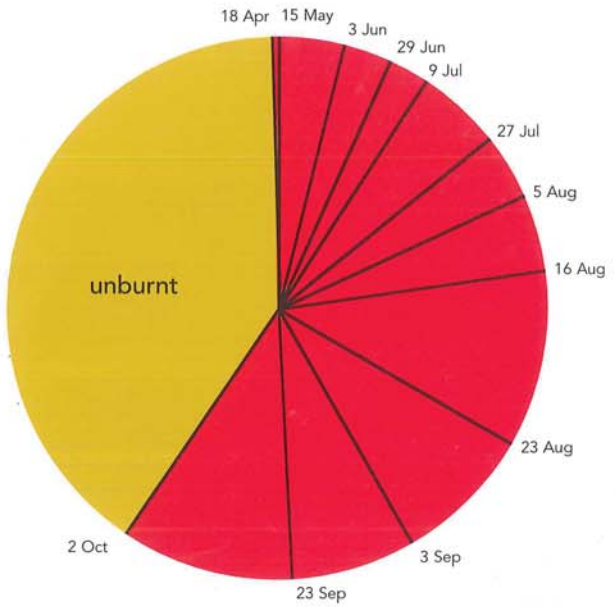


The progressive accumulation of fire scars during the 1996 fire season in the Caprivi and surrounding areas

The series of images below provides a dramatic picture of the progression of burning during the 1996 fire season. Satellite images were analysed to produce pictures which show, month by month, areas that were detected as burn scars[5]. In April, there were just a few small fires in the eastern floodplains. Part of the Linyanti–Liambezi area had burnt by mid-May and there had been a few fires in the woodlands along the Zambian border. By the end of July, the whole Liambezi area had burnt and a number of large fires had burnt just west of the Kwando River. From then on, fires burnt throughout the region so that little appeared not to have been burnt by the end of October. Adding up all the burnt areas showed that a total of 60% of the vegetation in Caprivi burnt in 1996.

The number of individual fires that were set in 1996 was also impressive. There were few large fires in Caprivi, and none of the massive burns visible in the Chobe area of Botswana and in the Kavango Region. Rather, large numbers of fires were set throughout the year. As an absolute minimum, there were 905 individual fires in Caprivi in 1996, and the actual total could be higher than 3 000 individual fires. Many people, with lots of matches, clearly have interests in starting fires!

The chart below shows that the cumulative area of fire scars, and thus rate of burning increased substantially from early August onwards. The percentage of vegetation burnt was probably lower than in most other years because rainfall and grass growth in the 1995/96 season was poorer than normal, and less plant material was therefore available for burning. These pictures present the first attempt made to track and evaluate the extent of burning in Caprivi. Similar work needs to be done in other years, especially when burning is more extensive. Those studies will also show how often the same areas are burnt.



Chapter 6

Farming in Caprivi

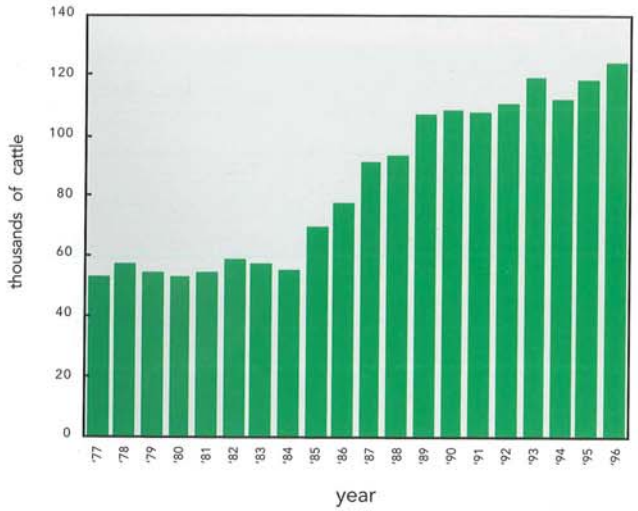
Of all economic and livelihood activities in Caprivi, agriculture is the most important. People spend more time farming than at any other economic activity. It provides the majority of people with most of their income, food and security. Farming activities have also had the greatest impact on the region's natural environment. Large areas have been cleared to plant crops, great numbers of cattle graze the region's natural pastures, and much of the area is burnt each year, apparently to stimulate the growth of new grazing.

Stock farming

Stock farming is dominated by cattle in Caprivi. Cattle are highly prized for their value as tangible resources providing benefits such as draught power, milk, meat and cash income, but especially for their social value in giving herd owners security, rights to land and status. Goats and poultry, by contrast, are valued only in terms of food and as a source of income. Control over cattle and goats is in the hands of men, while women control poultry. Cattle owners employ herd boys — because the majority of Caprivian children go to school, most child labour is obtained from Zambia and the Kavango Region.

The major constraints on cattle numbers are water, pasture or grazing availability and quality, and diseases. The total number of cattle in 1996 amounted to about 135 000 head — 10 500 cattle in the Mukwe area, 300 in the Caprivi strip and 124 000 in eastern Caprivi[1]. Information on numbers of other stock are only available for the eastern Caprivi where, in 1996, there were about 6 600 goats, 21 500 chickens and just a handful of pigs and horses. Some 5 700 dogs and 1 900 cats were also counted!

Vaccination programmes which keep cattle healthy have been responsible for increasing cattle numbers in Caprivi recently. However, lung disease could have a devastating effect on Caprivi's cattle. Cattle in eastern Caprivi have not had any recent history of lung disease infection, so resistance levels are low. Widespread and significant mortality is probable if, or when, the disease is brought into the region, and radical control measures may be necessary. Several hundred thousand cattle were killed in north-western Botswana in 1996 in an effort to control an outbreak of lung disease. Cattle carrying the disease occur just north of the border in Zambia, and Caprivi cattle could easily be infected from that source.



Cattle numbers (1977–1996) ▲

Cattle numbers have increased dramatically over the past 20 years, and have more than doubled during the last 11 years[1]. There are probably two main reasons for this increase. The first is that the occurrence of many diseases has dropped in recent years[2]. Perhaps the most important of these is the bacterial disease *Pasteurollosis*. Vaccines against the disease were introduced in the mid-1980s and cattle deaths dropped dramatically. The vaccination programme was stopped in 1992. The second reason is that the lower river levels and reduced flooding in recent years have led to increasing access to grazing pastures on the eastern floodplains, around Lake Liambezi and in the Linyanti Swamps. With increased pastures, cattle are probably in better condition, resulting in higher calving rates and lower death rates.

These changes in cattle numbers have had several major impacts in Caprivi:

- grazing pressures on natural grasslands have doubled over the past 11 years
- the wealth and consumption levels of cattle owners have increased substantially
- the number of cattle owners has increased
- draught power with which to prepare fields for cultivation has increased, enabling farmers to clear and cultivate more land

Densities of cattle, pasture quality and grazing pressure

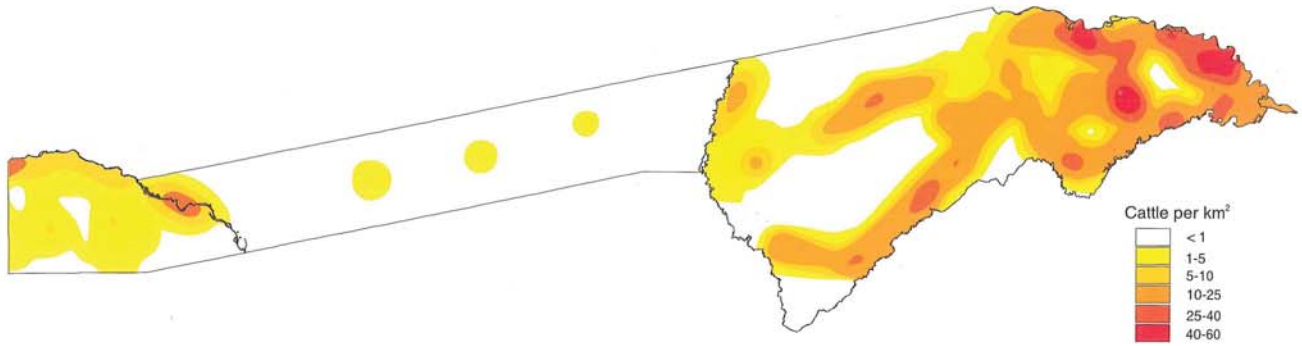
About half of all cattle in Caprivi are concentrated in the eastern floodplains. This map is based on cattle numbers counted at all crushpens and the assumption that all cattle are distributed within a range of ten kilometres from each crushpen[3]. Other areas with high densities are along the Linyanti and Chobe swamps, along the Golden Highway (road between Katima Mulilo and Kongola), and along the Kwando and Okavango rivers. The crushpen counts were largely obtained during winter in 1996, but counts in 1995 provide very similar density patterns. In winter, cattle are more concentrated near permanent water, either along rivers or near water provided from wells and boreholes. After good summer rains have fallen they are often moved further afield into areas where temporary pans have filled with water. However, these movements are not over great distances and the overall density patterns in summer are similar to those shown here.

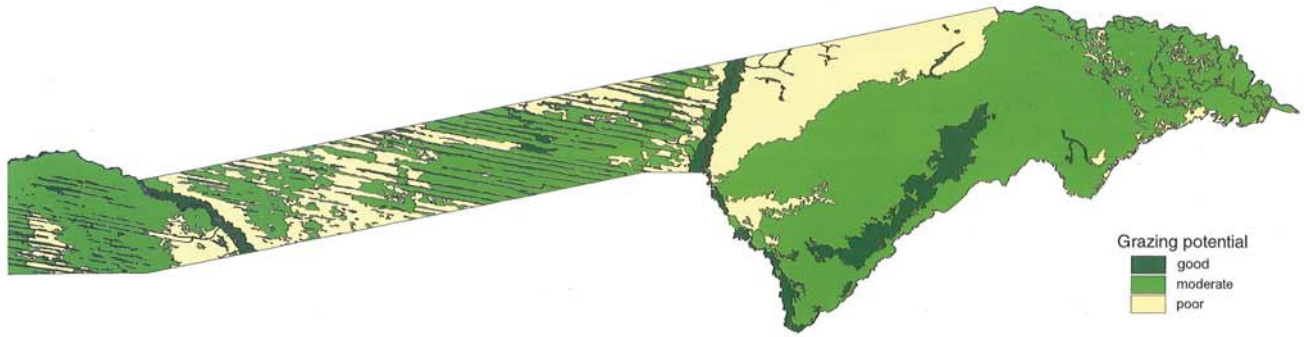
(PT)

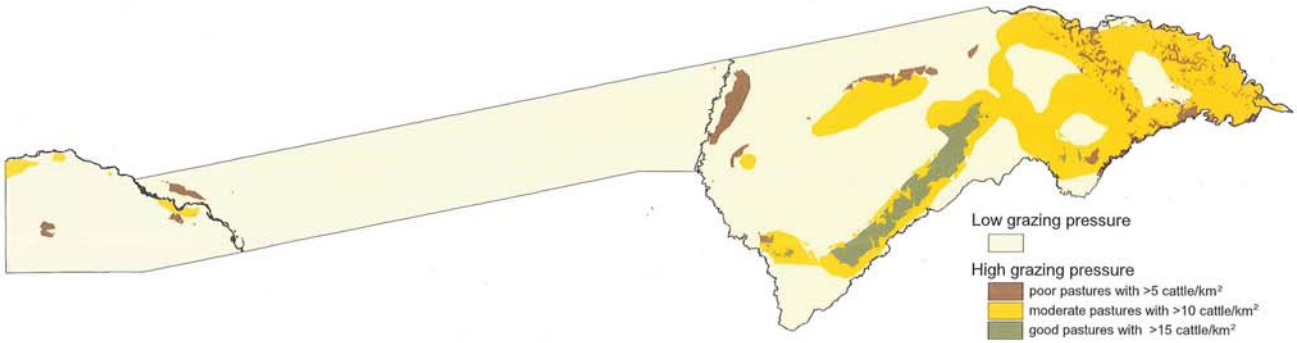
What consequences do cattle have on the plant life in Caprivi? An index of grazing potential for different vegetation units was derived, with each unit being rated as low, moderate or good grazing potential. This was based on an overall assessment of the palatability of grasses and their abundance. Carrying capacities for these indices were not determined directly, and are known to vary according to rainfall and local conditions. However, results from studies in the Caprivi during a period that had seen much more rain than has fallen in recent years and from a variety of similar habitats[4] suggest suitable stocking rates of roughly 15 cattle/km² on good pastures, 10 cattle/km² on pastures with moderate potential and five or less cattle per square kilometre on poor pastures.

(CW)

Comparing stocking rates with grazing potential provides an idea of where natural pastures are under greatest pressure, and shows that much of the eastern Caprivi is probably over-stocked with cattle. One further concern is that localized patches of highly nutritious grasses along drainage lines on the eastern floodplains must be under extreme pressure, since most of the floodplain area consists of leached sands where grasses have little nutritional value.







Crop farming

Three crops predominate in the Caprivi: *mahangu* (pearl millet) being planted in 47% of fields, sorghum in 27%, and maize in 26% of fields surveyed during 1994/95[5]. Maize is planted more often in the eastern, moister areas while *mahangu* and sorghum are preferred in drier areas. Other, minor crops include various vegetables, especially pumpkins, beans and groundnuts.

Cultivation practices are often characterized as "low input – low output", with farmers tending to invest little in their fields and harvesting low yields. Most fields are planted using seed collected in previous years, rather than "improved" seeds or cultivars which should produce better yields. Very few fields are fertilized with commercial fertilizers, manure or compost, and few fields are irrigated[5,6]. Although inputs into fields are seen as "low", considerable amounts of time are invested in the fields, varying between 150 and 400 hours of labour per field. The majority of fields (81%) are prepared using draught power, usually cattle, to pull ploughs, while 12% are prepared by hand (usually by women) and 5% are prepared using tractors. Weeding is done mainly by women. The availability of labour and draught power at the times that it is required can be a limiting factor[6].

Not only are yields low, they are also highly variable. From year to year yields vary between 70 and 445 kg/ha of *mahangu* and sorghum, and between 30 and 700 kg/ha of maize. Much of the variation in yield is due to the variation in rainfall, with yields being lowest in the driest years. However, even in years with high total rainfall, yields can be poor if the rain is badly spaced. Other factors affecting yields include outbreaks of pests such as locusts and other insects and birds.

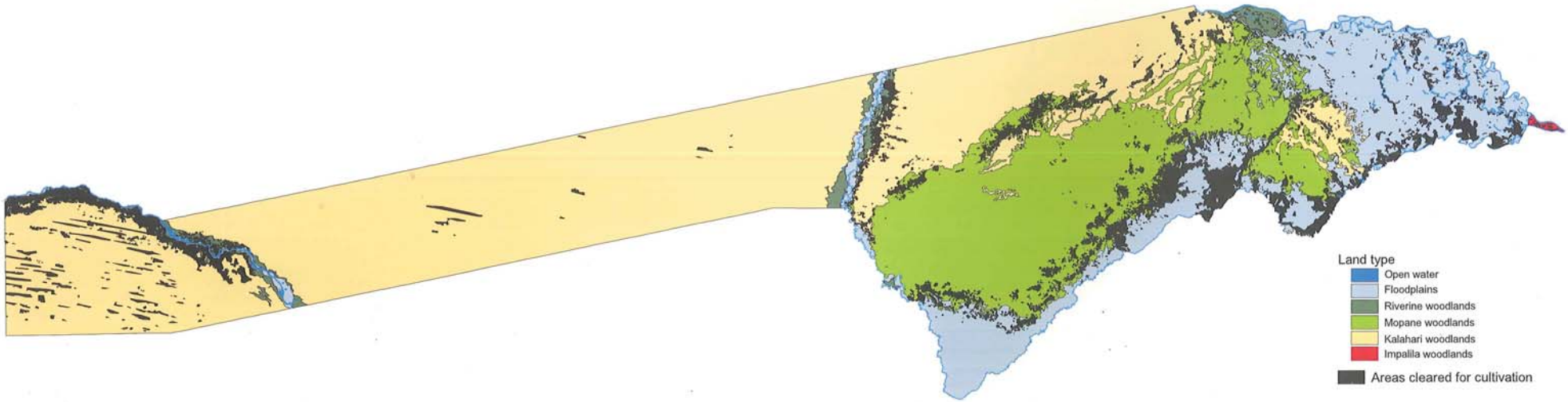
Of all the activities, the clearing of land for cultivation has perhaps the greatest and most visible impact on the environment in Caprivi. New fields are cleared when existing fields are considered to be no longer as fertile as they should be, and when householders have enough resources to increase the area they can farm. This is especially true when a farmer gains access to more oxen and labour for preparing and weeding fields. The total amount of land farmed by each household varies considerably, from less than one hectare to about ten hectares. The average subsistence farmer in the Caprivi probably farms about four hectares. However, the growing number of commercial farmers (page 29) clear and farm much bigger areas.

There are three categories of land cleared for cultivation: active fields, fallow fields, and abandoned fields. Fallow fields are those that are left to "rest" for one or more years before being planted again. Abandoned fields are those that farmers consider to be no longer productive. Of all the fields maintained by farmers during 1994/95, about 70% were active and 30% were fallow[5,7]. No one has yet measured the area of abandoned fields, but almost all of this land is badly degraded; plants growing there consist largely of pioneer shrubs and weeds.

Storing the season's harvest

Land type	Area (km²)	Area cleared (km²)	% cleared
Open water	166	9	5
Floodplains	3 762	673	18
Riverine woodlands	511	212	41
Mopane woodlands	4 613	437	9
Kalahari woodlands	10 939	384	4
Impalila woodlands	18	4	22
Total	20 009	1 719	9

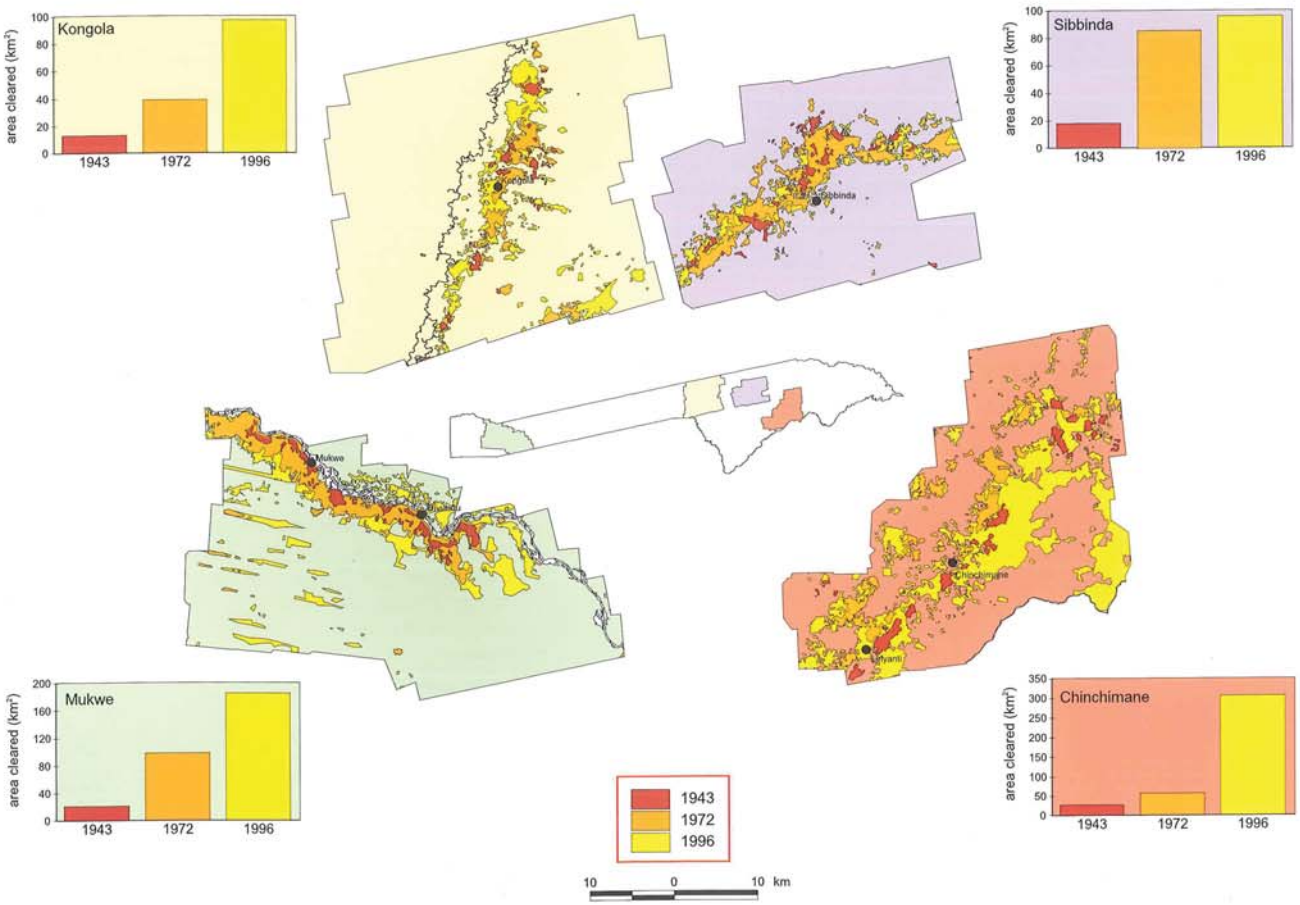
Areas of different land types cleared for cultivation, 1996



Distribution of areas cleared for crop cultivation by 1996 ▲

As seen on aerial photographs[8], the areas shown on this map had obviously been cleared for fields. They were most visible in woodland vegetation types where the original trees had been removed leaving distinct scars. In floodplain areas, old fields were not as clear and many areas that have been used for cultivation were no longer visible, and were not mapped. This is therefore a minimum estimate of the area that has been used for crop farming.

The majority of cultivation takes place along rivers and in areas occasionally flooded when these rivers reach high levels. Away from the rivers, most cultivation is in the mopane woodlands, especially along the margins, and down the dune valleys in the Kalahari sands area.



Areas cleared for crops in 1943, 1972 and 1996 in the Mukwe area, and around Kongola, Sibbinda and Chinchimane ▲

The minimum total of 171 900 ha, or 1 719 km², cleared by 1996 amounts to about 9% of the total surface of Caprivi. To see how this figure has changed over the years, areas cleared for cultivation were also mapped off aerial photographs taken in 1943 and 1972. Cleared land was compared in these areas with those mapped in 1996.

Four areas were selected to represent different landscapes. In the Mukwe area, scattered fields in 1943 had been expanded to a continuous band of cleared land along the west bank of the Okavango River by 1972. After 1972, most newly cleared land was away from the river, especially along dune valleys, as well as along the east bank. In the Kongola area, the few scattered clearings in 1943 expanded uniformly along the east bank of the Kwando River, while the large area of fields near Sachona only started being cleared after 1943. There was a substantial increase in the area cleared around Sibbinda from 1943 to 1972, but relatively few areas were cleared after that. The Chinchimane area has, by contrast, seen a dramatic increase in cultivated areas since 1972, and this was largely due to the drying of Lake Liambezi (page 38) and the surrounding floodplains. In 1972, the lake was large and all fields were then on much higher ground away from flooded ground. In 1943, however, the area was dry with many of the fields placed closer to what would later become the lake.

Although patterns of increased clearing of land differ to some degree in the four areas, the total area cleared has increased at an average rate of 4.1% each year since 1943. If the large expansion of farms in the Chinchimane area is excluded, the rate drops to 3.8%. Both rates are similar to the population growth rate of about 4% over these last few decades (Chapter 4).

Soil quality	Total area (km2)	Area cleared (km2)	% cleared
Poor	14 021	581	4
Moderate	2 851	355	12
Best	3 137	783	25
Total	20 009	1 719	9

Areas of different quality soils cleared for cultivation, 1996 ▲

Not surprisingly, most cultivated fields are on soils that are of relatively high quality, especially loam, sandy loam and clay-loam soils. About 25% of the area rated as having the best soils in the region had been cleared by 1996. The scale at which soils were mapped and rated for the suitability for cultivation did not allow for recognition of much of the very fine variation in the distribution of soil quality. For example, very small fields are often located above termite mounds which are rich in nutrients, but may cover an area of perhaps 10x10 m². In the eastern floodplains, many fields are along the edges of old drainage channels and meanders, and are therefore thin and long. There are thus many small areas with good soils in large geographic units which are generally rated as having poor quality soils, and many patches unsuited to cultivation in areas with soils which are generally of higher quality.

Commercial farming

Farming in the Caprivi is characterized as being subsistence in nature, giving the general idea that all farmers cultivate small field areas and have small herds of cattle. However, there is also a growing commercial sector. Farm products are sold in a number of ways, ranging from local bartering and sales within villages to the sale of cattle, maize and sorghum to buying agencies in Katima Mulilo, Rundu and Windhoek. For example, about 2 500 tonnes of maize was sold in the 1995/96 season to the mill in Katima Mulilo, about 360 tonnes of sorghum was sold in 1996 to a company in Windhoek, and MeatCo have been buying between 4 500 and 5 500 head of cattle per year in Katima Mulilo over the past few years. Total maize sales to the mill amount to about 20% of the total yield per year, while only about 2–3% of the total number of cattle are sold to MeatCo. Local sales of cattle in so-called "bush markets" amount to about another 2% of the total cattle herd per year.

One of the main reasons for the growing number of large, commercial farming units is the fact that many people are employed by government as teachers, extension officers, nurses, policemen, etc. Salaries paid by these jobs are substantial, especially if living costs are relatively small in the absence of major housing costs, local taxes, and water and electricity charges. Such employees often save money which can be invested in cattle, seed, fencing, labour, farming equipment and other assets. Perhaps about 20% of all households have a household member earning such a salary[6], but no information is available on what proportion or number of people use these assets to become commercial, large-scale farmers. What is likely, however, is that the number of commercial farmers will grow, as will demands on land to serve their needs. Indeed, many people have recently been asking government to clear large areas to create new farms for them.

Chapter 7
Wild animal resources

(PT)

Wild animal resources are of substantial value to Caprivi for several reasons. First, they provide people with food. The fishing industry is a good example of this, but many people also hunt for food. Second, tourism in the region depends largely on the diversity and abundance of animals. Visitors are attracted by the prospects of seeing game and birds. Tourists to Caprivi are estimated to contribute some $31 million to Namibia's economy[1]. Third, many species occurring in Caprivi have great conservation value because they are found nowhere else in Namibia. Some of these species need both national and international conservation efforts because they are uncommon elsewhere in Africa. Finally, wild animals are an integral part of the natural environment and Caprivi's heritage. They contribute to the health of that environment in many ways. For example, many people now believe that, in addition to lower rainfalls and subsequent river flows, the recent clogging of river channels in the Linyanti and Kwando river systems is due to declining numbers of hippo. These animals help to keep river channels open which otherwise become overgrown with reeds and other aquatic vegetation. The reduced supply of water to villages along the Linyanti and reduced fishing grounds in that area might well be due to the lower numbers of hippos further upstream.

More is known about large mammals, birds and fish in Caprivi than other animals, and this account therefore focuses on these animals. However, patterns and processes important to other animals will be similar to those shown for mammals, birds and fish. For almost all groups of animals, Caprivi has a substantially higher diversity of species than other regions in Namibia.

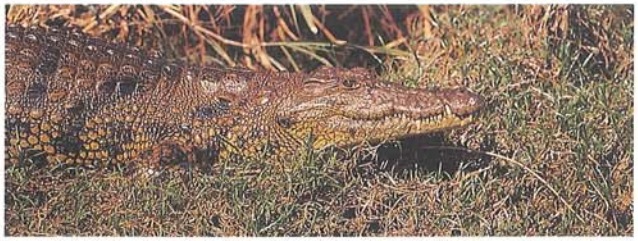
Large mammals

Over the past 17 years a number of aerial counts have provided good information on the distribution and numbers of large mammals. These studies have shown that most large mammals are confined to nature reserves and the areas immediately around them, as well as areas near the Okavango and Kwando rivers. This comes out clearly on the maps showing their distributions.

There have been substantial changes in the numbers of large mammals over the past 15 years. The most dramatic has been that of the lechwe population which dropped from over 11 000 in the early 1980s to just a few hundred in 1995. This species used to occur in large numbers on the eastern floodplains and in the Chobe Swamps, but has now essentially disappeared from these areas[6].

Black rhino is now extinct in Caprivi, and giraffe and wildebeest are no longer found in eastern Caprivi. Large numbers of several species (elephant, buffalo, eland, roan, sable and kudu) were counted in the state forest area during the 1980s, but these have all but disappeared. The same is true for the eastern floodplains where several species have essentially gone: sable, kudu, reedbuck and waterbuck, in addition to lechwe. However, total numbers of elephants in Caprivi have increased substantially, and perhaps those of buffalo. These increases have been most marked in conserved areas, because areas elsewhere are now less suitable for these large animals.

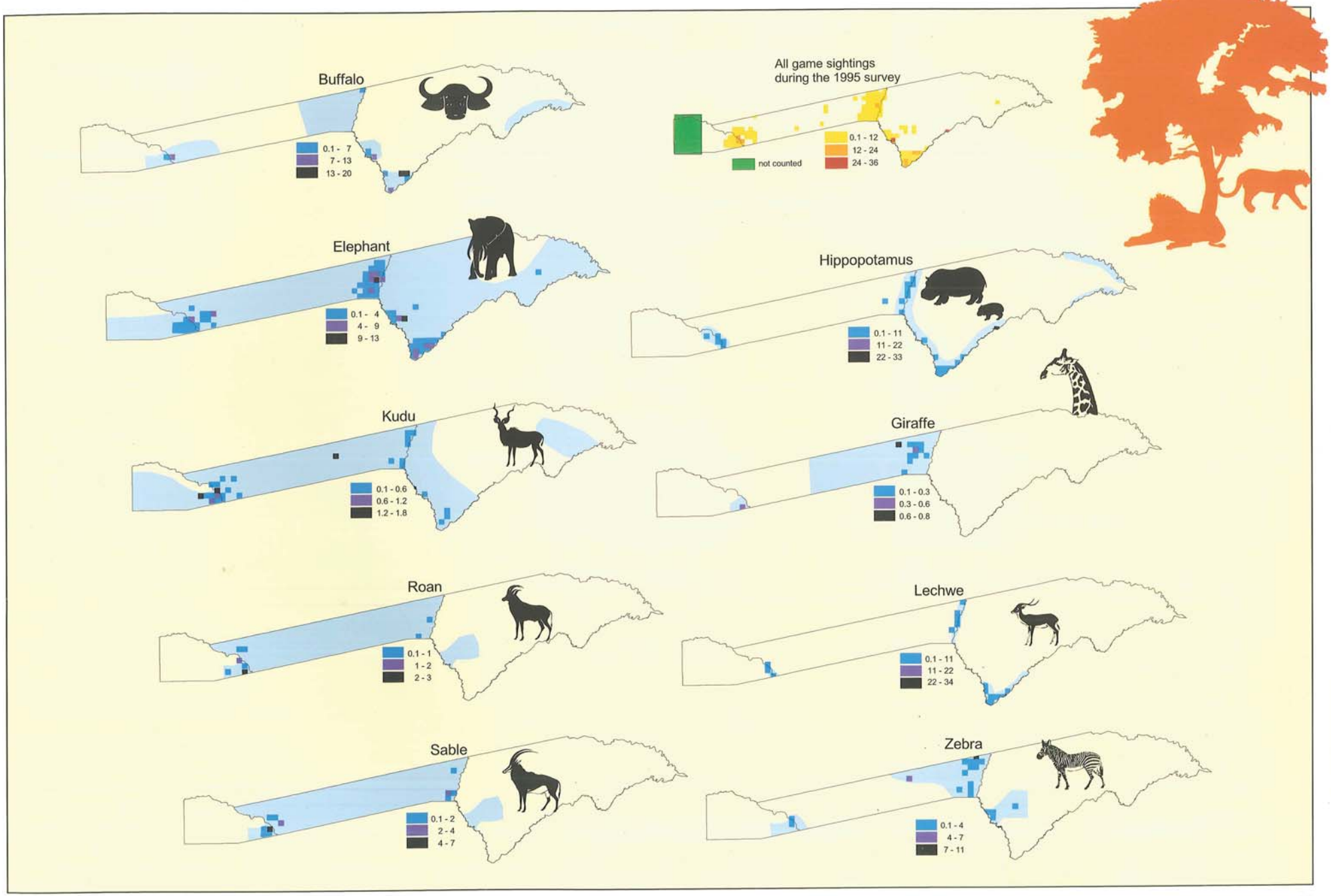
There appear to be two major factors which account for most of the changes in numbers of large mammals. First, increasing human populations and increased exploitation have led to a reduction in their numbers and ranges. The second is that lower rainfall and river levels have led to changes in their habitats. Surface water in small pans and depressions is less available than during wetter periods, and suitable grazing may be less abundant. In addition, the extensive areas of waterlogged floodplains no longer exist and are now used to a greater extent by people. For species such as lechwe, that prefer these flooded habitats, changes in numbers are largely due to these recent climatic changes. But for species such as giraffe and wildebeest in the eastern Caprivi, exploitation through poaching has probably led to their numbers being reduced.

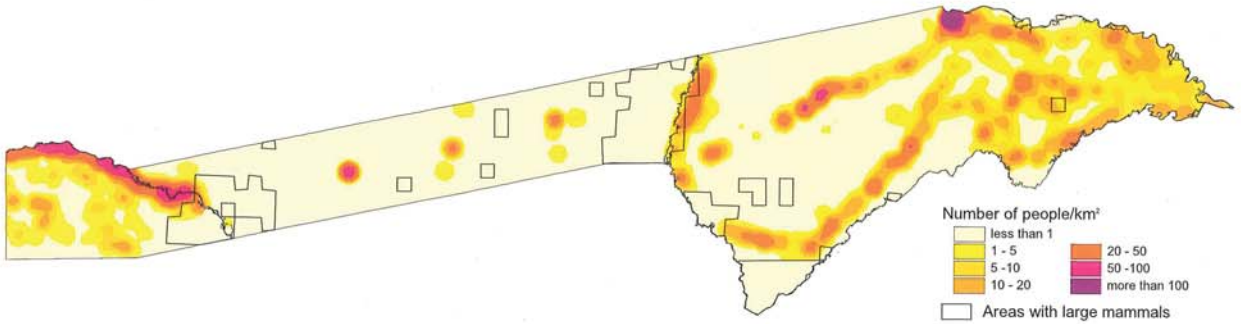


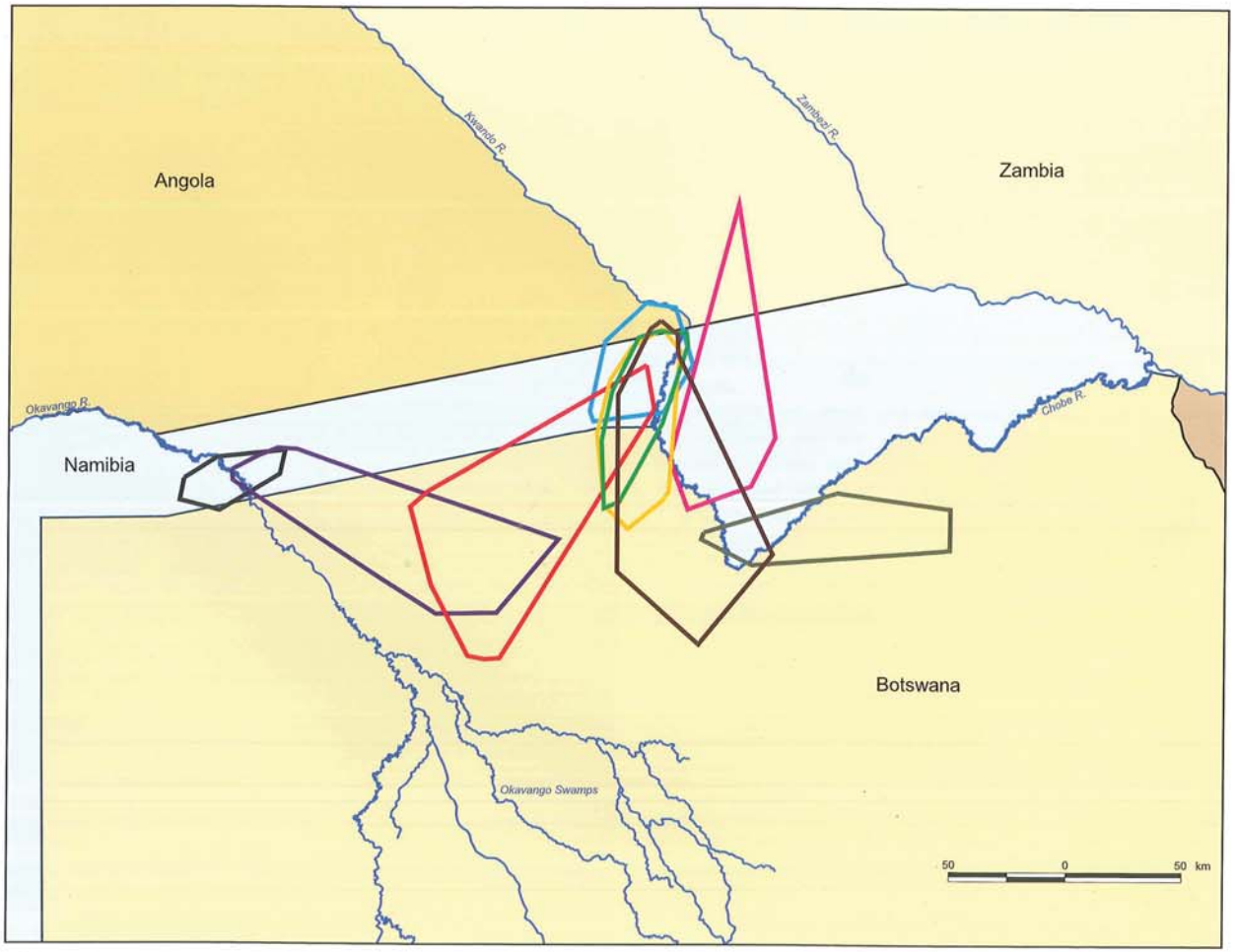
(CW)

Estimated densities of large mammals (each square is 5x5 km) and the broader zones in which these species range ( )

While estimates of mammal densities are based on just one year's counts, information from other years provides results showing similar patterns of abundance and distribution. Densities were calculated from an aerial census in late August and early September 1995 before the summer rains had started[2]. During these dry winter months most animals concentrate near the rivers where they have access to water.


Buffalo
0.1 - 7
7 - 13
13 - 20
All game sightings
during the 1995 survey
not counted
0.1 - 12
12 - 24
24 - 36
Elephant
0.1 - 4
4 - 9
9 - 13
Hippopotamus
0.1 - 11
11 - 22
22 - 33
Kudu
0.1 - 0.6
0.6 - 1.2
1.2 - 1.8
Giraffe
0.1 - 0.3
0.3 - 0.6
0.6 - 0.8
Roan
0.1 - 1
1 - 2
2 - 3
Lechwe
0.1 - 11
11 - 22
22 - 34
Sable
0.1 - 2
2 - 4
4 - 7
Zebra
0.1 - 4
4 - 7
7 - 11





◀ Conflicts between people and large mammals

Most conflicts between animals and farmers result from damage caused to crops and stock. In a study along the Kwando River, 80–100 cases of elephant damage to crops were reported each year between 1991 and 1995. About 70–80 head of cattle were also taken each year, mainly by lions and hyaenas[3].

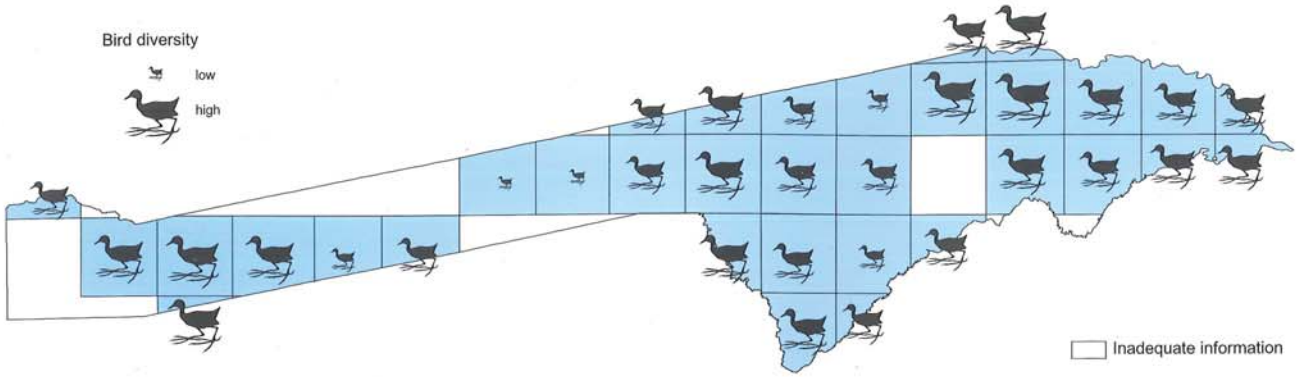
This map compares the distribution of people with that of large mammals recorded in the 1995 aerial census. It is clear from this that most mammals avoid areas where there are lots of people, and so most people in the Caprivi do not suffer these kinds of damage.

This map also shows those areas where there are high densities of both large mammals and people, and consequently where the great majority of conflicts are likely to happen. Such areas are confined to zones along the east bank of the Kwando River, north of Mamili National Park and just north of Mahango Game Reserve. The limited extent of these "conflict" areas suggests that much could be done to manage problems by placing a few Ministry of Environment and Tourism staff in appropriate places. In addition, there is an area along the Chobe River where large mammals move out of the Chobe National Park in Botswana on to the eastern floodplains. This usually happens at night, so these animals are not seen during aerial surveys. Damage in other areas may also occur in the rainy season when some animals move away from the rivers.

Elephants come into conflict with humans more than any other animal in Caprivi (PT)

◀ Movements of nine elephants

The total population of elephants in Caprivi is estimated to be between 5 000 and 6 000 animals[4]. A study which tracked nine individual animals (eight of which were females moving in family herds), each carrying a satellite transmitter, have shown that they are largely confined to areas near the large rivers in the dry, winter months. During the summer rainy season, however, they move away from the rivers. Many move south into northern Botswana, but some also move north into Angola and Zambia and into the central area of the Caprivi strip. Some of these tracked elephants covered areas up to 5 500 km² during their regular annual movements. It is important to realise that elephants and many other species are dependent not only on protected nature reserves but also on much larger areas that surround these reserves. Caprivi's elephants are, indeed, part of a much larger population of about 120 000–130 000 elephants that occupy a broad zone across northern Botswana, western Zimbabwe, and southern Zambia and Angola.[5]



Bird diversity in Caprivi ▲

Each square represents a quarter-degree square (15′ of latitude x 15′ of longitude). The size of the bird in each square is directly related to the diversity of birds recorded there[7].

Wattled cranes – an endangered species in Africa (PT)

Kudu are widespread in the woodlands (CW)

Birds

Information on the distributions of birds in Caprivi shows that the greatest number of species are to be found along the major river systems, especially in the Mahango, Mudumu and Mamili protected areas, and in the area around Katima Mulilo. Mahango Game Reserve actually has the highest diversity of birds recorded anywhere in Namibia[8]. Vegetation along the big rivers is much more diverse than elsewhere and the diversity of birds follows the same pattern. Water birds are also restricted to rivers and flooded areas. Of 110 species of birds in Namibia that are rare, endangered or need to be monitored, 73 have been recorded in Caprivi[9]. While some of these are common in countries further north and east, others are generally rare, and the Caprivi is the only area in Namibia which can offer them some protection.

Fish have both household and commercial value (CW)

Fish

Fish are clearly an important resource in Caprivi, providing food and income for many people, as well as recreational angling[10]. The rivers are home to a diverse fish fauna: 79 species having been recorded in the Okavango River system and 82 species in the Zambezi[11]. Forty-three species of fish were recorded in Lake Liambezi in the early eighties (see page 38). Different species of fish use the rivers in different ways. Some remain as residents, others migrate up and down the rivers, while others move laterally between the river channels and seasonally inundated floodplains.

Perhaps the most prominent feature of fish in Caprivi is the dynamic nature of their populations, their habitats and the resulting exploitation. Much of what is now known about Caprivi's fish is based on information collected during the 1970s and early 1980s when river levels were higher and flooded areas were much bigger than now. At peak levels, as much as about 3 265 km² of flooded area might be available, while the rivers and open water channels amounted to only about 166 km² in mid-1994, or 5.5% of the area that can be flooded (Chapter 8).

While lower river levels have reduced the extent of fish habitat dramatically, a more important change concerns the relative scarcity of flooded areas for species that require such habitats in which to breed. These species live as adults in open water but lay their eggs among plants growing in shallow water. The absence of regular flooding has probably had a major impact on breeding rates and consequently the populations of those fish. In addition, flooded areas have been damaged in many areas by increasing numbers of cattle trampling and grazing grasses and other vegetation growing in the water. Finally, erosion and increased deposits of silt along the banks of rivers cause the rivers to flow along more defined channels, thus reducing the chances of flooding.

In its day, Lake Liambezi was estimated to yield some 600–800 tonnes of fish per year[12]. A fishing co-operative existed in Caprivi and fish were then exported to Zambia, Botswana and Zimbabwe. That all stopped in 1985 when the lake finally dried up. For the rest of the region, estimated annual yields amounted to about 700–900 tonnes from the Zambezi, Kwando and Chobe rivers, and perhaps about 150 tonnes from the section of Okavango River flowing through Caprivi. These estimates were also obtained during previous wetter periods. New information on current yields would be worth collecting.

Fishing is an important aspect of the local economy and food security for the region as a whole, but especially for those communities living near the major rivers and floodplains. There are substantial differences in fishing practices between those along the Okavango and those along the Zambezi, Chobe and Kwando rivers[10]. Along the Okavango, many households fish (about 35–55%), access to fishing grounds is not restricted, catches per day tend to be small, greater use is made of traditional fishing methods (such as fish traps), most of the catches are consumed at home, and a good deal of the fishing is done by women and children. By contrast, along rivers in the eastern Caprivi, relatively few households catch fish (about 15%), access to fishing grounds is often based on territorial rights, daily catches are larger, more use is made of nets and other modern gear, many of the fish are sold commercially, and fishing is largely the preserve of men.

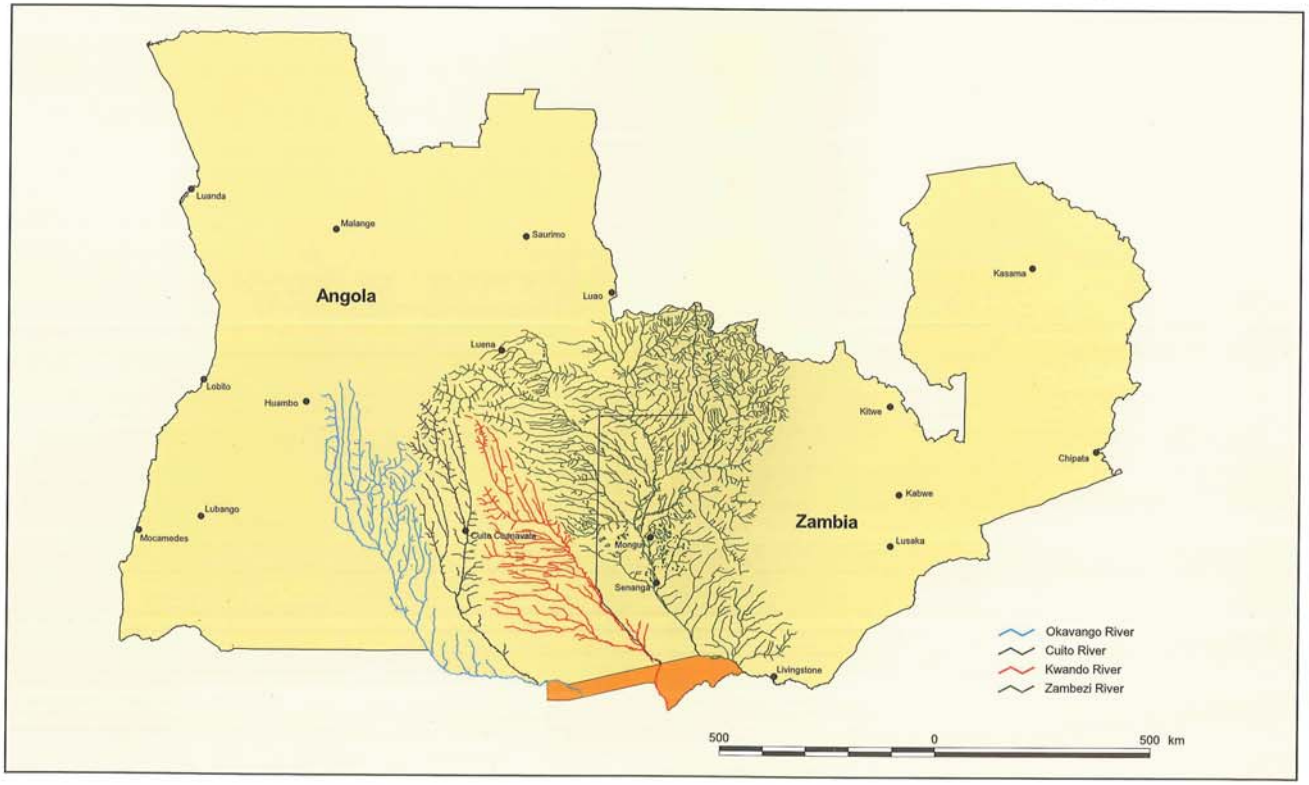
Chapter 8

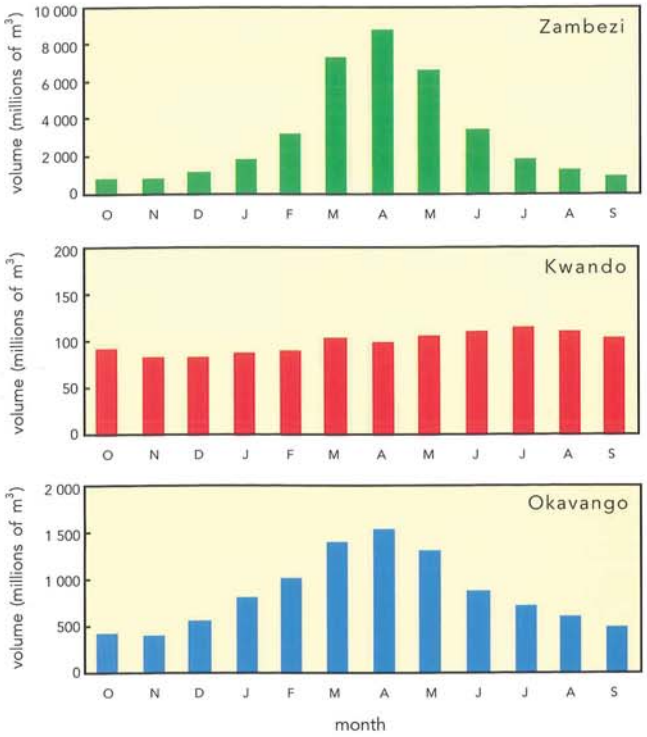
Rivers, wetlands and water supply

Caprivi's rivers

The abundance of water, perhaps more than anything else, sets the Caprivi apart from the rest of Namibia. Of only five permanently flowing rivers in Namibia, Caprivi has three — the Okavango, Kwando or Mashi, and Zambezi. Not only do these rivers hold water permanently, but they are also relatively large rivers. In years of high rainfall, their waters may flood over large areas, forming extensive marshes and the legendary Lake Liambezi. There are two other rivers in Caprivi that are often regarded as rivers in their own right — the Chobe and the Linyanti. However, both are really extensions to the Zambezi and Kwando rivers, respectively.

In fact, all these rivers can connect with one another if water levels are high enough. The Zambezi and Kwando Rivers are often connected through the Linyanti and Chobe Rivers and Lake Liambezi. The Okavango River can also connect with the Kwando River when river levels are exceptionally high. This is through the Selinda Spillway, an outlet from the north-eastern corner of the Okavango Swamps which joins the Kwando at its southern limits and merges into the Linyanti. Water can potentially flow in either direction — from the Kwando into the Okavango Swamps, or from the swamps into the Kwando, up the Linyanti, through Lake Liambezi, into the Chobe and finally into the Zambezi. (See map on page 3.)





▲ Average monthly volumes carried by the Zambezi River past Katima Mulilo, the Kwando River past Kongola and the Okavango River past Mukwe[1]

Seasonal changes in the levels and volumes of these rivers reflect seasonal changes in rainfall. However, the increased volumes of water in these rivers are only seen in Caprivi several months after the summer rains have fallen in the catchment areas. At Katima Mulilo and Mukwe, flows in the Zambezi and Okavango peak in March, April and May, having been lowest in October and November. The Kwando shows a much longer lag between the summer rains falling in Angola and highest flows passing Kongola in June, July and August. The fluctuations in the flow of the Kwando are small because it first drains through a large swamp system in Angola which holds and slows the flow of water into the river.

◀ Catchments of the Zambezi, Kwando, and Okavango and Cuito rivers in Zambia and Angola

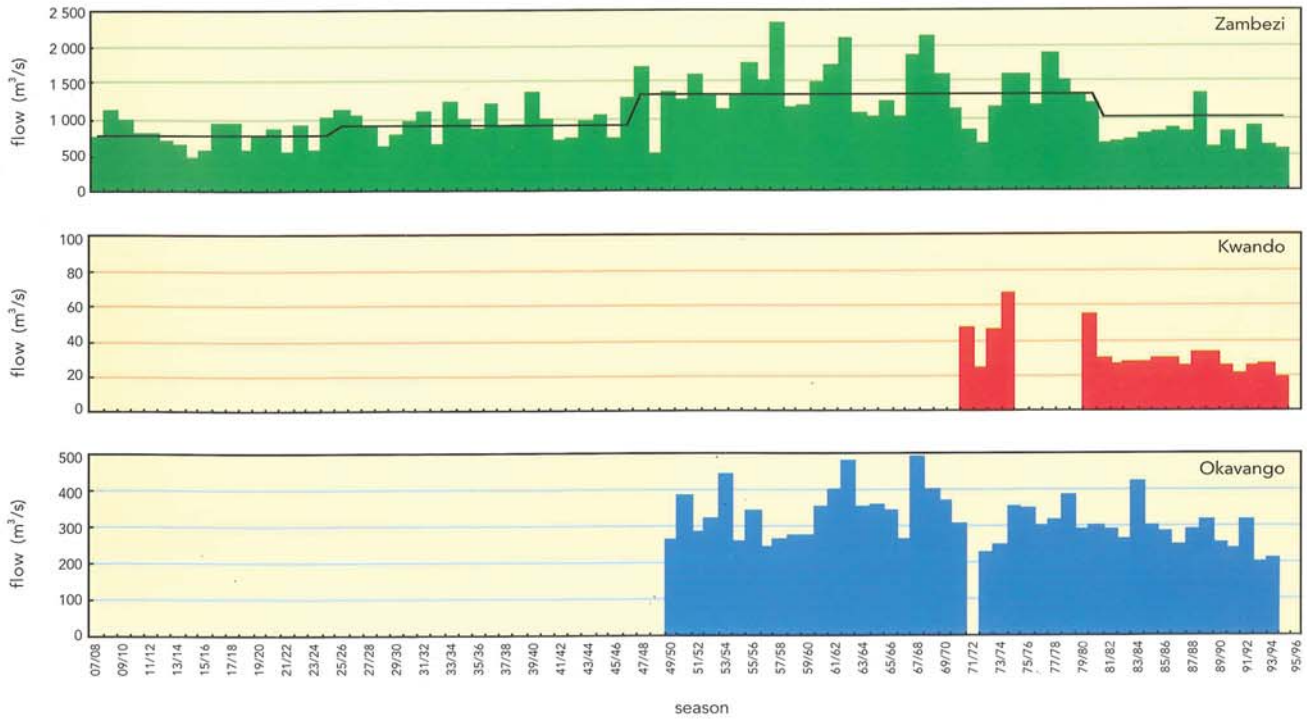
The three major rivers have their origins or catchments in Angola and Zambia, up to 800 km from where they reach Caprivi. Just before the Okavango River enters Caprivi it is joined by the Cuito River which carries about the same volume of water as the Okavango. The total area of Angola and Zambia drained by these rivers is huge, amounting to about 750 000 km² — an area not much smaller in size than the whole of Namibia!

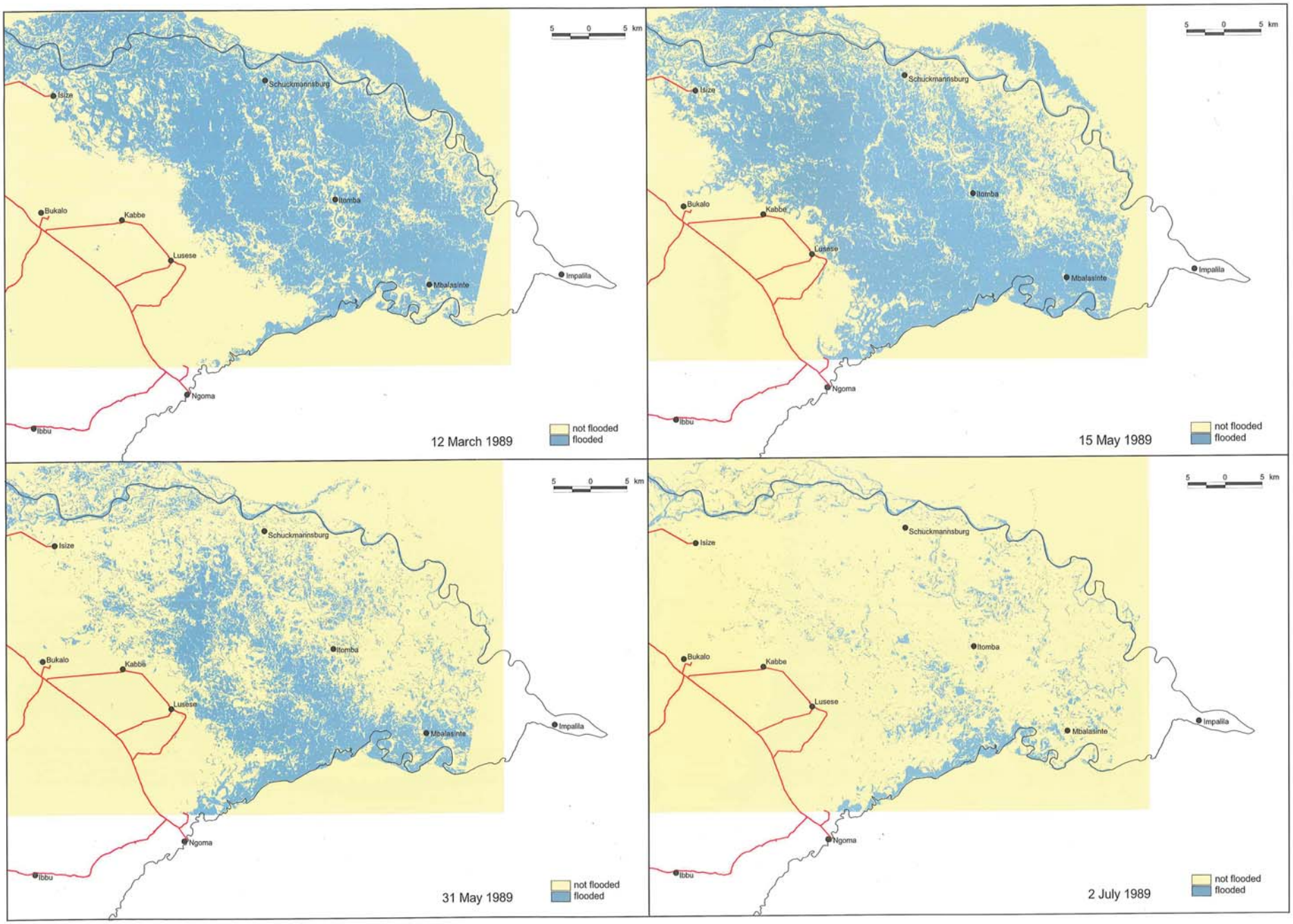
Oxbow lake on the Kwando River

Popa Falls on the Okavango River

Annual changes in the average flow of water carried by the Zambezi River past Victoria Falls, the Kwando past Kongola and the Okavango past Mukwe[1] ▼

Dramatic changes have occurred to the levels and volumes of water carried by the three rivers during this century. The longest and most complete set of information to illustrate these changes has been recorded for the Zambezi River at Victoria Falls since 1907. Even though there has been a good deal of variation from year to year, four quite different phases seem to have occurred over these 90 years[2]. The first phase ran from the 1907/08 to the 1923/24 season when the average flow at Victoria Falls was 756 m³/s. The second lasted from the 1924/25 to the 1945/46 season when average flows increased to 941 m³/s. The third phase was the most dramatic this century when average flows of 1 392 m³/s were recorded, almost double that recorded in the first phase. This lasted from the 1946/47 to the 1980/81 season and it was then that Lake Liambezi filled with water and became such a prominent feature in Caprivi. The last period, from the 1981/82 season to the present, has seen average flows of about 750 m³/s, similar to those at the start of the century. Similar, but less dramatic, changes have occurred in the flow of the other rivers. In the case of the Kwando, river levels are now much lower than before and also hardly change from year to year. As a result, many of the channels in the river are now choked with reeds and other vegetation to such an extent that the flow of water up into the Linyanti is greatly reduced. The few years of data available from before the early 1980s suggest that the river sometimes carried very large volumes of water, and these substantial flows could have cleared the channels of blockages.



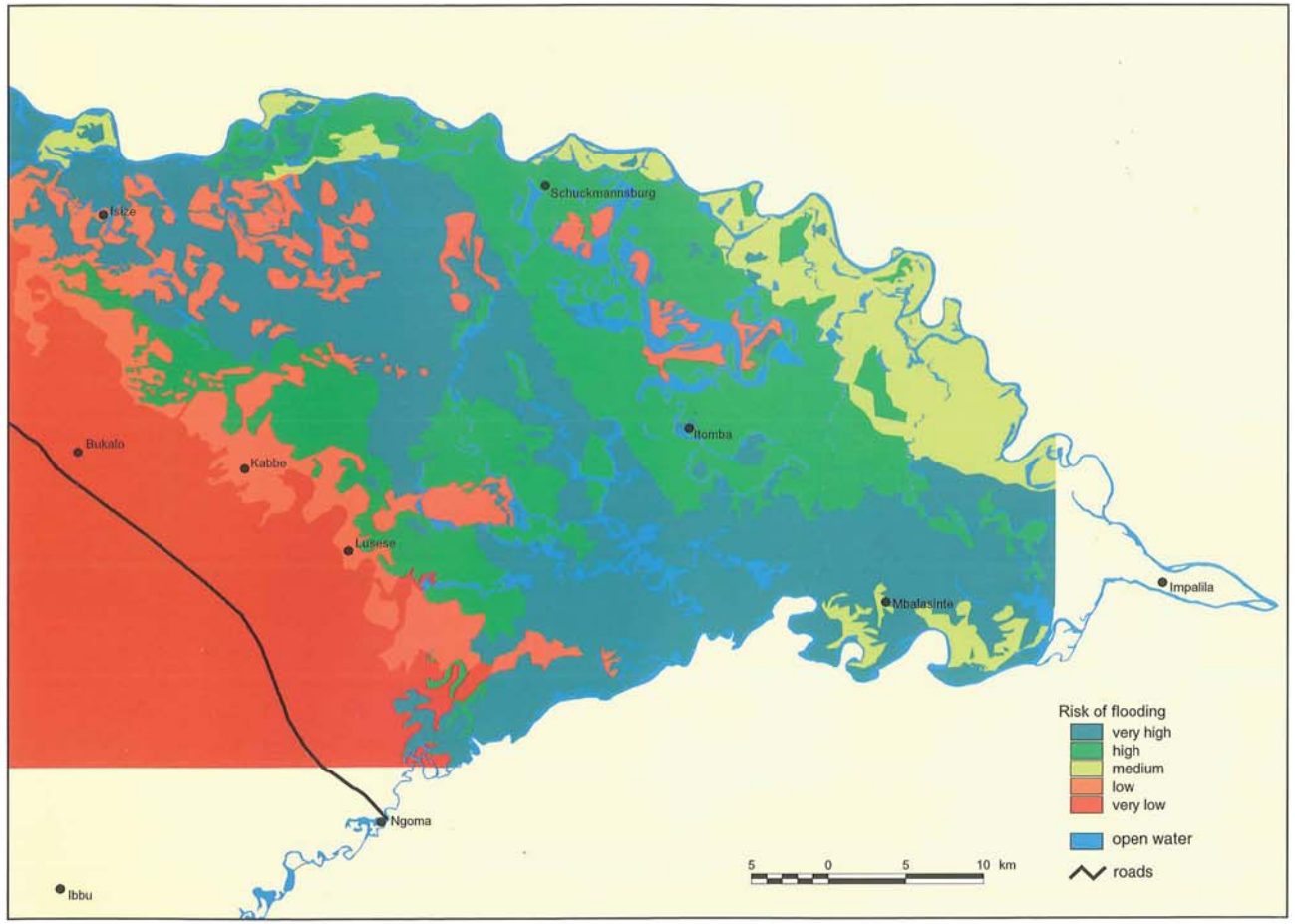

5 0 5 km
Isize
Schuckmannsburg
Itomba
Bukalo
Kabbe
Lusese
Impalila
Mbalasinte
Ngoma
Ibbu
12 March 1989
not flooded
flooded
15 May 1989
31 May 1989
2 July 1989

The flood in 1989

One exception to the generally dry conditions and low river levels over the past 16 years occurred in 1989 when the Zambezi pushed up to levels approaching those seen regularly between 1946/47 and 1980/81. The river was never high enough to start spilling into and down the Bukalo Channel towards Lake Liambezi, and its maximum level at Katima Mulilo in 1989 was still two metres lower than a high flood recorded in April 1969. Nevertheless, a large part of the eastern floodplain was flooded. These maps were drawn from an analysis of four photographs taken from a satellite at intervals between March and July[3] and show how flooded areas expanded and then receded. (The photographs excluded the eastern section near Impalila Island.) The first areas to be flooded were those immediately south of the river as the waters broke over the banks, and the large Simalaha Flats in Zambia. This initial flooding had started before the first image was taken on 12 March 1989. From areas around the river, flood waters spread out over the floodplain in a fairly broad and shallow layer. They then drained southwards towards the Chobe River. In addition, water from the Zambezi flowed up the Chobe from Impalila Island and contributed to further flooding north of the Chobe. The largest, deepest and longest lasting flooded areas were therefore those north and north-west of the Chobe. Some water also pushed all the way back along the Chobe to form a small pool in Lake Liambezi. The pool lasted only a few months, however.

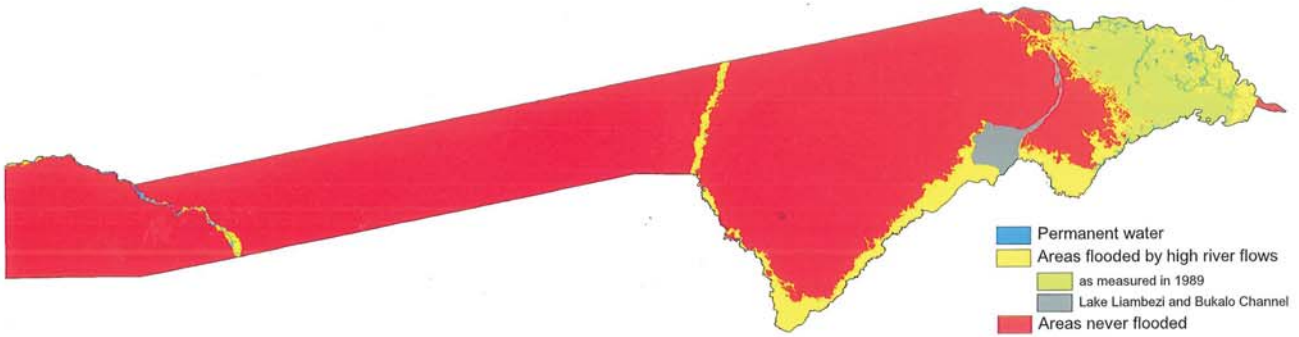
The risk of flooding on the eastern floodplains

Studies of the 1989 images of the eastern floodplain[3] also provide an assessment of which areas are most likely to be flooded. Those rated "very high" are likely to be flooded most frequently and extensively. Those rated "low" are likely to be flooded only rarely, perhaps only once every 50 years. Within these broad zones there is considerable local variation in relief, with old river channels, meanders and other low-lying areas being inundated with water much more than higher surrounding places. There has been an expansion of settlements and farming on the eastern floodplains in recent years, and some settlements will probably be threatened by high flood waters when levels of the Zambezi reach heights previously recorded. Taking all settlements in Caprivi, a total of about 3 640 households and 20 440 people would be affected if river and flood levels rose to the extent that they were in previous decades[4]. Lives would not be in danger, but current farming practices and food supplies would be threatened.



Areas that may be flooded in years when river flows are high

It is possible to get an idea of what areas are sometimes flooded elsewhere in the region by looking at the distribution of grasslands that are characteristic of floodplains. This is because most trees do not grow in areas where their roots may be saturated. The total area which can be flooded covers about 3 265 km², which is about 16% of the total surface of the region. During dry periods the total area of water in rivers and open water channels may amount to only about 166 km², or about 5% of the total area that could be under water[5].



Lake Liambezi

The explorer, Frederick Selous, saw Lake Liambezi filled in 1879, and this appears to be the only previous record of the lake before it filled again sometime during the 1950s. Because the lake is at a low elevation in eastern Caprivi, water could flow into it from several directions. The Zambezi, being highest in March and April would overflow its banks east of Katima Mulilo and water then flowed down the Bukalo Channel, past Muyako, and into the lake. Then, two or so months later, high waters in the Zambezi would have pushed up the Chobe through the Chobe Swamps until these waters, too, were added to the lake. Finally, water from the Kwando coming down the Linyanti would reach the lake in September and October. Flows into Lake Liambezi stopped in 1982, and the lake then gradually dried up. By 1985 it was completely dry, and the huge fishing industry that it supported collapsed. Today, the lake is a vast expanse of open grasslands and fields.

Lake Liambezi in 1982 (SB)

In 1996 large areas of the former lake were under cultivation

Kariba weed

The Kariba weed (*Salvinia molesta*), a floating aquatic fern, occurs in the eastern Caprivi as an invasive alien. It probably first established itself sometime before 1948, but even now new plants continue being washed down the Zambezi River into the region. The plant occurs naturally in Brazil and has become a major pest on many African rivers and lakes over the past few decades. It can grow very rapidly, forming dense mats of floating plants which may cover large areas, sometimes the entire water surface. More than 20% of the surface of Lake Liambezi was covered with Kariba weed in 1975[6]. The weed only grows on quiet waters, such as in swamps, lakes and river backwaters.

The *Salvinia* problem has now been reduced substantially, especially since 1981 when a tiny snout beetle (*Cyrtobagous salviniae*) was introduced to the Caprivi. This beetle controls *Salvinia* plants by feeding on them, and the level of Kariba weed infestation is now generally low. However, patches of the weeds covering small channels and ponds are still found, especially in the northern parts of the eastern floodplains and along the Kwando[7]. It seems very likely that both the weed and beetle are now permanent features of Caprivi's plant and animal life. Water levels have also been low since the early 1980s when the beetle was introduced and the weeds could become more of a problem if increased river levels and flooding led to an increase in the area of habitat favoured by the weed. The beetle may then not breed quickly enough to control a massive new growth. Fertilizers applied to fields can stimulate growth of the weed when they wash into the water and add more nutrients for the plants to use.

Mats of Kariba weed forming in a backwater near Katima Mulilo (CH)

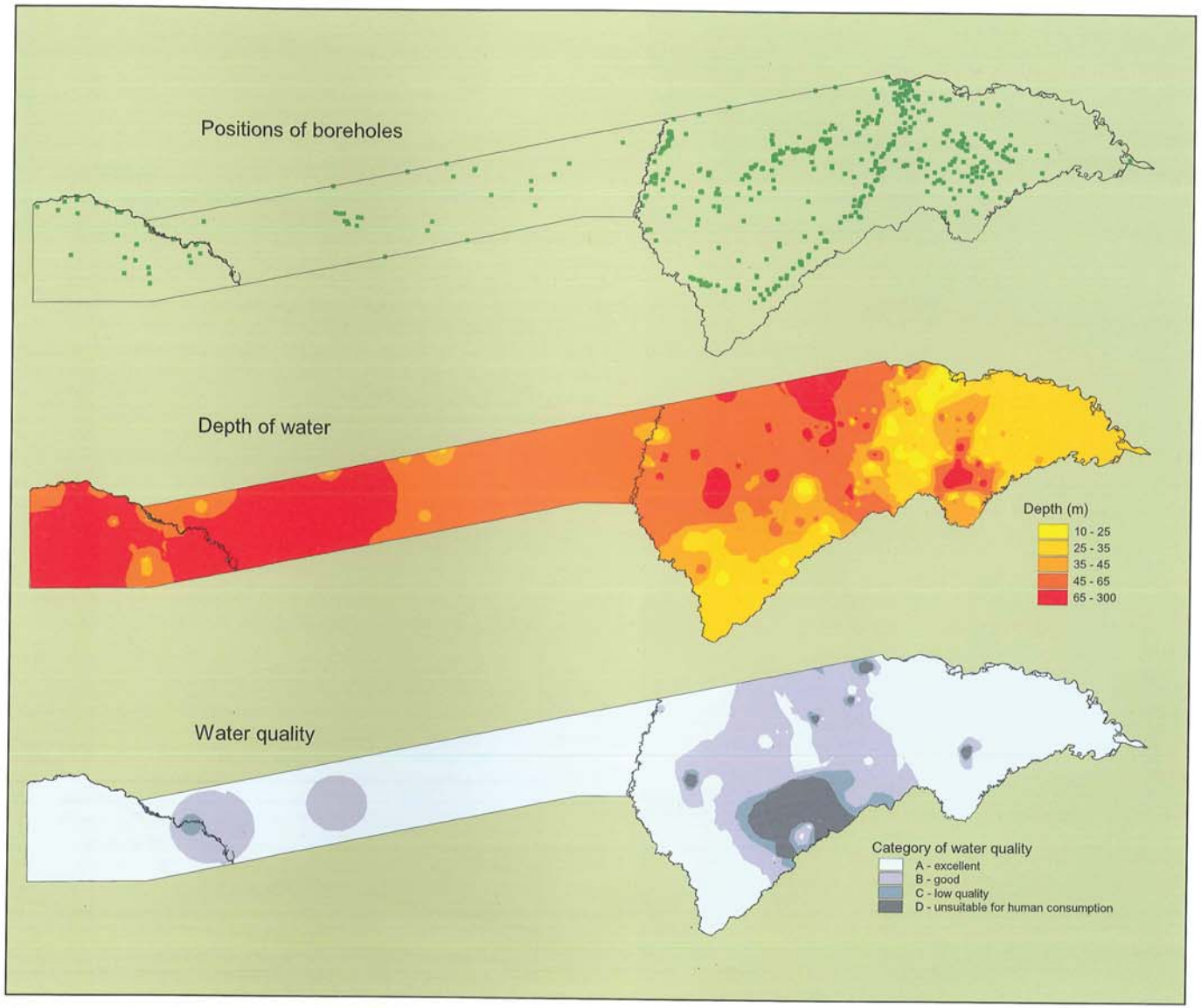
If the Kariba weed mat becomes well established, as it did here in areas of Lake Liambezi, secondary growths of reeds start to form (CH)

Water supply

People and cattle obtain water from several sources in Caprivi. In Katima Mulilo, almost all water is piped, either to communal or indoor taps. In rural areas, however, 32% of households obtain their water from rivers and other open, surface waters, 26% of households depend on wells, 24% on piped water, and 16% on boreholes[8]. While Caprivi has more rivers and open water than any other region in Namibia, people in the region perhaps have greater problems with the supply of water than anyone else. One survey of peoples' attitudes towards rural water supplies found lower levels of satisfaction in the Caprivi than in any other region[9].

Several different kinds of problems are reported. Sources of water may be far from their homes, so women have to walk long distances and spend much time collecting domestic water. Access to water is also a problem for cattle, especially in the dry season when the only water available may be far from preferred grazing pastures. Farmers may have difficulty preparing fields before the summer rains because water sources for draught animals are far from fields that are to be ploughed. The volume of water available is often a problem, especially from boreholes that yield little water, that have silted up, or have been fitted with low-volume pumps, causing people and cattle to queue for water. Pans have dried up and underground waterlevels have dropped as a result of the poorer rains in recent years. Adding to the problem of reduced supplies is the fact that demands have risen a good deal over the same period. There has been a massive increase in numbers of cattle (Chapter 6) and, of course, numbers of people have also increased substantially. Finally, there are many problems associated with the quality of water. In some areas the groundwater is unpalatable, being salty and unfit for consumption, while in other areas people have to use dirty water from wells and backwaters. Water from these unhygienic sources contributes to the high incidence of diarrhoea, especially among children.

Over the years, many hundreds of boreholes have been drilled throughout the region, and many were fitted with pumps to deliver water. Most of these are close to settlements, but others have been drilled further away to gather information on how underground water varies from area to area. Unfortunately, a proper analysis of water supply in relation to demands by people and cattle cannot be carried out because there is no complete set of information available on which boreholes remain in productive use. A major pipeline runs along the road from Kongola to Katima Mulilo, carrying water pumped from both the Kwando and Zambezi rivers. While many people have depended on this pipeline, the water is not treated and the supply is inadequate to the extent that little water reaches the middle section of the line[10]. A new drilling programme is currently underway to supply communities in this area with underground water.



The positions of boreholes, depth of water below the surface of the ground and quality of the water[11] ▲

Underground water reserves generally are fairly abundant, so there is a good chance of finding water in most areas. Water reserves are also fairly close to the surface, between 10 and 40 metres below the ground in most areas, and closest to the surface in the eastern floodplains and in the southern areas of eastern Caprivi. The deepest reserves are in the West. The quality of water varies considerably, and some underground water is not palatable, especially in the area north of the Linyanti Swamps. This area now also suffers from the reduced flow of the Linyanti River, caused by lower river flows and blocked channels in the river. The pumping scheme at Chinchimane has been discontinued as a result. The trends shown here are general ones, and illustrate the overall likelihood of striking water at a particular depth and of finding water of a certain quality.

Chapter 9

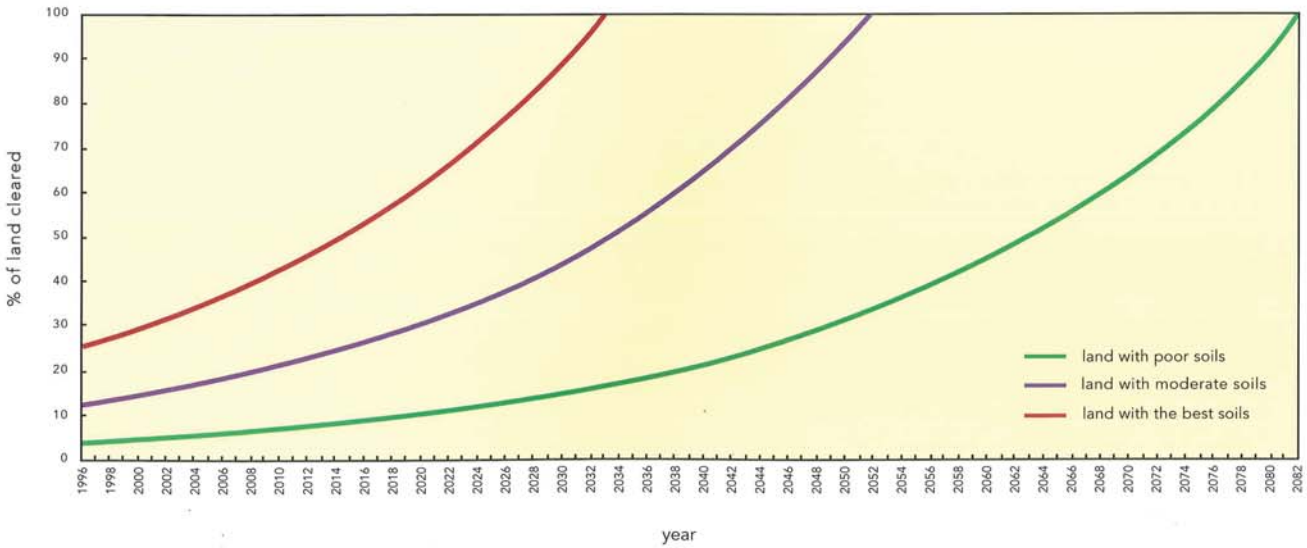
Caprivi in years to come

Much of this book has looked at current environmental issues and some aspects of these in the past. In looking ahead, there is a need to be mindful of how Caprivi's population is developing, what efforts are being made to look after natural resources, and how land can be used. It is hard to escape the general conclusion that land in Caprivi is often misused. For much of the area there are no policies to direct what happens, and where there are policies and legislation they are sometimes ignored. Stock numbers have risen dramatically and to a point where pastures may have become overgrazed; frequent fires have destroyed woodlands and have resulted in the loss of nutrients from soils that are inherently poor; and land for cultivation is being cleared at an alarming rate while little effort is made to restore nutrients to the ground.

Considerations for the future

In 1996 the total number of people in Caprivi was about 110 000, having grown at a rate of over 4% over the past 20–30 years. At 4% growth, we can expect the population to double every 18 or 19 years, reaching about 190 000 by the year 2010 and over six million by the end of the next century! Some would argue that population growth will slow, as increasing levels of education lead to smaller families and AIDS takes its grim toll. Estimates for Zambia suggest that population growth rates could fall to about 1.2% by the year 2010 as a result of the AIDS epidemic, compared to 3.1% in the absence of this disease. Life expectancy in Zambia is now 60.1 years, but could fall to about 30 years by 2010 due to AIDS[1].

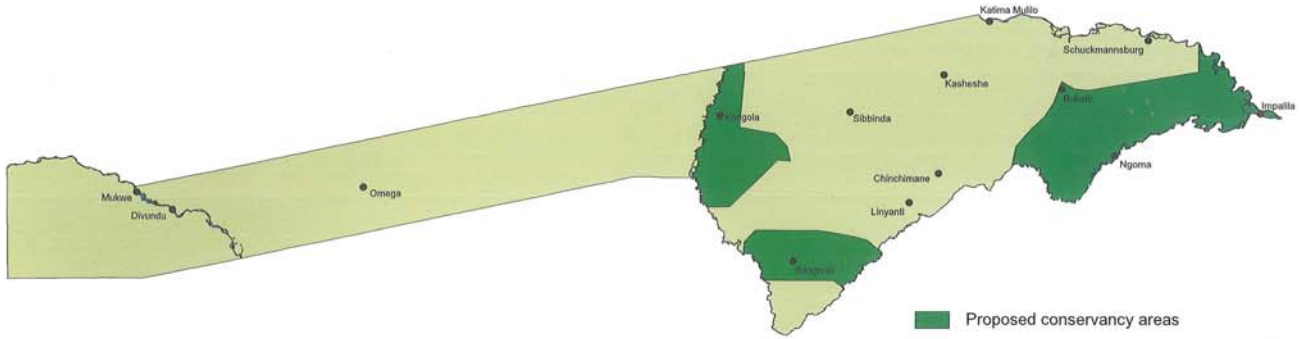
These figures are all estimates and it is difficult to predict exactly how numbers of people will change in the future. It is clear, however, that



Projected increases in the clearance of land for cultivation ▲

If the rate of clearing continues as it has over the past 53 years (page 29), all land in Caprivi will have been cleared for crops by the year 2082. This calculation includes all areas, whether or not the soils are suited to crop farming. All areas with soils rated as having the "best" potential for cultivation will have been cleared by 2033 — just 36 years into the future and within the lifetime of many Caprivians now living. All areas with soils rated as having only moderate potential will have been cleared by the year 2052, and all areas with poor soils will have been cleared by about 2082.

House of bottles — as resources become short, more people will have to resort to alternatives (PT)



Conservancies — communities take charge of their wildlife ▲

Conservancy programmes aim to encourage communities to conserve wildlife and appropriate habitats. In return, the community obtains income benefits from the wildlife, for example, by selling hunting rights to wealthy hunters and granting tourism concessions. These activities are in addition to farming and other practices, and are not intended as alternatives. The hope is that peoples' livelihoods will improve, and that they will attach greater value to animals and unspoilt habitats, more readily accepting occasional damage caused by wild animals, and being more tolerant of formal conservation areas and activities.

Caprivi's population will grow a good deal. We can also predict confidently that demands for land will increase, and more land will be cleared for cultivation each year.

But we could argue that if population growth was to slow down, there may not be as many new farmers needing new land. Crop cultivation practices could also change. If farmers fertilized their land they could harvest similar yields from smaller field areas, and there would be less need to clear new land if existing fields remained fertile. However, there is little evidence to predict that farmers will radically change their cultivation practices. Also, if yields increased, farmers would probably still farm similar areas, rather than reducing the sizes of their fields. Higher yields would improve their incomes — both for consumption and as cash sales. Finally, as more people become wealthier and have surplus cash, demands on land for farming are likely to increase. This is already happening, with commercial farmers now clearing large new farms. These "big" farmers are likely to get access to some of the best land, often at the expense of poorer farmers and people with other uses for the land.

Another scenario for the future would hope that large numbers of people might move off the land to take up jobs in other sectors such as trade, industry and tourism. Again, there is no clear evidence that this is likely to happen to a degree that would significantly change demands on land for farming. Caprivi has no tradition of large-scale migrant labour which might expose and predispose many people to entrepreneurial opportunities. The number of jobs offered by expanding commercial farming and tourism developments will be limited, and there is little likelihood of job-intensive industrial and manufacturing sectors developing to any great extent.

All of this means that there will be greater pressure on areas that are not occupied by people and cattle. Remaining natural resources will have greater value as more and more people compete for access and use of those resources. What can be done? We face several alternatives. We could sit back and ignore these problems. Alternatively we could acknowledge them and hope that somebody will do something about them for us. The other option is to set about improving the treatment of land by developing policies and implementing practices which make the best use of land.

Conservation and ideas on land uses

Against these gloomy scenarios, what can be said about a continued future for Caprivi's natural resources and wildlife? Until recently, formal conservation activities have largely been confined to the five proclaimed reserves. Areas that have enjoyed the greatest attention and assumed value are Mahango Game Park; Mudumu and Mamili national parks; the so-called Buffalo Core Conservation Area across the Okavango River from Mahango; and the triangular strip of land between the Kwando River and eastern border of the Caprivi Game Park.

Most of the emphasis has been placed on the need to look after the populations of large mammals in these conservation areas. Other areas have been treated more arbitrarily. For example, a variety of non-conservation activities are accepted in the Caprivi Game Park, there has been little attempt to conserve woodlands in the state forest, and Popa Falls is largely regarded as an accommodation resort.

Two processes are developing which hope to give wildlife and natural resources much greater value. Both processes are based on the assumption that the future of the environment will be more secure if it is regarded as having a higher value.

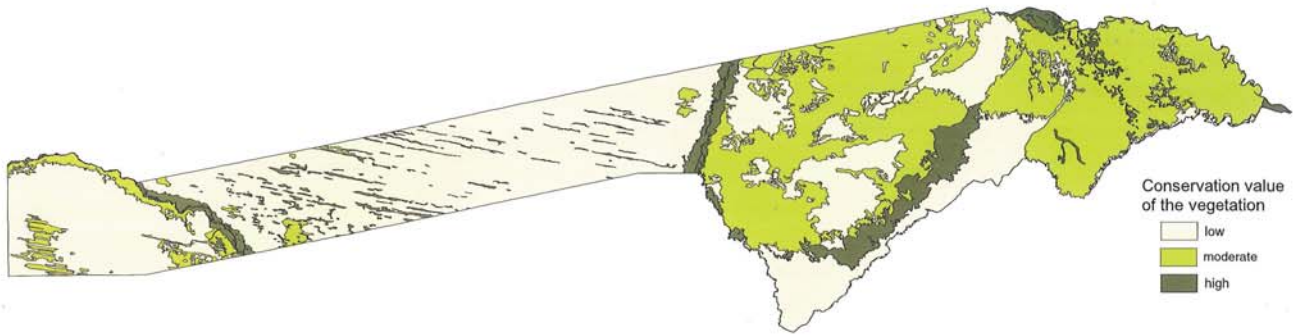
The first process involves promoting tourism. Almost all tourism to the Caprivi is based on the region's wildlife and scenic attractions, and could be expanded substantially[2]. Such expansion would have huge benefits, contributing up to four times as much to the national economy as it does now. The incomes and welfare of people in Caprivi would also increase as they gained employment in the tourism and supporting sectors, and were exposed to a bigger market for the sale of craft, services and other items. People likely to see the best economic gains from tourism would be those living close to protected areas[3]. An expanded tourism sector would enhance the value of protected areas and those surrounding them. It would also create better links between the interests of people living in surrounding areas and those responsible for managing protected areas.

The second process seeks to involve people in conservation efforts within their communities[4]. This follows the recognition that conservation cannot occur within the boundaries of parks alone. Local people have certain rights to the wildlife in their area, and they should be able to reap benefits to ensure wildlife a prolonged future. One programme in Caprivi has promoted the development of conservancies, which are areas managed by, and for the benefit of, local people. A number of conservancies are being developed, some of which are closer to being operational than others. A parallel programme focusing on woodland resources has also been started. Communities are being encouraged to cut and maintain firebreaks and to take an active role in the conservation and management of the vegetation in their area. The involvement of communities in monitoring natural resources has also been promoted. Some people are employed as game guards to patrol areas rich in wildlife, while others monitor the use of natural resources in villages.

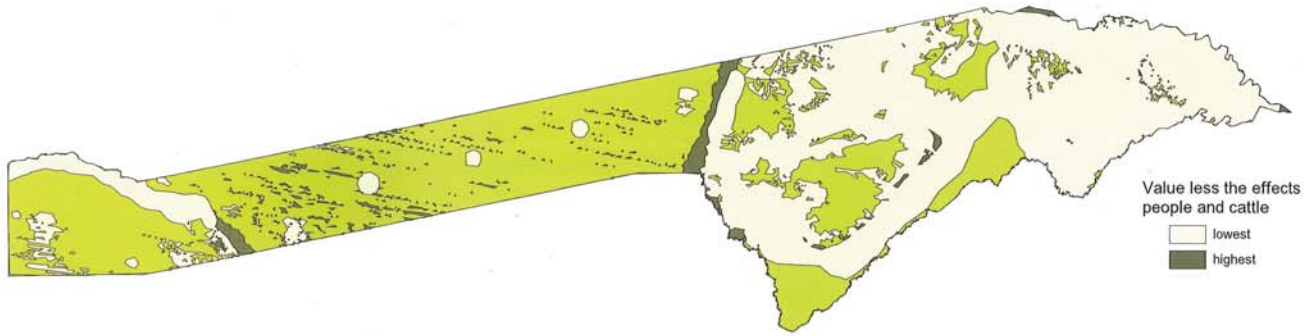
The potential of different areas of Caprivi for conservation and subsistence farming — an evaluation

The following six maps provide some ideas on the suitability of land for conservation purposes and for subsistence farming. The analyses bring together pieces of information presented earlier in this book, and are designed to help highlight those areas where these land uses might be most appropriate[5]. In attempting to value various resources, several assumptions have necessarily been made about what is desirable, workable or useful.

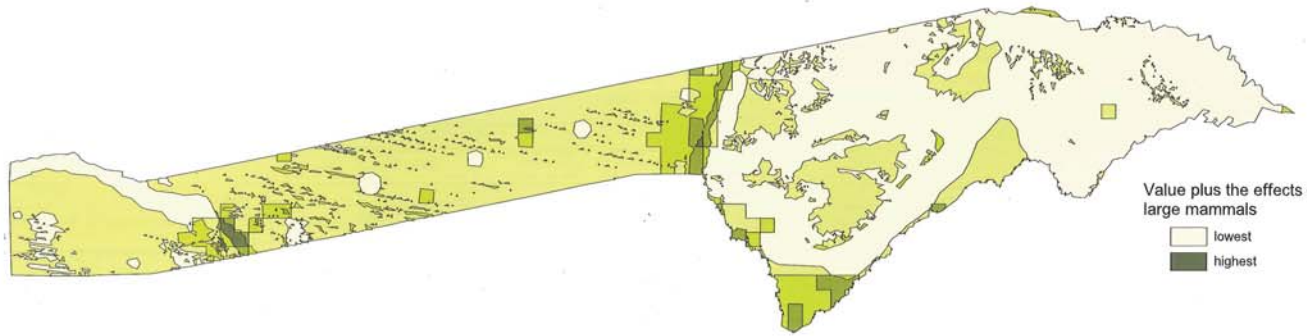
1. An assessment was made of the conservation value of each vegetation unit described in Chapter 5. The three classes (low, moderate or high) provide an overall value which reflects the diversity of plants and animals; the importance of the vegetation unit on regional, national and international levels; the degree of threat by degradation; and the degree to which the vegetation types are conserved elsewhere. Nine units were given high values: Open water, Zambezi woodland, *Omuramba* fringe woodland, Linyanti woodland, Impalila woodlands, Salambala camelthorn woodland, Maningimanzi woodland and channels, and Okavango–Kwando valley woodland and Okavango–Kwando grassland.

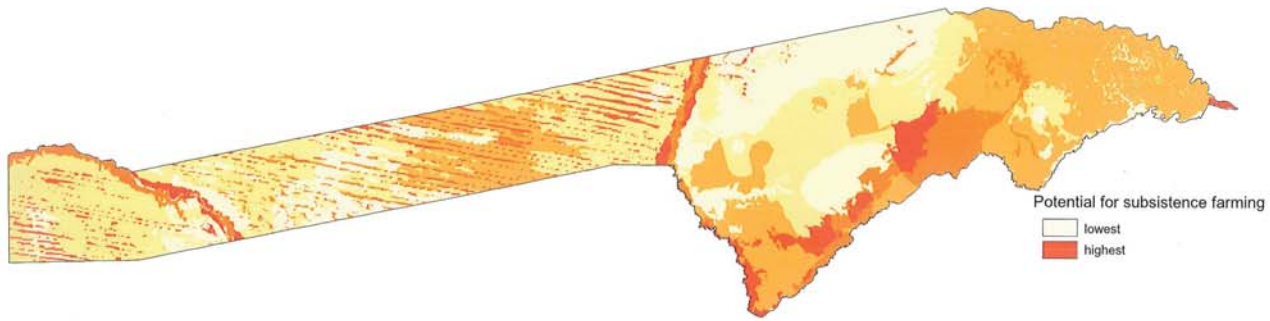


2. In this map, all areas having densities of more than 10 people/km² or 10 cattle/km² have been reassigned to having low conservation value. This is because they are likely to be degraded, and because there are greater chances of conflict between subsistence activities and conservation. Almost all Open water, Zambezi woodland, Linyanti woodland and Salambala camelthorn woodland areas are heavily used by people and cattle. Small areas of Impalila woodlands and Maningimanzi woodland and channels remain available for conservation, as do larger areas of Okavango–Kwando woodland, Okavango–Kwando grassland and *Omuramba* fringe woodland. The small group of islands near Andara, although not visible on the map, deserve special mention because they harbour some of the only riverine woodland in the region and remain largely uninhabited (photo on page 18).

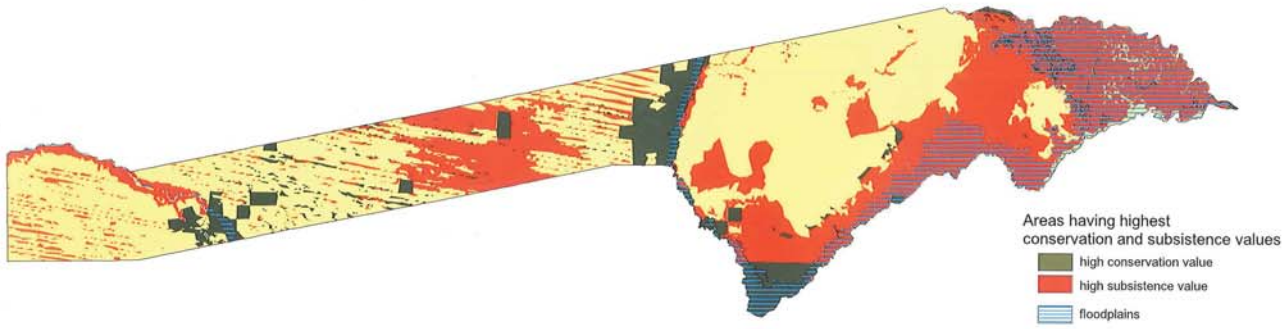


3. Here the presence of large mammals as an indicator of value for conservation has been added. While this information is based on just one survey in 1995 (see page 31), the general patterns of distribution and abundance agree with information collected in other years. There are three reasons why higher densities of large mammals provide additional conservation value:
   - the animals are valuable in their own right,
   - they provide an important attraction to tourists and thereby contribute to tourism revenue, and
   - their presence shows that natural habitats are in good condition.

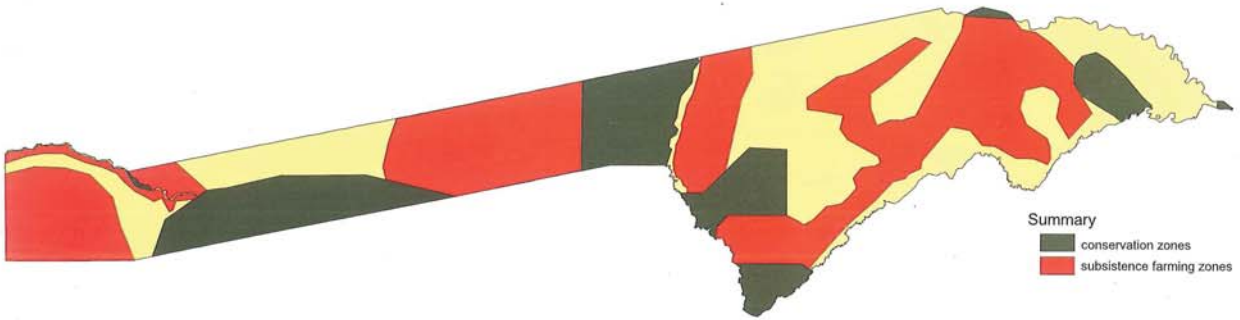




◀4. Land values for subsistence farming were assessed by combining the potential values of soil for crops (page 17), ground water quality (page 39), vegetation resources (page 24), and pasture quality (page 27). The relative importance of these factors will vary from area to area, but the combination highlights those areas where, on average, subsistence farming may be most viable. All sandy areas have low values because they offer little potential for crop or stock farming, while lower-lying areas in dune and river valleys offer greater potential. The large zone running along the Linyanti Swamps has high overall potential, but water supplies in that area may present a problem.



◀5. This fifth map lifts out areas which have the highest values for conservation (from map 3) and those having the highest values for subsistence farming (from map 4). Areas that do not rate highly for either purpose are pale yellow. The map also shows areas that are susceptible to flooding. Even though they can provide good, temporary farming opportunities, any plans to develop and settle people on the floodplains will probably be jeopardized if rain and river levels return to what they were in the 1950s, 1960s and 1970s.



▼6. The final map summarizes those zones in which subsistence and conservation activities might best be developed or maintained. Areas rated highly for conservation include the existing Mahango Game Reserve and Mamili and Mudumu national parks. Other areas justifying some kind of protection are the northern fringe of the Maningimanzi woodland and channels, part of Impalila Island, islands in the Okavango River at Andara, and the eastern third and south-western section of the Caprivi strip. An additional proposal would be to offer protection to an area in the eastern floodplains which could link to the Chobe National Park. This would allow wildlife now hemmed in on the Chobe River to use part of the floodplains. This particular area is subject to a high risk of flooding (page 37) and is consequently not suited to subsistence settlement. Perhaps the best way to conserve all of these areas would be to foster the development of tourism, rather than applying conventional conservation protection to them. Each of these areas has features which could be attractive to tourists, and that kind of development would bring economic benefits to Caprivi and also to people living near those areas.

Broad zones shown in orange are those that emerge from these analyses as being suited to continued or new subsistence activities. These are in the Mukwe area, the central section of the Caprivi strip, the east bank of the Kwando River, north and north-west of the Linyanti Swamps, around Lake Liambezi, along the central section of the Golden Highway, and in a broad band between Katima Mulilo southwards to the Chobe Swamps and Ngoma. Within these broad zones there will be a good deal of local variation, especially in soil quality and water availability, and that variation will determine where subsistence activities are most viable. Areas left as yellow appear not to be particularly suited to either subsistence or conservation uses. They include the floodplain areas, where land-use practices depend on river levels and rainfalls, and the state forest woodlands. Every effort should be made to improve the management of these woodlands, especially through the control of fires, and to restore them in the longer term.

The case for a conservation zone around Caprivi

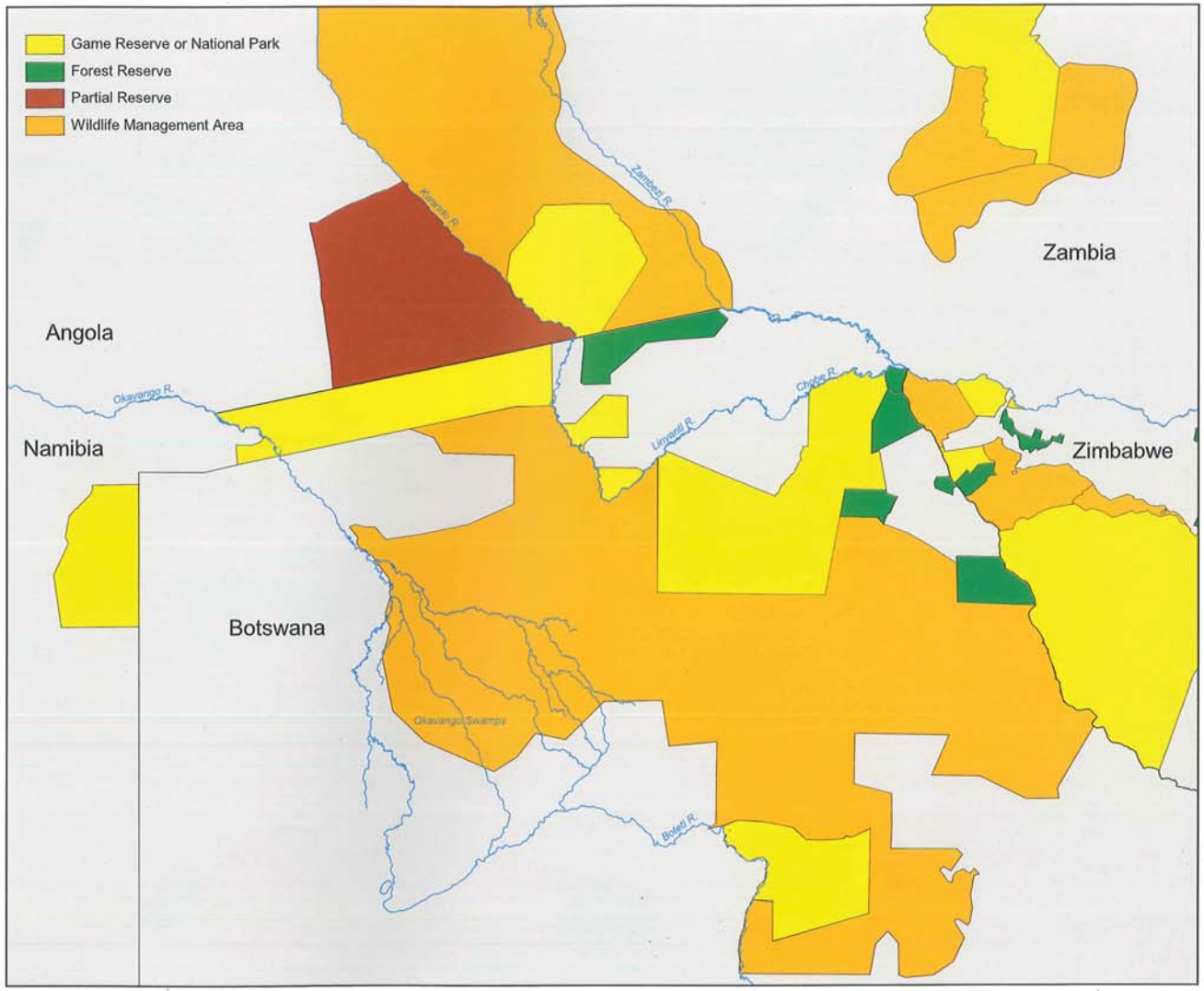
As described in Chapter 2, Caprivi is surrounded by Angola, Zambia, Botswana and Zimbabwe, and the borders cut across broader landscapes of wetlands and Kalahari woodlands. As a result, many animals move across these borders, living both in conserved areas within Namibia and in neighbouring countries. Leaders of today need to give immediate attention to declaring a world conservation zone to encompass this area. This is not the place to recommend the precise boundaries of the zone, but it should include features shown in the adjacent map and perhaps extend northwards, further into Zambia and Angola. Such a proposal is not a new one and has often been on the minds of people concerned about the region's future[6].

Apart from being well-endowed with protected areas, this region also supports large numbers of wildlife. For example, about 120 000 to 130 000 elephants live in this area, perhaps 20–30% of all African elephants[7]. In addition, some of the most important water resources in southern Africa are in the region. These waters need every kind of protection possible, both for people living in the area and for those using that water elsewhere.

This zone is also worth a great deal of money because it holds several valuable tourist destinations. The value of these attractions depends to a large extent on the successful conservation of both wildlife and attractive, unspoilt habitats. Botswana's most lucrative tourist destinations are here (the Okavango Swamps and Chobe), as are Zimbabwe's (Victoria Falls, Lake Kariba and Hwange). The Kafue National Park and Victoria Falls are popular venues for visitors to Zambia. About 9% of all tourists to Namibia include Caprivi on their trip. Because tourists often visit more than one attraction, even in different countries, there is a need to see the whole area as a broad attraction to tourists and tourism revenue.

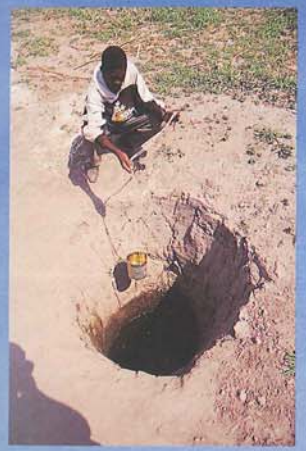
Recognition of this broader area as a world conservation zone would strengthen the need to maintain existing protected areas, and would help guard against detrimental development projects. It would also help persuade different countries to keep their borders open, rather than carving up the region with barrier fences. Tourism and tourist revenues for each country would have added value because the status and prominence of the whole region would be raised. The beauty of the region, its people, water and wildlife resources would indeed face a far more secure future!

Restricted to small areas, elephants become stressed and destructive (PT)



Designated conservation areas in and around Caprivi ▲

The distribution of protected areas in adjoining countries shows how Caprivi's protected areas fit into a regional network of parks, forest reserves and game management areas. Not shown on the map are a large number of community programmes, for example the many Campfire project areas in Zimbabwe, conservancies in Namibia's Caprivi and Otjozondjupa regions, and community wildlife projects in Botswana and Zambia. Each of these countries has gone to considerable efforts to integrate the interests of people living here with environmental conservation. Many of these areas also remain sparsely populated and relatively free of the effects of agricultural degradation.



Appendix

Vegetation units

Compiled by CJH Hines

The structural type given at the end of each description follow: Edward, D. 1983. A broad-scale structural classification of vegetation for practical purposes. *Bothalia* 14:705–712.

Open water

Apart from the obvious rivers, the unit also covers the permanent wetland systems associated with open water and channels on the eastern Zambezi floodplain. Plants characteristic of the margins of these permanent waters are *Phragmites australis* (15–50% cover), *Cyperus papyrus* (15–50% cover), *Salvinia molesta*, *Nymphaea* sp., *Polygonum* sp. and numerous sedge species. The size of this unit varies considerably between years, depending on river levels and the extent of flooding.
Area: 166 km²

Floodplains

Bukalo–Liambezi grassland — This unit is found in the extensive braided drainage system running off the Zambezi floodplain, down the Bukalo Channel and on to the upper drainage of the Liambezi system. As with most of the grasslands of the eastern Caprivi they comprise a mosaic of wetter and drier habitats. Wetter soils are dominated by extensive areas of *Cynodon dactylon* lawns which provide an important grazing resource. Where peat-rich soils occur in these wetter areas, *Imperata cylindrica* is common, occurring in almost mono-specific stands of 25–40% cover. The drier upslope areas are generally sandy with coarse, unpalatable species such as *Hyperthelia dissoluta*, *Hyparrhenia hirta*, *Trachypogon spicatus* and *Eragrostis* spp. occurring at low cover values (5–10%). The soils in this system are heavily utilized for arable agriculture, particularly in the lower sections of the Bukalo Channel and Liambezi drainage.
Structure: Tall open grassland
Area: 223 km²

Chobe grassland–hummock mosaic — This unit is distributed on a series of low sandy plains and hummocks along the Chobe River. Areas of higher ground and hummocks are well wooded with species such as *Acacia erioloba*, *Lonchocarpus capassa*, *Kigelia africana* and *Diospyros mespiliformis* characteristic in the tall tree layer (15–18 m, <5%). An understory of small trees and shrubs (total cover 20–30%) including *Croton megalobotrys*, *Acacia hebeclada*, *Diospyros lycioides* and *Grewia flava* is usually present. The grasslands are dominated by coarse perennials such as *Hyparrhenia hirta*, *Loudetia simplex*, *Aristida stipitata* and *Hyperthelia dissoluta* (20–30% total cover). Some patches of *Cynodon dactylon* lawns also occur here, but they are not particularly extensive.
Structure: Tall open grassland
Area: 294 km²

Chobe Swamp grassland — The grasslands of the Chobe watershed in the area east of Lake Liambezi are similar to those of the Bukalo–Liambezi grassland unit. *Hyperthelia dissoluta*, *Hyparrhenia hirta*, *Setaria sphacelata* and *Loudetia simplex* are all characteristic of this unit at total cover values of between 10–25%. Woody species are rare with the exception of small dense hummocks of *Diospyros lycioides* which are widely distributed in the landscape.
Structure: Tall open grassland
Area: 177 km²

Chobe wetland — These wetlands are limited to the area running along the banks of the Chobe River from Ngoma towards Impalila Island. They are dominated by hydrophytic grasses such as *Vossia cuspidata*, *Echinochloa pyramidalis*, *Phragmites australis* and *Leersia hexandra* at high cover values (25–50% total cover). *Cyperus papyrus* forms large floating rafts or mats. Woody species are rare and normally only found along well developed banks where *Syzygium guineense* and *Rhus quartiniana* are characteristic.
Structure: Wetland mosaic
Area: 73 km²

Dry Mamili grassland — Tall, coarse grasslands are found throughout the northern section of the Mamili National Park. This drier habitat is subject to less frequent flooding than the Wet Mamili grassland. The wooded hummocks here are largely absent and the woody component is restricted to small (3–6 m), isolated *Combretum imberbe* and *Terminalia sericea* trees. The area is predominantly grassland which is made up of a mosaic of coarse tall species such as *Hyparrhenia hirta*, *Cymbopogon excavatus*, *Andropogon schirensis* and *Setaria sphacelata* (total cover of 15–30%), with extensive patches of *Cynodon dactylon* lawns.
Structure: Tall closed grassland
Area: 340 km²

Kwando–Linyanti grassland — This unit describes the tall, flooded grasslands which dominate the seasonally inundated areas along the margins of the Kwando River where it enters the Linyanti swamp system. There are several distinct sub-units in the area, which can only be distinguished in the field. Generally, *Miscanthus junceus* forms dense stands together with *Vetiveria nigritana* as co-dominant. These stands can have cover values of up to 60% but are not extensive. This unit is found on the drier end of the seasonally flooded areas, and is not found in areas of perennial inundation. *Echinochloa stagnina* forms floating mats in areas of extended flooding often occurring with *Vossia cuspidata* and *Echinochloa pyramidalis*. *Phragmites australis* forms extensive dense reed beds throughout this unit.
Structure: High open grassland and wetland mosaic
Area: 121 km²

Liambezi–Linyanti grassland — This grassland unit describes the extensive and largely unwooded grasslands of the Liambezi basin and the fringe of grasslands north of the Linyanti River. Soils are peat-rich organic forms or loamy clays. Most of these are heavily utilized for arable agriculture. The principal grass species are patchily distributed in relation to the relative wetness of soils. Characteristic species include *Eragrostis cf. lappula*, *Imperata cylindrica*, *Loudetia simplex*, *Hemarthria altissima* and extensive patches of *Cynodon dactylon* lawns. Total cover values in the grass layer are between 25–50%.
Structure: Tall open grassland
Area: 617 km²

Okavango–Kwando grassland — The seasonally flooded grasslands and wetlands that line the margins of the Okavango and Kwando rivers are important grazing resources for both wildlife and livestock. Much of the area covered by this unit is made up of extensive mats of *Echinochloa stagnina*, *E. pyramidalis* and *Vossia cuspidata* which can have cover values of 30–60%. Tall emergent grasses such as *Vetiveria nigritana* and *Miscanthus junceus* are also characteristic. *Cynodon dactylon* forms lawns on the water margin and drawndown zone. Perennially wet areas tend to be dominated by *Phragmites australis* and *Cyperus papyrus*. Few woody species occur, but *Rhus quartiniana*, *Acacia hebeclada* and *Sesbania* sp. are characteristic at low cover values (1–3%).
Structure: Tall open grassland and wetland mosaic
Area: 182 km²

Wet Mamili grassland — These grasslands occurring throughout the southern section of the Mamili National Park are periodically subjected to extended periods of flooding. The soils here are variously clay-loams or peat-rich organic deposits both of which remain wet long after flooding has receded. Grasses here are predominantly hydrophytic or water tolerant species with *Imperata cylindrica* the commonest at high cover values (15–25%) and *Hemarthria altissima* dominating wetter habitats with cover values of up to 20%. Wet channels are dominated by a variety of sedges and *Phragmites australis*. Other common species in this unit include *Eragrostis cf. lappula*, *Digitaria brazzae*, *Hyparrhenia rufa*, *Loudetia simplex* and *Tristachya superba*. Small upland hummocks form islands of large trees such as *Acacia nigrescens*, *Garcinia livingstonei*, *Lonchocarpus capassa* and *Diospyros mespiliformis* (1–5% total cover). A distinct understory of *Euclea divinorum*, *Diospyros lycioides* and *Combretum hereroense* occurs on these hummocks.
Structure: High closed grassland
Area: 95 km²

Zambezi floodplain channels — These wetlands are similar to the rivers and open water unit, with the exception that woody species such as *Rhus quartiniana*, *Sesbania* sp. and *Syzygium guineense* can provide cover of up to 5%. These wetlands are characterized by dense, almost monospecific stands of *Phragmites australis*, *Cyperus papyrus*, *Echinochloa pyramidalis* or *Vossia cuspidata* which all occur at high cover values (15–30%). Other grass species such as *Cynodon dactylon*, *Leersia hexandra*, *Miscanthus junceus* and *Hemarthria altissima* are characteristic of the "drier" part of these wetlands. These wetlands dry out irregularly and the highly organic soils called "sitapa" are cultivated for maize production.
Area: 64 km²

Zambezi floodplain grassland — These grasslands cover a large area of the eastern floodplains. This area is a complex, fine-scaled mosaic of wet to dry habitats, the complexity of which is not adequately reflected in this large single unit. However, the separation of the component facies of the mosaic is not possible at the broad scale of this project. The whole area is predominantly grasslands with small islands of woody species widely separated throughout the floodplains. Some woody species such as *Faidherbia albida*, *Terminalia sericea* and *Combretum imberbe* can be found as scattered, isolated individual plants on the floodplains. The wettest facies of the grasslands is dominated by various sedges and grass species such as *Leersia hexandra*, *Hemarthria altissima* and *Phragmites australis*. The moist slopes near channels are commonly dominated by *Imperata cylindrica*, *Setaria sphacelata* and *Miscanthus junceus*, but most importantly by *Cynodon dactylon* lawns which are a valuable grazing resource. Grasses characteristic of drier areas include *Loudetia simplex*, *Eragrostis* sp., *Trachypogon spicatus*,

Digitaria brazzae and *Andropogon schirensis*. Dry sandy habitats are dominated by *Eragrostis pallens*, *Tristachya superba* and *Hyparrhenia* sp. Parts of these floodplains are intensively grazed by livestock, but the resource as a whole can be considered a poor quality grazing resource. Organic channel soils deposits (termed "sitapa") are highly prized arable agricultural areas and much of the maize grown in the Caprivi is grown on these soils.
Structure: Tall open grassland
Area: 1 168 km²

Zambezi transition grassland — This unit describes the extensive and dominant grassland mosaic of unpalatable, coarse species which cover much of the transition area lying between the Kalahari sand upland and the Zambezi floodplain grasslands of eastern Caprivi. Woody plants are uncommon and are usually isolated individuals scattered through the landscape, with some hummocks occupied by *Hyphaene ventricosa*, *Combretum hereroense* and *Euclea divinorum*. The following grass species are characteristic of the association: *Vetiveria nigritana*, *Hyperthelia dissoluta*, *Cymbopogon* sp., *Tristachya superba*, *Aristida stipitata*, *Loudetia simplex* (5–10%), *Andropogon schirensis* (1–5%), *Setaria sphacelata*, *Eragrostis rotifer*, *Imperata cylindrica* and *Diheteropogon* sp. Total cover in the grass layer is generally 10–25%. The relative proportions and occurrence of the different species varies considerably depending on soils, degree of wetness or flooding and soil drainage conditions. For example, *Imperata cylindrica* is most common in areas of extended flooding with organic peat-rich soils, whereas the other species listed (e.g. *Hyperthelia dissoluta*) tend to form a complex on the drier sandy soils less subject to ponding and inundation. *Cynodon dactylon* may form extensive lawns or subcover in taller grassland units. This species is regarded as one of the most important grazing resources on the floodplains. These grasslands form a mosaic with the other units of the floodplains and it is not possible to differentiate them on aerial photographs. *Cynodon* tends to occur on heavier soils and is heavily grazed throughout the year. Zambezi transition grasslands are extensively burnt every year and provide some grazing, but are of generally poor quality and are not heavily used by local stock owners.
Structure: Tall open grassland
Area: 308 km²

Zambezi woodland — These woodlands occur as a series of wooded "islands" throughout the area of transition between the western uplands and the eastern floodplains of eastern Caprivi. They are distinctive in that they form discrete units in an area made up predominantly of grasslands. Total cover in the tall tree (18 m) layer is between 25–50% and is made up characteristically of *Parinari curatellifolia*, *Kigelia africana*, *Diospyros mespiliformis*, *Trichilia emetica*, *Acacia sieberana*, *Lonchocarpus capassa* and *Afzelia quanzensis*. A lower tree layer (8–12 m) is usually present with *Garcinia livingstonei*, *Piliostigma thonningii*, *Acacia sieberana* and *Albizia versicolor* occurring. Palms (*Hyphaene* and *Phoenix*) are also characteristic, usually at low cover values. The shrub layer can be dense (20–40% cover) with *Antidesma venosum*, *Phyllanthus reticulatus*, *Grewia* sp., *Diospyros lycioides* and *Euclea divinorum* being characteristic. Grass cover is variable with annuals such as *Aristida* sp., *Chloris virgata* and *Eragrostis trichophora*, dominating at some sites and perennials such as *Cynodon dactylon*, *Panicum maximum* and *Digitaria* sp., dominating at others. Cover value for grasses range from 5–15% total cover. Soils are generally heavier clay-rich loams and are not extensively cultivated. The grazing resources although not extensive are considered important by local farmers. These woodland "islands" have considerable conservation value in that they are centres of high diversity in otherwise depauperate landscapes.
Structure: High closed woodland
Area: 100 km²

Riverine woodlands

Maningimanzi woodland and channels — The Maningimanzi area, east of Katima Mulilo, is a broad sandy plain made up largely of old river sandbars incised by deep river channels. This broken landscape floods regularly and the vegetation of the area is defined in two distinct sub-units. The sandy areas are covered predominantly by high (15–18m) *Terminalia sericea* woodlands providing 25–50% cover. Other trees include *Albizia versicolor* and *Burkea africana* (1–5%). Shrubs are almost absent under the *Terminalia* canopy and grasses are sparsely distributed. The open water habitats of the river channels and backwaters are covered by *Phragmites australis*, *Typha capensis*, *Vossia cuspidata*, *Echinochloa pyramidalis* and emergent macrophytes. The margins are dominated by dense stands of *Syzygium guineense* and *Rhus quartiniana* (5–15%), with species such as *Trichilia emetica*, *Garcinia livingstonei* and *Kigelia africana* characteristic of the drier margins.
Structure: High closed woodland and wetland mosaic
Area: 88 km²

Okavango–Kwando valley woodland — This unit is found only on the floodplain margins, levees and old fluvial courses along the Okavango and Kwando rivers. The woody component of this unit is well stratified with a high (18 m) stratum comprising *Acacia nigrescens*, *Acacia erioloba*, *Ficus sycomorus*, *Kigelia africana*, *Lonchocarpus capassa* and *Diospyros mespiliformis* being characteristic, especially in a narrow band close to river channels and floodplain margins. Total cover in the high tree layer is usually between 15–30%. A distinct stratum of trees 10–12 m in height is usually found in slightly drier habitats and is characterized by *Acacia tortilis*, *Albizia harveyi*, *Terminalia prunioides* and *Combretum imberbe* at low total cover values (5–10%). *Euclea divinorum*, *Diospyros lycioides* and *Combretum hereroense* characterize the shrub layer but usually provide <5% cover. The loamy soils found within this vegetation unit represent some of the best potential arable soils in the Caprivi and have been extensively cleared for farming on both the Okavango and Kwando rivers. Some are, however, prone to saline accumulation, particularly close to the margins of river courses and channels. These woodlands have some of the highest species diversity indexes (birds and plants) of any habitats in the Caprivi. They are heavily utilized by wildlife and livestock and are probably one of the most threatened habitats in the region. They are largely unprotected, with the exception of areas within the Mahango Game Reserve.
Structure: Tall open woodland
Area: 236 km²

Okavango valley fields and shrubland — This unit reflects the heavy utilization of the Okavango River fringe for arable agriculture, where it is now difficult to assess the original vegetation types of the area. Most of this area is used for growing pearl millet and other small grain crops. Old fields are rapidly encroached by species such as *Dichrostachys cinerea* and *Maytenus heterophylla*, as well as a variety of herbaceous weeds and pioneers. Grasses are predominantly annuals such as *Urochloa brachyura* and *Dactyloctenium giganteum* which often occur in dense (75% cover), monospecific stands.
Structure: High closed shrubland
Area: 187 km²

Mopane woodlands

Gunkwe *mulapos* — This grassland unit is limited to the braided system of drainage lines which run through the extensive Kalahari sand deposits running south-west from Katima Mulilo. The bottomland soils here are loamy clays, and are poorly drained, with some areas subject to prolonged inundation during the wet season. Woody species are limited to small patches of scrub *Colophospermum mopane*, *Terminalia sericea* and *Combretum hereroense* with total cover values never exceeding 5%. Grasses are patchily distributed relative to how well soils are drained, the length of flooding and saline accumulation. On the wetter soils *Eragrostis rotifer*, *Diplachne fusca*, *Setaria sphacelata* and *Dichanthium* sp. are common at cover values of 10–20%. *Cynodon dactylon* forms mat-like patches in areas which are quickly drained but are heavy clays. *Sporobolus fimbriatus*, *Sporobolus coromandelianus* and other low growing species occur on drier clay soils. Patches of large coarse grasses such as *Cymbopogon* sp., *Andropogon* sp., *Heteropogon contortus* and *Hyperthelia dissoluta* are found in areas of sandier soils where water accumulates for short periods. Other than the *Cynodon* lawns these grasslands are of a generally poor quality and the soils are not suitable for arable agriculture.
Structure: Tall open grassland
Area: 148 km²

Linyanti woodland — This unit occurs along a broad belt stretching between the margin of the Linyanti Swamps and the extensive mopane woodlands of the central parts of the eastern Caprivi. This area is heavily settled and much of this unit has been cleared for arable agriculture, fuel and construction wood. The soils are predominantly sandy loams, with small patches of heavier clay-loams which are seldom cultivated. *Acacia erioloba* and *Lonchocarpus capassa* form a distinctive tall tree stratum (15 m) at cover values of 5–15%. They can be found together with *Combretum imberbe* and *Acacia nigrescens* (12 m) which tend to have a patchy distribution and contribute little cover (1–5%). *Terminalia sericea* occurs throughout the area, usually as a large tree (12 m) at cover values of 10–25%. It also occurs in the short tree and shrub strata where it occurs together with *Ziziphus mucronata*, *Combretum hereroense*, *Rhus tenuinervis*, *Grewia flavescens* and *Acacia fleckii*. The cover of the shrub stratum can vary considerably from 5–30%. Perennial grasses are characteristic of the ground layer, although in many areas there is evidence of overgrazing and some of these species are rare or absent. *Stipagrostis uniplumis*, *Digitaria eriantha*, *Eragrostis rigidior*, *Schmidtia pappophoroides* and *Panicum maximum* are all typical of this unit and can contribute up to 25% cover.
Structure: High closed woodland
Area: 623 km²

Mopane–*Aristida* woodland — These woodlands occur only in eastern Caprivi and represent one of the largest and most important vegetation units in the area. Soils are generally heavy clay-loams which are mostly unsuitable for arable agriculture because most are subject to some saline accumulation. Grazing quality is poor and biodiversity low. The greatest value of this particular vegetation resource (and all the other *Colophospermum mopane* dominated units) is as a source of durable construction wood and an important source of fuel wood for the urban centres of the eastern Caprivi. *Colophospermum mopane* is often the only large tree species found in this unit. It varies considerably in size

(8–18 m) and cover (10–30%). In certain areas where soils are better drained, species such as *Acacia erioloba*, *Acacia nigrescens* and *Albizia harveyi* may be found, but these are generally rare and at low cover percentages (<1%). A shrub layer is generally absent but species such as *Euclea divinorum*, *Diospyros lycioides*, *Ximenia americana* and *Croton gratissimus* can be found, usually on termitaria. The grass layer is dominated by coarse, unpalatable annuals such as *Aristida adscensionis*, *Aristida rhiniochloa*, *Chloris virgata*, *Urochloa brachyura* and *Eragrostis viscosa*. Where there are small pockets of reworked alluvial sands *Terminalia sericea* may occur at low cover values and the grass layer may contain species such as *Eragrostis rigidior* and *Digitaria eriantha*.
Structure: Tall closed woodland
Area: 2 374 km²

Mopane–*Burkea* woodland — This unit is found in the central eastern Caprivi and is characterized by a mosaic of heavy clay-loam soils and pockets of deep sands, resulting in a mix of species not normally found together. *Colophospermum mopane* occurs in two distinct forms. The tree form up to 12 m is usually sparse (1–5%) and often found on the margins of small pans, whereas the shrub form (<2 m) dominates the landscape at 15–25% cover. On the pockets of reworked sands, Kalahari sand species such as *Burkea africana* (10–12 m, 5–10% cover), *Erythrolphleum africanum* (8–10 m, 1–5% cover) and *Combretum collinum* (8–10 m, 5–10% cover) are characteristic. Other than *Colophospermum mopane* there are few other species in the shrub layer. Grasses are of variable quality, but are generally of low grazing value. Typical species include *Aristida adscensionis*, *Aristida rhiniochloa*, *Aristida stipoides*, *Chloris virgata* and *Melinis repens* on the heavier soils (5–15% total cover) and *Eragrostis rigidior*, *Schmidtia pappophoroides* and *Stipagrostis uniplumis* on the sandier soils (1–5% total cover).
Structure: Tall closed woodland
Area: 845 km²

Mopane–*Terminalia* woodland — This unit is found in two discreet units within the eastern Caprivi, both of which are associated with the reworking of extensive areas of Kalahari sand and heavier clays resulting in a complex mosaic of highly leached, white sands (dominated by *Terminalia sericea*) interrupted by patches of clay-loams (on which *Colophospermum mopane* dominates). The bands of *Terminalia sericea* have few other woody species, with *Erythrophleum africanum*, *Burkea africana* and *Combretum collinum* the most important but at cover values of about 1%. *Acacia fleckii* is common in the shrub layer at 1–3% cover. Grasses occur at low cover values (1–5%) and are generally unpalatable species such as *Tricholaena monachne* and *Aristida stipoides*. *Colophospermum mopane* (5–10 m) dominates the unit as a whole (probably about 70% of the mosaic of vegetation in the unit is *Colophospermum mopane*) and occurs at cover values of 20–40% cover. Once again there are few other tree species and the shrub layer is largely absent. Grasses are typical of other *Colophospermum mopane* dominated habitats with species such as *Aristida adscensionis* being common.
Structure: Tall closed woodland
Area: 375 km²

Mudumu *Mulapo* woodland — This unit is defined in two discrete areas in the eastern Caprivi. The most extensive area is along the Mudumu Mulapo which runs east off the Kwando River, the smaller unit occurs south of Bukalo. In both these areas the Kalahari sands have been extensively reworked by fluvial action, resulting in a landscape dominated by deep, dystrophic, highly leached sands, interrupted occasionally by small pockets of clay-loams. The vegetation on the sands is characterized by large (8–12 m) *Terminalia sericea* at 10–20% cover. Other species typical of Kalahari sand habitats such as *Burkea africana*, *Baphia massaiensis*, *Bauhinia petersiana* and *Combretum collinum* also occur at low cover values (1–5%). The grass layer here is dominated by coarse grasses such as *Eragrostis pallens* (10–20%), *Aristida meridionalis*, *Aristida stipitata*, *Andropogon chinensis* and *Panicum kalaharense*. The pockets of heavier soils are dominated by low (2–4 m) *Colophospermum mopane* at cover values of 10–20%. Other woody species are uncommon. The grass layer is dominated by annual grasses such as *Aristida* sp., *Chloris virgata* and *Eragrostis viscosa*. This unit has very low values for agriculture, conservation and biodiversity.
Structure: Tall closed woodland
Area: 229 km²

Salambala camelthorn woodland — This unit is limited in extent and is specifically associated with a fluvial dune system south of Katima Mulilo in the Salambala area. It is easily recognizable on satellite imagery and aerial photography of the area. The woody component of this unit is clearly stratified and is characterized by high (15 m) *Acacia erioloba* trees occurring at cover values of up to 20% with a distinct substratum of shrubs and small trees. Other large tree species include *Lonchocarpus capassa*, *Afzelia quanzensis*, *Combretum collinum*, *Berchemia discolor* and *Acacia nigrescens* at low cover values. *Terminalia sericea* dominates the low tree layer (8–12 m) and shrub layers at cover values of <20%. The shrub understory has a variable species composition but comprises <15% cover throughout. Characteristic species include *Dichrostachys cinerea*, *Rhus pyroides*, *Grewia flavescens* and *Euclea divinorum*. The grass layer is dominated by annuals such as *Dactyloctenium giganteum*, *Panicum cf. maximum*, *Aristida stipoides* and *Tricholaena monachne*. Perennials such as *Schmidtia pappophoroides*, *Eragrostis rigidior* and *Digitaria eriantha* occur at low densities. Soils are grey-brown medium to fine grained sands and sandy loams which are well drained, but are thought to have only moderate development potentials for arable agriculture. Although the grass layer is dominated by annuals it is nevertheless an important grazing resource in the area.
Structure: High closed woodland
Area: 20 km²

Kalahari woodlands

***Burkea–Combretum* woodland** — Units are found through-out the region, largely west of the Kwando River, which form a continuum with the *Burkea*–kiaat–false mopane woodlands and the *Burkea* shrubland. The *Burkea–Terminalia* woodland of eastern Caprivi may represent the same woodland type, but are separated because of the influence of fluvial processes in the local topography and the presence of *Colophospermum mopane*. This unit is typically dominated by *Burkea africana* (10–15 m) at varying densities (15–25%). Species such as *Pterocarpus angolensis*, *Guibourtia coleosperma* and *Ricinodendron rautanenii* all occur within this unit, but at low cover values. The overall structure of the vegetation is considerably more open than *Burkea*–kiaat–false mopane woodland. *Terminalia sericea* dominates the low tree layer (10–15%, 4–8 m high) together with *Combretum collinum*, *Erythrophleum africanum*, *Combretum psidioides* and *Ochna pulchra*. The shrub layer is generally open (15%) with *Baphia massaiensis*, *Bauhinia petersiana* and *Grewia retinervis* contributing most of the cover. *Diospyros chamaethamnus*, a mat-forming woody species, can provide up to 10% cover, and is especially common in areas burnt frequently. The grass cover is generally low (5–10% total cover) with *Schmidtia pappophoroides*, *Digitaria eriantha*, *Eragrostis pallens* and *Stipagrostis uniplumis* being characteristic. Soils are deep, dystrophic sands on dune slopes and sandy plains, and have low potential for farming. Grazing is likely to be of moderate to poor quality.
Structure: High closed woodland
Area: 2 717 km²

***Burkea*–kiaat–false mopane woodland** — This woodland occurs in two widely separated areas of deep sands. West of the Okavango River it is common and widespread, mostly on deflated dunes and undulating sandy plains. It also occurs as a broad band of woodland running west and south of Katima Mulilo in an area of Kalahari sands which have been extensively reworked by fluvial action. These woodlands may represent a "mature" form of the *Burkea–Combretum* woodland described above, the biggest difference between the two being the higher canopy cover of the main species in this unit. *Burkea africana* dominates the tall (13–15 m) tree layer at cover values of 10–25%, which together with *Guibourtia coleosperma* (5–15% cover), *Pterocarpus angolensis* (5%) and *Ricinodendron rautanenii* (5%) provides a dense woodland. The small tree layer (4–8 m) is dominated by *Terminalia sericea*, *Erythrophleum africanum*, *Combretum psidioides*, *Combretum collinum* and *Lonchocarpus nelsii* at total cover values of 10–20%. The shrub layer is characterized by *Bauhinia petersiana* and *Grewia retinervis*. Grasses are predominantly perennials with species such as *Schmidtia pappophoroides*, *Stipagrostis uniplumis*, *Aristida stipitata* and *Digitaria eriantha* dominating at low cover (10–15%).
Structure: High closed woodland
Area: 1 142 km²

***Burkea* shrubland** — These shrublands may represent a degraded form of the previous two units and *Burkea–Terminalia* woodland (below) or an edaphic form of shrublands which has the same component species as those units but has assumed a completely different structure. Soils are dystrophic sands and have little agricultural value, either as an arable resource or for grazing purposes. Trees over four metres high are rare and seldom contribute more than one percent total cover. Characteristic species include *Burkea africana*, *Pterocarpus angolensis*, *Combretum collinum* and *Acacia erioloba*. The shrub layer is generally characterized by *Terminalia sericea* (dominant at 15–30% cover), *Lonchocarpus nelsii*, *Bauhinia petersiana*, *Baphia massaiensis*, *Burkea africana* and *Grewia retinervis*. Total cover in the shrub layer can be as high as 50% in badly encroached or disturbed areas. Grasses are generally unpalatable annuals or woody perennials such as *Eragrostis pallens*, *Aristida stipoides* and *Aristida stipitata*.
Structure: High closed shrubland
Area: 393 km²

***Burkea*–teak woodland** — Occurs on deep Kalahari sands in an area of well-developed dunes in the central Caprivi strip. The woody vegetation is clearly stratified with a tall (15–18 m) tree layer comprising *Burkea africana* (10–20%), *Baikiaea plurijuga* (10–20%), *Guibourtia coleosperma* (1–5%), *Pterocarpus angolensis* (1–5%) and *Ricinodendron rautenenii* (1–5%). A tree layer 6–8 m high (10–15% total cover) is present and

dominated by *Terminalia sericea*, *Erthrophleum africanum* and *Combretum collinum*. Shrub cover is low (5–15%) and is mostly provided by *Bauhinia petersiana*, *Grewia retinervis* and *Baphia massaiensis*. Grasses are predominantly annuals but *Schmidtia pappophoroides*, *Stipagrostis uniplumis* and *Digitaria eriantha* all occur at cover values of 1–5%.
Structure: High closed woodland
Area: 1 037 km²

***Burkea–Terminalia* woodland** — This discrete unit in eastern Caprivi and is formed on a large sandy ridge running south and east of Bukalo towards Ngoma. The sand has been extensively reworked by the flow of water which has resulted in a mosaic of extensive sand deposits and small lenses of heavier soils characterized by *Colophospermum mopane*. Those areas which represent transition soils between the sands and heavy clays are favoured for cultivation. This unit has much the same component species as *Burkea–Combretum* woodland and *Burkea*–kiaat–false mopane woodland, with the exception that *Terminalia sericea* occurs at much higher cover (15–25%) in the low tree layer, and that apart from *Burkea africana* the other large tree species, e.g. *Pterocarpus* are rare or absent. *Combretum* species are also relatively more important in here than in *Burkea–Combretum* woodland and *Burkea*–kiaat–false mopane woodland. The quality of the grasses is poor because annuals dominate (*Aristida adscensionis*, *Eragrostis dinteri*, *Aristida stipoides*, *Urochloa brachyura*) and the perennials which do occur are woody and unpalatable, e.g. *Eragrostis pallens*, *Aristida stipitata*. This may be a reflection of the poor quality of the soils, most having been reworked and leached by the action of water.
Structure: High closed woodland
Area: 242 km²

***Omuramba* fringe woodland** — This vegetation unit forms a distinct fringe along the lower slopes of dunes or *omuramba* margins throughout the Caprivi strip. *Acacia erioloba*, *Combretum imberbe* and *Acacia nigrescens* form a distinct tree layer 10–15 m high at cover values of 10–25%. Elements of vegetation characteristic of both heavy soils and Kalahari sands occur and *Terminalia sericea* dominates the low tree layer (four metres) at 10–15%. Other tree species characteristic but providing little cover include *Acacia fleckii*, *Lonchocarpus nelsii*, *Peltophorum africanum*, *Combretum hereroense* and *Burkea africana*. The shrub layer is dominated by *Dichrostachys cinerea*, *Baphia massaiensis*, *Bauhinia petersiana* and *Croton gratissimus*, usually at low cover percentages. Perennial grasses characterize the ground layer with *Schmidtia pappophoroides*, *Digitaria eriantha* and *Panicum maximum* providing the bulk of the cover (10–20%). This unit provides important grazing habitat for wildlife within the West Caprivi and has high potential for arable agriculture. Given the diversity of species recorded within this unit it has a high conservation value.
Structure: High closed woodland
Area: 257 km²

***Omuramba* grassland** — These grasslands occur in the *omuramba* bottoms throughout the Kalahari sand areas. They mostly lack woody vegetation with the exception of large (12 m) isolated *Acacia erioloba*, *Combretum imberbe* and *Combretum hereroense* which are scattered throughout at low cover values (1–5%). *Imperata cylindrica* dominates the wetter areas of the *omuramba* bottoms occurring at 10–30% cover. The drier grasslands are characteristically made up of a variety of palatable grazing species such as *Schmidtia pappophoroides*, *Brachiaria nigropedata*, *Digitaria eriantha* and *Anthephora pubescens* at moderate cover values 15–25%. Other characteristic species are *Hyperthelia dissoluta*, and *Stipagrostis uniplumis*, *Melinis repens*, *Heteropogon contortus* and *Urochloa brachyura*. These grasslands represent some of the best grazing resources in the Kalahari sand areas of the Caprivi. Additionally the soils are mostly sandy loams which are extensively cultivated near settlements.
Structure: Tall closed grassland
Area: 855 km²

Open camelthorn woodland — This unit has a limited distribution in the eastern section of the Caprivi strip on clay-loam soils which are generally poorly drained and subject to ponding. The vegetation is characterized by well-distributed, tall (15 m) *Acacia erioloba* at low cover values (<10%), with a distinct understory of low trees (four metres). Typically this understory comprises *Acacia hebeclada* (in well defined clumps), *Dichrostachys cinerea*, *Acacia luederitzii*, *Combretum imberbe* and *Combretum hereroense*. *Diospyros lycioides* and *Grewia flava* are the commonest shrubs in this unit. Perennial grasses are well-represented in the ground layer of this unit, with *Schmidtia pappophoroides*, *Digitaria eriantha* and *Eragrostis rigidior* being the most important species, with cover values of up to 20%. Annual grasses such *Urochloa brachyura*, *Aristida adscensionis* and *Panicum* sp. are common but do not contribute significantly to the cover. Given the relatively high cover values of palatable grass species this unit is presumed to have high value as a grazing resource.
Structure: High closed woodland
Area: 80 km²

Teak savanna — This unit occurs extensively in both the Caprivi strip and in eastern Caprivi but is largely absent west of the Okavango River. It occurs in areas of deflated dunes where the landscape is made up of gently rolling sandy plains. *Baikiaea plurijuga* is the most important tree species (8–15 m high) in this unit, occurring at moderate cover densities of 15–20%, giving the landscape a savanna-like appearance. *Terminalia sericea* (4–6 m) also occurs at low cover values, as do *Burkea africana*, *Pterocarpus angolensis* and *Guibourtia coleosperma* (10–15 m). The shrub layer is open to sparse with species such as *Baphia massaiensis*, *Bauhinia petersiana* and *Grewia retinervis* contributing to the cover but with a total cover of 10–15%. In areas which are frequently burnt the low growing *Diospyros chamaethamnus* can dominate large areas. Perennial grasses such as *Digitaria eriantha*, *Schmidtia pappophoroides*, *Aristida stipitata* and *Eragrostis pallens* are characteristic of this unit and can contribute 10–20% cover. Considering the relatively high proportion of palatable grass species these woodlands are important wildlife grazing areas, especially during the wet season where some surface water is available. However, they are considered to have poor potentials for livestock grazing because of the poor nutrient status of the vegetation and lack of water.
Structure: High open woodland
Area: 945 km²

Teak shrubland — This is thought to represent a degraded form of teak woodland described below. It only occurs east of the Kwando River in areas which have been extensively logged in the past, and the logging probably opened the woodlands up sufficiently to allow fire to have a major effect on their structure. These woodlands are characterized by sparsely distributed large *Baikiaea plurijuga* and *Acacia erioloba* at low cover values (10–15%) with a distinct, dense shrub understory made up largely of *Combretum elaeagnoides* (10–20%), *Terminalia sericea* (10–20%), *Croton gratissimus* (5–8%) and *Bauhinia petersiana* (5–10%). Grasses are predominantly annuals such as *Dactyloctenium giganteum*, *Aristida stipoides*, *Eragrostis dinteri* and *Melinis repens*. Some perennials such as *Schmidtia pappophoroides* and *Digitaria eriantha* do occur at low cover values. This unit is widespread in eastern Caprivi but has little value in that the soils are predominantly sands poor in nutrients, the vegetation has been degraded by repeated burning and, thus, has low value for conservation.
Structure: High open woodland
Area: 1 530 km²

Teak woodland — These woodlands are widely distributed and found on deep, well drained sandy plains and dunes. The woody component of this unit is dominated by large (10–20 m) *Baikiaea plurijuga* which form dense stands with cover values of 25–60%. *Burkea africana*, *Ricinodendron rautanenii*, *Guibourtia coleosperma* and *Pterocarpus angolensis* all occur as tall trees but at low cover values (1–5%). The shrub layer is characterized by *Baphia massaiensis*, *Bauhinia petersiana* and *Markhamia acuminata* which can provide a very dense layer of up to 50% cover. Grasses are predominantly annuals with species such as *Melinis repens*, *Eragrostis dinteri*, *Tricholaena monachne* and *Megaloprotachne albescens* being characteristic at low cover values. This unit occurs on deep, dystrophic sands, usually on the crests of well vegetated dunes or pockets of deep sand. They can be seen clearly on aerial photographs and satellite imagery as dense woodlands. Their potential for grazing and cultivation is poor, but they have high value as a timber resource. *Baikiaea plurijuga* woodlands have been severely overutilized for commercial timber production or have been fire damaged in certain parts of the Caprivi, so those remaining sites of intact forest have a relatively high conservation value.
Structure: High closed woodland
Area: 1 741 km²

Impalila woodlands

The basalt rocks that form Impalila Island have resulted in an environment quite different from the rest of Caprivi. The combination of rich soils, surface rocks and a complex mosaic of wetland and dryland habitats contributes to an extremely diverse vegetation which is unique in the Caprivi. Many species of trees and plants with essentially eastern and tropical African distributions (e.g. *Pappea capensis*) reach their distribution limits here and occur nowhere else in Namibia. The island, therefore, has a high conservation value related to its high biodiversity. Drier vegetation is dominated by *Colophospermum mopane*, with species such as *Terminalia prunioides*, *Adansonia digitata*, *Afzelia quanzensis*, *Sclerocarya birrea* and *Acacia tortilis* being characteristic. The margins of the island are characterized by species typical of river levees such as *Diospyros mespiliformis*, *Lonchocarpus capassa*, *Ficus sycomorus*, *Cassine transvaalensis* and *Kigelia africana*. The river margin habitats are dominated by extensive dense thickets of *Syzygium guineense*. Cattle numbers are seasonally high on Impalila Island and the grass layer is consequently denuded and extensive patches of unpalatable species such as *Aristida rhiniochloa*, *Aristida adscensionis* and *Chloris gayana* are common. In areas where damper soils occur *Cynodon dactylon* may form patchy lawns.
Structure: Tall closed woodland
Area: 18 km²

Notes

Chapter 2

1 The 21° E line of longitude forms the western boundary of Caprivi with Kavango, its neighbouring region in Namibia. From the intersection of this line with the Okavango River, the northern boundary follows the midstream of the river to Dikuyu Island from where it runs in a straight line to a point in the Zambezi River (17°28'29" S, 24°14'50" E), separating it from Angola and Zambia. The eastern boundary of Caprivi with Zambia then follows the midstream of the Zambezi River to the confluence of the Chobe River. The southern boundary with Botswana then follows the midstream of the Chobe–Linyanti–Kwando river system to 18° S. At the intersection of the Kwando River and this line of latitude, the border cuts along straight lines westwards and largely parallel to, and 32.2 km from, the northern boundary, to 21° E.

2 Information for these maps was calculated by interpolating rainfall averages and standard deviations from weather stations in Namibia (Katima Mulilo, Andara, Rundu), Botswana (Shakawe, Maun, Kasane, Gumare, Kavimba, Seronga, Sehitwa) and Zambia (Livingstone, Senanga, Masese, Sesheke).

Chapter 3

1 The borders of the six constituencies were gazetted in 1992, as follows:

Mukwe Constituency

From a point where the line of longitude 21° E intersects the middle of the Okavango River, east along the middle of the river to Dikuyu Island, then along the straight line Namibia/Angola border to the middle of the Kwando River, then along the middle of that river south to the Namibia/Botswana border, and then west along this border to the 21° E meridian; thence northwards along that meridian to the point of the beginning.

Kongola Constituency

Beginning at the point where the Kwando River enters Namibia, eastwards along the Namibia/Zambia straight line border to a point with system 22/25 co-ordinate Y+87000; then along grid direction 341°30' to meet the middle of the Katima Mulilo-Kongola road or "Golden Highway"; then along the middle of the road westwards until it crosses the middle of the Kwando River at Kongola Bridge; then northwards along the middle of the river to the point of the beginning.

Linyandi Constituency

Beginning at the Kongola Bridge crossing of the Kwando River, along the middle of the Kongola-Katima Mulilo "Golden Highway" in an eastwards direction to system 22/23 co-ordinate Y-83500; then south-eastwards in a straight line to a point in the middle of the Linyanti River at system 22/25 co-ordinate Y+95000, so as to include the Linyanti community in the constituency; then along the middle of the Linyanti and Kwando rivers to the point of the beginning.

Sibinda Constituency

Beginning at the point where the middle of the Katima Mulilo-Kongola "Golden Highway" is intersected by system 22/25 grid direction 341°30' coming from co-ordinate Y+87000 on the Namibia/Zambia border, along that direction prolonged through Lake Liambezi until it meets the Namibia/Botswana border; then south-west along the middle of the Linyanti River to the point with system 22/25 co-ordinate Y+95000; then along a straight line in a north-westerly direction to the point in the middle of the "Golden Highway" at system 22/25 co-ordinate Y-83500; then following the middle of the "Highway" to the point of the beginning.

Katima Mulilo Constituency

Beginning at the point on the Namibia/Zambia border with system 22/25 co-ordinate Y+87000, then eastwards along the Zambian border to the middle of the main channel of the Zambezi River; then along the middle of the main channel downstream to a point with co-ordinates Y+71000 and X-499000; then in an south-easterly direction to a point with co-ordinate Y+24000 in the middle of the Chobe River; then westwards along the Namibia/Botswana border to the point where the Sibinda Constituency begins, and then along a straight line in a grid direction 161°30' to the point of the beginning.

Kabe Constituency

This constituency consists of that part of Caprivi which is east of the Katima Mulilo Constituency.

2 Deloitte and Touche Consulting Group. 1997. Tourism development planning framework for the Caprivi Region. *Report*. Ministry of Environment and Tourism. Namibia.

Chapter 4

1 The Environmental Profiles Project organized to have 1:20 000 aerial photographs taken of the whole region in 1996. Those for eastern Caprivi and the strip along the Okavango River could be used to map and count all households. Photographs for the rest of the region were only taken in mid-1997 after these analyses were done. Other methods were used to estimate household numbers in these areas. In the Mukwe area south of the main tar road, oblique aerial photographs were taken of all villages to count and map households; estimates of the number of people in each village in the Caprivi strip were provided by M Brenzinger. To estimate population figures, household numbers were multiplied by the average household sizes for each enumeration area, as recorded in the 1991 Population and Housing Census. For five areas copies of 1:30 000 photographs taken in 1943 were obtained to provide comparisons on the numbers of households in those areas.

2 Densities were calculated using ArcView 3.0's Spatial Analyst to distribute the number of people in each cluster of households over an area with a radius of five kilometres.

3 CSO. 1995. 1991 Population and Housing Census: basic analysis with highlights. *Report*. National Planning Commission. Namibia.

4 CSO. Undated a. Living conditions in Namibia: the 1993/94 Namibian Household Income and Expenditure Survey. *Report*. National Planning Commission. Namibia.

5 CSO. Undated b. Basic tables of communal agriculture: 1994/95 Namibia Agricultural Census. *Report*. National Planning Commission. Namibia.

6 Average household sizes were calculated by overlaying a map of enumeration areas used in the 1991 Population and Housing Census with a map of households. Average household sizes were calculated for each enumeration area and then allocated to the households within each enumeration area. The map of households was finally converted to a 500x500 m grid to produce a more even representation.

7 UNDP. 1996. Namibia human development report. *Report*. United Nations Development Programme. Namibia.

8 UNDP. 1997. Namibia human development report. *Report*. United Nations Development Programme. Namibia.

9 Pretorius, JL. 1975. *The Fwe of the Eastern Caprivi Zipfel*. Unpublished MA thesis. University of Stellenbosch; Van der Vegte, JH, Forster, CW & Forse, WB. 1983. Eastern Caprivi regional development strategy. *Report*. South West African Administration; 1991 Population and Housing Census data; Environmental Profiles Project data.

Chapter 5

1 Steps taken in the compilation of the vegetation map were as follows. Three Landsat TM images taken in June and July 1994 were processed using bands 4, 5 and 3. The three images excluded the eastern tip of the eastern floodplains and information for this area was added separately using existing 1:50 000 SPOT xs false colour composites from June 1992. Enhancements were made using intensity, hue and saturation decorrelation, and the three decorrelated layers were combined into a normal red, green and blue image. Lastly photographic images were printed at scales of 1:150 000 retaining a pixel size of 30x30 m. The boundaries of apparently homogenous units were digitised off these images. Sample data on soils and vegetation taken at 137 sites were overlaid on the units and additional descriptive information was provided by aerial and ground surveys.

2 CSO. 1994. 1991 Population and Housing Census. *Report B*. National Planning Commission. Namibia.

3 Ashley, C & LaFranchi, C. 1997. Livelihood strategies of rural households in Caprivi: implications for conservancies and natural resource management. *Research Discussion Paper # 20*. Directorate of Environmental Affairs, Ministry of Environment and Tourism. Namibia.

4 Data on population densities were combined with the map of highest, moderate and lowest non-agricultural resource values to produce three categories:

- *"Least" pressure areas* have low population densities of <1 person/km², or have "highest" woodland resource values and population densities of 1–20 people/km².
- *"Medium" pressure areas* have moderate resource values and population densities of 20–50 people/km², or "highest" resources with densities of 50–100 people/km².
- *"Greatest" pressure areas* are those with lowest resources and densities >1 person/km², those with moderate resources and densities of >50 people/km², and those with "highest" resource values and densities of >100 people/km².

This rating is based on the assumption that in areas with few useful trees (poor resources) there will be significant pressure put on the few trees if there are reasonable numbers of people, and that pressures will increase as population densities become greater. It is also assumed that people exert little direct pressure on vegetation in the three protected areas.

5 Trigg, S. 1997. Fire monitoring in the Caprivi. *Report*. Environmental Profiles Project, Directorate of Environmental Affairs, Ministry of Environment and Tourism. Namibia.

Chapter 6

1 Based on stock census data provided by the Directorate of Veterinary Services, Ministry of Agriculture, Water and Rural Development.

2 Paskin, R. & Hoffmann, G. 1995. Socio-veterinary study: East Caprivi. *Report*. Directorate of Veterinary Services, Ministry of Agriculture, Water and Rural Development. Namibia.

3 Densities were calculated using ArcView 3.0's Spatial Analyst to calculate densities by spreading the number of cattle counted over an area with a radius of 10 km around each crushpen, assuming that all cattle counted have come from within 10 km of the crushpen. Because of the lung

disease outbreak in Botswana, most cattle in the Caprivi strip were moved away from their normal locations. For this analysis, cattle numbers collected in 1995 at Omega, Dwarspan and Chetto were used for 1996.

4 Opperman, DPJ, Viljoen, MF, du Toit, D & Wilke, PI. 1982. Landbou-ontwikkelingsplan vir die Oos-Caprivi. *Report*. Publishers unknown; Hines, CJH. 1997. Salambala Conservancy: a preliminary resource assessment. *Report*. WWF/LIFE. Namibia; Hines, CJH & Burke, A. 1997. Vegetation survey of NOLIDEP pilot communities. *Report*. NOLIDEP. Namibia.

5 CSO. Undated. Basic tables of communal agriculture: 1994/95 Namibia Agricultural Census. *Report*. National Planning Commission. Namibia.

6 Ashley, C. & LaFranchi, C. 1997. Livelihood strategies of rural households in Caprivi: implications for conservancies and natural resource management. *Research Discussion Paper # 20*. Directorate of Environmental Affairs, Ministry of Environment and Tourism. Namibia.

7 Directorate of Planning. 1997. Farm management survey of the Kavango Region, Namibia. *Analysis Report 1*. Ministry of Agriculture, Water and Rural Development. Namibia.

8 The Profiles Project arranged for 1:20 000 aerial photographs to be taken of the region in 1996. Those for eastern Caprivi and the strip and along the Okavango River could be used to map and count all areas cleared for crop farming. For other areas, cleared areas were mapped off 1:80 000 aerial photographs taken in 1996 for the Surveyor-General's office. Fields were digitized and stored in a GIS database, allowing areas to be calculated and the data to be analysed in relation to other geographic information.

Chapter 7

1 Barnes, J. 1997. Internal note on the economic value of tourism in the proposed Okavango National Park. Directorate of Environmental Affairs, Ministry of Environment and Tourism. Namibia.

2 The position and number of animals at each sighting was recorded during the aerial survey, as was the flight path and width of area counted on each side of the aeroplane. A 5x5 km grid was assembled for the whole region, and the proportion of each block sampled was calculated by overlaying the flight path and width of area surveyed. From that sampling proportion, it was then possible to estimate an extrapolated density of animals.

3 O'Connell, C. 1995. East/West Caprivi natural resource monitoring project: elephant/human conflicts. *Report*. Ministry of Environment and Tourism. Namibia.

4 Rodwell, TC. 1996. Caprivi elephant monitoring project. *Report*. Ministry of Environment and Tourism. Namibia

5 Craig, C. 1997. The ELESMAP project. *Report*. Namibia Nature Foundation. Namibia.

6 Compiled from: Ministry of Environment and Tourism game count data; and Rodwell, TC, Tagg, J & Grobler, M. 1996. Wildlife resources in the Caprivi, Namibia: The results of an aerial census in 1994 and comparisons with past surveys. *Research Discussion Paper # 9*. Directorate of Environmental Affairs, Ministry of Environment and Tourism. Namibia.

7 This information was compiled and analysed from data assembled by the Ministry of Environment and Tourism and Southern African Bird Atlas Project. Shannon diversity indices were estimated by calculating the number of species recorded in relation to the number of atlas cards collected for each quarter-degree square. Only squares with five or more atlas cards were used in the analysis.

8 Barnard, P, Brown, CJ, Jarvis, AM, Robertson, A & van Rooyen, L. In press. Extending the Namibian protected area network to safeguard hotspots of endemism and diversity. *Biodiversity Conservation*.

9 Schlettwein, CHG, Simmons, RE, MacDonald, A & Grobler, HJW. 1991. Flora, fauna and conservation of East Caprivi Wetlands. *Madoqua* 17: 67–76.

10 Tvedten, I, Girvan, L, Maasdorp, M, Pomuti, A & van Rooy, G. 1994. Freshwater fisheries and fish management in Namibia. *Report*. SSD. University of Namibia.

11 Curtis, B, Roberts, KS, Griffin, M, Bethune, S, Hay, CJ & Kolberg, H. In press. Species richness and conservation of Namibian freshwater macro-invertebrates, fish and amphibians. *Biodiversity Conservation*.

12 Van der Waal, B. 1990. Aspects of the fishery of the eastern Caprivi, Namibia. *Madoqua* 17:1–16.

Chapter 8

1 Graphs compiled from data held and provided by the Department of Water Affairs

2 Van Langenhove, G & Rukira, L. 1995. Investigation into recent river flow regime changes in the southern African region: conditions in Namibia. Paper presented to 27th meeting of the Standing Committee for Hydrology of SARCCUS, Maseru, Lesotho.

3 These analyses were requested by the Environmental Profiles Project and were done as part of a MSc thesis by Francois Binzouli. (Binzouli, F. 1997. *Assessment and zonation of the 1989 flood along the Zambezi River for environmental management in Eastern Caprivi, NE Namibia, using multi-temporal remote sensed imagery and GIS*. MSc thesis. International Institute for Aerospace Survey and Earth Sciences. The Netherlands.) TM Landsat imagery was interpreted to map out the distribution of flood waters from five images taken at intervals between March and August 1989, four of which are shown here.

4 These figures were obtained by counting all households and estimated numbers of people in areas which may be flooded. The great majority of settlements are on ground that is higher than the surrounding floodplains, but fields and grazing pastures are usually on lower ground.

5 This is the area appearing as rivers and open water in the June 1994 LandSat images used to map vegetation units (Chapter 5)

6 Schlettwein, CHG, Simmons, RE, MacDonald, A & Grobler, HJW. 1991. Flora, fauna and conservation of East Caprivi wetlands. *Madoqua* 17: 67–76.

7 Taylor, E. 1997. The status of *Salvinia molesta* infestation in the eastern Caprivi wetlands — 1996 report, update and recommendations. Department of Water Affairs, Ministry of Agriculture, Water and Rural Development. Namibia.

8 Analysed from data collected during the 1991 Population and Housing Census.

9 SIAPAC. 1997. Integrated summary report: community consultation and survey programme. *Report*. Department of Water Affairs, Ministry of Agriculture, Water and Rural Development. Namibia.

10 DWA. 1994. Feasibility study for the development of water supply for the area between Katima Mulilo and Kongola in the eastern Caprivi. Report No. 2300/6/1/2/P1. Ministry of Agriculture, Water and Rural Development. Namibia.

11 Data held and provided by the Department of Water Affairs were used to interpolate depth and quality values between the values recorded for those boreholes for which data were recorded. Quality of water is rated on the basis of TDS (total dissolved solids) as follows: A = <990, B = 991–1980, C = 1981–2640 and D = >2641 TDS.

Chapter 9

1 UNDP. 1997. Namibia human development report. *Report*. United Nations Development Programme. Namibia.

2 Deloitte & Touche Consulting Group. 1997. Tourism development planning framework for the Caprivi Region. *Report*. Ministry of Environment and Tourism. Namibia.

3 Barnes, JI. 1995. The value of non-agricultural land use in some Namibian communal areas: a data base for planning. *Research Discussion Paper # 6*. Directorate of Environmental Affairs, Ministry of Environment and Tourism. Namibia.

4 Jones, BTB. 1995. Wildlife management, utilization and tourism in communal areas. *Research Discussion Paper # 5*. Directorate of Environmental Affairs, Ministry of Environment and Tourism. Namibia.

5 Each vegetation unit was given a rating — 1 (low), 2 (moderate), 3 (high) — to reflect overall value for conservation (map 1), as described in the text. These units were then overlaid with data on the densities of people and cattle. Those areas having more than 10 people or 10 cattle per km^2 were reassigned to the "low" conservation category (map 2). To this new set of data were then added the densities of large mammals, as counted in the 1995 aerial survey. Densities were grouped in three categories: 1 = less than one animal/km^2, 2 = 1–10 animal/km^2, 3 = more than 10 animal/km^2 and the values for these three categories were added to the three values for conservation value. The result of the addition gave a final rating for conservation purposes (map 3), and all areas having a rating of 4 and above were taken as having priority for conservation. Values for subsistence farming are based on soil potential for crops (weighted four times), pasture quality (weighted twice), vegetation resource (not weighted) and water quality (not weighted). The assessment thus attaches the greatest importance to soil potential and pasture quality since these are at the core of subsistence activity. The weighted values for each component were added together to provide the index shown in map 4.

6 Gibson, J. 1995. Proposal for a southern African wildlife sanctuary in the wetlands associated with the source of the Zambezi. In: Matiza, T, Crafter, S & Dale, P. (Eds). *Water resource use in the Zambezi Basin*. International Union for the Conservation of Nature.

7 Craig, C. 1997. The ELESMAP project. *Report*. Namibia Nature Foundation. Namibia.

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ISBN 0-86976-408-X