CHAPTER 1

INTRODUCTION

1.1 GENERAL

Botswana (Fig. 1.1) is located within the central part of the southern African region, and is generally drier than other parts further north, east and south. The Kalahari, which is often referred to as a desert, covers almost all of Botswana. Thus Botswana is essentially an arid country.

The northern and eastern parts of the country receive higher rainfall and have more fertile soils than the western and southwestern parts. Consequently, arable agriculture, settlement, and human and livestock populations are concentrated there. The eastern areas especially have long been settled and hence the grazing resources have been reduced considerably by the ever increasing livestock numbers. The increasing human population has also demanded more food production and therefore more croplands.

The increasing populations of livestock have led to demand for more grazing lands in the western part of the country, which forms the centre of the much wider Kalahari and is drier than the rest of Botswana. Because the area has been least settled, wildlife, protected as a national heritage, has remained in moderately high numbers here. Thus the expanding domestic livestock populations create potential land-use conflict with this resource. There is therefore a need for planning the optimal use of land by both wildlife and expanding domestic stock ranges.

Information on Kalahari and its wildlife is insufficient for resource planning. Unlike the acacia savanna of eastern Africa with its well studied ungulate communities, the Botswana Kalahari is relatively little studied. The present study has therefore been undertaken to provide some information for future management of the western central part of the Kalahari as well as provide more scientific information about the area and some of its big animal species.

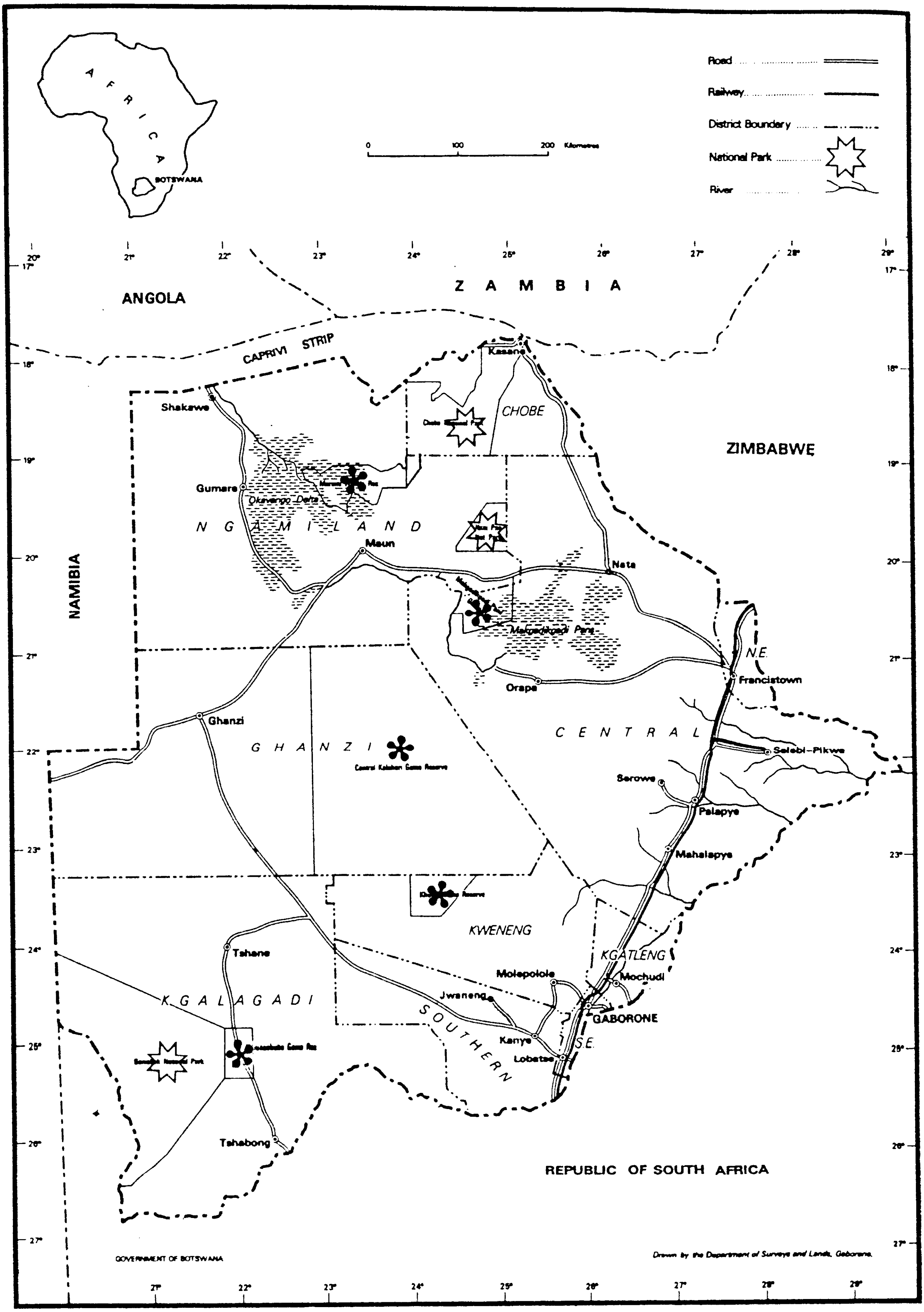

FIG. 1.1 REPUBLIC OF BOTSWANA

1.2 THE STUDY

Knowledge of wildlife and livestock distribution and abundance is important and necessary for the rational management of the Kalahari resources such as land, grazing and overall protection of the environment. Planning the establishment of conservation areas (national parks, game reserves and wildlife management areas), the development and location of cattle ranches and general land use all require knowledge of the distribution and abundance of wild and domestic animals. Conservation areas cannot effectively coexist with areas heavily utilised by domestic stock. These are matters for consideration in a plan for the Western Central Kalahari.

Knowledge of both wild and domestic animal abundance is necessary for planning animal harvesting. Since hunting still takes place in the Western Central Kalahari, an estimate of wild animal numbers assists in the determination of hunting quotas. Knowledge of cattle numbers also enables determination of numbers to be marketed in order to maintain the carrying capacity of the range.

It would be expected that the distribution and numbers of domestic stock, especially, cattle would be known. However, in Western Central Kalahari the cattle roam unherded and the extent of their range is not strictly known. Because of this, no reliable figures for number of cattle exist.

The Kalahari ecosystem, although not fully known, is generally thought to be fragile (see Leistner 1967, Parris 1976, Skarpe 1981), i.e. it is highly sensitive to factors like grazing and wind erosion. This is exemplified by many instances of overgrazing around settlements and by action of wind on sanddune stability. Overgrazing is here defined as exploitation of the grazing resources to the extent that grazed areas are almost denuded of the palatable herbaceous plant layer. The grazing regime can be planned efficiently only with adequate knowledge of the distribution and numbers of livestock, and indeed of wild herbivores as well.

Wild animals and domestic livestock distribution are generally believed to be influenced by various habitat factors such as availability of food and water, and the physical environment. The extent to which these factors influence the wild animal distribution in the Western Central Kalahri is little known.

The degree to which the various land use types affect the distribution of especially the various wild animal species is also not well known. However, it is generally speculated that since some wild animals species in their wild state do not generally tolerate people, any areas heavily utilised by people, such as settlements, communal areas or cells (areas where there is free community access to grazing resources and ploughing fields) and farms or ranches are likely to have few or no wild animals in them. In the Western Central Kalahari little is known about these interactions.

Land use planning in the Western Central Kalahari has, in view of the general lack of information in the various resources of the area, tended to be to satisfy the requirements of the user. This has resulted in many land uses not being adequately planned, nor their environmental impact assessed beforehand. It was therefore decided the study should aim to achieve the following in Western Central Kalahari:

(a) Document principal environmental factors and investigate their influence on the distribution of selected wild and domestic animals.

The environmental factors considered were physiographic, (landscape types, drainage systems, pans and soils); climatic, (seasonal availabiltiy of surface water, rainfall, temperature, relative humidity and other climatic conditions); vegetation factors; and land uses.

(b) Document distribution and abundance of selected wild animal species and domestic livestock.

The main wild animal species chosen for study were the eland *Taurotragus oryx* (Plate 1), the gemsbok *Oryx gazella* (Plate 2) the red hartebeest *Alcelaphus buselaphus caama* (Plate 3), the blue wildebeest *Connochaetes taurinus taurinus* (Plate 4) and the springbok *Antidorcas marsupialis hofmeyri* (Plate 5). However, the greater kudu *Tragelaphus strepsiceros* (Plate 6) and the ostrich *Struthio camelus* were also observed as a secondary activity. Cattle was the main domestic animal studied, however, horse and donkey were also included in the study as a secondary activity.

It was hypothesised that:

PLATE 1

Eland on a pan
Note salt-lick
pit near top
left corner

PLATE 2

Gemsbok

PLATE 3

Hartebeest on a
pan. Springbok
in foreground.
Note one animal
with head in the
salt-lick.

PLATE 4

Wildebeest in open woodland community. Trees are *Acacia mellifera*, *A. erioloba* and *A. luederitzii*. Grass is *Stipagrotis uniplumis* .

PLATE 5

Springbok on a pan.

PLATE 6

Kudu in open woodland community. Trees are *A. mellifera* and *A. erioloba*. Grass is *Stipagrostis uniplumis*.

(i) the selected wild animal species have been displaced in farms, settled and communal areas and that in these areas their occurrence was minimal and their abundance low.

(ii) because of uncontrolled numbers and distribution of domestic livestock in communal areas and farms, overgrazing will continue to be a problem in these areas and any new areas occupied.

(c) examine the present main land use policies, land use planning methods, and prevailing management practices, and propose appropriate modifications.

The policies to examine here are a general land policy, a grazing policy and a wildlife management policy. These are to be examined in relation to how they affect the Kalahari environment, and land resources.

1.3 THE CONSTRAINTS

This study was undertaken under several constraints.

(i) The field study was originally planned to last for eighteen months to enable nine surveys, one every two months, to be undertaken. This was planned such that out of the nine surveys three would have been repeated for the same months in different years. This would have enabled some comparisons and a search for changes with time. Financial and other circumstances beyond the control of the author reduced the duration to fourteen months and seven surveys. Only one repeat survey of the same month in different years was made.

(ii) The overall study, from beginning to end was tied to the study leave-of-absence of the author from his usual government duties. This meant certain aspects of the study could not be given as much time as would have been desired to obtain optimum results. The time available for analysis and interpretation of data and subsequent compilation of the thesis proved inadequate, and as a result detailed analysis could not be made of all the data. This has tended to leave gaps in reportage of factual information, which have had to be filled by inferences.

CHAPTER 2

STUDY AREA AND ITS ENVIRONMENT

2.1 LOCATION AND GEOGRAPHICAL SETTING

The study area, the Western Central Kalahari, Fig. 2.1, is located between 23°00'S and 24°30'S latitudes and between 20°00'E and 23°03'E longitudes in Western Botswana. This coincides almost with the Bakalahari Rise or "Schwelle" which was first identified by Siegfried Passarge in 1904 (Boocock and Van Straten 1962). The northern part of the study area includes a small portion of the Ghanzi District lying above the Tropic of Capricorn while the rest lies within the Kgalagadi District and below the Tropic of Capricorn. The northeastern and eastern boundaries are the Kweneng and Southern Districts respectively, with the Ghanzi-Lobatse road forming the actual physical northeastern boundary. Districts are local government's administrative delimitations into which the whole country has been divided.

To the west, the western boundary is the fenced international Botswana-Namibia border.

The whole study area falls on what has been designated the Central Kalahari region of the much wider Kalahari (Boocock and Van Straten 1962, Parris 1976). The Kalahari overall, has invariably been described as a "desert". The significance of this is examined below.

The term "desert" is generally used to describe the surface condition of an area. For example desertification, a process leading to establishment of a desert, is generally described in terms of vegetation deterioration and denudation which may be caused by overstocking, overgrazing, other human consumptive activities, frequent droughts and other deleterious environmental influences which lead to greater exposure of soils to erosive forces like wind and water. A desert, the end result of desertification, is therefore an area or region that has been denuded and is devoid or almost devoid of vegetation. From the present knowledge, the Kalahari is well covered

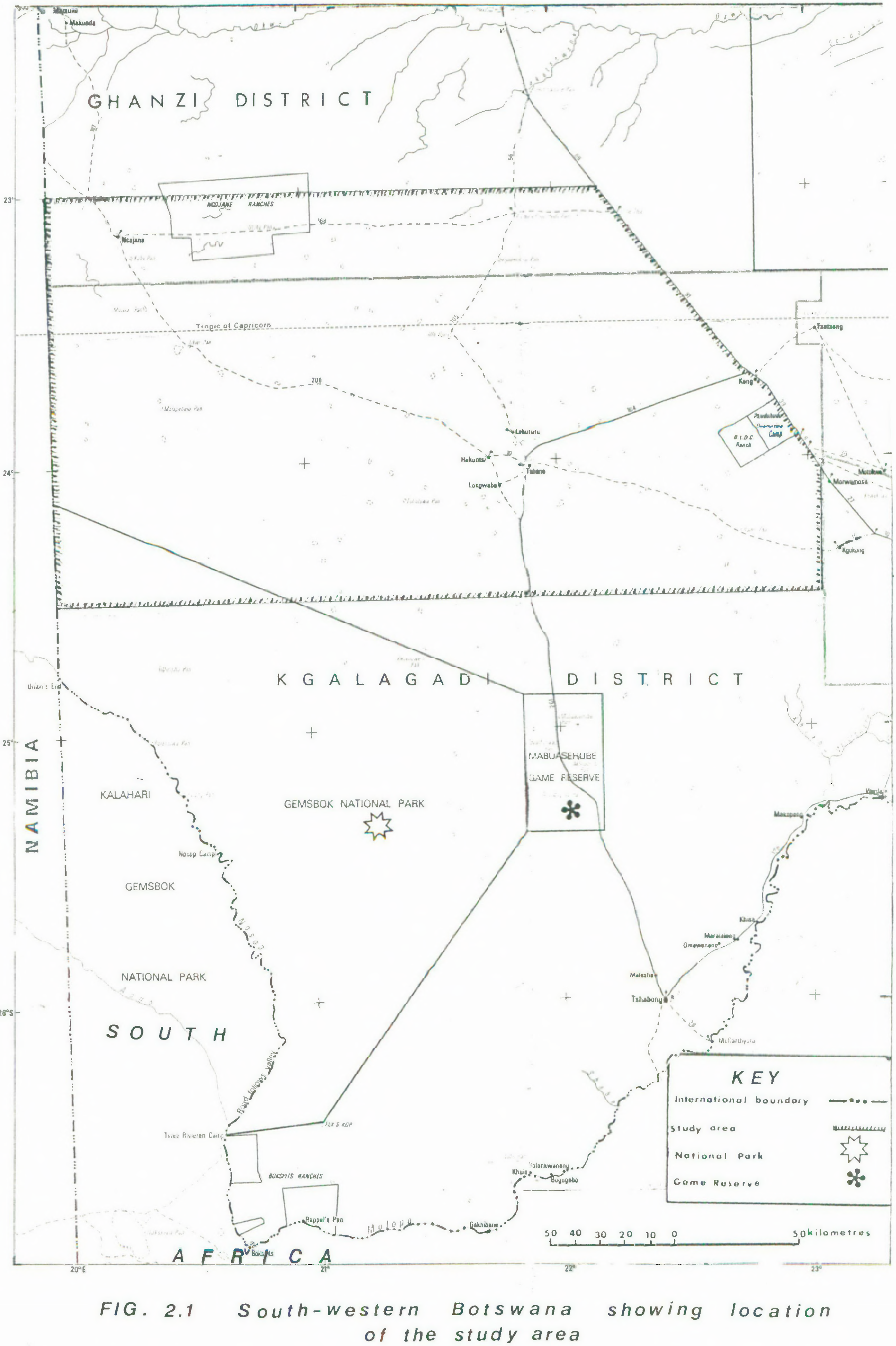

FIG. 2.1 South-western Botswana showing location of the study area

with vegetation (Leistner 1967, Grove 1969, Weare and Yalala 1971, DHV 1980 Vol III, Skarpe 1981). The application of the term "desert" to describe the Kalahari is therefore considered superfluous.

However, because the Kalahari receives relatively low rainfall, it is more a thirstland than a desert. But to avoid conflicts over descriptive terminology, it will, for purposes of this study, be referred to only as the Kalahari.

The Kalahari, then, is an immense upland, thirstland sand basin reaching up to 1300 metres above mean sea level in places in Western Botswana, with a sub-desert and semi-arid environment. Unlike the adjoining Namib Desert to the west, it has relatively well established vegetation of great diversity. The study area is located on the western portion of the Central Kalahari as shown on Fig. 2.1.

2.2 PHYSIOGRAPHY

2.2.1. General.

The topography of the study area is best described in terms of the relief characteristics of the Bakalahari Schwelle. The Bakalahari Schwelle divides the Western Central Kalahari into two natural hydrographic portions (Boocock and Van Straten 1962). It is a highland sand area rising gradually from the south and east to about 1300 metres above sea level in the Kule-Ncojane area on the northwest of the study area. It extends approximately from west of Kanye in south-eastern Botswana westward into Namibia and forms a catchment for the Nosop-Molopo rivers flowing south and the Okwa river flowing north-east towards the Makgadikgadi Salt Pans. The study area is, however, located mainly on the western (west of 24° 00'E longitude), highest part of the Schwelle, (DHV 1980 Vol II, Surveys and Lands 1982). The contour map (Fig. 2.2) and the block diagram (Fig. 2.3) show the altitudinal variations in the study area.

Although the Schwelle is described as if it was a conspicuous relief feature, it is actually not discernible as such. Flying over the entire area from east to west, it appears flat to undulating with a few sandhill and low sand-dune areas.

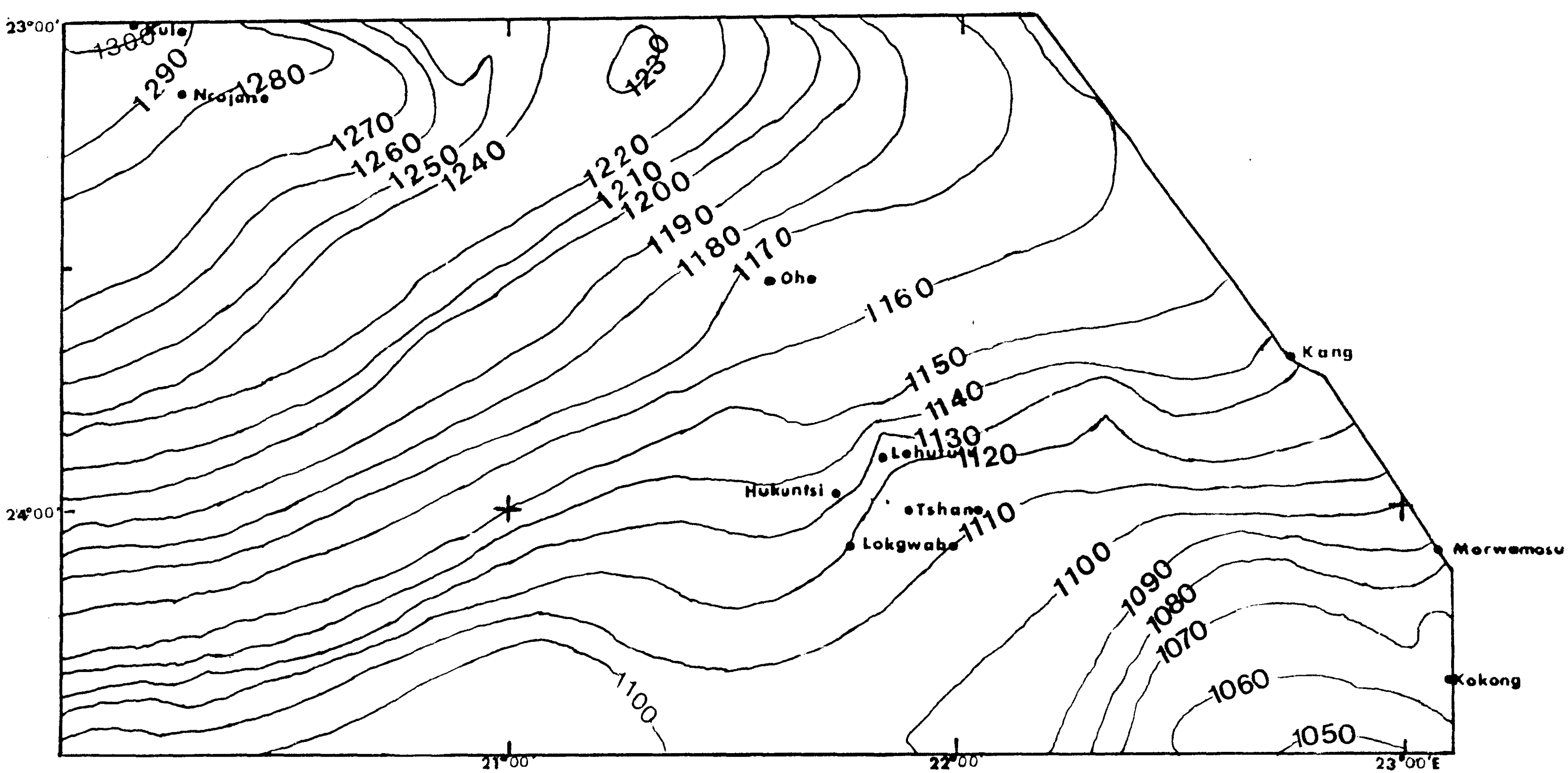

FIG. 2.2 **Contour Map, Western Central Kalahari (After DHV 1980).**

(metres above sea level)

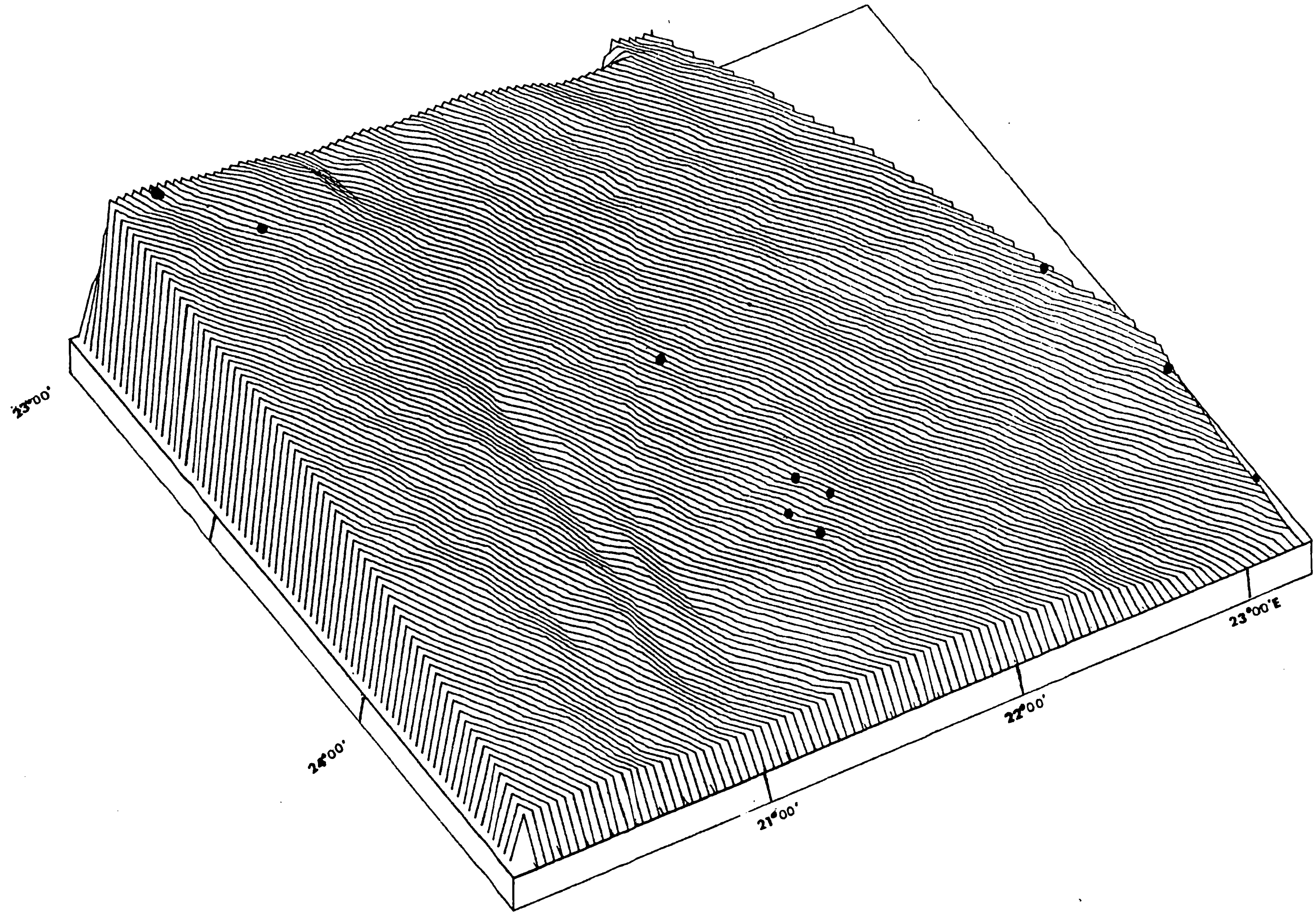

FIG. 2.3 Altitudinal Gradient, Western Central Kalahari

2.2.2 Land features.

The two most conspicuous land features in the study area are the sand-dunes and pans. Some sand-dunes and sand-ridges, are in places up to 90 m high (DHV 1980 Vol. II).

The pans, which are scattered throughout the study area, are localised depressions with hard floor, differing in physical and chemical properties from surrounding soils and lower than the surrounding area by from 5 metres to 15 metres, with widths ranging from 0.5 km to 4 km or more, and area from 1 km^2 to over 10 km^2, (Parris 1976, Lancaster 1978). Various types are those covered with vegetation, those without vegetation but with clay surface, and those with bare and white, often saline, pan-floor. Their shapes and nature also vary, from almost round to pan-handle shapes, and from series of pans associated with distinct fossil river or tributary valleys to solitary pans.

2.2.3 Drainage.

No currently flowing rivers occur in the study area. However, traces of fossil drainage lines locally called *Mekgatsha* (singular *mokgatsha*, corrected spelling of *mokgacha* in Boocock and Van Straten 1962), occur in association with some pans (see Chapter 5). These *mekgatsha* are almost completely covered with sand in some places, and low level flight inspection is only able to identify them by the greyish soils of generally shallow, meandering or elongated depressions.

Two prominent drainage systems occur outside but near the study area, the Okwa River in the north, and the Nosop-Molopo Rivers in the south. The Okwa has been classified as a fossil river, not having flowed for many centuries, while the Nosop-Molopo rivers have been classified as having flowed in recent times (Boocock and Van Straten 1962, Leistner 1967, Grove 1969, DHV 1980 Vol. II). These two drainage systems drew their headwaters from and along the Schwelle, thus some of their fossil tributaries are present within the study area (see Chapter 5).

2.3 GEOLOGY AND SOILS

2.3.1 General.

The biggest hindrance to exhaustive study of the geology of the Kalahari is the sand cover. This has created difficulties in determining the origin and detailed stratigraphy of the Kalahari basement complex in Botswana and elsewhere. The field has thus remained a contentious one among geologists since the early 1950s (Wayland 1953, Boocock and Van Straten 1962, Baillieul 1975, Farr *et. al* 1981). This field is reviewed below.

The geology of the bed-rock complexes, their general stratigraphy and cover sands are reviewed in some detail for several reasons:

(i) Settlements in the study area and location of cattle ranches rely on underground water almost exclusively as there are no reliable perennial surface waters. Understanding of the geology and hydrogeology of the area helps focus attention on potential areas of land use conflict over exploitation of underground water reserves;

(ii) mineral prospecting, one of the land uses of interest in this study, is directed by the nature of bed-rock geology.

2.3.2. The Rock Geology.

The study area has practically no exposed rock formations. Two exist outside its boundaries, one 90km to the north is the Ghanzi Group, and another 190km to the south is the Waterberg Series around Tsabong. The rocks of the Ghanzi Group, consist of 90 per cent of late Pre-Cambrian pre-metamorphic medium-grained arkose (Litherland 1982). This Ghanzi Group, composed of three formations has been estimated as 13 km thick. To the south, exposed rocks of the middle Pre-Cambrian Waterberg extend in thickness from a few metres to several hundreds of metres (DHV 1980 Vol. II).

Between the exposed Ghanzi Group to the north and the Tsabong Waterberg Series to the south is a sand covered expanse of land with only a few rock outcrops around some big pans (however see Chapter 5 for observations from the present study). Thus because no exposed natural sections exist for direct study, knowledge about areal extent of the basement rocks of the study area has remained an educated and deductive guesswork, based on examination of borehole substrata material supplemented with information from the infrequent and more deeply etched pans. More information has recently been obtained by aero-magnetic survey of 1976/77. Generalised stratigraphy both laterally and vertically is still currently suggested. Table 2.1 gives the generalised stratigraphy of the study area.

The predominant bed-rock sequence has been suggested as the Karroo with a small portion of the Waterberg Sequence. The Kalahari Beds are probably the biggest, areally, of the stratigraphic units.

Laterally, the various formations in the Karroo sequence extend to outside the study area. By far the largest of these formations represented in the study area is the Ecca, which extends from the south to as far north as approximately 23° 30'S latitude where it then adjoins the Cave Sandstone stage of the Stormberg Formation. The Stormberg Formation then extends as far north as approximately 23° 00'S latitude and as far west as approximately 20° 30'E longitude. In the eastern part of the study area, the same Stormberg Formation again appears just southeast of Kang and extends to just southeast of Morwamosu Village. In the southeast of the study area, around Kokong-Masiaphotshane intrude the northeastern limits of the much older Mid-Precambrian non-Karroo Waterberg Sequence.

The lateral extent of these sequences and their formations is shown in Fig. 2.4. The Kalahari Beds, the cover sands, are excluded for simplicity.

2.3.3. The Kalahari Sand Cover.

The Kalahari Sand cover mantles over 90 per cent of the Central Kalahari (Boocock and Van Straten 1962). In the Western Central Kalahari, this cover is interrupted only by the numerous pans scattered throughout the area although with varying degrees of concentration.

The Kalahari Sands recently reviewed by DHV (1980 Vol. II) and Farr *et. al* (1981), lack the presence of fossilised ancient life forms. They are mainly composed of a variety of aeolian sands, silicified and calcretised sandstones and grits, marls, calcretes and silcretes. Areal correlations and extent of such deposits have not been fully achieved in Western Botswana because the terrain lacks natural sections. Like the bed-rock case, information has therefore

TABLE 2.1 *Generalised Stratigraphy of the Western Central Kalahari*
(Sources: Boocock and Van Straten 1962, DHV 1980)

Layer	Stratigraphic Unit	Age	Lithology
First-Top	Kalahari Beds	Tertiary to Recent	Pan sediments, undifferentiated Kalahari sands, marls, calcretes, silcretes, grits and minor conglomerates
Second	Karroo Sequence	Late Carboniferous to Jurassic	
	1. Stormberg formation		
	(i) Cave Sandstone		Sandstone, grit, small conglomerate
	(ii) Red Beds		Shale and marl
	2. Ecca Formation		
	(i) Upper Ecca		Shale and siltstone
	(ii) Middle Ecca		Grit, sandstone, conglomerate, shale limestone
	3. Dwyka Formation		Shale, tillite, mudstone, limestone, calcareous sandstone
Third	Waterberg Sequence	Middle Pre-Cambrian	Sandstone, grits, shales, conglomerates, limestone

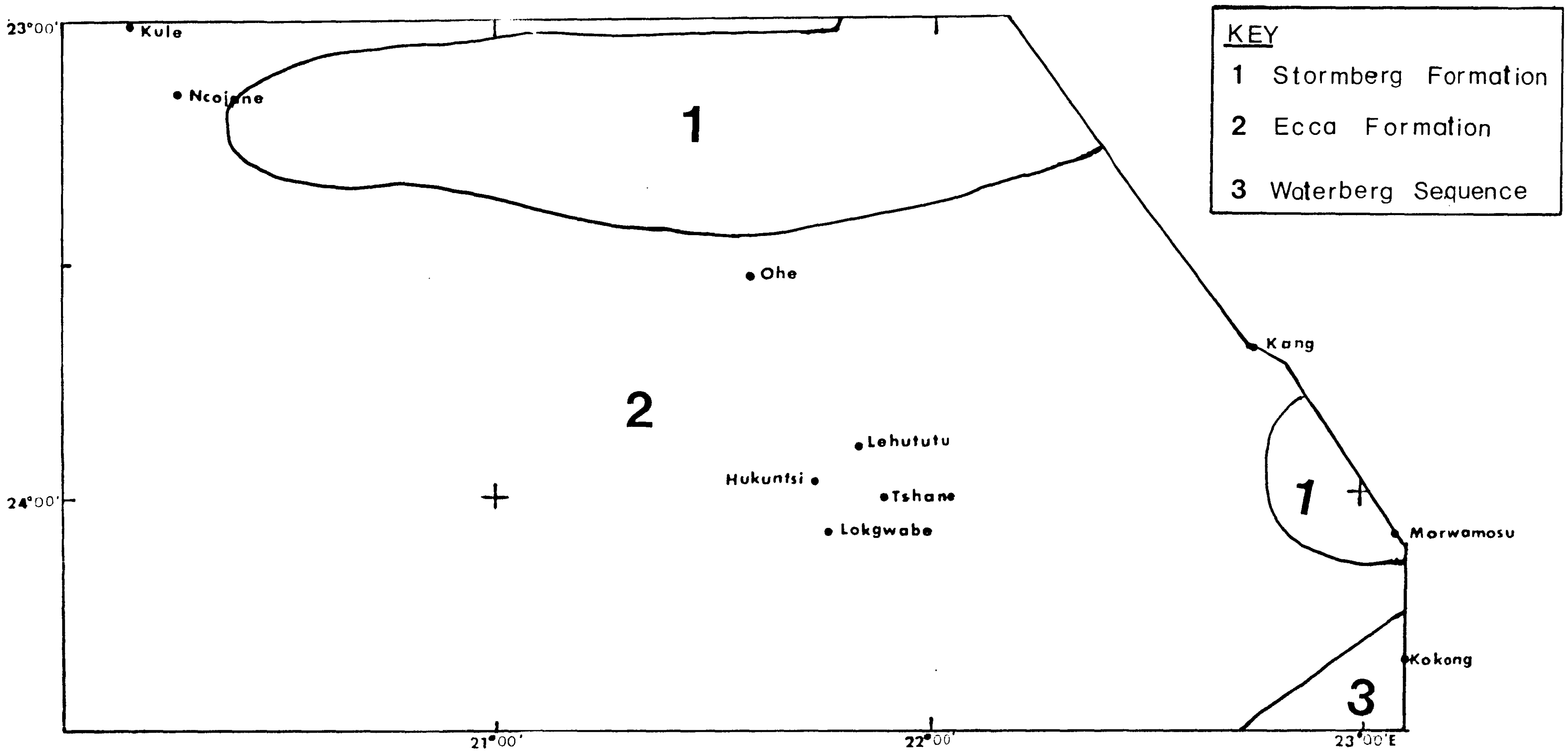

FIG. 2.4 Presumed Extent of Geological Formations, Western Central Kalahari

tended to be deduced from samples and data obtained from boreholes drilled for various purposes, as well as from observations along incisions left by fossil rivers.

The overall thickness of the Kalahari sand cover varies quite considerably. There is also a marked inhomogeneity in both vertical and lateral planes. The thickness ranges from less than 10 metres to over 150 metres depending on the underground pre-deposit relief structure.

The basal material in the deepest layer in this Kalahari depositional sequence appears to be gravels mixed or overlain at irregular intervals by marls and red calcareous clayey sands. Marls of this nature are usually close to ancient drainage lines directly overlying the Karroo rocks.

The middle layer is varied but is mostly calcified and silicified sands mixed with sandstone intermixed with silcretes and calcretes. The thickness of this layer also varies, but calcretes and silcretes where developed, may attain thicknesses of 20 to 30 metres. The mode of development of these calcretes and silcretes remains one of debate, with current opinion favouring intra- depositional formation from movements of waters rich in carbonates, as opposed to the other opinion of lacustrine depositional origin (Farr *et. al* 1981).

The top-most layer, overlies the calcified and silicified middle layer. It is made up of reddish-brown and greyish white sand. The most predominant is the reddish-brown sand, the reddish colouration being a coating of an iron oxide around sand grains. The greyish-white sands are a result of bleaching when this iron oxide is reduced in a moist environment. This layer is widespread, also varies in thickness and is usually calcretised where it meets the middle layer and other lower lying parts. The highest thickness is mostly associated with ancient drainage lines which have been filled up (Boocock and Van Straten 1962). The sand particles are fine grained and almost uniform (0.15 to 0.25mm in diameter), are generally loosely compacted, and display evidence of some distribution by water and other fluvial processes (Farr *et. al* 1981).

The depositional period for the Kalahari sands is estimated as from 60 million years ago during the Cretaceous period to recent times. The origin of the sequence has also been related to the changing phases of major geomorphological periods during which there were also cycles of climatic changes leading to erosional processes (Grove 1969). The most recent deposits are those on *mekgatsha*. These *mekgatsha* have sequences of layered calcrete often silicified on the flanks and valley, and often mixed with gravels and other fluvial material deposited by the river. These riverine sequences have been recently dated to and beyond the Quaternary Age (Farr et. al 1981).

2.3.4 Hydrogeology.

2.3.41 General: The study area experiences very low annual rainfall of about 250mm to 300mm per annum on average (see section 2.4.21). Because of the thick soft Kalahari Sand Beds, any showers that fall are soon absorbed. No surface run-off occurs except on lower slopes of pan depressions where surfaces are harder. This surface flow collects on the pan floor as surface water. The quantity is related to the amount of rain that has fallen.

Outside the periphery of the pan the soils absorb the rain water. However, since the soils as described by Leistner (1967) for Southern Kalahari and DHV (1980) for Central Kalahari become finer with depth, this fineness acts as an argillaceous barrier and retards infiltration to greater depths. Thus, whatever rainfall there is, its contribution to ground recharge is minimal and may be non-existent in a lot of areas. In such areas sources of aquifer recharges are apparently located further away from where such underground water is tapped by an open well or a borehole. Various stratigraphical units have varying water-bearing properties and those found in the study area are reviewed below.

2.3.42 The Kalahari Beds: Since deeper soils of the Kalahari Beds do not allow water to infiltrate to considerable depths, water trapped in the upper coarser layers of this unit is lost again to the atmosphere through evapo-transpiration (Boocock and Van Straten 1962, Hyde 1971). Thus the Kalahari Beds do not appear to contain aquifers of significance. However, in the *mekgatsha*, water may be found where it rests between Kalahari sands and basement rock, especially if the latter is impervious. Sip-wells, found in parts of the study area, occur in sand depressions under possibly similar conditions as for *mekgatsha*, except in these cases the sand cover has to be thin to allow infiltration to base rock level where water stays perched.

The only exceptions to poverty of Kalahari Beds as aquifers is around some pans where there are calcareous sandstone and calcrete outcrops allowing infiltration to greater depth. Boreholes and open wells on these aquifers can provide reliable yields over a long period of time.

2.3.43 The Karroo Sequence: The Cave Sandstone and the middle Ecca are two important Karroo aquifer bearing stages in the study area. The sources of recharge are, however, not fully known, but they are believed to be usually further away from the locality of the stages and are also believed to be calcareous sandstone or calcrete sites (Boocock and Van Straten 1962).

The middle arenaceous layers of the Ecca are the best aquifers with generally potable water. The borehole at Morwamosu on the eastern edge of the study area, about 170 metres deep and about 20 years old now, terminates in this layer (Hyde 1971).

2.3.44 The Waterberg Sequence: The sandstone/quartzite members of this sequence are significant aquifers. In areas where these outcrops occur or the rock is at shallow depth both the quality and quantity have been good, otherwise at greater depths these characteristics deteriorate. This sequence occurs in the Kokong-Mashiaphotshane area on the southeastern edge of the study area.

2.3.45 Water quality: According to Boocock and Van Straten (1962), the quality of the Kalahari groundwater is divided into three groups:

(i) Group A, which has fresh to slightly mineralised sodium bicarbonate water, is found in the calcrete/silcrete levels, in the middle Ecca and Cave Sandstone basalt aquifers of the Karroo sequence, in the aquifers of the Waterberg Sequence and in the Ghanzi Group. Boreholes which yield water of Group A are thought to be near sources of recharge.

(ii) Group B has waters which are slightly to heavily mineralized with magnesium and calcium salts. This group is encountered near pans, in the middle Ecca sandstone layers west of Kokong and in some areas underlain by the Upper Ecca Stage beneath the Kalahari sands. Waters of this group, according to Hyde (1971) are probably very old, receiving little or no present day recharges.

(iii) Group C has waters rich in sodium carbonate salts and is usually found near pans and old drainages.

Groups found near pans, may occur at shallower depths and may be reached by open wells usually at depths of about 15 metres or shallower.

2.3.5 Soils.

Several surveys have been done on the soils of the study area (see Baillieul 1975, Eldridge and Bulawa 1978, DHV 1980 Vol. II). Eldridge and Bulawa however, studied only the area around the Matsheng Villages and produced a soil map of the area.

To the south, outside the study area, Leistner (1967) studied soils of the Southern Kalahari. He divided the soils of that area into two broad groups, each with its own sub-groups.

(a) The first group was the *Fine Soils* with sand composition of 40% to 85% and grain size of 2.0mm down to 0.02mm. This group was composed of:

(i) Pan soils with pH $>$ 9 and

(ii) River soils with pH $\leq$ 9

(b) The second group was the *Sandy soils* with sand composition of 86% to 99% and grain size larger than 2.0mm. This group was composed of:

(i) White sand with up to 0.5% calcium

(ii) Pink sand with up to 0.05% calcium and

(iii) Red sand with up to 0.02% calcium.

The *fine soils* occurred in river beds and pans with their deposition and consolidation brought about mainly by water from the surrounding generally higher land. The fine soils found on the commonest type of pan, the calc-pan, a pan with bare white floor, had pH of above 9. This extremely low acidity was due to high concentration of salts. These soils were greyish-white in colour, hard, poorly drained, almost impenetrable, rich in potassium (0.076%) and phosphorus (0.033%) and high in magnesium (0.43%), and calcium (0.63%). The fine river soils were greyish brown, compact (but less so than the pan soils), poorly structured, poorly drained, rich in phosphorus (0.032%), potassium (0.028%), high in magnesium (0.38%) and calcium

(1.67%) with a high pH of 8.7.

The *sandy soils* were the commonest, and they covered about 90% of the Southern Kalahari. They were pinkish to brownish-red. The whitish soils that resulted from reduction of iron oxide of brownish-red soils, had 0.4-0.5% available calcium, and had high percentages of phosphorus and potassium, whereas the red soils had a neutral pH value, were low in mineral and organic content, had calcium content of less than 0.02% and a clear deficiency of phosphorus.

However, the sandy soils, because they were coarser, allowed infiltration of water to slightly deeper levels. In comparing the soils from the dune crests with soils from dune valleys, a difference in degrees of coarseness was noticed. The dune crest soils were coarser and allowed more infiltration than the less coarse valley soils. The dune slope soils were intermediate between the two.

The DHV (1980 Vol II and VII) study showed that the soils of the Central Kalahari (inclusive of the study area), were closely similar to soils of the Southern Kalahari when colours were similar. The red, pink and white or greyish soils described in Southern Kalahari are prevalent in the study area.

Eldridge and Bulawa (1978) and Mafoko and Kgatlwane (1984 pers. comm.) identified soil groups using the FAO/UNESCO grouping system within the Matsheng Village area. Soils identified by these investigators were similar to those identified by Leistner (1967) for Southern Kalahari and by DHV (1980 Vol II and VII) for the rest of Central Kalahari covered by their study.

The soils of both the study area and the Southern Kalahari fall within the Sand Area III of Baillieul (1975). Soils of this Sand Area III have been described as almost pure quartz. Their origin has been identified as the underlying Karroo Cave Sandstone (Leistner 1967) and according to Baillieul (1975) are produced *in situ* rather than imported from elsewhere.

From the foregoing, it may be concluded that the soils of the study area, and indeed of the whole western and southwestern Botswana, are mixed and similar over the whole region as confirmed by similar findings by different investigators. Basically the pans and river valley soils are finer, white to greyish brown with higher concentrations of calcium, magnesium, phosphorus, potassium and sodium. The bleached greyish soils have the next highest (descending) mineral concentrations, and the red soils have very low concentrations or deficiencies of these minerals.

2.4 CLIMATE

2.4.1 Past.

The past climate of the Kalahari has been referred to by Wayland (1953, 1954), Boocock and Van Straten (1962), Grove (1969) Lancaster (1974, 1978) and by Baillieul (1975).

Evidence of palaeoclimatic conditions is given by presence of pans, *mekgatsha* (fossil river courses) and sand-dunes. All the three land features were formed under varying climatic conditions. In the Pleistocene the Kalahari varied from an excessively wet and cold climate to relatively dry conditions. According to Grove (1969), two periods of aridity were separated by a major wet period in this area during the later Quaternary. During the arid period sand-dunes were formed by the then prevailing winds. The formative winds for the transverse sand ridges blew in directions perpendicular to the ridges in this case mainly from the north and northwest, while the non-directional sand-dunes were possibly formed from local wind turbulences with the source material being the local basal rock formations.

The now-fossil river courses were formed during the wetter period. Grove (1969) has argued that the Molopo river in the south, fed by the "fairly extensive ancient north bank tributary drainage system" must have carried a much greater volume of water as evidenced by gorges it cut through the tough, banded ironstones and schists near "Pitsani" (must have meant Phitshane-Molopo), and a 30-metre-deep trench it cut into the quartzite rocks near Khuis.

North of the study area, the now-dry Okwa river is also associated with long fossil tributary courses (*mekgatsha*) some originating from the Schwelle in the study area. The Okwa river flowed into the ancient lake which was apparently much wider than the area now occupied by the distinct Makgadikgadi Salt Pans, over 300 km away in northeastern Botswana.

Pans, which pock-mark most of the study area, are fossil remnants of ancient, either localised or sand-choked tributary systems of both the Okwa and Nosop-Molopo river systems. The maintenance of these depressions as water bodies occurred during wetter periods of low temperatures, minimal evaporation, and higher rainfall while their formation occurred during the prior arid period in the Pleistocene (Lancaster 1974).

Further evidence for past wetter climatic conditions has been adduced by Cooke and Baillieul (1974) for northwestern Botswana, further north of the study area where their study of caves of the area also showed evidence of possible past alternating wetter and drier periods in the overall region of northwestern and Western Botswana.

2.4.2 Present.

2.4.21 General: The present weather patterns prevailing in the Western Central Kalahari can best be discussed in relation to the climatic conditions prevailing over all of Botswana and the Southern African sub-continent.

The present climatic conditions of Botswana have been discussed by several authors. Andersson (1969), Pike (1971) and Tyson (1978) have discussed the general regional climatic patterns with direct influence over Botswana, in the southern African sub-continent. Andersson (1971) has discussed the effect of insolation in Mahalapye and Ghanzi, in the eastern and western Botswana respectively, while Brown (1974) has discussed the climate and climatic trends in the Ghanzi District, and Cooke (1978b) the past and present climatic changes in Botswana. According to these authors, the generalised picture, discussed below, of the present climate of Botswana emerges.

2.4.22 Rainfall, its Causes and Distribution: Eastern Botswana receives slightly higher rainfall than the west, because of the influences of the moist winds associated with the movement of the **Indian Ocean Anticyclone.** These winds originate from the moisture-generating warm Agulhas Current washing the southeast coast of South Africa. The Limpopo river area in eastern Botswana forms the approximate terminus for this Anticyclone although its effects naturally extend further west of the Limpopo. This northward movement of this Anticyclone occurs in winter. Associated with this winter movement are the winter rains in the Southern Cape (Pike 1971) of South Africa.

The central part of Botswana is influenced by the **Continental Anticyclone** originating from the northern tropical inland region. Because of this inland and continental origin, the northerly and northwesterly winds, arriving in the central western and southern parts of the country carry very little moisture, most of it having been deposited as rain in the nothern part of the country. Thus rainfall in the centre and west of the country is less than in the north and east.

The western part of the country is influenced by the cold **Atlantic Ocean Anticyclone.** This Anticyclone results from the cold Benguella Current washing the southwest coast of Namibia. Winds associated with this Anticyclone are cold and dry, and carry that spell inland into Western Botswana. Rainfall from that source is practically non-existent.

The rainfall picture, then, is that of a diminishing sequence as one moves from the east to the west and from the north to the south. This pattern is shown by the rainfall distribution map on Fig. 2.5 and the distribution figures for some locations in the country given in Table 2.2.

Pike (1971), in recognition of these in-country regional differences, divided the country into three rainfall zones:

(1) the **Northern Zone**

(2) the **Eastern Zone**

(3) the **Kalahari Zone.**

The **Kalahari Zone** he defined as covering the central, western and southern regions of the country. This Zone, he indicated, was an extension of the arid zone of the northern cape and of southern Namibia. Rainfall in this zone was highly variable with the annual coefficient of variation ranging from 50 to 80 percent, and mean annual totals of between 250mm and 350mm.

Most of the rainfall occurring in Western Botswana is likely to be from the tail-end portions of the higher moisture content winds from the east and not much from the north, west or south. According to Brown (1974) moist air enters the Kalahari from the northeast but having originated from the Indian Ocean Anticyclone in the east and deflected by the Drakensberg Mountains. He also notes that generally very little rain falls in winter in Western Botswana. These minimal

TABLE 2.2 Mean Annual Rainfall at Several Stations in Botswana
(Figures from Cooke 1978, DHV 1980, MFDP 1980)

Station	Location in the Country	Mean Annual Rainfall (mm)	Long Term Norm (mm)
Kasane	Northern extreme	688	700
Gaborone	Southeast	518	514
Ghanzi	West	401	415
Tshane	Western Central Kalahari*	308	335
Tsabong	South	249	251

*study area

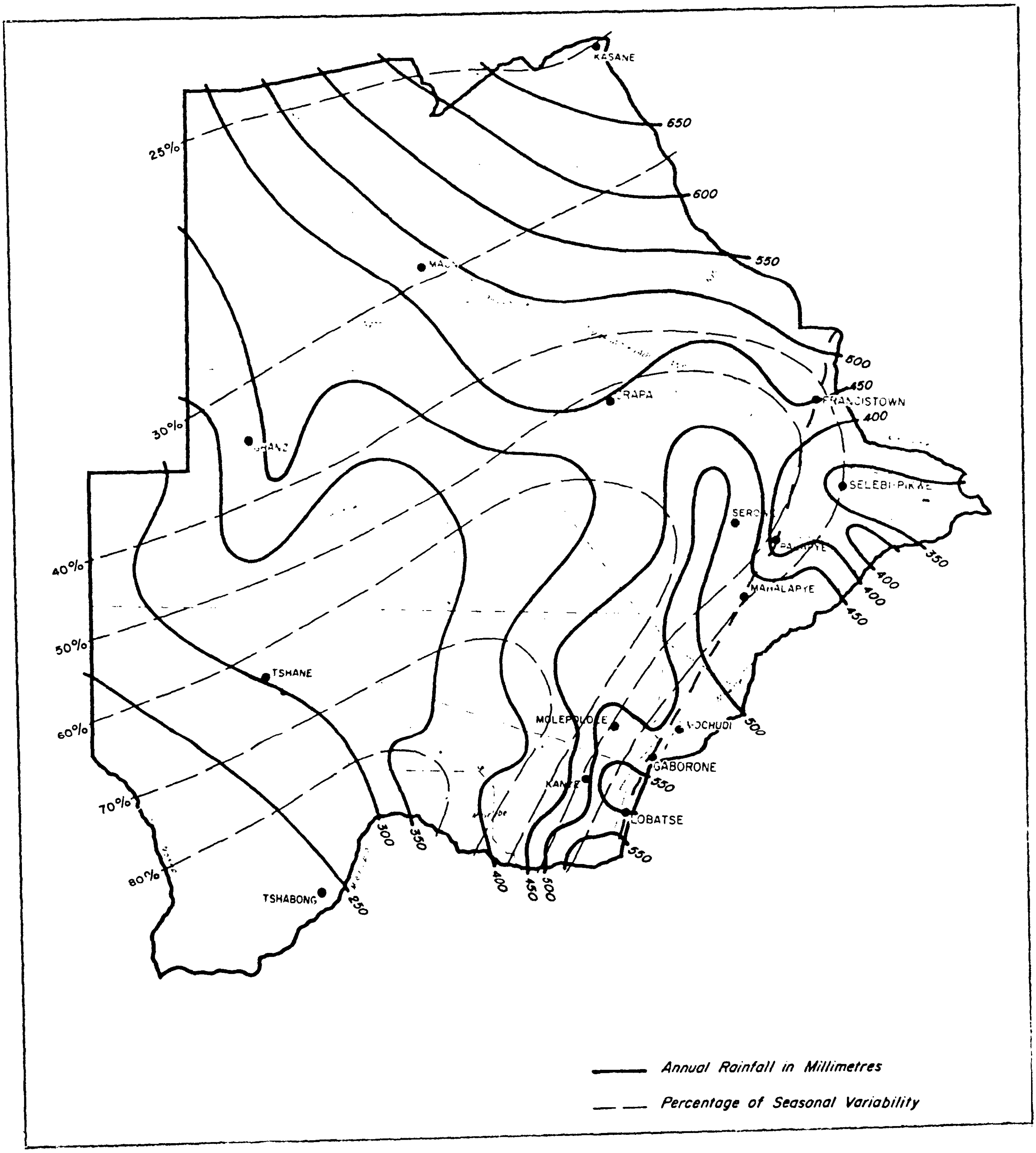

FIG. 2.5 Rainfall Distribution in Botswana
(from MFDP 1980)

winter rains are a result of strong depressions from the South Atlantic which move through the Cape in South Africa and penetrate the Kalahari region from the south. The rains are, however, very minimal and highly infrequent, most of them having fallen in the Southern Cape.

No systematic studies of the present climatic conditions seem to have been made of the study area although some indirect observations on the area, as already indicated, have been made by some investigators while pursuing studies elsewhere or on some other topic such as by Zumer-Linder (1976). This may partly be because only one meteorological observation stations exist there (Tshane), or because this marginal area is of little interest to agricultural planners. In this area, therefore there is paucity of up-to-date information on rainfall patterns and the dynamics of local atmospherics. To what extent do the local weather conditions contribute to the overall prevailing-wind-brought rainfall? Cooke (1978b) appropriately notes that there are substantial local variations in rainfall and these cannot be revealed by inadequate rainfall recording stations in the country.

The nearest area to the study area that has been directly studied is the Ghanzi District (Brown 1974). That study gives an insight into what may be happening in the rest of Western Botswana.

In the Ghanzi District, Brown (1974) says rain normally falls in short convection storms. Convection storms are created by differential heating of the air masses, which if laden with moisture may lead to formation of clouds and rainfall during the cooler parts of the day. Although these storms are very localised, they often give up to one third of the total annual rainfall in a single downpour. Because of variability in convection heating and moisture content of the air, rainfall totals are very erratic within that district. In comparing five stations in Ghanzi, over a six year period, he showed that annual totals could differ even between stations twenty-five kilometres apart such as between Ghanzi Town-station and Oakdene. This demonstrates the importance of local convection storms and the understanding of local atmospheric dynamics if reasonable long term planning is to be initiated.

In analysing the Ghanzi rainfall trends since 1922, Brown (1974) found no readily detectable trend in increasing or decreasing rainfall up to the early 1970s. The ten-year running mean analysis, however, showed that rainfall totals were decreasing. However, Tyson (1978), after analysing data for over sixty stations from 1910 to 1977 over the Southern African sub-continent, was able to predict that the wet spell of the seventies would continue with diminishing average yearly rainfall until about 1982, or 1983 in the sub-continent. This confirmed the observed decrease in Brown's ten-year running mean rainfall analysis for Ghanzi. Tyson further predicted a dry spell would follow the wet spell of the seventies, continue until about 1992 and thereafter another wet spell until the end of the century.

While the Ghanzi study may not strictly be used as representative of the rainfall position in the Western Central Kalahari study area further south, it at least can be used as a general guide to what may be expected in the study of rainfall patterns in that part of the country.

All in all, the following conclusions are drawn from the foregoing review of rainfall status in the country:

(1) most rain falls in the whole of Botswana in summer to early winter (November to April/May);

(2) there are marked differences in the distribution of rainfall in the country; the west gets less rainfall than either the east or the north;

(3) there is a high degree of rainfall unreliability and variability in the west, even over relatively short distances making short-term rainfall predictions difficult;

(4) rainfall quantities are low, the wettest part of the country (Kasane) receives an average of about 690mm per annum, while Tsabong, the driest at present receives approximately 250mm per annum;

(5) the rain is of poor quality in that it may fall in isolated thunderstorms of short duration and highly localised, instead of being evenly spread out both spatially and temporally over the rainy season;

(6) In Western Botswana localised thunderstorms probably play an important role in the overall rainfall budget of the area.

2.4.23 Temperature: Botswana's temperatures are highest in summer and lowest in winter. In Western Botswana frosts are common in winter, while summer daily maximum temperatures may rise to 39° C.

The influence of insolation has been examined by Andersson (1971) for eastern and western Botswana. He examined the records for Mahalapye in Eastern Botswana, and Ghanzi in Western Botswana. He found there was general increase in temperatures at both localities between 1921 and 1946. At Ghanzi, from 1951 to the early 1970s, the mean maximum temperature had risen by between 0.7° C and 1.0° C. This period coincided with the increase in cattle farming operations in Ghanzi. He suggested the increases in Ghanzi temperatures were as a result of exposure of more soil through grazing by livestock. Such general increase in mean temperatures meant plants including grasses were under increased heat stress. This was likely to affect grass growth, and further the high temperatures from the bare soils were likely to affect the neighbouring grass covered area, apparently in the form of a heat wave, contribute to the plant stress and eventually change the structure of such plants and grasses. Zumer-Linder (1976), in a brief twelve-day field study in September 1972, found that at a height of 2cm above ground level, temperatures near Tshane rose to an average daily maximum of 48° C on bare ground and 35° C under bush cover thus supporting Andersson's contention about the relationship of ground cover and temperature gradients.

Brown (1974), found that in Ghanzi November was the hottest month with the mean daily maximum of 33° C. At Tsabong, the hottest month was January with a mean maximum of 34.5° C. The coldest month in both Ghanzi and Tsabong is July, with a mean daily minimum of 3.8° C and 0.9° C respectively. Most winter nights in Ghanzi were calm and cloudless and under such conditions, temperatures at ground level tended to be much lower than at a height of 1.2 metres the height at which official measurements are taken. Ground frosts were therefore likely to be more common than observed by official measurements.

In his examination of temperature trends, Brown found the mean annual temperature in Ghanzi showed an increase of 1.6° C over the period of the records (1922 to the early 1970s). This also confirmed observations made by Andersson (1971) for the same place. The years covering 1940 to 1960 had a more extreme temperature range (up to

32.2° C) more than other years which averaged out at 29.4° C. Brown explained these increases in terms of their association with extreme continentality and a more stable high pressure, while Andersson (1971) explained them in terms of increased soil temperatures resulting from more exposure of soils through cattle grazing. An apparent anomaly was identified in Brown's explanation when he postulated that marked changes such as he observed should coincide with periods of decreased rainfall. But the observed rainfall for 1940 to 1960 was on the whole wetter than other periods. He could not explain the anomaly either by the ten-year running mean temperature analyses for the summer and winter half-yearly periods, because the overall annual trends and increased range were reflected in both winter and summer temperatures. However, if man's influence on the grass cover through denudation of grasses and exposure of more soil by livestock in the Ghanzi District, as postulated by Andersson (1971) for the same place and practically the same period, is considered, Brown's paradox is partly resolved. The bare soils could heat up to higher temperatures in between the infrequent and generally low rainfalls (which occurred over an average period of about five out of twelve months), and create a net increase in mean temperatures despite the generally and comparatively wetter environment observed by Brown (1974). Indeed the observations by Zumer-Linder (1976) for the month of September in 1972 proves this, for September is by no means the hottest month in either Ghanzi, Tshane or Tsabong and yet temperatures of 48° C and 35° C were recorded for it near Tshane on bare ground and under bush cover respectively. That man's action can affect arid micro-climates is also demonstrated by Cooke (1978b) who gives examples from the Middle East. In this context, therefore the overall rise in temperature in that area may be blamed on the form of land use that removed a lot of especially herbaceous plant cover and exposed more bare soil.

2.4.24 Cloud Cover, Evaporation and Humidity: Western Botswana generally has cloud free-skies. Most cloud cover occurs in summer, but winters are predominantly cloud free.

Potential evaporation greatly exceeds precipitation. In Ghanzi, the peak evaporation month is October and this coincides with high temperatures, while in Southern Kalahari the peak evaporation month is January, the hottest month. The corresponding average annual evaporation figures from a free-water surface are approximately 2840mm and 2500mm for the two areas respectively.

The average annual relative humidity in Southern Kalahari ranges from about 50 per cent to 60 per cent at 0800 hrs in the morning and 25 per cent to 30 per cent at 1400 hrs in the early afternoon, while in Ghanzi at 0800 hrs it is about 61 per cent and 31 per cent at 1400 hrs. In this respect the two areas are almost identical. In Southern Kalahari, the highest relative humidity values are recorded in June and the lowest in October. In this area, humidity is generally highest at sunrise. During summer, when there are rain showers, humidity is usually 50 per cent to 60 per cent but never exceed 80 per cent in the Southern Kalahari (Leistner 1967). At Ghanzi, on some March nights, relatively moist air is cooled to below dew point and both dew and fog may form and persist into the early morning. The importance of high relative humidity and dew to aridland animals is shown in Chapter 7.

2.4.25 Winds: Winds blow in Ghanzi mostly from the east (18%) with diminishing frequency from the northeast (12%), the north (10%) and with least frequency from the west (2%). The easterly wind is the strongest.

In the Southern Kalahari, the dominant winds are the northwesterlies (Leistner 1967). They blow with the greatest frequency and violence during August and September. This is the time when vegetation is driest and subject to wind erosion. These winds are dry.

2.4.26 Summary: The climatic conditions prevailing in the study area are little known. It is however, in between the Southern Kalahari and Ghanzi District both of which have been studied. It may thus be presumed to form a transition between the two with its northern portion more under the influence of the Ghanzi conditions while the south would be more under the influence of conditions prevailing in the Southern Kalahari. The data obtained for the study area by the present study is presented in Chapter 5.

The neighbouring Southern Kalahari and Ghanzi are relatively dry with low and highly variable rains. They have high summer and low winter temperatures. Evaporation greatly exceeds precipitation and relative humidity is low. Winds, because they are generally dry, enhance evapo-transpiration.

2.5. VEGETATION

The vegetation of Botswana with specific reference to the study area has been covered by Weare and Yalala (1971) in their provisional vegetation map of Botswana, by Field (1976) concentrating on Botswana grasses, by Timberlake (1980) concentrating on Botswana acacias and by Skarpe (1981) in her range ecology project for Western Kalahari based in Ncojane Ranches. Leistner (1967) has also discussed the vegetation of the adjoining Southern Kalahari to the south of the study area.

The study area falls within two vegetation types zoned by Weare and Yalala (1971) as Southern Kalahari and Central Kalahari Bush Savanna. It will be shown later that the vegetation type classification that could best fit the area is Tree Savanna and not Bush Savanna. The vegetation of the study area will be described and discussed in Chapters 3 and 5 and Appendix 1.

2.6 ANIMALS

2.6.1 General.

The study area abounds in large numbers of big wild animal species. The big carnivores include the lion *Panthera leo*, the leopard *P. pardus*, the spotted hyena *Crocuta crocuta*, the brown hyena *Hyaena brunnea*, the cheetah *Acinonyx jubatus* and the wild dog *Lycaon pictus*. The big herbivores include the Cape eland, the gemsbok, the blue wildebeest, the red hartebeest, the kudu and the springbok. The antbear *Orycteropus afer* is also found in this area.

The big birds are the ostrich and the Kgori bustard *Ardeotis kori*.

In addition to these big animals are small animals both diurnal and nocturnal, ranging from the black-backed jackal *Canis mesomelas* to the mole rat *Cryptomys* species.

A countrywide inventory and distribution of the animals found in the study area have been given by Smithers (1968, 1971). No ecological studies have been made of the small animal communities of the area and of some of the big mammals. DHV (1980) studied several big animal species and compiled some data on their numbers and distribution. Their population estimates are given in Table 2.3. To be noted in relation to Table 2.3 is that the area covered by Central Kalahari for

TABLE 2.3 Merged Population Estimates for Central Kalahari
(from DHV 1980 Vol IV)

Species	Population estimate	Variance	Std Error	95% Confidence limits
Hartebeest	269,182	1.29×10^{9}	3.12×10^{4}	± 26%
Wildebeest	257,184	9.64×10^{8}	3.58×10^{4}	± 24%
Gemsbok	54,125	2.16×10^{7}	4.65×10^{3}	± 17%
Ostrich	56,930	2.76×10^{7}	5.15×10^{3}	± 18%
Kudu	4,841	5.90×10^{5}	7.86×10^{2}	± 31%
Duiker	3,620	3.99×10^{5}	6.32×10^{2}	± 34%
Steenbok	1,584	2.40×10^{5}	4.90×10^{2}	± 61%
Warthog	878	3.06×10^{4}	1.75×10^{2}	± 39%
Eland/ Springbok	No data available			

which DHV information is given is more than four times, and includes, the study area. The data includes the duiker *Sylvicapra grimmia*, steenbok *Raphicerus campestris* and warthog *Phachochoerus aethiopicus*.

Further west in neighbouring Namibia, Shortridge (1934) compiled the distribution of Namibian big animals up to the international border in Western Botswana. Some of his information was updated by Bigalke (1958) and Joubert and Mostert (1975). In South Africa's Kalahari Gemsbok National Park to the southwest of the study area, several observations have been made of animal distribution and movements from as far back as 1959 and earlier (see Eloff 1959, 1961, 1962) to date (Hall-Martin 1985 pers. comm.).

Some big animals which used to exist in the area during the 19th century have since become extinct. In the 1830s, the following species existed from the upper to the lower reaches of the Nosop River as well as further inland into the study area: the elephant *Loxodonta africana*, the African buffalo *Syncerus caffer*, the giraffe *Giraffa camelopardalis*, the rhinoceros (probably black *Diceros bicornis*), the zebra *Equus burchelli* and the impala *Aepyceros melampus* (Campbell and Child 1971). The major causes of extinction were apparently hunting and the drying up of the river and subsequent change in habitat, as riverine vegetation was replaced by more arid vegetation.

Further into the study area, the springs that existed at some pans must have also supported some of these species. Although some of these springs still exist they are inaccessible to wild animals because the sites are now settled (see Chapter 5). During the field work of the present study, in November 1983, elephant bones were recovered by the author from Hukuntsi pan "dam" in the Matsheng Village area when the dam was being excavated under a local village project. The author also received reports in Kalkfontein (Tsootsha), north of the study area, that elephant bones have also been found in the dry mudpool on Kalkfontein pan.

2.6.2 Some Notes on the Animals being studied

2.6.21 **Cape Eland.**

Local name: *Phofu* (ph pronounced like p in powder)

Identification: The Cape eland is a light fawn to greyish fawn antelope standing approximately 200cm at the shoulder. It is the

largest of the antelopes but agile. It is able to jump obstacles 250cm high from a standing start (Smithers 1971, Morris 1980).
Habitat: The eland utilises light to open woodland, dry valleys, open plains, bush savanna and scrubland (Smithers 1968, 1971, Hanks 1974). It is said to avoid wetlands and heavily populated areas.

Food and feeding habits: The eland is predominantly a browser but will graze when grass is fresh and sprouting. It browses mainly *Acacia*, *Grewia*, *Commiphora*, and *Terminalia* species. Under domestication in Zimbabwe, the eland has been known to use a wide range of vegetation for food, for example weeds like marigold *Tagestes minuta*, black jacks *Bidens pilosa*, morula fruit *Sclerocarya caffra*, wild oranges *Strychnos* etc. (Smithers 1971). In Botswana it has been observed feeding on tsamma melon *Citrellus lunatus*.

It also uses its hooves to dig for bulbs and tubers as well as its heavy horns for breaking off twigs by twisting (Bramwell 1973). The plant species whose fruits, bulbs, roots and tubers it is known to use include the *Citrellus* species (fruits), *Cucumis* species (fruits, roots and tubers), *Elephantorrhiza* (roots), *Crinum* (bulbs) and *Oxygonum delagoense* (stems and leaves) (Smithers 1971). These fruits, bulbs, roots and tubers are rich in water and provide the eland with its water requirement.

It has also been observed to eat soil from salt licks on pans (Parris 1976).

Breeding: The eland bears one young per birth after a gestation period of about nine to ten months. The peak breeding months for domesticated eland in Zimbabwe were found to be August and September, while in the wild in Botswana, juveniles have been observed in February, March, June, July and August (Smithers 1971).

Utilisation: The domesticated eland has been exploited for meat, milk and hide in Zimbabwe for about thirty years now and in the Ukraine USSR for almost a century (Carr 1964). In the wild, it has been hunted for trophy, meat and hide.

2.6.22 Gemsbok.

Local name: *Kukama*

Identification: The gemsbok has a pale yellowish grey coat with black and white marks on the legs and the lower body. It has long straight horns with rough almost circular rings around them. The horn tips are very sharp. It is the largest of the oryxes standing 120cm at the shoulder and weighing approximately 200 kg (435 lbs) (Smithers 1971). It is the only oryx subspecies in Southern Africa.

Habitat: The gemsbok uses open grassland plains, open bush savanna to light or open woodland (Smithers 1971, Hanks 1974). It is well adapted to arid and semi-arid conditions as it can go without drinking water for prolonged periods.

Food and feeding habits: The gemsbok is predominantly a grazer but will feed on succulent roots and tubers which it digs up and eats to also extract moisture. It also feeds on fruits of *Citrellus* species and fruits, roots and tubers of *Cucumis* species. Smithers (1971) found the stomach contents of the gemsbok having very high moisture content and no recognisable roots and tubers eaten. He concluded that the animal masticated these roots and tubers to an unrecognisable mass in order to extract the moisture.

The gemsbok also consumes soil from salt-licks on pans (Parris 1976).

Breeding: The peak breeding season is December to March but calves have been seen as early as August and September by the author. One young is born per birth.

Utilization: The gemsbok is hunted for meat and hide. It is also heavily sought after by trophy hunters for its decorative horns. Its East African subspecies, the fringe eared-oryx *Oryx gazella callotis* has been domesticated with success in Kenya, East Africa.

2.6.23 **Red Hartebeest.**

Local name: *Kgama.*

Identification: The red hartebeest has a reddish-fawn to reddish-brown coat. It is one of the large antelopes standing 120cm at the shoulder. The horns are not too long, they grow upwards and curve backwards.

Habitat: The red hartebeest utilises various habitat types. It uses dry flood plains and river beds, savanna grassland, open bush savanna and avoids thick woodlands (Smithers 1971, Kok 1975). It is well adapted to arid and semi-arid conditions. It is able to survive for prolonged periods without drinking water.

Food and feeding habits: The red hartebeest is mainly a grazer (Hanks 1974, Kok 1975). In Botswana, stomach contents have been found to consist only of grass (Smithers 1971). However, Van Zyl (1965) reported the stomach contents of the red hartebeest in Lombard Nature Reserve, South Africa having 55.6% grass and 44.4% browse. This has been disputed by Smithers (1971) and Kok (1975).

Kok (1975) recorded 36 species of grass utilised by the red hartebeest at one time or another during their growth stages.

The red hartebeest digs up and consumes succulent roots from which it also extracts moisture. It also digs up and consumes soil from salt licks on pans (Parris 1976).

Breeding: It bears one young per birth. The peak breeding season is between August and December (Smithers 1971, Hanks 1974). In the Kalahari Gemsbok National Park, Eloff (1959) recorded October and November as the peak breeding months.

Utilization: The red hartebeest is hunted for meat and skin. It is also hunted by trophy hunters for sport and trophies.

2.6.24 Blue Wildebeest.

Local name: *Kgokong*

Identification: The blue wildebeest, is a relatively big, dark silver-grey antelope standing 145cm at the shoulder (Hanks 1974). Its dark silver-greyish colour appears almost black from a distance. The young calves are light reddish fawn, the same colour as those of the hartebeest and gemsbok.

Habitat: The habitat for the blue wildebeest is open grass plains, dry valleys, open woodland and open bush savanna (Smithers 1971, Hanks 1974). Of the aridland dwelling antelopes, it is probably the least well adapted as it drinks water more frequently than either hartebeest or gemsbok.

Food and feeding habits: The blue wildebeest is predominantly a grazer (Smithers 1971, Hanks 1974). Although not necessarily a selective grazer, it prefers flushing green grasses. It also consumes soil from salt licks on pans (Parris 1976).

Breeding: The breeding season has its peak between November and March. One young per birth is produced.

Utilization: The blue wildebeest is hunted for meat and hide. It is also hunted for sport and trophies by sport hunters.

2.6.25 **Springbok.**

Local name: *Tshephe* (Tshe- is pronounced as T-s-e, ph as p)

Identification: The springbok, is a medium sized antelope standing 75cm at the shoulder. The underparts, lower rump and the face are white, the sides are reddish-brown and the back is rufous fawn. It is the most southerly representative of the gazelles (Carr 1964).

Habitat: The springbok favours open bush savanna, grass pans and open grassland (Smithers 1971). It avoids thick woodlands.

Food and feeding habits: The springbok is a mixed feeder. It will browse mainly where there is greater browse and graze where there is mainly grass. It eats fruits of *Ziziphus mucronata* and *Solanum* species, pods of *Acacia hebeclada, A. mellifera* and *A. erioloba*. It eats succulent roots, bulbs and tubers which it digs up with its hooves. These succulent plant parts also provide it with moisture (Smithers 1971), and like the gemsbok it is probably one of the best adapted to arid and semi-arid conditions as it can go for prolonged periods without drinking water. The springbok also eats soil from salt licks on pans (Parris 1976).

Breeding: The peak breeding period is August to January. The springbok bears one young per birth.

Utilization: It is hunted for meat and skin. It is also hunted for sport and trophy by sport hunters.

2.6.26 **Kudu.**

Local name: *Tholo* (th pronounced like t in Tom)

Identification: The kudu, is a big antelope with a shoulder height of 150cm. The horns in males have an open spiral. The females do not have horns. The ears are big, and in females they easily dwarf the head when they are cocked sideways. The coat is fawnish grey. The kudu runs with a laboured gallop.

Habitat: The kudu favours woodland and thickets, the nature of the terrain being unimportant as the species may also occur on both hilly and flat open land with thickets.

Food and feeding habits: The kudu is predominantly a browser but will feed on herbaceous plants depending on the season. When herbs and grasses are growing and green, kudu will feed on them more if there are poor browsing conditions. The relative amounts of either browse or grass eaten are related to prevailing local conditions (DHV 1980 Vol. V). The browse species include the *Acacias, Terminalias* and *Boscias*.

Kudu has been observed consuming soil from salt licks on pans (Parris 1976).

Breeding: Breeding in kudu possibly occurs throughout the year with one young given per birth (Smithers 1971).

Utilization: The kudu is hunted for meat and skin. The horns are a much sought-after trophy by sport hunters.

2.7 LAND USE PRACTICES

2.7.1 General.

The traditional human land use practices in the study area have been:

(i) hunting and gathering;

(ii) establishment and maintenance of settlements;

(iii) pastoralism;

(iv) arable agriculture;

Although these practices continue even to date, they have been significantly changed in many cases.

The environmental impact of traditional land use systems and modern land use practices will be examined in Chapter 5. This section is meant to review the history of the traditional practices only.

2.7.2 Hunting, gathering and nomadism.

The Basarwa (Bushmen), the oldest practitioners of nomadism, were the first known occupiers of the Kalahari, with all other tribes being recent arrivals (see Section 2.7.3 below). They kept no livestock and they obtained their food by hunting and gathering.

Hunting provided animal meat protein. Wild foods gathered were mainly edible tubers and roots, wild melons and cucumber, fruits of *Grewia* species, *Ziziphus mucronata* and others. Their hunting methods included the use of pitfalls, spears, and bows and poisoned arrows. Hunting and gathering still continue today.

Apparently the nomadic movement was among other things, in pursuit of game as well as to harvest wild produce over a wider area to avoid localised over-exploitation. Plant foods were gathered during these movements. The limits of areas over which movement by members of a certain clan or tribe could take place were dictated by the extent of movement of other clans or tribes.

In addition to hunting and food gathering as a cause for movement, advantage was taken of rains when they filled pans with water. Temporary camps would then be established near these pans whose water and salt licks attracted wild animals. When water dried up and animals became scarce around the pan, the camp was moved, usually to a sip-well site, locally called *mamuno* (literally translating "the place where you suck water"). This practice continues even today but is now influenced by modern external pressures to settle. The nomadic life style of old has changed a lot. Basarwa settlement areas have been identified and supplied with boreholes, livestock, schools and clinics in the Ghanzi District. Within the study area, however, this has not yet been done although plans are afoot to do it. The Basarwa still practice their nomadic lifestyle in the study area.

The Ngologa arriving in the Kalahari in the late 18th century and during the 19th century found the Basarsa's nomadic life style useful for survival in the Kalahari and copied it. Since they kept low numbers of livestock nomadism did not present problems; in fact the need was even greater because, rather than look for feed for human consumption, they had also to look for feed and water sources for their animals. They are now settled in permanent villages where water and other facilities are provided. However some form of nomadism is still practised - people still take their livestock to pans away from settlements, when rain water is available in such pans; and livestock is also still taken to areas where tsamma melon is abundant at specific seasons to feed them on the melons.

2.7.3 Settlements.

The more recent human movement patterns to settle the Kalahari, and the socio-political structures used to manage the settlements, have been discussed by various authors, the most quoted being Isaac Schapera with publications from 1938 if not earlier. The more recent discussions are by Kuper (1970). Only aspects relating to movements and settlements and not the government structure, are considered here.

About the beginning of the 19th century, the Ngologa clan, the clan in the majority in Western Central Kalahari, arrived in the Matsheng cluster of pans - Lehututu, Tshane, Lokgwabe and Hukuntsi after sojourn in Ukwi, Ojwe and Nxang further northwest in the study area. They had originally settled the eastern part of Botswana around Kanye and Molepolole but had been forced out of those areas by oppression and subjugation from the more war-like recent arrivals in these former areas. The Ngologa arrived in the Western Kalahari with very few livestock.

No open wells existed and water was obtained from sip-wells supplemented by occasional rain water held by pans after rains. Because of this scarcity mainly of water, nomadism was practised and livestock populations remained low and had no major impact on the grazing resources. However, towards the end of the 19th century, through the influence of the Tlharo and Ngwaketse tribes from the southeast and east, the technique of sinking open wells and tapping slightly more reliable underground aquifers had been learnt. Availability of more reliable water sources for their livestock and themselves encouraged sedentarisation. These were new developments that paved the way for what now plagues the area - overgrazing and displacement of the wild animal populations.

By the early 20th century, the first signs of overgrazing were in existence immediately around the villages, that in 1904 Hodson, an explorer through the area found that his oxen could not recuperate at Lehututu because of lack of grazing in the vicinity of the village (Devitt 1971). Settlement in Kalkfontein to the north by emigrants from the Matsheng Villages had taken place as far back as about 1890, as a result of, among other things expanding cattle numbers and diminishing grazing resources. By 1915 Kule and Ncojane were settled.

In the eastern part of the study area, Kang according to local sources was used as a temporary settlement during hunting expeditions from both the Matsheng Villages and Kokong to the south. Kokong had been settled somewhat earlier than the Matsheng area by the Ngologa group that travelled directly west from near Kanye and Molepolole. Kang apparently became a permanent settlement at about the same time Kalkfontein was settled, and was apparently settled for the same reasons as Kalkfontein.

Some of the old settlements now almost completely deserted and now classified as temporary are Ukwi, Ojwe and Nxang.

2.7.4 Pastoral and arable practices.

Cattle rearing supplemented with goat and to a lesser extent sheep have been the historical pastoral activities of the residents of this area. Apparently, at initial settlement livestock were in very low numbers and during the nomadic lifestyle did not increase much. The numbers began to build up after sedentarisation around more reliable water sources. Although the problems of increasing livestock numbers and overgrazing around water-points which were the focus of the village were recognised and counteracted by emigration, they were merely transferred to new locations.

The other form of relief was by locating the cattle-posts further away from the villages, and utilising surface water on pans provided by occasional rains.

The livestock number per family varies. The majority, the poor (approx. 70%) possess below twenty cattle and the rich exceed two hundred head of cattle per family.

Arable farming, because of the aridity of the area, could only be subsistence. The combined effects of low and unreliable rainfall, and low fertility of the soils precluded large produce arable farming. Melons, beans, sorghum and maize (corn) are traditional staple food crops. The average area of a ploughing field per person is about one half kilometre by one half kilometre at most.