4

Climate

Driving rains, drying sunshine

Advancing clouds signal the approach of rain and new flows of water into the Okavango.

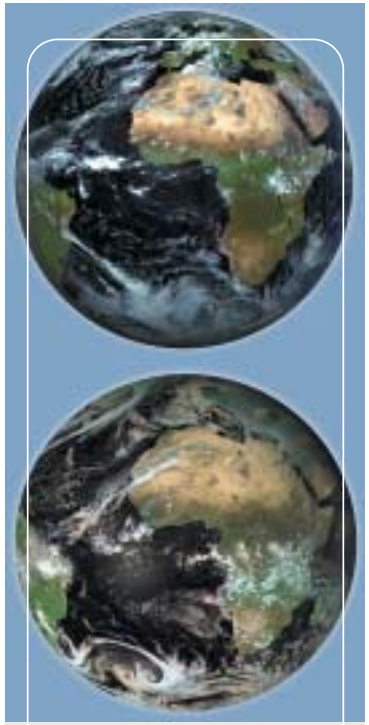
THE OKAVANGO BASIN'S climate changes gradually from north to south, following the same trend as the river as it flows from top to bottom and higher to lower elevations. Thus, rainfall is higher in the north where the air is more humid, cloud cover is greater and evaporation rates are lower than in the southern areas around the Okavango Delta. The steady southward changes in these three features mean that the river flows progressively into drier country. In fact, the river becomes more of an oasis to the south where the surrounding environment becomes increasingly arid. All of this gives the water increasing value to people, plants and animals in the south.

These trends result from interplay between the two major climate systems that affect the Basin's climate. The first is the Inter-tropical Convergence Zone (ITCZ), which brings in moisture from the north. Northern areas in the Basin thus receive more and earlier rain. Less and less moisture remains as the tropical air moves south, resulting in reduced cloud cover and rainfall, and higher solar radiation and rates of evaporation. The zone moves southwards early in the summer and back north in autumn, and this is why almost all rain falls during the summer. Most moisture in the ITCZ feeds into equatorial Africa from south-easterly Indian Ocean trade winds, but moist air also blows into the Zone from the Atlantic across the Congo Basin and northern Angola and down towards the highlands in the upper catchment.

A second climate system counteracts the flow of moisture from the ITCZ. This is the zone of high-pressure anticyclone cells that lie to the south. The cells also move north and south, bringing cool and dry air to southern Africa. Interactions between the anti-cyclonic cells and the ITCZ amount to something of a contest, the southerly high-pressure cells feeding in dry air, which pushes away the warm and moist ITCZ air. The high-pressure cells shift north to dominate the Basin in winter but also during sporadic dry spells in summer, while wet summers occur when the ITCZ has pushed far south.

The rains

Rain usually falls in strong and localized showers accompanied by thunderstorms, often in the afternoon after a steady buildup of clouds during the morning. Average totals per season in the highest areas of the catchment are over 1,300 mm. Since average seasonal or annual totals around Maun are approximately 450 mm, there is a three-fold decline in rainfall from north to south **(Figure 11)**. Note that, for purposes of



Little remains of the Intertropical Convergence Zone in winter when its band of moisture-bearing clouds has shifted well to the north, as shown in this satellite image taken in May 2003 (top). *Clear, dry and cool air has then been driven into southern Africa by subtropical high-pressure air systems. The image below, taken in February 2003, reflects conditions in summer when the ITCZ and its rain-bearing clouds have moved well south. It is under these conditions that the Basin receives rain to add to the flow of water in the rivers of the Okavango.*

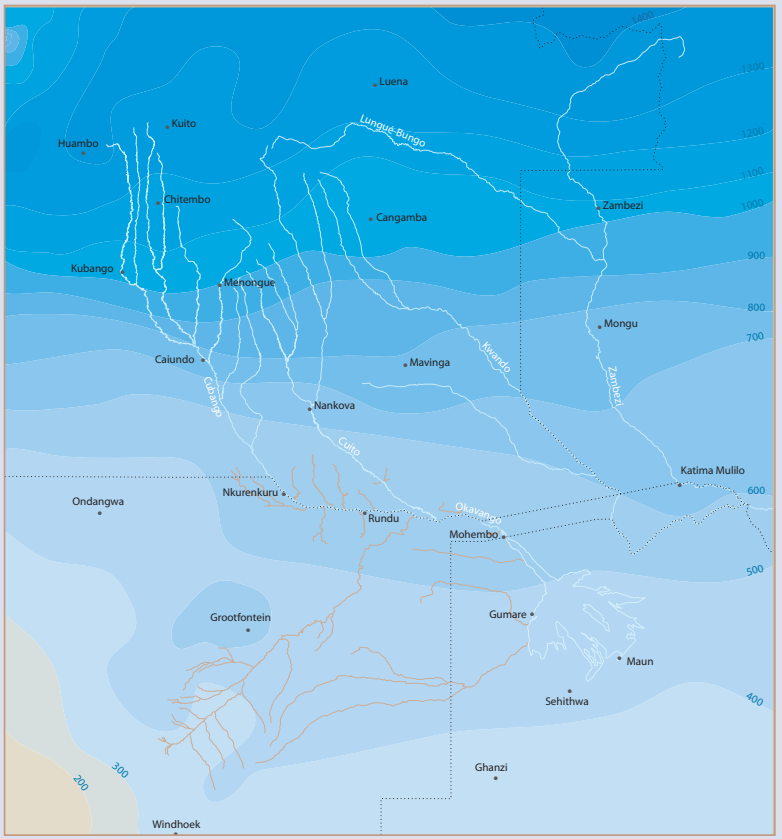


Figure 11

There is a steady gradient of rainfall across the Basin from areas in the north to those in the southern parts of the Delta. The highest totals of over 1,300 mm per season fall near Huambo, more than double the average of 560 mm at Rundu in the middle of the Basin and three times more than the average of 450 mm at Maun. All the perennial tributaries (white lines) have their origins in areas that receive more than 700 mm, while all the dry tributaries (brown lines) drain more arid areas.[1]

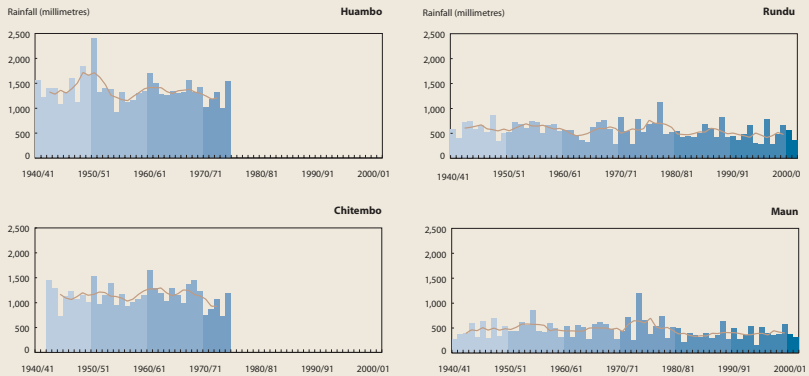


Figure 12
Rainfall varies greatly from season to season, as shown in these graphs of totals recorded over the past 60 years at Huambo, Chitembo, Rundu and Maun. The highest and lowest totals ever recorded during the years covered by these records are: Huambo: 2,350 and 962 mm, Chitembo: 1,849 and 814 mm, Rundu: 1,121 and 274 mm, and Maun: 1,186 and 151 mm. There are no figures over the past 27 years for Huambo and Chitembo because most weather stations closed after Angola's independence in 1975. The brown lines are moving averages.

measuring rainfall, a season lasts 12 months from July of one year to June of the next year.

These averages hide the obvious fact that rainfall varies from season to season, a point made clear by the graphs of seasonal totals at Huambo, Chitembo, Rundu and Maun **(Figure 12)**. However, moving averages in the graphs also reveal some longer cycles, particularly the fact that the 1960s, 1980s and most of the 1990s were considerably drier than the 1950s and 1970s. Rainfall is much more variable – and therefore less reliable and predictable – in the southern part of the Basin than in the north **(Figure 13)**. Natural vegetation and crop growth in the southern areas is thus limited both by shortages of rainfall and more frequent extreme scarcities. Some of these may be so severe that they are called droughts, and farmers may become eligible for government assistance. Droughts are, however, often proclaimed rather too readily. For example, 27 of the 33 years between 1964 and 1997 were declared as drought years in Botswana where dry periods are certainly a regular and normal occurrence.[2]

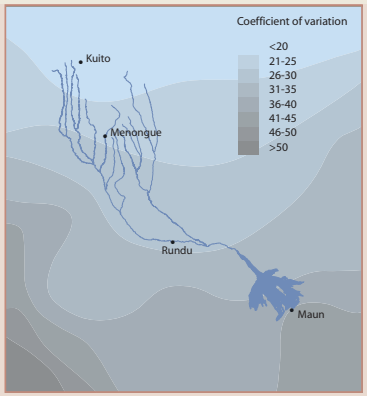


Figure 13
Rainfall in the southern areas of the Basin is much more variable than in the northern catchment. The co-efficient of variation of rainfall is about twice as high in the south as in the north.[3]

Early morning mists fill the valley of the Cuebe River near Menongue.

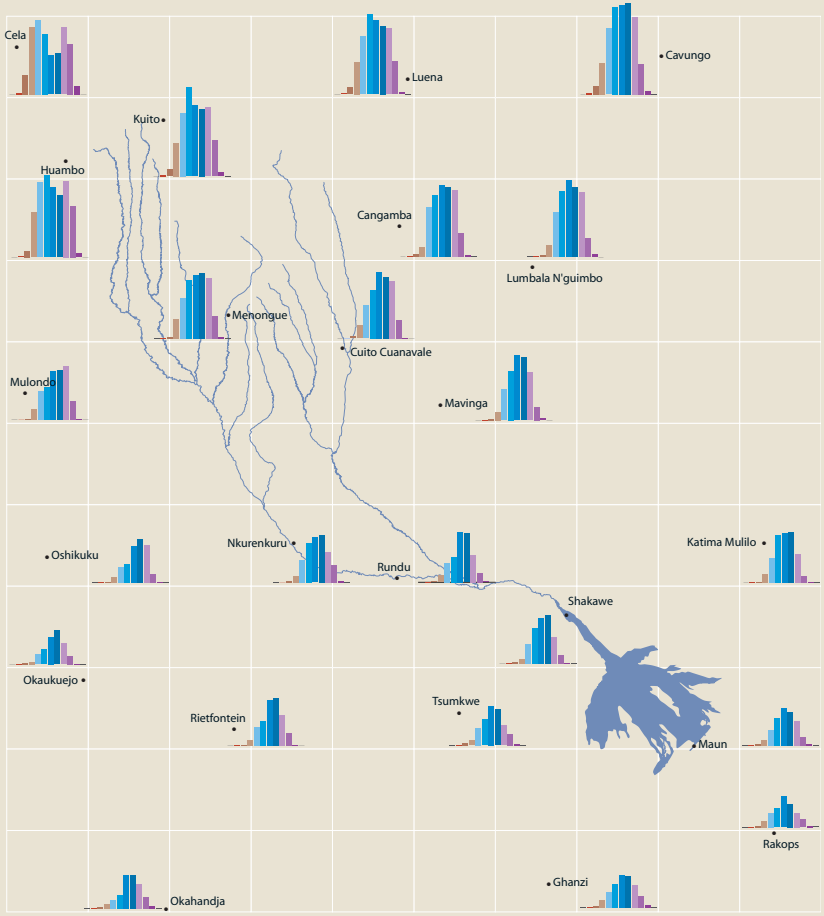


Figure 14
Most rain falls during the summer months between October and April, as shown by these histograms of average rainfall each month at places in and around the Okavango.[4]

Over much of the northern catchment the rains are also spread fairly evenly over the summer months, while falls are more concentrated in January and February further south **(Figure 14)**. However, there are two peaks in the northernmost areas: one in November and December and the other in March and April. The two peaks correspond with the periods when the ITCZ passes overhead, first on its way south early in the summer and then on its return north in March and April. During the trough in January and February the Zone of moisture is usually further south, and it is then that Kavango and Ngamiland receive the best falls of rain.

Levels of humidity are greatest during the rainy season, especially between January and March, and the air is generally much more humid in the northern than in the southern regions. The air is driest during the heat of the day in late winter and early summer, when afternoon humidity levels typically range between 10 and 20% in Kavango and Ngamiland.

The flow of water is of course only possible because of abundant rainfall in the northern catchment. However, the river valleys as we see them now were probably largely formed during periods of much higher rainfall, for example those occurring in about 23,000 year cycles over the past 200,000 years **(Figure 15)**. Rainfall during the wettest cycles was often several times higher than the averages of today. This is when water would have carved the fossil drainage lines such as the Omatako and Nxamasere or Khaudum. By contrast, some of the rivers might have been completely covered up by sand during the driest of cycles. Average rainfall was then two or three times less than it is now and much of the area was covered in sand dunes (see **Figure 3** on page 33).

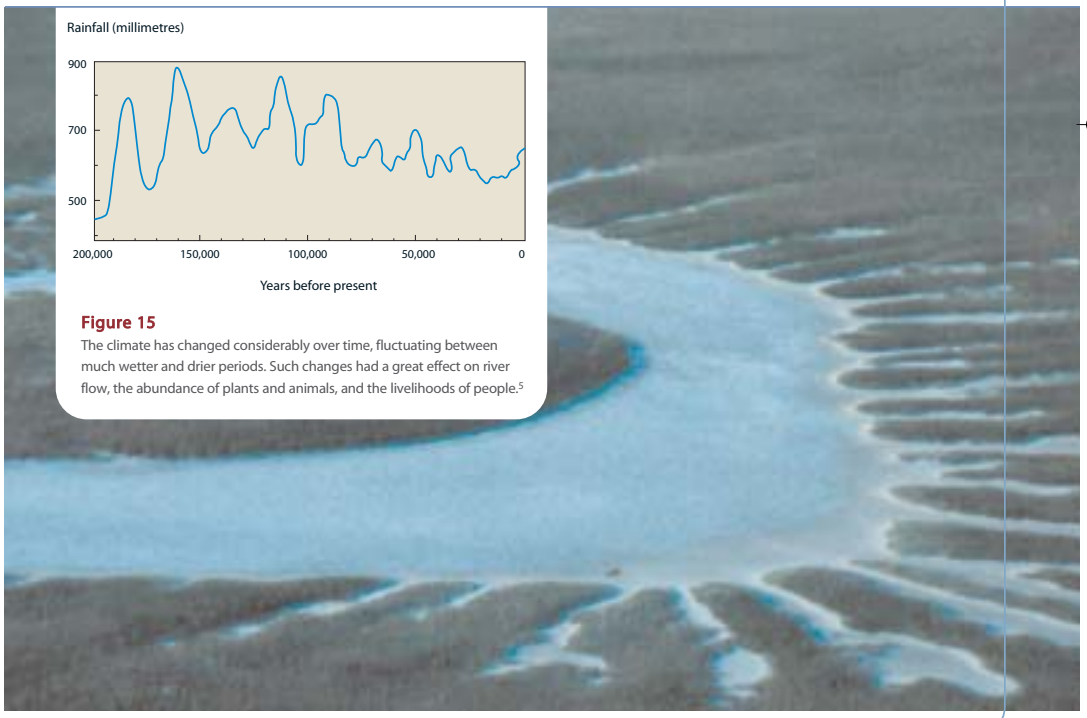
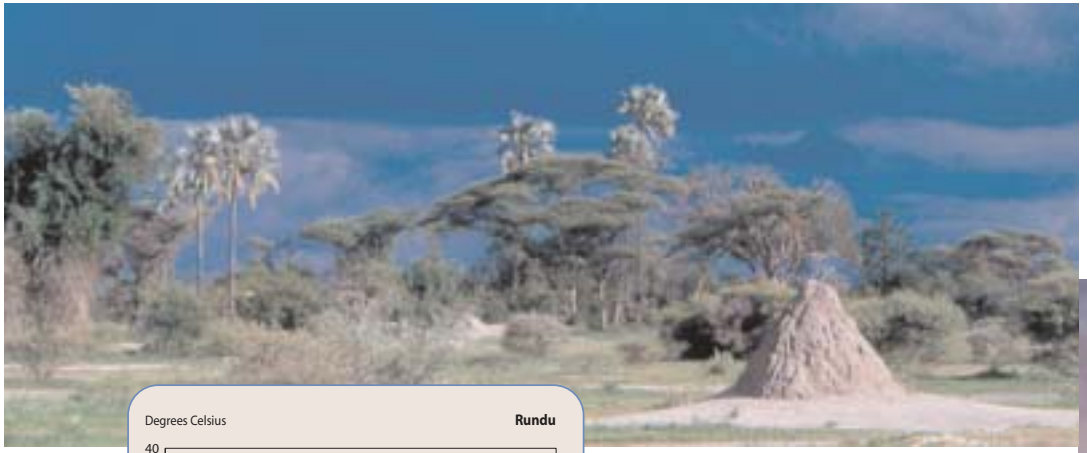
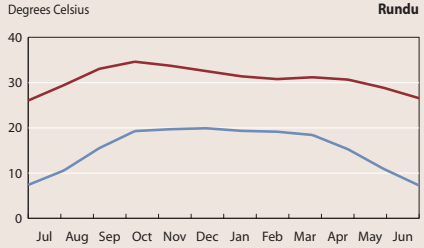


Figure 15
The climate has changed considerably over time, fluctuating between much wetter and drier periods. Such changes had a great effect on river flow, the abundance of plants and animals, and the livelihoods of people.[5]

During much drier periods, the Okavango Delta might have looked like this salt-encrusted 'backwater' of the Makgadikgadi Pans.



Most rain in the Basin falls during afternoon thunderstorms.



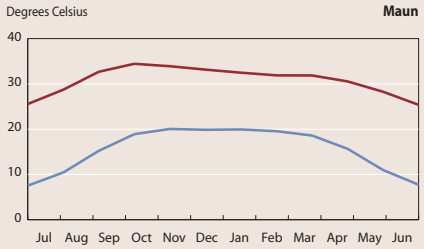


Figure 16

Average daily maximum temperatures vary from 30 to 35° C during the months of October to January at Rundu and Maun. Thereafter, increasing cloud cover and rainfall lowers temperatures during the later summer months. Average minimum temperatures fall to about 7° C in the coldest months of June and July.[6]

Heat and wind

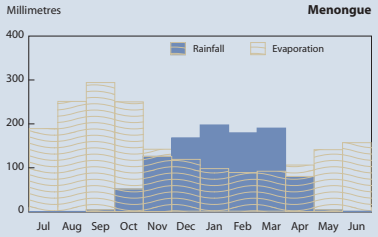
The Basin is characterized throughout by warm or hot conditions during most of the year and for much of every day **(Figure 16)**. Annual temperatures throughout the area average about 20° C, increasing by two or three degrees from north to south as a result of higher solar radiation in the southern areas. Winter nights and early mornings can be cold anywhere, but especially so in low-lying river valleys. Occasional frost occurs in such low-lying areas, sometimes frequently enough in the Angolan highlands to limit the growth of crops.

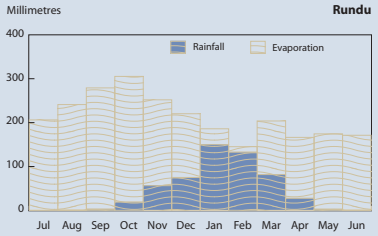
Although strong gusts blow during occasional storms, wind speeds are very low for most of the time across the Basin. In fact, it is completely calm for much of the time. For example, no wind was recorded for over half the time in most months at Rundu.

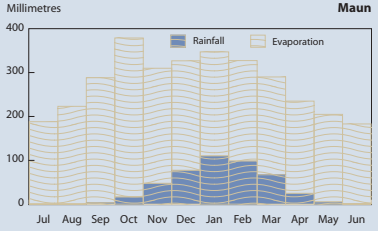
Evaporation varies from the highest rates of water loss in the south to much lower rates of water loss in the north **(Figure 17)**. Several times more water evaporates each year than is received by rain in most areas, which means that there are considerable overall deficits of water. Thus, the amounts of water lost to the atmosphere are higher in all months than the water received by rainfall at Maun and Rundu. At Menongue, by contrast, more water falls as rain than evaporates between December and March.

Figure 17

The highest rates of evaporation are in August, September and October when temperatures are high, there is little moisture in the air and it is often more windy than at other times of the year. Lower rates of water loss in mid-summer are due to the higher humidity and the cooler conditions brought about by cloud cover. Total average rates of evaporation per year at these three places were: Menongue: 1,924 mm, Rundu: 2,549 mm and Maun: 2,851 mm. Note that these rates are recorded on standard size evaporation pans, and actual rates of water loss over open stretches of water are generally about 30% lower than pan measurements.[7]







Key points

- Annual rainfall at the top of the catchment is about three times higher than that at the Delta.
- Most rain falls during summer between October and April in the northern catchment and from December to March in the south.
- The timing and amount of rainfall varies greatly from year to year, month to month and day to day. Dry spells occur regularly, especially in the southern Basin.
- Rainfall was generally low during the 1960s, 1980s and 1990s and higher in the 1950s and 1970s.
- Temperatures increase rapidly from the coldest months of June and July to the warmest month of October.
- Between two and three metres of water is potentially lost each year as a result of high evaporation rates.
- Winds are generally light, and it is completely calm for much of the time.