CHARACTERIZATION OF HUMAN INDUCED VEGETATION CHANGES IN FALGORE GAME RESERVE, KANO STATE

BY

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A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR' THE DEGREE 0F MASTER OF SCIENCE IN GEOGRAPHY (ENVIRONMENTAL RESOURCES MANAGEMENT).

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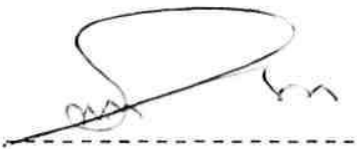
I hereby declare that this work was carried out by me. It has not been presented in any previous application for a higher degree. All quotations and sources of information are duly acknowledged by means of references.

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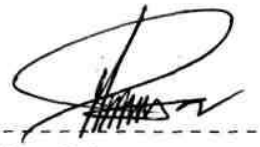
CERTIFICATION

This is to certify that the research carried out by EYONG Pauline Nkongho as a fulfilment of part of the requirements for the award of the degree of Master of Science in Geography has been read and approved.



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DEDICATION

This piece of work is dedicated to the loving memories of my father, Mr. Zacheus Eyong Mbibok, my beloved mother Mrs Lucy Eyong Manyi Agbor, my ever caring uncles Mr. Bawak Egbe Christopher and Rev. Fr. Paul Besong Enow.

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ABSTRACT

This study is an attempt to characterise vegetation changes in Falgore game reserve area of Kano State, in relation to variation in ianduse activities. Both intensive and extensive ground truthing exercise were employed to collect data on the ground vegetation characteristics such as species type, number, density, height trunk diameter, basal area, crown cover and percent vegetation cover, as well as information on Landuse history and practices in the area. The result obtained revealed that part of the study area under cultivation, representing about 33% of the sampled area, have low values of species number, density and percent vegetation cover. In areas where Landuse activities such as grazing, wood exploitation and settlement development predominating (representing about 67% of the sampled area) , the major vegetation characteristics that appear to have been affected include species height, trunk diameter, crown cover and basal area. Results of statistical analysis of the data for the various vegetation characteristics revealed that the vegetation characteristics that are mostly affected by variation in Landuse practice and intensities are species height and trunk diameter suggesting a somewhat strong link between changes in vegetation height and trunk diameter and effects of Landuse activities like grazing, wood exploitation and settlement development.

ABBREVIATIONS

BA	-	Basal Area
CA	-	Canopy Area
CV	-	Coefficient of variability
et al	-	And others
FAO	-	Food and Agricultural Organisation
GBH	-	Girth at Breast Height
ha	-	hectare
NCF	-	Nigerian Conservation Foundation
PVC	-	Percent Vegetation Cover
SEM	-	Standard Error of the Mean
SD	-	Standard Deviation
TCA	-	Total Canopy Area
UNEP	-	United Nations Environment Program
WCMC	-	World Conservation Monitoring Centre
WRI	-	World Resource Institute

CHAPTER ONE

1.0 INTRODUCTION OF THE STUDY

1.1 INTRODUCTION AND BACKGROUND

Vegetation refers to the total mass of plant life that occupies a given area. The organisation in space of the mass of vegetation confers a particular appearance or physiognomy upon the country side: The height, branching and spread or coverage of the plants, the size, texture and density of their foliage, the ratio of woody to herbaceous to mossy tissues, and the emergence of definite layers contrast rather strongly from place to place.

Our natural vegetation has evolved in conjunction with other elements of the environment to produce clear-cut patterns. Climate is an especially important control, but many other factors are influential (Collins, 1993).

Over much of the world, the natural vegetation would be forest, except where conditions are too cold or too arid. In general terms, the distribution of forests as well as other vegetation types follow closely the pattern of rainfall, with adjustments for edaphic conditions, drainage and biotic factors.

Many natural and semi-natural vegetation formations have high levels of floristic diversity, at some scales and in some areas approaching that of tropical forests. For example tropical savannas occur over huge areas as a mosaic of grassland and forest, sometimes as extensive grassy plains

with scattered trees, sometimes as grass land with strips of woodland and sometimes as islands of grassland in vast tracts of forest (WCMC, 1992).

However, much of the natural plant cover has been removed and most of what is remaining has been modified to some extent. Hence natural vegetation devoid of human influence is seldom found today. Extensive undisturbed forest can now be found only in remote and inaccessible regions. Similarly, most of the world's grasslands have been affected to some extent by man and his animals (Mikesell, 1978).

It has been estimated that grasslands covered approximately 40% of the earth's surface prior to the impact of man and his domesticated animals (Clements and Shelford, 1939). Estimates of the area of grassland present today are generally much lower than this but are very variable. One of the highest estimates suggests that grasslands occupy 27% of the world's natural vegetation (Knystautas, 1987). Whatever the actual area of grassland present today, it is said to be diminishing (WCMC, 1992).

The extent of world's forest has declined steadily as agriculture has expanded around the world; and the rate of global deforestation can be used as one indicator of how fast the world's species are extinguishing, ;such are destroying watersheds, manipulating microclimates and affecting the carbon and nutrient cycles (WRI, 1990). World Resources (1992) put the average global annual deforestation at 400,000

ha. between 1981 and 1985.

Modification and destruction of vegetation is taking place both in temperate and tropical areas, although most publicity has focused on the tropical rain forest. Tropical forests are a unique and endangered resource. Tropical deforestation is a topic that has received considerable attention recently as a major theme in the global change initiative. Despite its importance, accurate statistics on current tropical deforestation rates are difficult to obtain (Myers 1988; Booth 1989). The FAO/UNEP Tropical Forest Resources Assessment study in 1981 went some way to fill the information gap, and concluded that Africa was losing forest at the rate of 1.3 million hectares per year. Despite such efforts, we still have only a patchy and incomplete picture of what is happening. The rates and extent of deforestation in West Africa are even less-well known, as deforestation here is more a case of degradation than large scale felling in contrast to the Amazon basin (Booth, 1989).

According to FAO report (Laporte et al., 1995), Gabon is one of the few tropical countries in the world whose forest resources are not seriously threatened by clearing for agriculture. In Zaire, the then Congo and Cameroon, losses to agriculture appear relatively small in relation to the total forest area, while FAO (1990) gave an annual rate of deforestation of 0.76 for Nigeria, Repetto (1988), quoted by Abubakar (1998), states that the estimated rate of

deforestation in Nigeria is about 300,000 ha annually. This is quite considerable when compared to the current world rate of tropical forest and woodland depletion, which stands at 11.1 million ha annually (Hussain, 1989).

It is worth noting that there are substantial disagreements on estimates of forest/woodland extent and deforestation rates, mainly due to differences between classification typologies and diversity in methodologies, such as comprehensive mapping versus statistical sampling or modelling assessment (Townshend, 1992). However, it is known that as much as 50 - 80% of the West African rainforest has been depleted (Myers 1989; Laporte, 1990; FAO, 1993). The Central African rainforests still occupy a large Portion (75%) of their bioclimatic domain (FAO, 1993) but they are under increasing pressure for timber resource and agricultural land (FAO, 1993).

The term deforestation means different things to different people. For some, it is the total clearing of trees; for others it is any activity ;which disrupts the natural ecology of the virgin forest or other forms of vegetative cover. In general terms therefore, it is regarded as the most pervasive process of vegetation modification. It causes imbalance in the ecosystems and socio-economic status of the communities; and could lead to the total collapse of the natural eco-support system.

Thus aware that the history of the human race is commingled with the use and abuse of forests and grasslands, and considering the importance of vegetation, the need to study the dynamics of vegetation over the earth's surface becomes imperative especially because such studies form a fundamental requirement of land resources planning and sustainable management of land and land-use, so as to meet the obligation of future generations.

The effects have particularly been marked in Nigeria's semi-arid region via increase collection of fuelwood, grazing of more livestock and the soil is impoverished through expansion of cultivated land and reduction in the fallow period. Too often, a short-term utilitarian view has contributed to decline in vegetal cover leading to serious environmental problems such as drought and desertification and general land degradation. Hence studying the nature of vegetation changes becomes important in knowing the state of vegetation and intervention efforts required. Information on vegetation may be required to help solve an ecological problem; ranging from biological conservation to management purposes; as an input to environmental impact assessment; to monitor management practices or to provide the basis for prediction of possible changes (Kent and Coker 1992).

1.2 Statement of Research Problem

The Falgore Game/Forest Reserve which constitutes about 50% of the forest mass in Kano State (Falgore Game Reserve, 1999) is contained within the Northern Guinea savanna belt of the country. It is therefore one of the good examples of forest community within the State. It has been established with the primary objectives of boosting tourism while protecting indigenous species of both flora and fauna for the use of present and future generations; control of desertification, erosion and flooding; acting as a source of wild life to zoological gardens and other research institutes and as out door museums to students; provision of recreational facilities through game viewing, sport hunting, booting and fishing and protecting the Tiga dam against siltation.

The area in which it is located (i.e. the semi-arid region of Nigeria) is one of the most sensitive, delicately balanced and fragile ecosystems in the world. The area's close proximity to sahara puts it under increasing threat of drought and desertification. In addition, unchecked human activities via diverse land use practices within this area are indisputable. As a result of these vegetation resources in particular, are under increasing stress in the area. However, there exist conservation efforts by means of afforestation, legislation or laws protecting both the vegetation resources and animals life, with appropriate disciplinary action on defaulters. Thus vegetation resources are said to be

witnessing either negative or positive changes. To ensure that sustainable forest resource programmes are designed and executed successfully, information is certainly required on the character of such changes. Moreover, such information is useful for land development and planning. Unfortunately, while the changes are generally known to be taking place, no much research information is available on the character of the changes. The need for such information constitute, the problem of interest to this study. This study thus seeks to advance such an understanding using Falgore area of Nigerian's semi-arid region as a case study.

1.3 Aim and Objectives

The aim of this study is to attempt a characterization of vegetation changes in Falgore Game Reserve, Kano State. The aim is to be realised through the following sets of objectives:

(i) To examine the extent of anthropogenic influence.

(ii) To assess the changes in terms of vegetation characteristics that are most affected.

(iii) To compare the changes under areas of different land-use and management practices so as to identify the practices that most affect the changes.

(iv) Some suggestions towards reducing the rate of change.

1.4 Hypothesis

The working hypothesis include:

Ho - There are no significant variation in the character of vegetation between sampling units of the reserve.

Hi - Significant variations do exist in the character of vegetation between the different units of the game reserve.

1.5 Justification of Study

Vegetation resources particularly forest resources are very important to mankind. They constitute a fundamental component of the biosphere and an integral part of an ecosystem and play vital roles in modifying or sustenance of ecosystems. This is because it forms and supports a major bank of biological diversity, and plays significant roles in the transfer of energy and matter over scales ranging from local to global. Besides being a major source of food and fodder for man and livestock, it serves as a major catalyst to a number of physical and biochemical processes that act separately or in combination in shaping the earth into what it is at a particular time. For instance, it does not only play a vital role in pedogenic processes (soil formation), it also influences the extent of soil conservation. Furthermore, vegetation cover plays an important role in modifying the

microclimate of an area and serves a number of aesthetic functions (WRI, 1990; Daura, 1997).

Vegetation is however, one of the most dynamic resources for human-kind, and as such subject to modification and destruction at an ever-increasing rate due to both natural (climatic) and human factors, with the impact of human action being both dramatic and speedy.

Though the government declares a forest/game reserve as a protected environment, the Falgore Game Reserve is faced with many encroachment problems by different landusers neighbouring the area, who see the forest as an endowment of nature. They consequently subject the forest to clearance for farmlands, grazing and fuelwood collection amongst other uses. Thus to ensure that sustainable forest resource programmes especially in a semi-arid zone are designed and executed successfully, information is required on the status and character of vegetation change in such an area. It is therefore imperative for a research of this kind to be carried out, and in the area.

1.6 Literature Review

1.6.1 Factors for Vegetation Changes

The vegetation of the earth as we know it today is the result of a long process of development under the influence of environmental factors, both past and present. Plant species are the building blocks of the plant communities that together

constitute the vegetation of the different regions. The environment of plants is definable as the sum factors acting upon them e.g. climatic, orographic and edaphic.

The vegetation of the world is made up of a mosaic of plant communities whose distribution is determined by a corresponding mosaic of habitat. Variation in habitat from one part of the earth's surface to another are reflected in varying combination of "ecologically related" plant species. Where abrupt variations of habitat occur such as those associated with a sharp break of slope or a marked difference in rock or soil-type, the changes from one plant community to another may be correspondingly abrupt and the boundary between them clearly defined and easily identifiable. Nowhere is this more marked, for instance than in man-created or man-modified landscape. Among the most sharply defined vegetation boundaries are those between cultivated and uncultivated land, between burnt and unburnt vegetation. Changes in physical conditions, whether of slope, soil or climate are, more often than not, gradual and continuous.

Variation in vegetation however, is the product not just of one but of a complex of a great number of interacting environmental variables. One of the most fundamental characteristics of vegetation is its susceptibility to change. The plant communities of which it is composed vary in relation to variations of the complex environmental factors that occur from place to place. But the composition and

structure of any given community also reflects the interaction between its component members and between them and their habitat through time. Any environmental changes must inevitably result in correspondingly minor or major changes in the associated plant community. This will tend to make the habitat less favourable for some and more favourable for other species. Some species may not be able to tolerate the new condition, or to survive the competition of those better adapted to them. Some species will tend to disappear from the habitat, some will decrease, others increase in number, while yet others, formerly not present, will be able to establish themselves in the community. The result of changes in a particular habitat, then, will be that one assemblage of plant species will be replaced or succeeded by another drift structure and composition.

The factors determining the status of savanna vegetation particularly, have long been a matter of debate. Seasonality of climate, fire, grazing, edaphic or soil factors and geomorphology have all been cited as of importance in the origin and maintenance of vegetation.

The impact of human action has been more dramatic and speedy than the gradual evolution pattern of the natural vegetation over the past decades. Today man is the major and most powerful instrument of vegetation change, either directly or indirectly, through his increasing modification of the physical environment. In many areas, he has completely

removed the pre-existing vegetation cover and replaced it with his "unnatural" and highly specialised communities of field crops or forest plantation and shelter belts and scattered trees afforestation of exotic and indigenous species. In others, he has destroyed both the vegetation and the soil cover, and left in his wake man-made deserts on which plant succession has not been able to recommence. Relatively few parts of the remaining uncultivated vegetation cover have completely escaped his activities, and regions whose primary (virgin) climax communities still exist intact are fast dwindling. Over considerable areas, man has removed or through his diverse unchecked activities, prevented the regeneration of forest and scrub growth. The continued operation of these factors has effectively checked the natural succession back to the climax, and has maintained the vegetation cover to what is referred to as a sub-climax or semi-natural stage. Grassland, heath or scrub which exist in areas which, were it not for the activities of man, could support forest vegetation are sometimes called biotic or anthropogenic climaxes, since the maximum vegetation development is controlled primarily by these rather than climatic or edaphic factors (Tivy, 1971).

Man's activities, however, tend not only to check succession and the re-establishment of the climax but also tend to give rise to a type of vegetation that might not otherwise have developed. Where a protective tree-cover is

removed and its regeneration inhibited, the resulting change in micro-climatic condition can have considerable repercussion on the nature of the soil. Less water is lost by transpiration and the surface is, in addition unprotected from the direct onslaught of rainfall. In cool, humid climates, increased leaching and soil erosion may result where temperatures are higher, the elimination of shade opens up the surface to full sunlight, and increased temperatures near the ground accelerate evaporation from the soil surface and the rate of organic decomposition. The cumulative effect of such changes may initiate changes in the composition and structure of the vegetation that might not have taken place had natural succession been able to recommence immediately.

A numer of studies have been carried out on such factors for vegetation change a few of which inclue the following: The rates and causes of forest destruction in Brazilian Amazonia by some ecologist, Fearnside (1989) Deforestation and Agricultural Development in Brazilian Amazonia, Fearnside (1990) The rate and extent of deforestation in Brazilian Amazonia, Fearnside (1990) Predominant landuses in the Brazilian Amazon, Fearnside (1990) Fire in the tropical rainfores of the Amazon Basin, Bussmann (1996) Destruction and management of Mount Kenya's forest, Sheehy (1992) A perspective on Desertification of grazing Ecosystems in North China, Imbernon (1999) A comparison of the driving forces behing deforestation in the Peruvian and the Brazilain Amazon,

Vanclay (1993) Saving the Tropical Forest: Needs and prognosis and Oyono (1998) Cameroon Rainforest: Economic crisis, Rural Poverty, Biodiversity.

1.6.2 Techniques of Assessing Vegetation Change

Vegetation, because of the multiplicity of its attributes, is among the most difficult of natural phenomena to describe and analyse. Classification and ordination are two means to this end (Tivy, 1971, Kent and Coker, 1992).

Some scholars for example McIntosh (1967) maintained that the purpose of both the traditional hierarchial classification system and ordination techniques is to arrange or organise a set of observations and to seek meaningful patterns of relationship.

Poore (1991) summaries the problem of vegetation analysis very aptly: "Many methods have been developed for the description and characterisation of communities which vary from subjective and qualitative to elaborately quantitative. The choice of method is a personal matter influenced partly by the particular view taken by workers of the nature of vegetation". But it should be noted that, however exact the method, it cannot describe all the attributes of even the simplest community at one moment of time. Every description is an abstraction from available data.

Several techniques are being used in vegetation changes assessment but they can broadly be classified into:

(a) Remote sensing-based methods and

(b) Ground-based methods.

Remote sensing based methods are further classified into digital (satellite-based) techniques, and photographic techniques. The satellite-based are the most widely used and are considered more effective not just because of the digital methods of data handling involved, but also because they allow more effective establishment of quantitative relationship between spectral satellite, and ground-based vegetation data (Abubakar, 1998). Ground-based techniques are also effective particularly in offering the greatest details, though relatively in limited use today as the method appears tedious and expensive both in terms of cost and time. These techniques involve actual ground verification exercises in the field.

So far, quite a lot of work has been done by researchers in different parts of the world to employ satellite-remote sensing-based methods of change detection algorithms in studying vegetation changes. Prominent among such works include those by Bryne et al (1980) to monitor land-cover changes in Batemans, U.S.A.; Howarth and Boasson (1983) to detect vegetation changes in areas of rapid urban expansion near Hamilton, Ontaria, Canada; Martin and Howarth (1989) to detect transformation of forested to build-up areas in the rural-urban fringes of scarborough, Ontaria Canada; Jukubauskas, et al (1990) to reassess vegetation change in a

fire altered forest landscape of Michigan Pine forest, U.S.A., Singh (1986) to monitor vegetation changes in Indian high forest subjected to cultivation and land-use cover types in Huntsville, U.S.A.; Omojola and Ezigbalike (1993) to assess environmental degradation in Sokoto-Rima River basin of Nigeria; Muchoney and Haack (1994) to detect and monitor forest defoliation in Warren and Shenandoah countries of Virginia, U.S.A. Jaccobberger - Jellison (1994) to monitor vegetation changes in drought-prone areas near Tombouctou, Mali; Green et al (1994) to detect and monitor land-cover and land use changes in portland metropolitan district of U.S.A.; Macomber and Wood-Cook (1994) to detect vegetation changes of the California/Nevada border in U.S.A.; Garcia and Alvarez (1994) to assess changes in green vegetation cover in Northern Territory of Australia; Ribed and Lopez (1995) to monitor burnt forest area in Donana National Park of Spain; Jusoff and Abdulmanaf (1995) to assess deforestation in the Sungai Bulor forest reserve of Malaysia; Shoshany, et al (1995) to assess seasonal tropical secondary forest regrowth in the Amazon basin of Brazil; Dimyati, et al (1996) to analyse land-use land cover changes in Yogyakarta, Indonesia; and Kimothi and Judal (1996) to assess vegetation changes resulting from intensive human activities in Chamoli district of Central Himalaya.

A review of such works indicate that different change detection alogrithms tend to offer different degrees of

accuracies in vegetation change detection in different areas. It appears however that in semi-arid area where vegetation species tend to stand distinct over the surface (due to low total vegetation cover), three main algorithms (namely image differencing, image rationing and post-classification comparison) are preferably employed in vegetation change monitoring because such algorithms rely on exploiting the naturally existing contrast between vegetation species and background surface (Abubakar and Abdulkadir, 1997).

Photographic remote sensing methods are also being employed because it is possible to numerically establish tree vegetation changes over time using small/medium scale air photographs and corresponding ground truthing exercises done, taking into consideration the discrepancies of tree undercounting on the air photos. This tool is a classification scheme based on the indrease in the cross sectional area of tree girths which is the area that is added for every unit increase in the circumference of a tree (Ibrahim, 1997). To classify the tree into seedlings, sapplings and adult trees, the height and girth measurements are collected by employing the use of Abney level and tape measurements. Thereafter, increase or decrease in tree vegetation can be deduced by comparing the adult population on air photographs and those obtained from field data.

Salami (1997), employed an aeropace approach to study deforeestation in south-western Nigeria (1963 - 1986). This

approach involves a combination of two methods: Data derived from aerial photographs of December 1963 (1:40,000) and January 1973 (1: 25,000) as well as SPOT (XS) of Dececmber 1986; together with final maps drawn at a scale of 1:50,000 in relation to topographical sheets covering the area.

Nicol (1988) and Mortimore et al., (1991) carried out studies on woody vegetation in some parts of Kano and Jigawa States using aearial photographs of scales 1:25,000 and 1:40,000. The results indicated that, there have been increases in tree vegetation of about 23% especially in Kano over the period of 1972 to 1981.

Mortimore et al. (1991), working with sequential air photographs of 1965 - 66; 1971 and those of 1981 at scales of 1:40,000 and 1:25,000 respectively, found that there was no significant changes in tree density between the three dates at 7.2, 7.3 and 7.3 trees/ha. respectively. Ground verification exercises indiccated an average of 11.5 trees/ha. Girth size distribution indicated that a large proportion of the trees were found in the lower girth size classes indicating regeneration (the abundance of young tree vegetation being a sign of active regeneration). Additionally, Nicol (1988) categorised the trees into six classes according to girth size and discovered that trees in the smallest class (0 - 20cms) were abundant espeically in the area close to Kano city.

Based on the above dicussion, it was observed that the

increases recorded by Nicol (1988) and mortimore et al. (1991) were increases in vegetation as observed on air photographs of different dates and not between air photographs and actual ground verification exercises; because trees whose crown diameters were less than 0.25mm did not appear on the air photographs. This therefore created a discrepancy during ground truthing since these trees could not be taken to be additions in their vegetation as they already existed prior to the air photo estimates. Thus an undercount was obtained from the air photos of trees with small crowns. It therefore appears that estimating vegetaion change over time using air photographs might be a problem, unless large scale air photos can be utilised which is expensive since there is less areal coverage with large scale photographs.

Another study by Ibrahim (1997) in Gezawa and Ungogo of Kano closed settled zone revealed that there was no significant differnce between the compostion and distribution of trees at the 2 sites. This is because the sites happen to have common physical factors e.g. the same drainage basin, physiological units, same textural band, geology and climatic belt. Regeneration was however shown to be more active at Ungogo (of closer proximity to urban Kano) than at Gezawa (at the pereiphery of the zone). There were thus more species diversity at Ungogo due to more exotic species and shade trees and more tree conservation and protection from livestock damage. This could be explained by the fact that farmers at

Ungogo are probably aware of innovations and likely to adopt them. Moreso, they are likely to have another means of livelihood apart from what accrue from farming and sale of tree products since close proximity to Kano ensures daily commuting and other economic outlets. Meanwhile, the farmers at Gezawa on the other hand, are said to be more dependent on the farm income and tree products and so more trees are being felled.

Abdallah et al. (1983) made use of ground data technique in estimating land cover area from satellite imagery of a fadama in North Eastern Nigeria. Aerial photographs and photo-mosaic map sheets provided effective tools for the study while the ground base estimates provided the basis for establishing the land cover and land use types in the study area. The results of the study revealed increase in deforestation activity leading to decrease in natural forests.

CHAPTER TWO

GEOGRAPHICAL BACKGROUND OF THE STUDY AREA

2.1. Location and Extent

The Falgore Game reserve is located at the southern tip of Kano Sate. It lies between latitudes 10°.50'N - 11°.20'N and longitude 8°.33'E - 8°.45'E, situated about 140km south of Kano. It is contained within three local government areas viz: Doguwa, Tudun Wada and Sumaila local government areas. It covers an area of about 1000km^2. The reserve borders Bauchi's Lame/Burra game reserve on the South Eastern part and Kaduna State on the Western end via Zarara rock ranges. The famous Tiga Dam lies in the northern part which flood back to the reserve for a distance of about 10km (Figure 2.1).

The Falgore game reserve is accessible from Jos on Kano/Jos high way via Saminaka in Kaduna State; Kano/Tudun Wada road via Zaria road and Tiga Dam by boating on Kano river.

2.2 Historical Origin

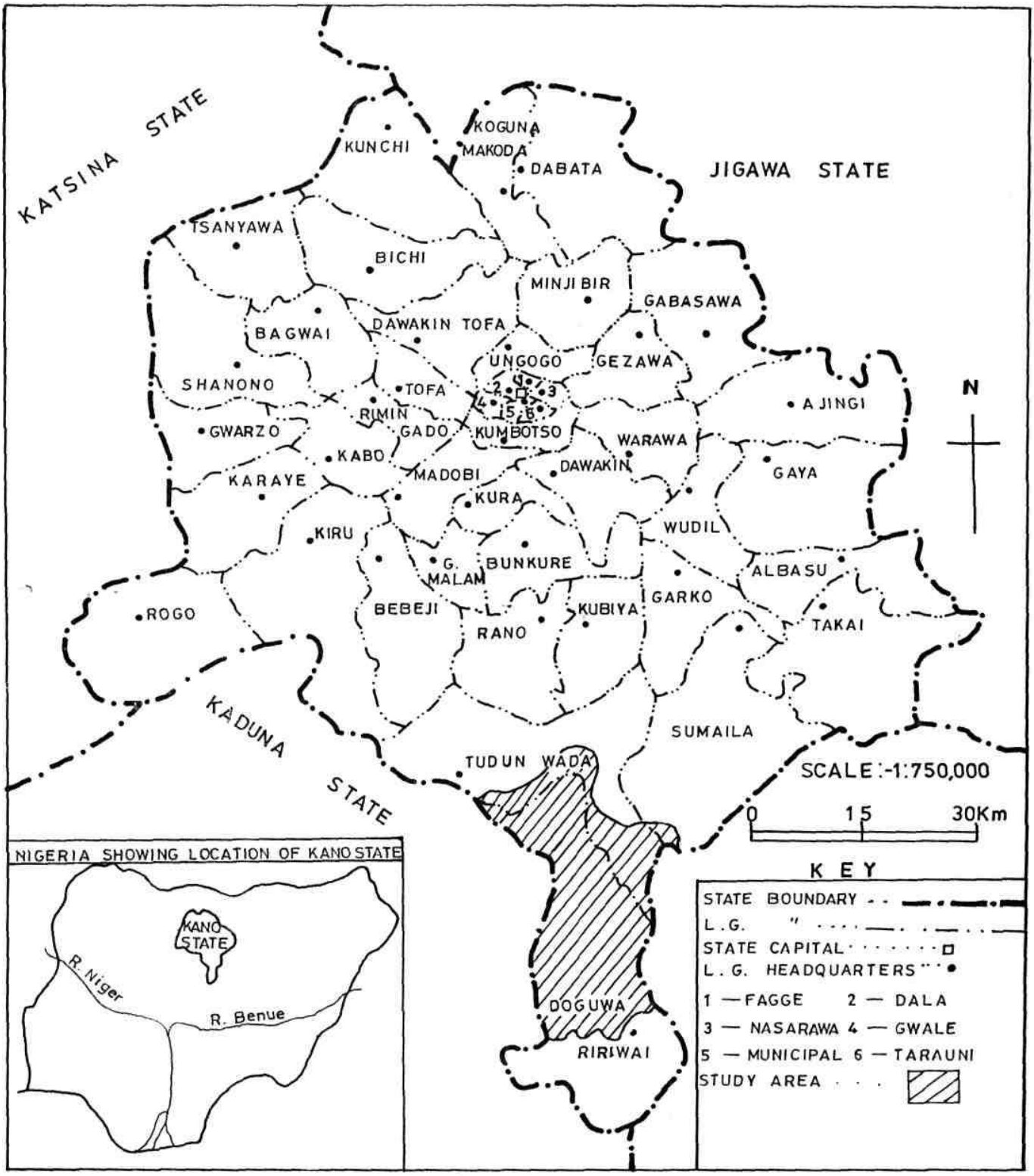
The Falgore game reserve was formerly a protected forest reserve known as "Kogin Kano forest Reserve" demarcated in 1944 and gazetted in 1946. It then covered an area of about 568km^2. In 1968, it was later converted to a game reserve and given its present name by the State government, with the encouragement and assistance of the Federal Department of Forestry, in order to conserve the dwindling wild animals

population in the State on one hand and to develop tourism on the other.

Because of the richness of its flora and fauna, and also the fact that the famous Tiga Dam passes through the Falgore game reserve, it became of utmost importance therefore that the area be protected against human encroachment in order to minimise erosion; otherwise the life expectancy of the dam will be short because of siltation.

Thus among the aims of establishing the reserve are: boosting of tourism, protecting indegenouos species of both flora and fauna for the use of the present and future generations, protecting the Tiga dam against siltation, control of desertification and erosion just to name a few.

The Reserve is divided into a Northern sector (with Gomo, Zamba, Zina and Dariya patrol posts), a Southern sector (constituting the Sabon Kaura, Yalwan Kasa and Maikwandira patrol posts); and the Base camp which is the administrative centre of the reserve with the Falgore and Natala patrol posts. In all, the reserve has in its perimeter nine patrol stations (Figure 2.2) with patrol staff/game guards for effective monitoring of illegal activities in the reserve.



SOURCE:- MINISTRY OF LAND AND REGIONAL PLANNING, KANO

FIG. 2·1a KANO STATE SHOWING THE STUDY AREA

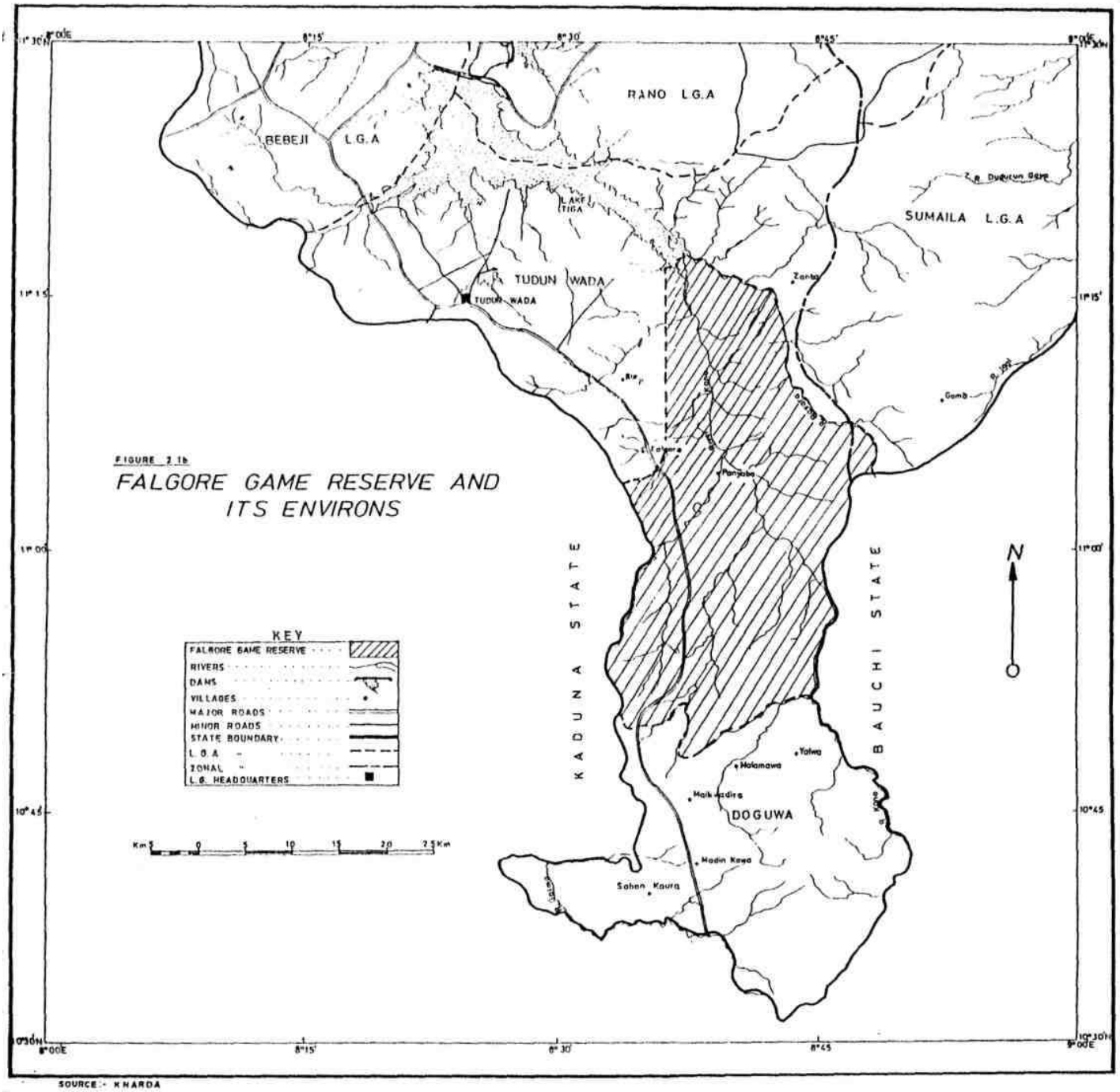
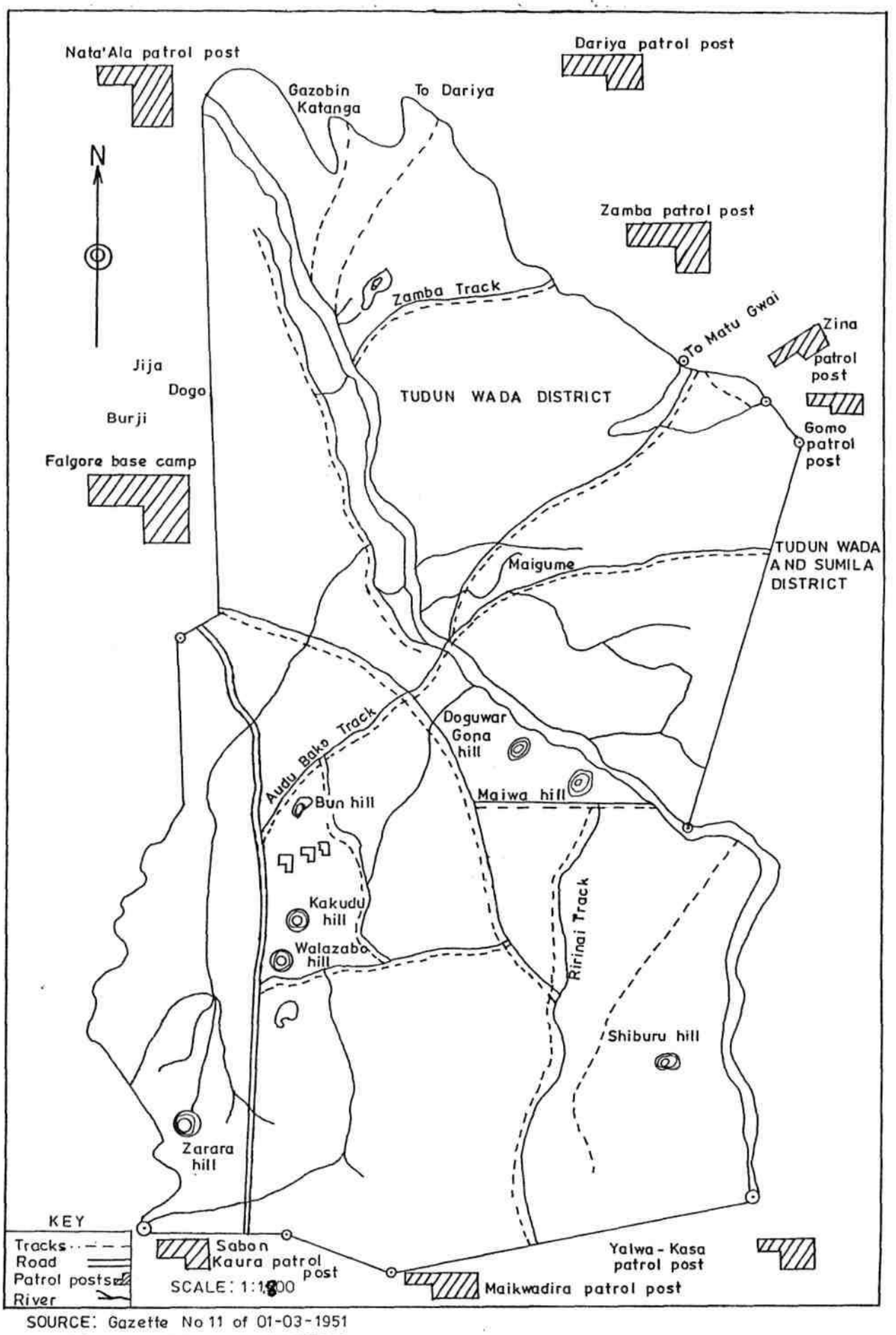


FIGURE 2.1b

FALGORE GAME RESERVE AND ITS ENVIRONS

SOURCE:- KNARDA



SOURCE: Gazette No 11 of 01-03-1951

FIG.2·2 FALGORE GAME RESERVE

2.3 Geology and Relief

Kano region is characterised by two major geological structures, with minor intrusions as third. The large area to the South and North west is underlain by rocks of the Basement Complex with intrusions of younger granites in the extreme southern parts. To the North east are unconsolidated sediments of the Chad formation. In most areas the solid rock is covered by several feet of weathered materials or sandy drifts, which have been accumulated under drier climatic conditions (Udo, 1970:18). The two structures are separated by a transitional zone which constitutes the well defined hydro-geological divide of the region.

The relief of the area is relatively simple, comprising gently undulating plains. Kano region occupies the Northern Western rim of the Chad depression and also shares physiographic divides with the Niger-Benue river system to the south west and west as the Chad-Sokoto divide (Olofin, 1987). The elevation of the region above the mean sea level ranges from about 400m at the North Eastern margin to over 1200m at the southern tip. Steep gradients occur particularly along the river banks where the effect of gullying is felt most and also where resistant granitic outcrops are occasionally truncated.

The Falgore game reserve, besides the fauna and flora have some notable features of either historic or sceneric beauty or both viz: the Zarara rock ranges which stretche

from the Kano State side right into Kaduna State; a cave in the rock emanating a roar similating that of a lion annually, to signal the arrival of the rainy season and the rock also possess high deposits of minerals such as mica, copper and Molybdenum (NCF, 1984).

2.4 Climatic Characteristics

The study area experiences a tropical savannah climate characterised by alternating wet and dry seasons coded as Aw by W. Koppen. The two seasons are in response to the seasonal movement of the inter-tropical convergence zone (ITC) i.e. the boundary between the tropical maritime air mass (MT) and the tropical continental air mass (CT) of contrasting weather conditions. Whereas the tropical maritime originating southward from the atlantic ocean is moisture ladden and brings rain to the area, the continental air mass brings dry condition, coming from the sahara desert.

The wet season in the region varies between 6 months in the southern parts and three and half in the Northern parts. The onset of rain is earlier in the south than in the north early June an late July respectively. In a normal year, the total annual rainfall ranges from 1000mm in the southern part of the State, decreasing to about 800mm around metropolitan Kano and about 600mm in the north and north eastern part. August is the wettest month with an average rainfall of about 304.8mm. In 1988 which was the particular rainy year, Kano

had over 488mm of rain in August. No other climatic variable has wide spatial variation as the rainfall. Temperature is warm all over the region, with an average of about 26°C in the south. Potential evapotranspiration over the region is fairly uniform (1,700 - 1,800mm per annum) but average evapotransspiration has a wide spatial spread. The average conditions of the climate of the region can be illustrated, using the climatic data from the Aminu Kano International Airport as in table 2.1 and figures 2.3 - 2.7.

Table 2.1: Long Term Data of Some Climatic Variables at the Aminu Kano International Airport

Month	Temperature				
	Mean	Rainfall mm	Evapotrans-piration	Sunshine Hours	Relative Humidity
January	21.2	0.0	133.0	9.0	28
February	23.7	0.3	141.1	9.0	25
March	27.7	1.8	182.8	8.6	23
April	30.5	8.9	104.5	8.4	36
May	30.4	10.2	187.9	8.8	51
June	28.1	123.7	156.3	8.7	65
July	25.7	210.9	126.4	7.5	78
August	24.9	314	112.7	6.0	83
September	25.9	132	126	7.9	79
October	26.8	12.8	144	9.5	58
November	24.6	0.0	139.9	9.8	37
December	21.7	0.0	127.4	9.2	32

Source: Aminu Kano International Airport's Meteorological Station, Kano Nigeria (After Ajayi, 1995)

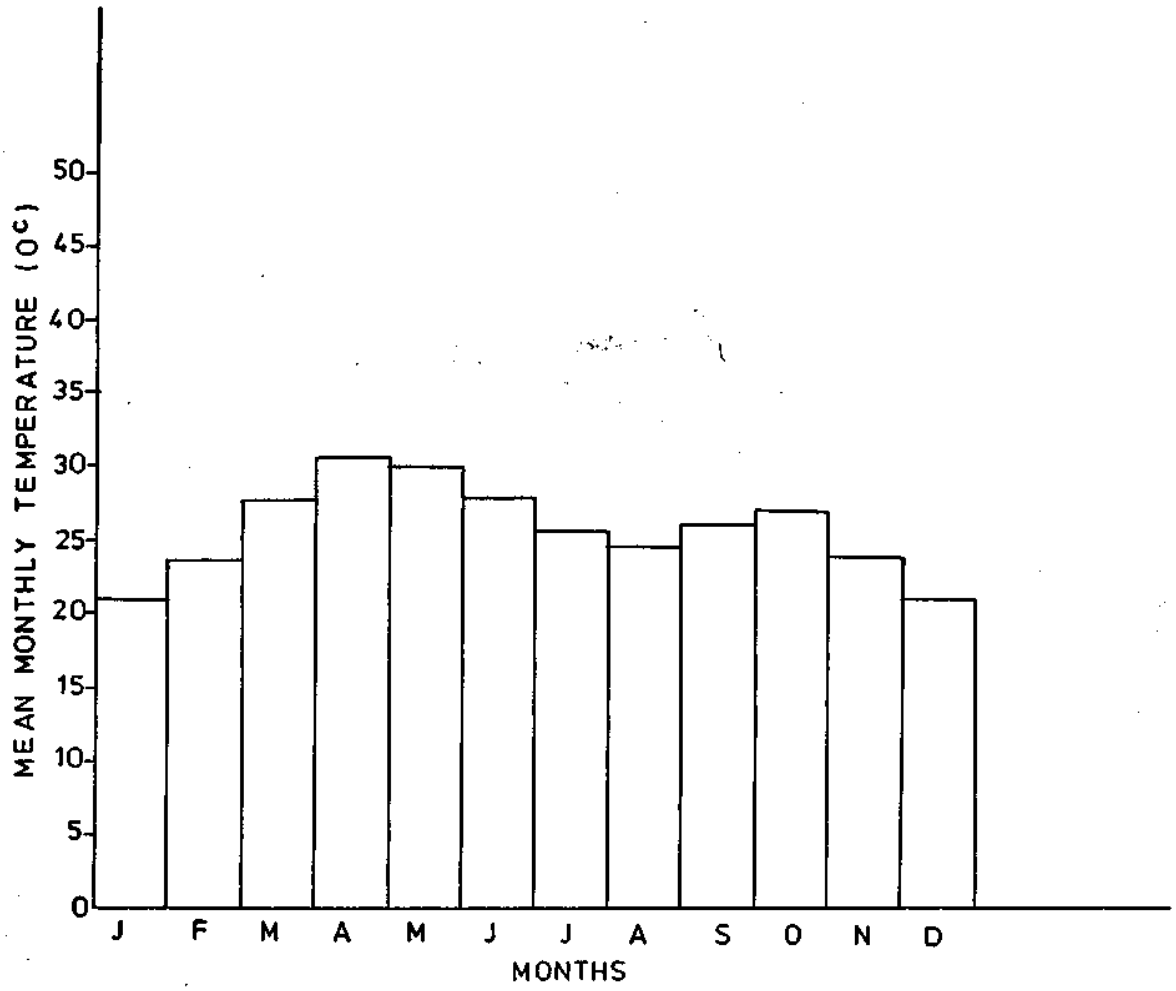


FIG 2·3 LONG TERM MONTHLY TEMPERATURE RECORDS AT KANO

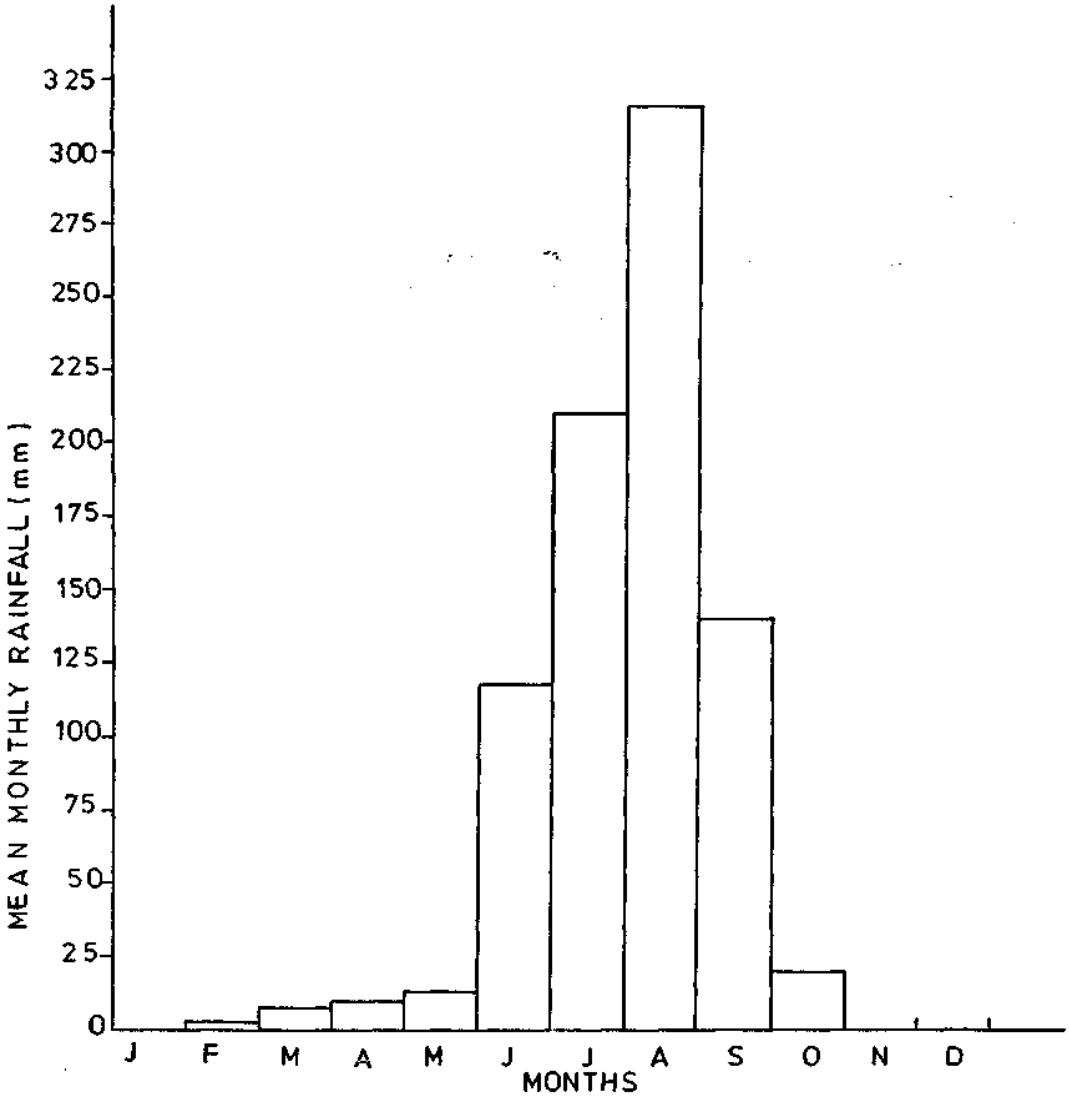


FIG: 2·4 LONGTERM MONTHLY RAINFALL RECORDS AT KANO

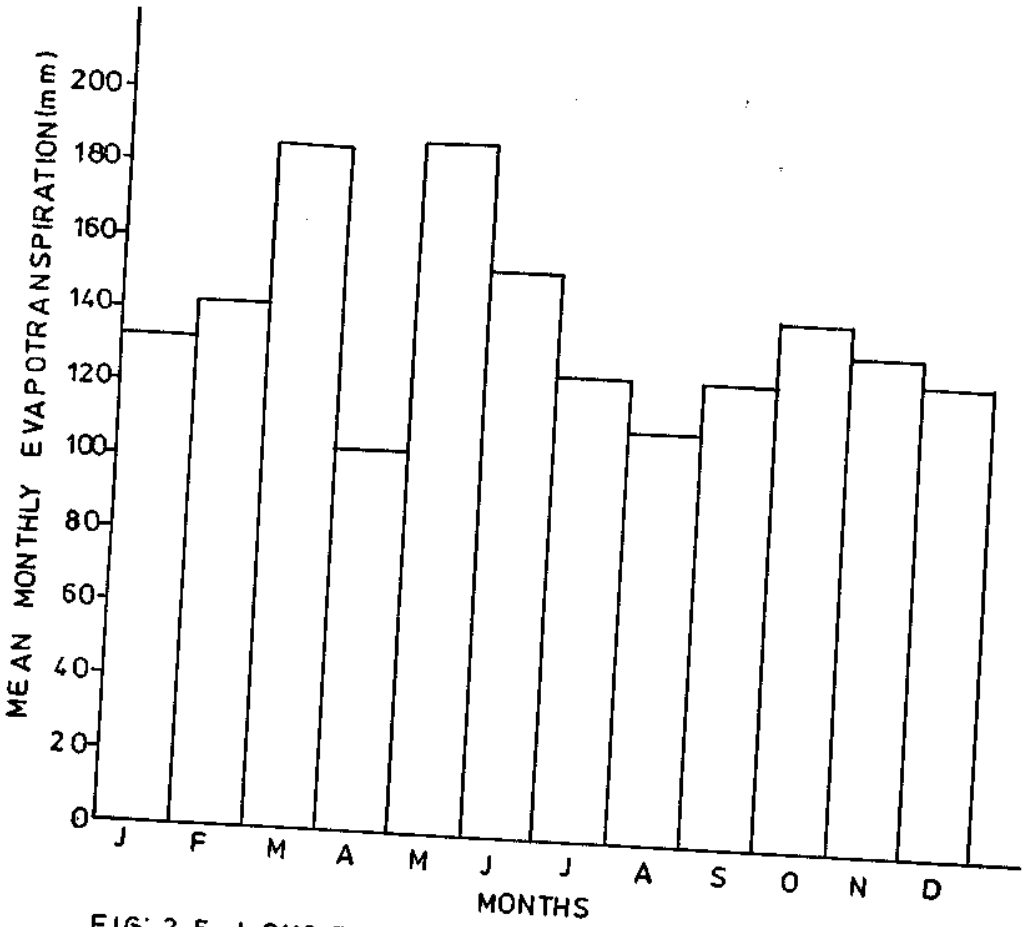


FIG: 2·5 LONG TERM MONTHLY EVAPOTRANPIRATION RECORDS AT KANO

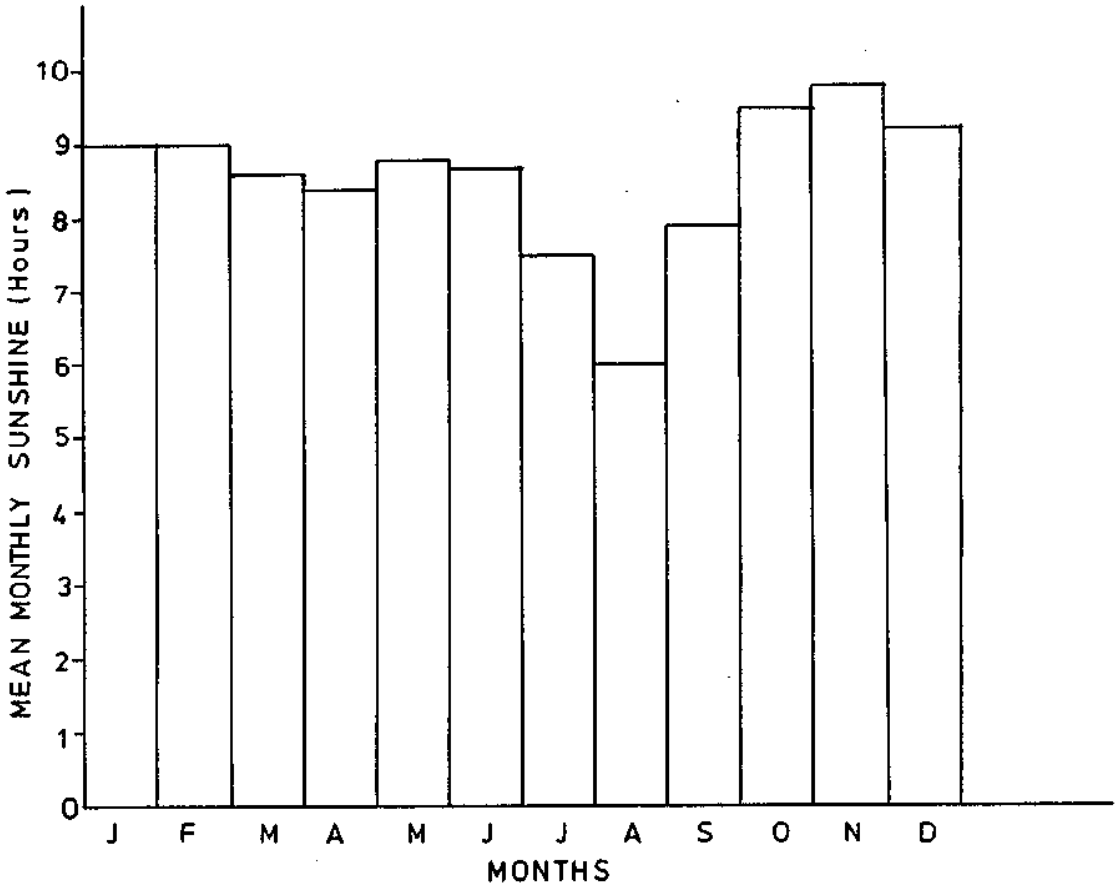


FIG: 2·6 LONG TERM MONTHLY SUNSHINE RECORDS AT KANO

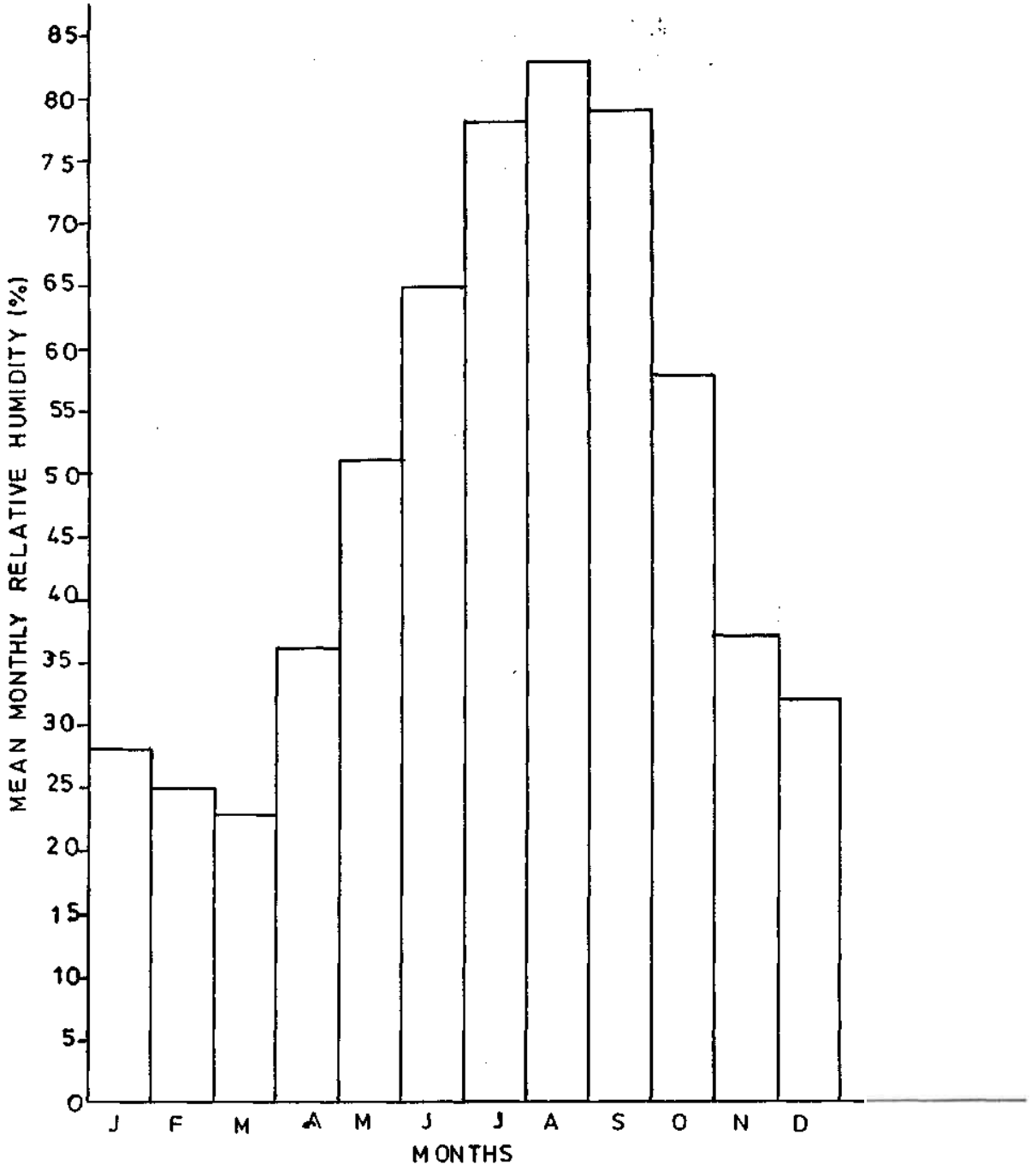


FIG: 2·7 LONG TERM MONTHLY RELATIVE HUMIDITY RECORDS AT KANO

2.5 Soils and Vegetation

Kano has weakly developed soils referred to as brown and reddish brown soils. These usually have a clay - enriched B-horizon suggesting some degree of eluviation. The degree of leaching of the soils in Kano is small and the soils have fairly high content of weatherable materials and of montmorillonite clays which have high water and nutrient holding capacities". With the help of adequate supply of water during the rainy season or by irrigation the soils of Kano are quite productive.

According to Falola (1994) the soils can be divided into four main groups. They are ferruginous tropical soils on crystalline acid rocks which occupy about 2/5 of the State to the south, south-west and south-east; the brown and reddish brown soils and the latosols of the northern half; the brown and reddish brown soils in the north-eastern corner; and the juvenile and hydromorphic soils which occur along the alluvial channel complexes. The soils largely reflect the influence of parent materials. Intensive use of the soil and addition of manure and chemicals fertilizers have altered their character, profile, texture, structure and chemical characteristics.

The game reserve located south of Kano State is thus composed basically of tropical ferruginous soils, which are highly leached, acidic, high in silt clay particles and very low in organic matter which is usually less than 0.5%. They soils are either silty loam or sandy loam.

In terms of vegetation, Kano region lies in the Sudan savanna belt, except the southern moist part which falls within the guinea savanna. The Sudan savannah type is composed of a variety of trees scattered over an expanse of grassland. The trees are usually characterised by broad canopies and they are hardly taller than 15 - 20m high. The Baobab tree is peculiar, taller and larger than others. Other types include acacia occasionally forming woodland. Most of the trees are adapted to drought condition through long tap root systems and tiny leaves. Grasses hardly grow taller than 1.5 - 2m high.

The Falgore game reserve located on the southern tip of Kano State lies entirely within the northern guinea savannah belt that runs across the northern part of the country from Sokoto to the Plateaux of Adamawa States. It is characterised by woodland savanna where trees and shrubs form a fairly close canopy and tree savannah (trees and shrubs are scattered). Trees usually have short boles and broad leaves and range from 12 to 30m or above in height. The most common tree species include Daniellia oliveri (most abundant), Lophira lanceolata, Terminalia glaucescens, Hymenocardia acida, Detarium microcarpum, Afzelia african, Butyrospermum paradozum amongst others. Under natural conditions this vegetation burns annually in the dry season, therefore fire-resistant species tend to dominate (have thick bark as an adaption). Shrubs include Ximenia, Gardenia spp, Ficus while the tall grass

species are mostly hypatthernia, Cynadon, Andropogon etc.

The reserve boasts of herds of roan antelope, western hertebeasts, warthogs, oribis, Duiker sand, Buffalos, reed petas moneys, baboons, gorillas, bushbucks and water bucks particularly along the Kano river. Lions foot prints are usually seen along the water holes or water bodies. Members of the cat family: caracals, civets and jackals apart from hyena are abundant but are not commonly sighted due to their nocturnal nature. Migratory elephants are seen around the boundary of lame/Burra game reserve. Among the avifauna species in the reserve are Bustards, Herons, stocks, Eagles, Partridges, guinea fowls, ground horn bill, horn bill, naming but few.

2.6 **People and Landuse**

Kano State is one of the most populated States in the federation with a projected population of over 11 million people based on the 1991 census. The three local government areas of Doguwa, Tudun Wada and Sumaila within which the reserve is contained constitute 98,560, 125,060 and 159,648 people respectively making total of 383,268 people (1991 census). Majority of the population of the area are Hausa, although the fulani and other foreigners are prominent. Though Kano is regarded as a commercial centre, agriculture and husbandry is one of the most important sectors of the State economy with about 75% of the total population directly

or indirectly engaged.

Farming is mainly dominated by the Hausas while cattle rearing is largely in the hands of the fulanis. Nevertheless, many Hausa peasants also own and rear cattle, while some fulanis are becoming sedentary. Apart from cattle/donkeys other livestock such as goats and sheep also exist most of which wander freely about.

Farming is dominated by a grain economy e.g. sorghum, millet, maize, cowpea and rice for local consumption; whereas groundnuts, sugar cane cotton, vegetables and fruits among other are grown for commercial purposes. Likewise, the State is the leading market for livestock in the country, at present considerable percentage of hides and skin are exported and the rest are tanned for local consumption.

CHAPTER THREE

3.0 MATERIALS AND METHOD

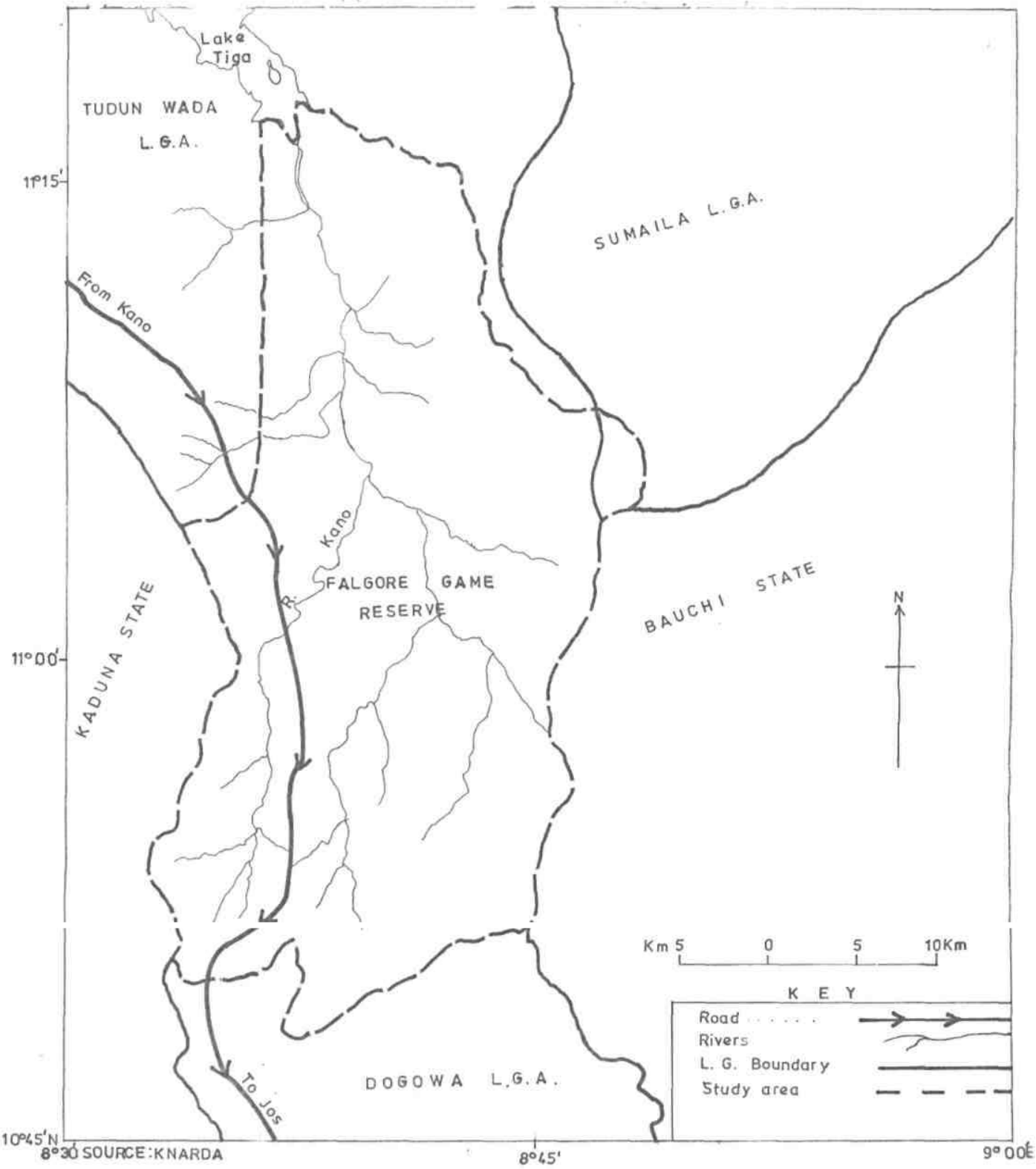
3.1 Theoretical Basis

Considering the fact that environmental parameters of relief, climate and geology are fairly uniform within any given area, the character and condition of vegetation over such an area is thus expected to differ mainly with the uses which man puts the area into. Based on this fact, in Falgore Game reserve for instance, it is to be expected therefore that differences in the character and condition of vegetation over units of the reserve, where such physical parameters are uniform, will differ mainly with variations in nature and intensity of land uses. Thus, any observed differences can be linked to variations in such uses.

3.2 Research Design and Selection of Experimental Sites

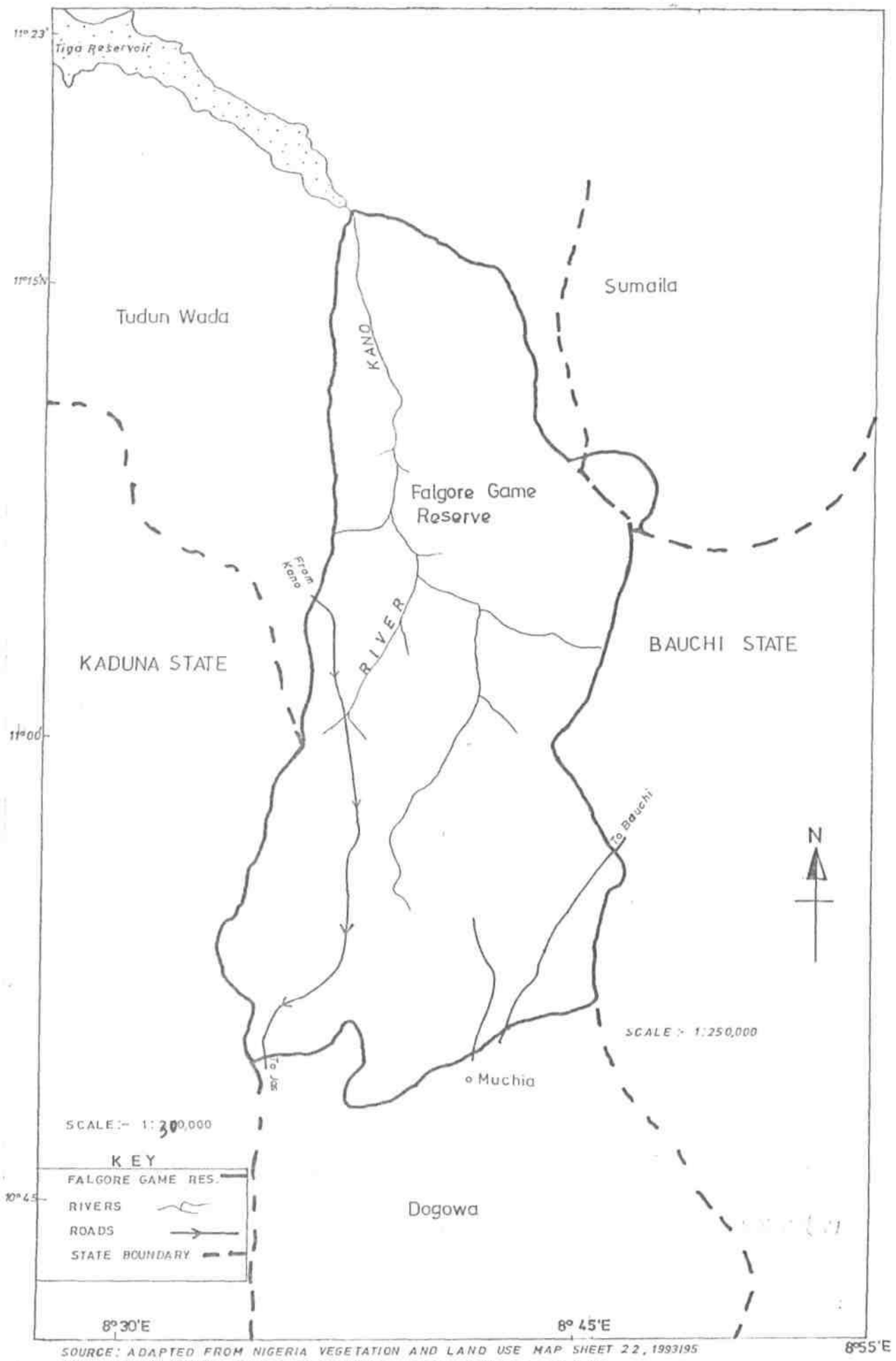
A preliminary interpretation of land cover data derived from remote sensing data was carried out to examine the areal extent of the Falgore Game Reserve. The data are for 1978 (made from panchromatic air photographs) and 1995 (made from SPOT XS satellite images). Comparison of areal estimates of the forest (Figure 3.1 and 3.2) for the two dates revealed, contrary to what is otherwise expected that the forest reserve did not witness any decrease in spatial extent of its area. This observed no-change in the forest's areal extent suggest most likely that, the changes the reserve seems to be

witnessing are more in terms of the quality (rather than the quantity) of the constituent vegetation species. Assessment of such qualities (such as height, number, trunk diameter, density, basal area, crown cover and percent vegetion cover) apparently requires that ground based t



SOURCE: KNARDA

FIG. 3·1: FALGORE GAME RESERVE AREAL EXTENT (1978)



SOURCE: ADAPTED FROM NIGERIA VEGETATION AND LAND USE MAP SHEET 22, 1993/95

FIG. 3·2: FALGORE GAME RESERVE 1995 SHEET 22 / 33

3.3 Materials

Materials used in the course of the field exercise include:

- Ranging poles used in demarcating the quadrant (sampling units).
- Prismatic compass to ensure that the poles were aligned to each other.
- Abney level used to measure the slope angle where the quadrants were selected(i.e at $\leq 0.5°$).
- A desingned 180° protractor with a sighting tube attached to it for measuring/estimating tree height.
- Measuring tape.
- A field note book for recording all measurements taken at the field.

3.4 Ground Data Collection

3.4.1 Descriptive Information on Landuse History and Practices

At each patrol zone, within which the sampling units were established, the researcher obtained information on the nature of landuse activities prevalent, taking particular note of which type(s) is more dominant or prominent over others. These qualitative information was offered by both the patrol staff and landusers preferably employed as field assistants and also by some other land users met at the sampling sites in the course of the field exercise. In addition, without being told, direct observations were made on the field by the

researcher. All the collected information which range from poaching, fruit collection, bush fires, fuelwood collection, grazing, settlement and cultivation were recorded in the field notebook carried along during the exercise. Such information is expected to help greatly in explaining some of the patterns of vegetation changes to be observed in the reserve.

3.4.2 Information on Species Types and Numbers

Also recorded for each sampling unit were information on the type of species and the number of the various species found within every quadrant (categorised into the major or dominant and minor ones. While information on species number was obtained directly on the field by simple enumeration, that on identification of the species was done by the assistance of landuser and patrol staff employed as field assistants. For consistency, only the local (Hausa names) of the species were obtained since there exist already published/unpublished literature on Hausa/Botanical names of vegetation specie found in the study area (Muhammad, 1994). Few unidentified species specimen were later identified in the reserve herbarium and that of the Biological Science Department of Ahmadu Bello University, Zaria. All the information collected were also recorded in the field note taken along to the field.

3.3.3 Measurement of Species Characteristics

Standard procedures as described in Bennett and Humphries, 1974; Wratten and Fry, 1980) and applied by other researchers (Abubukar, 1998) were followed in measuring/estimating the following vegetation characteristics within every quadrant.

3.4.3.1 Species Height

Height is the vertical distance between the ground and the highest living part. The height of the species present in each quadrant were measured by the use of a 180° protractor, having a sighting-tube attached to its basal segment. The protractor was held in such a way that one can view through the tube and see the topmost point of the vegetation species. The distance between the point at which this sighting was accomplished and the base of the species was measured (d) and the height of the observer's eye measured (h). From this, the height (H) of the species were estimated as:

$$H = d \times h$$

The heights of the various species within a quadrant were totalled and meaned to obtain a mean species height.

3.4.3.2 **Species Density**

The species density (D) within every quadrant was determined using the formular:

$$D = \frac{\text{Total number of species in quadrant}}{\text{Size of every quadrant}} = \frac{nsq}{50m \times 50m}$$

3.4.3.3 **Trunk Diameter**

To measure this, the trunk of every specie present within a quadrant was first identified, marked and its length measured. The length was then divided into ten units and at each unit, circumferal measurements were carried out, using a measuring tape. These were then added up and divided by 10 to obtain a mean trunk value for each specie.

3.4.3.4 **Species Crown Cover**

This was estimated for each species using the formula:

$$CC = \frac{\pi D^2}{4},$$

where

CC = Crown cover

D = Mean trunk diameter

$$\pi = \frac{22}{7} \equiv 3.14$$

3.4.3.5 **Species Basal Area**

This refers to the cross sectional area of the trunk (m^2). In quantitative evaluation of species characteristics, basal area is determined for species of more than 3m height and taken at 1.3m above the ground (Wratten and Fry 1980; Anderson et al., 1993). Thus the girth of each woody species was measured at breast height (GBH) as the circumference of the girth (C) using tape. The basal area (BA) of each specie was then estimated using the formula:

$$BA = \frac{C^2}{4\pi}, \text{ where}$$

C = girth size (circumference)

$$\pi = \frac{22}{7} = 3.14$$

The total basal area for each quadrant was obtained by summing up the various BA measurements, and recorded in the field notebook.

3.4.3.6 **Percent Vegetation Cover (PVC)**

Within every quadrant, the total number of individual species present was first enumerated. When the sun was at its zenith, the total shadow area cast by every species was then estimated to give a canopy area (Ca). The Ca for the various species present in a quadrant was then totalled (TCa).

Percent vegetation cover (PVC) was subsequently estimated using:

$$PVC = \frac{TCa}{\text{Size of quadrant}} \times \frac{100}{1} = \frac{TCa}{50m \times 50m} \times 100$$

3.5 Statistical Analysis

The various ground collected data on land use history and practices, species type and number for each quadrant are summarised and presented in tables.

On the other hand descriptive statistics (mean, standard deviation, standard error of the mean and coefficient of variability) calculated for each of the vegetation characteristic (height, trunk diameter, species basal area, percent vegetation cover etc.) are also presented in tables. After that the student t-test was used to compare the pairs of quadrants so as to identify those that differ most significantly in their vegetation characteristics. Such a significant difference is then used as a basis of assessing the extent to which variations in land use activities (within the quadrants) are causing variation in vegetation condition (i.e. how vegetation changes are influenced by variation in land use activities.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Introduction

This chapter deals with the analysis of the ground data collected over the nine selected quadrants (sampling units), in the study area. The aim of the analysis is to obtain a clear picture of the nature of changes in ground vegetation characteristics in relation to the landuse practices and intensity in the study area. The analysis is thus expected to provide a sound basis for understanding and assessing the nature of vegetation changes with variation in landuse in the area.

Both qualitative and quantitative methods of ground vegetation data collection and analysis have been employed. Table 4.1 presents the details of the nine quadrants surveyed during the ground truthing exercises, during which the ground vegetation data were gathered.

Table 4.1: Details on the quadrants selected.

Quadrants	Location	Associated Feature
1.	West of the Reserve (Falgore)	Along sterling track, about 2km away from Kano/Jos Highway.
2.	South-West of the Reserve (Sabon Kaura/Kauntun-Hautsin)	A number of permanent settlement very close by. A dispute area between Kano and Kaduna States.
3.	South of the Reserve (Maikwandira)	Prominent footpath by livestock and fuelwood collectors.
4.	South East of the Reserve (Yalwan-Kasa)	A more or less eroded prominent access route by livestock and fuelwood collectors, collapsed huts noticeable around.
5.	North-West of the Reserve (Natala)	Farmlands neighbouring the site. A marshy area close by. Itself quite an open area.
6.	North of the Reserve (Dariya)	Surrounding sites reveal evidences of fuelwood collection and grazing.
7.	North-North-East of the Reserve (Zamba)	Prominent footpath, 3-stones fire sites spotted here and there. A stream closed by.
8.	North-East of the Reserve (Zina Patrol Zone)	Traces of fruit collection particularly Borassus. Little huts spotted here and there for temporary settlements by fulani nomads quite evident. Erosion rills present.
9.	East of the Reserve (Gomo Patrol Zone)	A stream close by. Very large farmlands neighbouring it. Kano/Bauchi State dispute area.

Source: Field Work, 1999

4.1 Vegetation Characteristics per Quadrants

4.1.1 Species Type

Table 4.2 below presents details of the major specie types found per quadrant. The species are identified both in their local (Hausa) and botanical names.

Table 4.2: Species Type per Quadrant

Quadrants	Species (Hausa/Botanical names)
1.	Baushe (Terminelia glaucescens)
	Turna (Protea argrophaea)
	Shafa (Allium ascalonicum)
	Wuyam-damo (Combretum molle)
	Dargaza (Grewis mollis)
	Kwandari (Terminelia macroptera)
	Kargo (Philostigma thonningii)
	Arra-rabin (Boswallia dazielii)
	Kadanya (Butyrospermum paradozum)
	Taura (Detarium microcarpum)
	Faru (Lannea acida)
	Marike (Anogeissus leiocarpus)
	Tawatsa (Entada africana)
	Talauniya (Combretum ghasalens/glutinosum)
	Matsatasagi (Bauhinia refescens)
	Kawo (Afzelia Africana)
	Makarho (Afrormosia laxiflora)
	Janyaro (Hymenocardia acida)

2.	Tawatsa (Entada africana) Faru (Lannea acida) Makarho (Afrormosia laxiflora) Halshen tumkiya (Psychotria elliotii) Kadanya (Butyrospermum paradozum)
3.	Kwandari (Terminelia macroptera) Faru (Lannea acida) Taura (Detarium Microcarpum) Doka (Isoberlinia doka) Wuyam-damo (Combretum molle) Baushe (Terminelia glaucescens) Kadanya (Butyrosperemum paradozum) Madobiya (Pterocarpus erinaceus) Turna (Protea argrophaea) Gwanda daji (Annona senegalenisis) Dargaza (Grewia mollis)
4.	Talauniya (Combretum ghasalens/C. glutinosum) Shafa (Allium ascalonicum) Baushe (Terminelia glaucescens) Faru (Lannea acida) Marike Anogeissus leiocarpus Makarho (Afrormosia laxiflora) Wuyam-damo (Combretum molle) Rumfu (Cassia singueana)

5.	Talauniya (Combretum ghasalens/glutinosum) Gatsari (Albizia Chevalieri) Gurjiya (Bombax Costatum) Kukkuki (Sterculia setigera) Faru (Lannea acida)
6	Marike (Anogeissus leiocarpus) Makarho (Afrormosia laxiflora) Shafa (Allium ascalonicum) Kwandari (Terminelia macroptera) Talauniya (Combretum ghasalens/glutinosum) Gurjiya (Bombax Costatum) Tawatsa (Entada africana) Wuyam-damo (Combretum molle) Karya-gatari (Afrormosia laxiflora) Taura (Detarium microcarpum)
7.	Tawatsa (Entada africana) Kwandari (Terminelia macroptera) Marike (Anogeissus leiocarpus) Kadanya (Butyrospermum paradozum) Wuyam-damo (Combretum molle) Kirni (Bridelia ferruginea/seleronenra) Taura (Detarium microcarpum) Talauniya (Combretum ghasalens/glutinosum) Faru (Lannea acida) Tsamiya (Tamarindus indica)

8.	Talauniya (combretum ghasalens/glutinosum Shafa (Alium ascalonicum) Taura (Detarium microcarpum) Kwandari (Terminelia macroptera) Gwanda daji (Annona senegalensis) Sabara (Guiera senegalensis) Makarho (Afrormosia laxiflora) Kokiya (Strychnos spinosa) Kirni (Bridellia ferruginea/selenronenra) Gaude (Gardenia erubescens)
9.	Kwandari (Terminelia Macroptera) Talauniya (Combretum ghasalens/glutinosum) Faru (Lannea acida)

Source: **Field Work, 1999**
NOTE: Names given in brackets are the Botanical names, while the others are the local names in Hausa.

From the list of species presented in table 4.2, it can be concluded that the dominant species type now present over the reserve include: Butyrospermum paradozum, Terminelia macroptera, Terminelia glaucescens, Detarium microcarpum, Combretum ghasalens/C. glutinosum and Allium ascalonicum. Most of these species are exotic presupposing that most of the indigenous species to the area have been replaced with exotic non-indigenous ones. For instance typical species such as Afzellia africana, Hymenocardia acida, Daniellia oliveri, Isoberlinia doka appear to be no longer very common in the

area. Their disappearance could simply be accounted for by human interference, basically by way of fuelwood collection, poles and some timber. Plate I shows an example of a long standing indigenous specie (Daniellia oliveri) that has been cut down for fuelwood, Plates II and III on the other hand depict how a colony of an indigenous species (Hymenocardia acida) has virtually been cleared.



Plate I: Example of an Indigenous Specie (Daniellia oliveri) Cut Down by Fuel Wood Collectors



Plate II: An Example of a cleared Colony of Indigenous Specie (Hymenocardia acida)



Plate III: An Example of a Colony of an Indigenous Specie (Hymenocardia acida) that has been Severely Affected by Clearance.

4.2 Land Use History and Practices

The summary of the information on landuse history and practices on the respective quadrants is presented in table 4.3.

Table 4.3: Landuse History

Quadrants	History
1.	- No record of farming within the reserve. - Deforestation is basically via grazing, fuelwood collection and occasional trees burning for charcoal and poaching activities. - Of recent, areas completely bare of vegetation exist due to destruction by bulldozer and construction works along the Kano - Jos road via Falgore.
2.	- Farming/cultivation within the reserve over a period of 10 years and permanent settlements too for the farmers (indigenes) of Kaduna State. - Grazing and fuelwood collection also very prominent.
3	Being a very remote area with relatively low population, there exist abundant land for cultivation outside the reserve. The major human activity within the reserve is therefore grazing and fuelwood collection. Tree branches and smaller trees are cut down to provide pasture for the cattle, especially in the dry seasons.
4.	- No record of cultivation in the past, but attempt was made last year for establishment of farmland and even settlement especially by the Hausa - Fulani nomads, but for intervention by the wild life management of Kano State. Coupled with this the major activities of vegetation destruction are fuelwood collection, grazing and trespassing of the nomads and their cattle.

5.	- Area had been under cultivation some many years back; presently under intensive grazing and fuelwood collection. - Area is also characterised by bush burning from neighbouring farmlands.
6.	Basically grazing and fuelwood collection by the Hausa - fulanis.
7.	Mainly grazing, fuelwood collection and temporal settlement by fulani nomads; who clear up vegetation, at different times and by different groups or families. Prominent foot path or access route evident.
8.	Within the patrol zone where this quadrant was taken, the major human activity is grazing, fuelwood and fruits collection. Also vast areas within the reserve have been cleared-up by nomads and their cattle for temporal settlement. Different families or groups make stops at different sites in the reserve and their duration of stay ranges from a day or two to 3 - 4 months.
9.	- Grazing and fuelwood collection prominent. The sampled area has been under cultivation by the Bauchi State people who claim ownership of the area. This area has been converted to farmlands for a duration of over 10 years and appears as a more or less open field.

Source: Field Work, 1999.

On a general note, the major human activity that is evident across the entire study area is grazing and fuel wood collection, though their intensity tends to vary from one quadrant to the other. This practice is said to have been going on for quite a long time and is becoming even more rampant today. It is thus very common to find cattlemen and their livestock not only grazing and browsing in the reserve

but also cutting down tree branches and sometimes the entire tree, just to provide pasture for their animals. In the same way, others who own and rear goats/sheep are also in the habit of visiting the reserve to harvest food for them by way of foliage of the tree branches. Usually, the younger or smaller trees and shrubs are those destroyed by this practice. Plates IV - X display samples of various land use activities going on in the game reserve. Gadzama (1991) has explained that despite being a semi-arid and marginally fragile ecosystem, Nigeria's semi-arid region is a home to very large population of livestock (sheep, donkeys, camels, goats, cow etc.). Because of the virtual lack of adequate fodder to sustain such a huge livestock population, there is a more or less constant movement of stock within the region in search of any available fodder which is grazed more often than not ruthlessly and destructively. Plates XI and XII depict some observable effects of forest clearance on land in the area. In most cases, evidence of wood exploitation was observed from remnants of the cut stump, logs and splits of wood in the field and at home at its market/commercial point. The various agents of forest clearance observed in the area are portrayed in plates XIII - XVIII.

Farming/cultivation was and has since been observed particularly at two sites, which happen to be the border dispute areas between Kano State with Kaduna and Bauchi States. In each of these areas a considerable portion of the

reserve has been converted completely to farmlands and appear more or less as open fields. The major food crops grown here include maize, maize and rice respectively (Plates XVIII and V). It is thus little wonder that forest clearance in the area appear to be very complex in pattern (see Plate XIX).

Elsewhere, no record of continuous cultivation has been observed within the reserve; though at quadrant 5, it was identified that the area had been under cultivation some many years back. Also, another attempt to establish farmland as identified at quadrant 4 was promptly arrested by the management of the game reserve concerned.

Similarly, permanent settlement sites were only observed at one site (i.e. the Kano/Kaduna dispute area - Plate VII). There however, exist several temporal settlement sites within the reserve, created by the fulani nomads. This practice too has been going on as long as cattle rearing/grazing and has destroyed vegetation over vast expanse of the reserve. This was particularly observed at three quadrants (Plates VI and VIII).

Other practices worth noting, though not very noticeable by mere observation, include fruits collection, tree burning for making of charcoal, bush burning for chasing games for hunting, logging for local construction and some timber. Plate XX shows an example of seized bags of charcoal from charcoal vendors by officials of the game reserve. Another example of a similar



Plate IV: Landuse Activities within the Game Reserve: Indescriminate Grazing by Livestock (Note the Track being used by both Cattle and Possibly Fuel Wood Conveying Trucks).



Plate V: Land use Activities within the Game Reserve: Permanent Rain-fed Cultivation.



Plate VI: Land use Activities within the Game Reserve: Settlement of Herdsmen Created on Temporary Basis



Plate VII: Land use Activities within the Game Reserve: Permanent Settlement of Semi-Nomadic Herdsmen and farmers.



Plate VIII: Land use Activities within the Game Reserve: Transit Settlement of Nomadic Herdsmen.



Plate IX: Land use Activities within the Game Reserve: Fuel Wood Disposal Depot. (Note the size of the vehicle conveying the fuel wood away from the area)



Plate X: Land use Activities within the Game Reserve: Fuel Wood Disposal Depot/Commercial Point.
(Note How Areas Adjoining the Depot Have Been Completely Cleared of its Trees).



Plate XI: Some Effects of Forest Clearance on Land Condition: Erosion Rills Gradually Developing into Gullies.

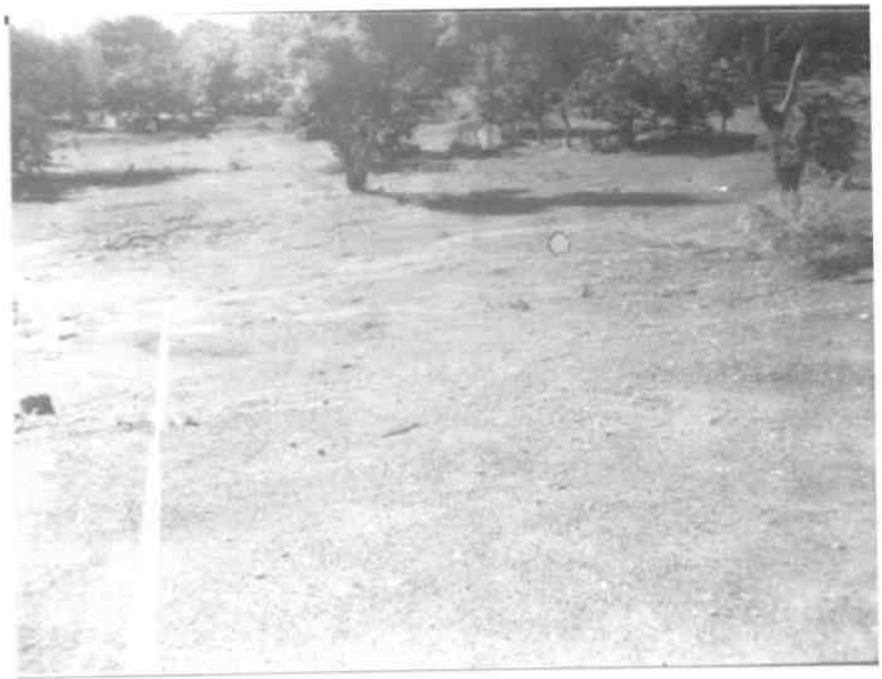


Plate XII: Some Effects of Forest Clearance on Land Quality: A Bald Land Created as a Result of Prolonged Erosion on Cleared Sites.



Plate XIII: Agents of Forest Clearance: Small Holder Fuel Wood Collection.



Plate XIV: Agents of Forest Clearance: Branches of Trees Cut Down and Fed to Livestock.



Plate XV: Agents of Forest Clearance: Systematic Cutting-up of Trees' Leaves and Branches for use in Feeding Domesticated Animals.



Plate XVI: Agents of Forest Clearance on the Reserve: Construction of Access Roads.



Plate XVII: Agents of Forest Clearance on the Reserve: Construction of Access Roads. (Note the Pool of Water that has Accumulated at the edge of the Un-cleared Forest).



Plate XVIII: Agents of Forest Clearance: Farmlands within the Reserve.



Plate XIX: Complex Pattern of Forest Clearance: While the Background has been Cleared for Settlement and Grazing Sites by Herdsmen, the Trees in the Foreground have had their Stems Cut-off for both Fuel Wood and Livestock Fodder.



Plate XX: Efforts Towards Forest Conservation: Charcoal Seized from Charcoal Vendors by the Officials of the Game Reserve.



Plate XXI: Efforts Towards Forest Conservation: Wood Logs Seized from Fuel Wood Collectors by the Officials of the Game Reserve.
(Note the Size of the Seized Trunk, suggesting the Olden Nature of the Cleared Specie).

4.3 Variation in vegetation characteristics with landuses

4.3.1 Species Height

The data on species height (m) is displayed on Table 4.4 below.

Table 4.4: Species Height Characteristics of the various quadrants

Quadrants	Mean	SD	SEM	CV
1	26.4	5.52	0.66	20.9%
2	50.4	9.41	3.84	18.7%
3	31.9	9.45	1.36	29.6%
4	31.5	5.58	0.93	17.7%
5	45.8	10.61	3.54	23.2%
6	38.2	10.60	2.16	27.7%
7	24.2	8.45	1.60	34.9%
8	23.1	4.99	1.06	21.6%
9	38.7	10.10	5.05	26.1%

Source: Field Work, 1999

As observed from the table, the mean species height varies from 23.1m to 50.4m with quadrants 2,5,9 and 6 in that order having higher values and quadrant 8 with the least value. However in terms of spatial variation quadrants 7,3,6 and 9 respectively show high values depicting high variability in the height of the trees. This could be explained by the nature and intensity of landuse practices in the areas because the more the disturbance by landuse practices, the more the

trees are expected to vary in height. Another reason that could be advanced for the generally high spatial variation in the height of the vegetation species over the various quadrants is the natural diversity in species types and so variation in physiognomic (growth form characteristics of the vegetation). The latter applies particularly to quadrants 1,3 and 7 which are relatively richer in species type diversity.

Results of t-test comparing the height indicate that out of a total of 36 pairs, 22 pairs show significant differences in their trees height. This seems to be a reflection of the variation in the type and intensity of landuse practices, as well as the composition and diversity of the species type in each quadrant. Areas with greater human interference as revealed by the degree of dispersion (high SD and CV values) tend to have more variation in the height of tree species than areas where human influence is comparatively low.

Meanwhile, quadrants with almost similar land use practices and history or species diversity tend to show little or no variation in species height. Typical example is quadrants 2v5, 2v9 all of which are or have been under cultivation and both their mean height values and SD values are very close.

Table 4.5: Summary Results of t-test comparing Vegetation Characteristics of the Quadrants

T-values for Pairs (at 0.01 level of significance)																	
Trees Height	Df=74 1v2	Df=116 1v3	Df-104 1v4	Df-77 1v5	Df-92 1v6	Df-96 1v7	Df-90 1v8	Df-72 1v9	Df=52 2v3	Df=40 2v4	Df=13 2v5	Df=28 2v6	Df=32 2v7	Df=26 2v8	Df=8 2v9	Df=82 3v4	Df=55 3v5	Df=70 3v6
	6.16*	3.63*	4.47*	5.39*	5.22*	1.27	2.64*	2.41	1.31	4.78*	0.88	2.77*	6.30*	6.85*	1.84	0.24	3.67*	2.46
	Df=74 3v7	Df=68 3v8	Df=50 3v9	Df=43 4v5	Df=58 4v6	Df=62 4v7	Df=56 4v8	Df=38 4v9	Df=31 5v6	Df=35 5v7	Df=29 5v8	Df=11 5v9	Df=50 6v7	Df=44 6v8	Df=26 6v9	Df=48 7v8	Df=30 7v9	Df=24 8v9
	3.67*	5.09*	1.30	3.91*	2.84*	3.95*	5.94*	1.40	1.83	5.57*	6.15*	1.15	5.21*	6.26*	0.09	0.57	2.74	3.02*
Trunk Diameter	1v2	1v3	1v4	1v5	1v6	1v7	1v8	1v9	2v3	2v4	2v5	2v6	2v7	2v8	2v9	3v4	3v5	3v6
	4.70*	4.80*	2.83*	6.33*	5.93*	1.69	1.09	4.60*	2.48	3.48*	2.42	0.33	3.41*	3.35*	1.23	1.99	4.76*	2.79*
	3v7	3v8	3v9	4v5	4v6	4v7	4v8	4v9	5v6	5v7	5v8	5v9	6v7	6v8	6v9	7v8	7v9	8v9
	1.85	1.80	3.10*	5.82*	4.16*	0.32	0.53	3.77*	2.93*	5.44*	5.34*	0.90	3.89*	3.70*	1.57	0.23	3.77*	3.76*

* = Pairs showing significant differences

DF = Degree of freedom

Table 4.5: Cont.d. Summary Results of t-test comparing Vegetation Characteristics of the Quadrants

	T-values for Pairs (at 0.01 level of significance)																	
	Df=74	Df=116	Df-104	Df-77	Df-92	Df-96	Df-90	Df-72	Df=52	Df=40	Df=13	Df=28	Df=32	Df=26	Df=8	Df=82	Df=55	Df=70
	1v2	1v3	1v4	1v5	1v6	1v7	1v8	1v9	2v3	2v4	2v5	2v6	2v7	2v8	2v9	3v4	3v5	3v6
Basal Area	3.12*	3.88*	2.30	3.62*	3.71*	2.13	0.95	3.38*	1.87	2.50	2.05	0.24	2.35*	2.93*	0.90	1.83	3.07*	2.05
	Df=74	Df=68	Df=50	Df=63	Df=58	Df=62	Df=56	Df=38	Df=31	Df=35	Df=29	Df=11	Df=50	Df=44	Df=26	Df=48	Df=30	Df=24
	3v7	3v8	3v9	4v5	4v6	4v7	4v8	4v9	5v6	5v7	5v8	5v9	6v7	6v8	6v9	7v8	7v9	8v9
	1.30	3.45*	2.47	3.34*	2.89*	0.29	1.68	2.93*	2.25	3.29*	3.53*	1.34	2.67	3.48*	1.17	1.61	2.83*	3.24*
Percent vegeta-tion cover	1v2	1v3	1v4	1v5	1v6	1v7	1v8	1v9	2v3	2v4	2v5	2v6	2v7	2v8	2v9	3v4	3v5	3v6
	3.86*	2.60	1.54	1.68	3.98*	5.17*	2.30	1.51	2.35	2.83*	0.34	0.94	0.58	4.62*	0.48	0.83	1.22	2.88*
	3v7	3v8	3v9	4v5	4v6	4v7	4v8	4v9	5v6	5v7	5v8	5v9	6v7	6v8	6v9	7v8	7v9	8v9
	2.51	3.84*	1.16	1.40	3.25*	3.19*	2.65	1.30	0.17	0.57	1.88	0.18	1.51	4.39*	0.08	6.00*	0.66	1.67

* = Pairs showing significant differences

DF = Degree of freedom

4.3.2 Trunk Diameter

Data on mean trunk diameter of the various quadrants is also presented as:

Table 4.6: Trunk Diameter (m) Characteristics of the various Quadrants.

Quadrants	Mean	SD	SEM	CV
1	0.72	0.11	0.013	15.3%
2	0.96	0.12	0.048	12.5%
3	0.83	0.13	0.019	15.7%
4	0.78	0.10	0.016	12.8%
5	1.16	0.20	0.066	17.2%
6	0.94	0.17	0.035	18.1%
7	0.77	0.14	0.026	18.2%
8	0.76	0.16	0.034	21.0%
9	1.07	0.15	0.075	14.0%

Source: Field Work, 1999

Just as for trees height, it can be observed that quadrants 5,9,2,6 and 3 respectively have high mean values for trunk diameter, as well as high CV values, an indication that the landuse practices have in these areas mostly affected trees of relatively small size. It is common practice for the small and medium size trees to be cleared for cultivation or cut down to provide pasture for animals. The rest of the

quadrants portray low mean trunk values which are almost close to each other. This tends to show that the larger tree size are rather those mostly affected in these other quadrants. This seems logical considering the fact that in these areas, fuel wood collection, and trees burning for charcoal, local logging are prominent amongst other practices (plates xxii and xxiii).

The result of student t-test for pairs of quadrant also reveal that 22 out of 36 pairs show significant differences in their trunk diameter. This can be attributed to the variation in the complex diversity in physiognomic characteristics and species composition over the various quadrants, in relation to variation in the type and intensity of landuse practices. Some landuse practices by their nature encourage the deforestation of specific species and comparatively bigger trees e.g. wood exploitation: trees burning for making charcoal, logging for timber or construction;



Plate XXII: Utility of the Cleared Forest's Products: Timber used in Constructing Shed in Falgore Village.



Plate XXIII: Utility of the Cleared Forest's Products: Timber Produced for use in Mud-house Roofing.



Plate XXIV: Tracks being used as Conveyance Routes for Fuel Wood, and Access Route by Livestock.



Plate XXV: Tracks being used as Conveyance Routes for Fuel Wood, and Access Route by Livestock.



Plate XXVI: Tracks being used as Conveyance Routes for Fuel Wood, and Access Route by Livestock.

4.3.3 Species Basal Area

Data on species basal area for each quadrant is shown in table 4.7 below.

Table 4.7: species Basal area (m^2) characteristics of the various quadrants.

Quadrants	Mean	SD	SEM	CV
1	0.013	0.014	0.002	107.7%
2	0.044	0.024	0.010	54.5%
3	0.025	0.018	0.003	72.0%
4	0.019	0.012	0.002	63.0%
5	0.094	0.067	0.022	71.3%
6	0.041	0.036	0.007	87.8%
7	0.020	0.015	0.003	75.0%
8	0.015	0.006	0.001	40.0%
9	0.059	0.027	0.013	45.8%

Source: Field Work, 1999

The data on mean species basal area of the various quadrants appear to exhibit a similar pattern with the data on mean trunk diameter. The data indicates that quadrants with high mean trunk diameter values have proportionately high values for basal area; and accordingly high coefficients of variability. This again is explained by the fact that the nature of landuse practice is such that it encourages

destruction of relatively smaller trees more than the bigger ones.

However, the result of the t-test for pairs of quadrants show 17 pairs out of the total of 36 pairs to be significantly different in their species basal area. A possible reason for this comparatively low significant variation in basal area characteristics between the various quadrants is the fact that basal area is usually defined more by larger species than smaller ones. Since most of the smaller species are affected by clearance, it is little wonder that the basal area created by the larger ones are not significantly differentiated. If otherwise that the species composition is made up of much of the smaller ones, such variations are expected to be greater.

4.3.4 Percent Vegetation Cover

The relative proportion in % of a given land area covered by vegetation is presented in table 4.8 below.

Table 4.8: Percent vegetation cover (%) characteristics of the various Quadrants.

Quadrants	PVC%	Mean CA	SD	SEM	CV
1	77.8%	27.77	15.92	1.90	57.3%
2	17.8%	74.34	29.17	11.91	39.2%
3	83.7	43.58	37.80	5.45	86.7%
4	53.3%	37.00	34.04	5.51	89.3%
5	31.3%	86.82	105.23	35.08	121.2%
6	69.6%	93.31	80.19	16.36	85.9%
7	74.2%	66.28	38.07	7.18	57.4%
8	18.2%	20.65	11.42	2.43	55.3%
9	15.5%	97.07	91.45	45.72	94.2%

Source: Field Work, 1999

A close look at the table reveals that the pattern of the data on percent vegetation cover very much reflects that of the data on species number in the various quadrants. This is so because the presence or absence of vegetation species over a given area determines greatly the percentage of the area that will be covered by vegetation. The data reveals that in 4 out of the 9 quadrants, the percent vegetation cover values are comparatively low perhaps reflecting the generally low vegetation density over these quadrants. These low percent vegetation cover values are said to reflect a cummulative effect of persistent disturbance of vegetation

cover via grazing, cultivation, wood collection, settlement etc.

The result of the student t-test for pairs of quadrants indicate that 11 out of the 36 pairs have significant differences in their percent vegetation cover. This significant variation appears to be low but seems to reflect the generally low variation in species density of the quadrants. A possible reason for the general lack of significant variation between the compared quadrants is the fact that branches of quite a large number of the standing trees have been chopped-off (Plate xix). Such chopping-off naturally limits the extent to which percent vegetation cover would be high enough as to influence significant variation over space. Under such condition, even if the total number of trees may be greater, the overall percent vegetation cover will be relatively small. The same situation applies to units whereby wood collection and tree burning dominate such that most of the trees left are relatively small in size. In such cases too, the canopy area cast on the ground is bound to be small resulting into low percent vegetation cover values.

4.3.5 Species number, density and Crown Cover

Data on the number of species, their density and crown cover are shown on table 4.9 below.

Table 4.9: Species Number, Density and Crown Cover Characteristics of the various quadrants.

Quadrant	Species Number	Density	Crown Cover
1	70	0.028	0.41
2	6	0.0024	0.72
3	48	0.020	0.54
4	36	0.014	0.48
5	9	0.004	0.06
6	24	0.010	0.69
7	28	0.011	0.46
8	22	0.009	0.45
9	4	0.0020	0.90

Source: Field Work, 1999

The results contained in table 4.9 above show that the more the number of species in a quadrant, the greater its density and vice versa. Quadrant 1 thus have the highest density and 9 the lowest. These suggest that quadrants with high evidences of vegetation degradation have comparatively lower density values.

The data on crown cover for the various quadrants appears rather to follow the variation in the pattern of the data on mean trunk diameter; in which case 55.6% of the sampled quadrants reveal high values for the crown cover. This

appears logical given that the bigger the tree size the more branches or canopy it is likely to have which will also reflect in the actual area covered by vegetation. Nevertheless, this may not necessarily apply in the strict sense of it, because the tree size may be relatively large but with few branches or canopy since most of these are being cut down to provide pasture for animals. On the other hand, the relatively low values for the other quadrants is an indication of the degradation of most of the bigger tree species through diverse human actions.

4.4 Vegetation Changes as function of landuse activities

As can be seen from table 4.3, the main landuse types recognised in the study area include cultivation, grazing, wood exploitation and settlement development amongst others. Each of these activities affect vegetation differently and at varied rates. This is implicit on the various vegetation characteristics considered as presented on the respective tables. Of the 9 quadrants, those under continuous cultivation or have been cultivated in the past (quadrants 2 and 9; and 5 respectively, constituting about 33% of the sample area) reveal comparatively higher mean trees height, trunk diameter, crown cover and species basal area with rather low values for species numbers, density and percent vegetation cover. Thus this land use activity is seen to affect vegetation condition adversely mainly in terms of number, density and percent

vegetation cover.

Grazing and wood exploitation is evident over the entire study area though at varied rates and intensity. However, of the 9 quadrants sampled, quadrants 1,3,4,6,7 and 8 representing about 67% of the total area sampled, such activities are predominant. These quadrants generally depict relatively low values of mean species height, trunk diameter, crown cover and basal area. It is however apparent that the rate and intensity of grazing and wood exploitation is relatively higher in quadrants 1,3,4 and 7 than in site 6. In terms of species number, density and percent vegetation cover, these six quadrants depict higher values than quadrants associated with cultivation. It therefore implies that the main vegetation characteristics adversely affected by these two landuse activities grazing/wood collection include tree height, trunk diameter, crown cover and basal area.

Quadrants in which deforestation was observed for purpose of settlement amongst other uses are quadrants 4,7 and 8 representing about 33% of the sampled area. In these areas, the data on the various vegetation characteristics reveal low values for mean species height, trunk diameter, crown cover and basal area; and also relatively low density values, fewer species number as compared to 1 and 3 where there are no observable evidences of deforestation for settlement purposes.

In terms of percent vegetation cover, quadrant 8 shows the

lowest value which implies a greater pressure on the vegetation cover by combined human activities.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary of Findings

This study is an attempt to characterise vegetation changes in Falgore game reserve area of Kano State, in relation to variation in landuse activities; using ground-based techniques. The major ground data considered include information on landuse history and practices, and on the various vegetation characteristics such as species type, number, density, height trunk diameter, basal area, crown cover and percent vegetation cover. The data were collected through extensive and intensive ground truthing exercises. The results obtained reveal that despite commendable efforts to maintain the reserve as a protected forest environment, it is still faced with encroachment problems which are rather complex in nature. The major human activities identified within the study area range from selective logging (for different purposes), fruits collection, poaching activities, tree burning to cultivation, grazing, fuelwood collection and settlement development. The rate and intensity of these activities however vary from one unit to another in the area and hence their effect on the considered vegetation characteristics. Major findings of the study are thus:

Parts of the study area under cultivation, representing about 33% of the sampled area, are shown to compose of few species and lower values for species density and percent

vegetation cover; suggesting a relatively high intensity of this landuse practice over the area.

On the other hand, quadrants with observable evidences of grazing and wood exploitation (representing about 67% of the sampled area) though appear to be comparatively denser in terms of species number and percent vegetation cover, are seen to consist of lower values for mean species height, trunk diameter, crown cover and basal area suggesting most likely that the present vegetation is a community of younger trees which have not yet attained maximum maturity. This also suggest that the older and more matured vegetation species of this area have been greatly affected by grazing and wood exploitation such that they have been forced largely to disappear.

Similarly, this applies to quadrants which in addition to the above practices are further exploited for some form of settlement. This appears to be in line with th result obtained from the assessment of vegetation and landuse change in Nigeria (Geomatic International, 1998) which pointed out that much of the tree cover at Kano State (817 km^2) dominantly trees/woodland/shrubs that was contained within the game reserve in 1976/78, was largely removed and in 1993/95 the area was mapped almost entirely as dominantly shrubs/grasses; representing a transition zone between the Sudan and Guinea ecological zones, with visible areas of gully erosion.

5.2 Conclusion

From the major findings above and the result of the t-test of pairs of quadrants for various vegetation charcteristics (table 4.5), we can reject the null hpothesis and rather accept the alternative hypothesis which is supportive of the fact that some significant variation exist in the charcter of vegetation between the different sampling units over the game reserve. This variation can be attributed to variation in the type(s) and intensity of landuse practices over these units of the reserve considering that the physical factors such as climate, geology and relief are fairly uniform and therefore the vegetaion conditionis expected to be fairly uniform.

The results of the statistical analysis further revealed that tree height and trunk diameter are the major vegetation characteristics affected by this variation inlanduse practices since many pairs showed significant differences in the two characteristics. This further suggests a somewhat strong link between changes in vegetation height and trunk diameter and effects of landuse practices like grazing, wood exploitation, cultivation and settlements development as observed over the study area.

5.3 Recommendation

Nature conservation is the most important challenge of the present century. Nothing affects the quality of our lives

quite like the welfare and state of nature and no future can be quite so bleak as one in which the living resources, such as plants and wild life, which are very essential for human survival, and development, are increasingly being destroyed or depleted by human carelessness.

For the Falgore game reserve to satisfy the objectives for which it was created, there arises a greater need to properly manage and conserve the forest. Games or wildlife cannot survive in a vacuum neither can the forests survive without management. Similarly, changes which lead to the degradation of wildlife habitats often result in reduced diversity and numbers of wildlife population. And so conserving the natural vegetation in the reserve should be a shared concern between the government and the public.

Government in particular should viewdeforestation in the area as a serious ecological disaster to be keenly monitored and redressed by adequately funding reforestation.

Secondly there should be some policy shifts which could pave the way for adjusting polices to minimise people's need to deplete natural vegetation. For instances, it is important that the government creates the necessary conditions in which effective forest conservation and management can succeed such as providing a legal frame work which is enforceable, and enforced. However, it has been realised that, it is no longer enough to constitute an area into a game reserve and expect Rangers/game guards to enforce the laws. Law enforcement

alone cannot save the forest. Moreover, many defaulters normally escape the attention of the few and ill-equipped management staff. Sometimes when accosted and prosecuted, they are often sentenced to ridiculously light terms of imprisonment or fines. Therefore, the people of the area should know what the forest offers them and why they should protect it.

Hence conservation education (public enlightenment) is both relevant and desirable. This may take many forms e.g. by way of extension services in which case the extension workers should live with the people, educate them and understand their feelings and aspirations towards conservation projects as this. Also extension services should utilise programmes on televisions, radios, seminars, workshops, leaflets, posters, stickers etc. as avenues of reaching the people more adequately.

Another good measure is to ensure increasing the involvement of local people of the area in the management of the game reserve. In particular head of communities in the immediate vicinity of the reserve should be involved in the day-to-day management of the reserve.

Also, the local population must be made to benefit from the reserve's proceed where any.

In addition, since the youths today are the government and leaders of tomorrow, it is equally important to introduce conservation curricula at all levels of education, the aim of

which is to instill in them a burning sense of environmental consciousness - i.e. spreading environmental awareness among the young ones.

To solve the problems of border and farmers encroaching into the buffer zones, a redemarcation of the reserve is necessary and possibly thereafter upgrading the game reserve to the status of a National Park.

Also necessary is the provision of well-trained and adequate numerical strength of the staff, operational equipment, adequate funding, infrastructural development or renovation of existing ones for the staff, approval of both overtime and hazard allowances for the staff as a way of increasing motivation and moral and thus commitment at work.

Also in planning for roads expansion, the government should take into consideration the possible effects of this development on the adjacent forest.

Another good measure is introduction and development of suitable energy alternatives (improved stoves for instance) that could help to serve as good alternative to the existing sole reliance on fuel wood.

Similarly, in order to curb illegal grazing in the reserve and looping of trees, the government could get all livestock owners within the area registered and apportioned areas where they will grow pasture to feed their animals all year round.

In this study, the ground based technique was used in assessing change in vegetation characteristics, however, further research is encouraged to use both remote sensing and ground data and comparison made.

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