PHOTOINTERPRETATION OF LANDCOVER AND SLOPE FACETS IN SOUTHERN ZARIA

BY

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QUOTATION

"Let us hear the conclusion of the whole matter: Fear God, and keep his commandments: for this is the whole duty of man." Eccl. 12:13.

D E D I C A T I O N

Spurred by the memories of their love, the challenge and encouragement in their lives, I dedicate this work to my late brother Benham Abdalla and my late mother In-law Wafudu Wadzani.

D E C L A R A T I O N

I hereby declare that this thesis is a record of my own research work and was composed by myself. This is a genuine and original work which has not been previously presented in this form.

All quotations are distinguished by quotation marks and the sources of information are fully acknowledged.



JACOB NATHANIEL ABDALLA DZARMA

(December, 1987)

C E R T I F I C A T I O N

This theris entitled: .....

.....

by .....

meets the regulations governing the award of the

degree of: .....

of Ahmadu Bello University Zaria and is approved for its contribution to knowledge and literary presentation.

.....
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A C K N O W L E D G E M E N T S

It is with the deepest appreciation and heartfelt gratitude that I acknowledge.

My wife and family - who never gave God rest that I work hard and honest so that we can share the joy of today together. I therefore, appreciate their concerns, prayers and suggestions.

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A B S T R A C T

Research reports have stressed the utility of remote sensing for the acquisition of basic landuse data.

Aerial photographs at 1:25,000 nominal scales were used to acquire landuse data of Kajuru S. W and S.E. in Southern Zaria (Kaduna State). A landuse classification developed by Field in 1985 was employed to provide the spatial distribution of landuse over the area. Landuse was sampled by dot grids and recorded on micro-computer files.

Land system/land facet classification was also employed to provide automatically the pattern of landuse in relation to the physiognomic features which were readily recognisable in the vertical plane from the stereo models. Analysis revealed correlations between slope and landuse.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Introduction

Landuse information is one of the most essential tools for the economic, social and political growth of any one nation. The various professionals that stand to benefit from landuse data include town planners, engineers, resource managers, foresters, geographers etc. But all these professional fields have tended to neglect the wealth of informations that are contained in aerial photographs and depend extensively on the range of readily available maps and plans obtainable from various survey department. There is therefore, inadequate relevant landuse information. Consequently planning is rendered a difficult task.

In Nigeria, the method that has generally been in use for the collection of landuse information data is the ground based method which is slow, time - consuming and expensive. "Fortunately, alot of researches in North America and Europe have demonstrated that remote sensing has a great potential to provide a cost-effective timely and effective information on landuse (changes)", (Adeniyi, 1980).

Remotely sensed imagery is taken to include satellite imagery, high level photography and the more conventional lower level photography at medium scales. In a forward to the NAS report on the remote sensing projects for developing countries, Cleveland (1977) noted that the experience with the use of remote sensing as an aid in resource management in developing countries is still scant that most of their judgements have been based on evidence from practical applications in the United States.

In Nigeria, the application of remote sensing for landuse data acquisition is very scanty until now, almost all aerial photographs flown have been purely for topographic map production using photogrammetic techniques. "This material (aerial photographs) is archived after use, and still contains a wealth of information on vegetation and landuse which has not been transferred to the topographic maps produced from it", (Field & Collins, 1986). Meanwhile, there is always the demand for the conduct of ground surveys and inventories of the nation's natural resources. But developments and redevelopment plans could be based on accurate and up to date information obtained periodically from landuse data obtained from aerial photographs.

1.2 Background of the Project

The collection and assessment of landuse information involves firstly, the recognition and identification of surface forms, structures and processes secondly, recording and assessing their spatial and temporal distributions and thirdly, analysing the nature, cause and effects of any significant relationship. We have already noted that the collection of land resources informations by ground based methods is slow, difficult and relatively expensive, particularly in Nigeria where the capital and technology is inadequate. And in most developing countries, many important development schemes are embarked upon with inadequate or no resource information available. Such schemes often fail and subsequently retared development and create new problems and unnecessary costs. As such there is a need for a quick, regular, relatively cheap and reliable means of collecting essential resource information within the limits set by technical manpower and capital constraints. Such surveys must be designed in a way that accurate data collection and evaluation minimises the risks of wrong decisions while at the same time capable of execution within reasonable time and cost. In the remote sensing methods of collecting and assesing land surface

information some of these requirements are satisfied.

1.2.1 The Aim and Objective of the Project

From the above observations, it can be seen that the acquisition of landuse data is very important for effective planning. In the words of Emmott, "the importance of the availability of landuse data as an integral part of an information system for planning is almost axiomatic" (Emmott, 1980). The object of this project therefore is to:

a) describe and explain how to employ simple interpretation techniques using aerial photographs and computer methods to acquire basic landuse data which can provide "an efficient means for the measurement, storage and representation of landuse data" (Emmott, 1981).

b) show that the wealth of informations "archived" away in aerial photographs could be harnessed and cheaply too, and could be

sufficient enough for all planning purposes. According to Phillipson (1980), "if the aerial photography is available, the expense of acquiring and analysing other forms of remote sensing may not be justified" moreso in a developing and debt ridden nation like Nigeria.

c) the landuse data generated and maps produced could provide guidelines for further indepth study of the area, and also serve as a "data bank" which would be relevant for researchers and planners on the study area.

1.2.2 Source of Data

The primary source of data is medium scale black and white vertical aerial photographs flown in 1972 by Kentings Africa Resource Services. Others include topographical maps at 1:50,000 and 1:100,000 scales of the test area; geological maps at 1:250,000 scale of the test area, unpublished thesis and reports, seminar papers and relevant testbooks.

CHAPTER TWO

2.0 REVIEW OF LITERATURE

2.1 The Study Area

The study area is covered by the national map series of Nigeria 1:50,000, sheet 145 S.E. and part of sheet 145 S.W. Kajuru. It is approximately a rectangular area bounded by longitudes $7^{\circ}41'E$ and $8^{\circ}00'E$ and latitudes $10^{\circ}00'N$ and $10^{\circ}15'N$. It has an approximate area of 1961.9Csq.km. The boundaries (for analysis) are however slightly modified because of lack of adequate photographic coverage.

The climate of the area is marked by 5-6 months of growing season followed by a severe dry season between the months of October and April, when growth is reduced to a minimum. The area generally falls within the Northern Guinea Savanna (LRDC, 1979). The mean annual rainfall is about 1700 mm. The activities of man in the area over the centuries have succeeded in modifying much of the vegetation so that most of the present plants consist of regrowth species (Blair et al, 1977).

The relief and drainage of the area comprise tracts of almost level to gently undulating

lightly dissected land, broken in places by groups of rocky hills and inselbergs. Much of the area lies between 200m and 300m above the surrounding land. The highest peak occurs in the central part of the sheet 145 S.E. where Tri Hill attains almost 1000m above surrounding land. The drainage is predominantly tributaries of the river Sarkin Pawa which in itself is a tributary of river Kaduna. Down cutting by rivers is most active in the central and South Western parts giving rise to wide valleys and extensive flood plains (fadamas). Gullying by ephemeral streams also occurs in many small areas throughout the study area.

The geology of the entire area is underlain by a complex of igneous and metamorphric rocks of mainly Jurassic to precambrian age (op cit). The only recent sediments consist of colluvial and alluvial deposits. The basement complex rocks are essentially granites, gneisses, migmatities, schists and quartzites. The quartzites commonly occur as linear ridges, while the granites and gneisses occur as inselbergs and undifferentiated plains (LRDC, 1979).

The soil can generally be described as being moderate to good physical fertility

including the flood plain soils.

Population density is virtually low, since no major selttlement is found in the area, except for several railway sub-stations. "No market villages have developed over the last 30 years" (Field and Collins, 1986). Communications are generally poor; the major communications being the Kaduna - Kachia highway and the Kaduna - Kafanchan railway line which traverses almost through the middle of the study area, "but there has been a certain amount of road improvement recently which has improved accessibility" (op cit).

This test area was selected because of the following reasons:

(i) availability of black and white vertical aerial photographic coverage for 1972 (1:25,000).

(ii) the area is situated within the Northern Guinea Savanna not too far to the North to include Sudan and Sahel savanna nor too far to the South to include the Southern Guinea savanna and forests. This could

be said to be a fair representation of a savanna region, thus allowing for a limited generalisation.

(iii.) there are several farming systems practiced in the area. This has been as a result of its climate and terrain. The possibility of this to have considerable influence on the landscape could be interesting to investigate.

(iv) with the area's close proximity to the ever expanding city of Kaduna, landuse informations would be of immense benefit when planning is to be made for the area.

2.2 The Landuse Classification Scheme

Clawson and Stewart (1965) defines landuse as "man's activities on land which are directly related to the land". Anderson et al, (1976) however stated that the widely accepted opinion about landuse is "the present use of land", and that this definition is recognised as significant for planning and management processes. Another concept which is closely related to and often

used interchangeably with landuse is "landcover". Burley, (1961) define landcover as "the vegetational and artificial construction covering the land surface."

In developing countries, and indeed the whole world, there is no ideal and universally accepted landuse classification scheme. This is more critical in Nigeria where there is a general lack of landuse maps and landuse data. Therefore, it is only pertinent on the part of the interpreter to adopt or formulate a classification system that would suit his purpose. "There is no ideal classification of landuse and landcover, and it is unlikely that one could be developed . . . Each classification is made to suit the needs of the user . . . "Anderson, et al (1976). Two basic requirements must however be met if one decides on formulating a classification system. These include:

a) making every effort to provide compatibility with other classification systems being used by various agencies involved in landuse inventory and mapping.

b) the classification should be applicable over extensive areas.

All classification schemes for medium scale photographs, Grigg, (1976) recommends, should have three major attributes:

i) given names to categories by simply using accepted terminologies;

ii) enable informations to be transmitted;

iii) allows inductive generalization to be made.

Rhind and Hudson, (1980) stated that a landuse classification must consist of a number of classes "which are mutually exclusive and which together cover all the categories of landuse likely to be encountered". This then implies that each of the classes must be clearly defined and the criteria used - whether form or function - be the same throughout the scheme.

The geographical location as well as the scale of photography of an area also helps in the design of a classification scheme. This is important because of difficulties encountered in interpreting functions or even forms of study. For instance, it is not uncommon that some open non-urban land can be misclassified as

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farmland.

Another important aspect of classification is that "it is desirable that each class should contain a reasonable percentage of the area to be viewed . . .", Field and Collins, (1986).

2.3 Land - System Classification Scheme

The geology, landforms, soil and drainage system are the inherent features of landscape that dictate the consequent landuse types. We know that land surface at one location and time is the end product of the processes of landform formation, the development of surface and sub-surface drainage system, soil formation, and the occupation and modification of habitant by the biosphere. Therefore several land characteristics are very important in the potential use of land but most of these are not directly visible and identifiable on aerial photographs. However, as surface and sub-surface characteristics of land are genetically related, it is possible to build up correlations and make decisions on the nature of the sub-surface characteristics, provided that the relationship is understood. These can be achieved through land-system analyses techniques developed by Christian and Steward (1953) of the Commonwealth Scientific and Industrial Research Organisation (Australia). This is based

on the fact that land surface of uniform landforms, soils and vegetation throughout its extent represent a distinctive type of environment and at each of its occurances. It will provide similar range of habitat for man, plants and animals. A land system would consist of land units which are sub-divided into mappable units of land facets. "Areas or group of areas of reoccuring patterns of topography, soils and vegetation are known as a land system" (op cit). A changge in this pattern determines the boundary of a land system. Therefore, in a mappable unit of landscape the land facet will have similar possibilities and problems for landuse.

The establishment of land system boundaries depends upon mapping the boundaries of different landforms using aerial photographs. These boundaries coincide with the break in slope which is easy to recognise on medium scale aerial photographs, because of the exaggerated impression of relief and overall view the photographs give when viewed stereoscopically. The soil and vegetation types associated with a particular landform will often have a distinctive textural and tonal pattern on aerial photographs, which together with other features such as the absence or presence and the extent

of erosion, the amount of land surface covered by bare rock and areas liable to waterlogging or flooding will give a particular landform a distinctive pattern (easy to detect on photo).

In principle, the land system classification scheme would consist of mutually exclusive land facets, that are capable of clear definition. The land facets which re-occur in association to form a recurring pattern indicate a land unit. The land units are components of a land system which are of different genetic factors such as parent material i.e. underlying geology that are reflected in changes in soils, slopes and vegetation.

2.4 Image Interpretation

Aerial photographs record detail of features at or above the land surface. The quality of the photoprint is determined by the amount of clarity of the features and their expressions through a wide range of tones without loss of detail at either end of the tonal range. This is dependent on the camera lens, film resolution as well as the time and day of the year of photography. The basic parameters that are used directly to identify, interprete and measure (whether quantitatively or qualitatively) the land features on photographs include the image shape, size, shadow, pattern, tone, texture

and location (site). The indirect parameters of interpretation involves the understanding of the functional relationships which describes the type and position of an object in its environment. A clear understanding of such relationships enables accurate interpretation by extrapolation. The use of interpretation keys (selective, elimination or dichotomous) also, often eases the processes of photointerpretation. The tonal description (black, grey, white) of landuse types on black and white photographs is not always meaningful for the assessment of detailed separability of two or more landuse types. According to Steiner, (1966), "it is better to compare the photographic aspect of fields with a standard density scale and assign the tone of each unit to one of the density classes".

In the savannah region, boundaries between farmlands can be recognised easily on aerial photographs, but the actual identification of crops is often very difficult mainly because farms are in small sizes with croppings often mixed, and the major crops often similar such as millet and Guinea corn. When and where necessary the accuracy of interpretation can be evaluated with "ground truth" observations. In some cases also, photographs are taken when the crops are not growing.

CHAPTER THREE

3.0 RESEARCH METHODS

3.1 Introduction

The research procedure involves:

i) the collection of basic materials and equipment which include vertical aerial photographs and mirror stereoscope;

ii) sampling and interpretation of the classified landuse classes and land facets;

iii) estimation of the area by dot grid method; and

iv) recording of the values of the landuse classes and land facets in form of coded matrix (digital form);

v) statistical analyses of data generated using a microcomputer.

3.2 Materials and Equipment

The aerial photographs used were 230mm x 230mm paper prints at a medium scale of about 1:25,000. These were examined stereoscopically with the aid of mirror stereoscope (Wild ST4 with 3 x magnification). Binocular of high magnification attached to the stereoscope proved very suitable for the interpretation which had to be one stereo - pair at a time. Lighting equipment

was also used to assist the researcher to distinguish the various shades of the panchromatic images.

There were better optical and higher magnification equipment such as the CP1, the A7 Wild Autoplotter etc at the disposal of the researcher, but the qualities of "better optics and higher magnification were counter balanced by the trouble of setting up the stereomodels", Field and Collins (1986) within these machines.

The landuse information was collected in digital form and analysis was performed using a 48 APPLE II Microcomputer with floppy disk and a dot matrix EPSON printer.

3.3 Sampling Procedure

There were 52 stereo-pairs in all, and the dot grid method was used for the interpretation.

It was not possible to make a complete survey of the whole area partly because the shape and size of the area of study was dictated by available aerial photographs, and partly because one of the objects of this study was to obtain information on landuse with a minimum of expense and effort. The Dot Grids sampling technique is considered as such a simple technique.

A random sample was at first taken form the total stereo-models of 52 (using random figures generated from an electronic calculator). This sample (6 overlaps) about 138.8 sq. km surface area and representing 11% of the total area, was used for the estimation of the theoretical sampling error of the systematic point sampling. A range of 1.00 ha dot grids was constructed 5mmx5mm apart on an acetate template. The dots separation were arranged in relation to the scale of photography so that each fell in the centre of the 1.00 ha area; allowing for the normal over laps between photographs ($\pm$ 66%) and runs of photographs (+ 25%). Each of the rectangular model area contained 321 dots evenly distributed in 11 rows and 21 columns, giving a total of 1386 points for the 6 overlaps. By reference to corresponding photo details, a particular dot is placed in coincidence with the principal point on the photograph. Under the Wild ST4 Mirror Stereoscope, the landuse category at each dot was recorded on a data sheet which indicates the position of each dot and a two - figure numeric landuse code. Care was taken to make sure that when the dot grid is placed back on the photograph after sometime and the particular dot in coincidence with the principal point, each other dot will fall exactly on the same feature that it was initially.

On the average, each stereo - model took about one hour, excluding the period of preparation and testing. Some models took well over one hour, especially at the initial stage.

The error estimate was carried out using two separate formulae developed by Emmott (1981)[1] and Connor (1975)[2] which estimate the error at 99% confidence level of a given sample according to its coverage and density.

(1) $E\% = K\left(\frac{100 - P}{NP}\right)^{\frac{1}{2}}$

(2) $E\% = \frac{153.1}{AD^{0.58}}$

Where E% = the percentage error of one individual category in relation to the total area samples taken as 100%

N = the total point samples used for the whole area

P = Percentage area of one individual category

K = a constant based on the t - distribution (if K = 1, E% is the standard error; K = 1.96 for the confidence limit of 95%).

A = area size in sq. km of the class

D = dot grid density per sq. km.

The summary of the error estimate for the sample area using various dot sizes can be seen in Tables 3.1 and 3.2. The percentage error for the 15 classes at various dot sizes is also shown in Tables 3.3a and b. Regarding 1.00 ha as a basic unit of measurement, one dot per 0.25 ha gave an acceptable precision for most of the classes encountered in the survey. Exceptions are evident however, in settlements as well as swamps and marshes, which account for a small surface area and could not be estimated with a high degree of precision by this method.

Table 3.2

Table of Error Estimate at Various dot grid densities using Formulae (1) for the sample area.

Classification	Total points	Percentage	Area Sq. Km	2 dots Sq.Km	4	6	8	10
1								
11	12	0.87	0.00044	15.7	11.8	9.6	8.3	5.3
2								
12	63	4.55	0.00233	7.2	5.1	4.1	3.6	2.3
3								
13	0	0.00	0.00000	0.0	0.0	0.0	0.0	0.0
4								
21	15	1.08	0.00055	14.9	10.5	8.6	7.5	4.7
5								
22	0	0.00	0.00000	0.0	0.0	0.0	0.0	0.0
6								
23	52	3.75	0.001911	7.9	5.6	4.6	4.0	2.5
7								
24	0	0.00	0.00000	0.0	0.0	0.0	0.0	0.0
8								
31	62	4.47	0.00229	7.2	5.1	4.2	3.6	2.3
9								
32	657	47.40	0.02416	1.6	1.2	1.0	0.8	0.5
10								
33	151	10.89	0.00555	4.5	3.2	2.6	2.2	1.4
11								
34	4	0.29	0.00015	29.0	20.5	16.7	14.5	9.2
12								
35	14	1.01	0.00051	15.5	11.0	8.9	7.7	4.9
13	51	3.68	0.00138	8.0	5.7	4.6	4.0	2.5
14								
41	153	11.04	0.00563	4.4	3.1	2.6	2.2	1.4
15								
42	152	10.97	0.00559	4.5	3.2	2.6	2.2	1.4
1386	1386	100.00	0.050					

Table 3.1

Table of Error Estimate at various dot grid densities using Formulae (2) for the Sample area.

	Classification	Total points	Percentage	Area Sq. Km	2 dots/ Sq. Km	4	6	8	10
1	11	12	0.97	0.00041	11.4	7.6	6.0	5.1	5.5
2	12	63	4.55	0.00233	4.3	2.9	2.3	1.9	1.7
3	13	0	0.00	0.00000	0.0	0.0	0.0	0.0	0.0
4	21	15	0.08	0.00055	0.1	6.7	5.3	4.5	3.9
5	22	0	0.00	0.00000	0.0	0.0	0.0	0.0	0.0
6	23	52	3.75	0.001911	1.3	0.86	0.67	0.6	0.5
7	24	0	0.00	0.00000	0.0	0.0	0.0	0.0	0.0
8	31	62	4.47	0.00228	4.4	2.9	2.3	2.0	1.7
9	32	657	47.40	0.02416	1.1	0.75	0.59	0.5	0.4
10	33	151	10.89	0.00555	2.6	1.75	1.4	1.2	1.0
11	34	4	0.29	0.00015	21.3	14.2	11.3	9.5	8.4
12	35	14	1.01	0.00051	10.5	7.0	5.5	4.5	4.1
13	36	51	3.68	0.00188	4.9	3.3	2.6	2.2	1.9
14	41	153	11.04	0.00563	2.6	1.7	1.4	1.2	1.0
15	42	152	10.97	0.00559	2.6	1.7	1.4	1.2	1.0
		1386	100.00	0.050 × 1961.96 = 100%					

Table 3.3a

Summary of Percentage Error for the 15 classes at various dot densities per sq. cm from formula (1)

Dot/Sq. Cm	E%	Total Dots expected for the whole area.
1	6.4	1962
2	4.1	3924
4	2.6	7848
6	2.3	11772
8	1.6	15696
10	1.5	39240

Table 3.3b

Summary of Percentage Error for the 15 classes at various dot densities per Sq. cm from formulae (2)

Dot/Sq. Cm	E%	Total Dots expected for the whole area
1	6.1	1962
2	4.1	3924
4	2.7	7848
6	2.1	11772
8	1.8	15696
10	1.6	39240

According to these formulae, it was decided to use a 4 - point gridsize of 5mmx 5mm for the whole survey and still expect a high degree of reliability at 95% confidence limit.

After deciding on the dot grid sizes to be used, a repeat reading was made on the initially sampled overlaps to determine the degree of reliability in interpretation and the amount of ease with which features could now be recognised. About 80% of the results agreed, with variation principally in the interpretation of classes 33 and 35 ie. Scrub and small trees, and woodland respectively. This problem was taken care of during the complete survey work by giving greater attention to the shape, size and location of these classes. Other features were easily recognised.

3.4 Data Acquisition

3.4.1 The Landuse Types

The researcher had at his disposal the classification scheme developed by Field (1985) of Kajuru area. Before adopting it, the researcher first evaluated its suitability to the situation under study, comparing it against other standard classifications, as well as satisfying Grigg's attributes mentioned above. The world Landuse survey (WLUS) classification by Avery (1977) was

first referred to. This is a scheme with nine classes which is unique only to some temperate region of the world (See Table 3.4). Field and Collins (1986), who did refer to it observed that "classes 4, 5, 6 are difficult to apply to the extensive farming methods with ill-defined boundaries typical of savanna areas". Another classification considered was one presented by Anderson, et al (1976). (See Table 3.5). But again these 9 classes classification are applicable "only for the United States". Reference was also made to the work of Prothero (1957) and LRDC (1977) which were works trying to deal with the situation around the area we are considering. All these were very helpful in the attempt to understand the classification scheme to be adopted.

Field's classification (Table 3.6) was adopted for the following reasons:

i) the terminologies were simple and familiar;

ii) scheme based on items that are easily recognisable on the photographs;

iii) could be broadly used in the savanna regions of Nigeria;

iv) the scale of photography (1:25,000) could not allow a convenient classification beyond the second level;

v) the author of the classification was very familiar with the study area.

Table 3.4

WORLD LANDUSE SURVEY CLASSIFICATION

Level	Landuse Type
1	Settlements and associated non-agricultural lands.
2	Horticulture
3	Trees and other Perennial crops
4	Cropland
	a) continual and rotation cropping
	b) Land rotation
5	Improved Permanent Pasture (Managed or enclosed)
6	Unimproved grazing land
	a) used
	b) unused
7	Woodland
	a) Dense
	b) Open
	c) Scrub
	d) Swamp forests
	e) Cut over or burnt over forest areas
	f) Forest with subsidiary cultivation
8	Swamps and Marshes
9	Unproductive land

Source: Avery (1977).

Table 3.5

Landuse and Cover Classification System

Level I	Level II	
1. Urban or built-up land.	11	Residential
	12	Commercial
	13	Industrial
	14	Transportation, Communication and utilities.
	15	Industrial and Commercial complexes
	16	Mixed Urban or built-up land
	17	Other urban or built-up land
2 Agricultural land	21	Cropland and Pasture
	22	Orchards, groves, Vineyards, nurseries, and ornamental hurticultural areas.
	23	Cofines feeding Operations
	24	Other agricultural land
3. Rangeland	31	Herbaceous rangeland
	32	Shrub and brush rangeland
	33	Mixed rangeland
4. Forestland	41	Deciduous forestland
	42	Evergreen forestland
	43	Mixed forestland
5. Water	51	Streams and canals
	52	Lakes
	53	Reservoirs
	54	Bays and estuaries
6. Wetland	61	Forested Wetland
	62	Non-forested wetland

7.	Barrenland	71 Dry salt flats
		72 Beaches
		73 Sandy areas other than beaches
		74 Bare exposed rocks
		75 Strip mines, quarries, and gravel pits
		76 Transitional areas
		77 Mixed barren lands
8.	Tundra	81 Shrub and brush tundra
		82 Herbaceous tundra
		83 Bare ground tundra
		84 Wet tundra
		85 Mixed tundra
9.	Perennial Snow or ice	91 Perennial snowfields
		92 Glaciers.

Source: Anderson, et al (1976).

Table 3.6 LANDUSE CLASSIFICATION SCHEME

	GROUP		CLASS
1.0	Settlement and Associated features	11	Settlements
		12	Communications
		13	Industry
2.0	Cultivation	21	Enclosed farmland (less than 10-ha.)
		22	Enclosed farmland (greater than 10 ha.)
		23	Unenclosed farmland
		24	Tree plantation
3.0	Uncultivated	31	Fadama (flood plains)
		32	Grassland (not fadama)
		33	Scrub and small trees
		34	Swamps and marshes
		35	Woodland
		36	Gallery forest and Kurumi (remnants of high forest)
4.0	Wasteland	41	Inselbergs and bare rock outcrop
		42	Rivers and lake beds.

Source: Field and Collins, (1986).

The following observation were however made on the classification.

a) though had simple and clear classes definition, the classification had no criteria which could be described as uniform throughout. As could be observed, categories 2.0 and 4.0 are based on form of object while 1.0 and 3.0 are based on functions. This therefore, fails to comform with the conditions earlier stated. The classification was however, adopted because the mixed theme situation is after all not haphazard;

b) in this research, classes 13 and 22 were not needed at the end, since (i) there was no industrial activities recognised (not even Field's excavations and pits), (ii) the area is rural and subsistence, and no commercial agriculture recognised. Even if these classes were represented, they would definitely have been on very small scale, and ". . . empty or nearly empty classes are a nuisance and a waste of time", Field & Collins (1986).

For interpretation and analysis purposes, the author also adopted the compressed 5 longer categories of the Field classification which was to facilitate the use of computer, since numeric values are used. See Table 3.7 below.

Table 3.7

The Final Categories

	GROUP	NUMERIC	SUB-	GROUPS
1.	Settlement	11	12	13
2.	Farmland	21	22	23
3	Grass/Scrub	31	32	33 34
4	Woodland	24	35	36
5.	Barren	41	42	

3.4.2 The Land Systems

The land facet categories developed for land resource analysis of central Nigeria (Kaduna Plain) by Bennett (1977) were adopted as land system mapping units. See Table 3.8 below.

Table 3.8

LAND FACET	CODE
Rock outcrop and Rocky hills	01
Iron cap	02
Interfluve crest	03
Valley Side Slope	04
Steepened covex or planar lower slope	05
More gentle convave or planar lower slope	06
Valley head	07
Narrow concave valley bottom	08
Wide concave valley bottom	09
Flat valley bottom including local flood plain.	10
Terrace	11
Colluvial debris slope	12
Ridge	13

Each stereo - pair of the photographs was oriented (model formation), and the land facets within the primary sample area were interpreted, using differences in relative height, changes in form, nature of the surface and break in slope of the landscape. The interpretations were recorded in matrix form using the code values and later analysed by the computer.

3.4.3 Analysis Procedure

Basic computer programmes that permitted the user to input, store and analyse the recorded land use and land facet informations into a micro computer with its floppy disk and line printer, were selected and used. The programmes were selected mainly from standard Algorithmes and Basic listings by Cooks, et al (1982). This research involves neither the development nor writing of computer programmes, but involves the selection, modification, typing in and running the necessary programmes into the computer system.

The programme ADDATA (Appendix,ii) developed from algorithme 4.1, enable the researcher to input the coded landuse and land facet data into the computer. This programme permitted the input of the data in a form of an array, with sub-routine that allows check and correction of the data input to storage on the disc.

The data stored in the micro-computer were statistically analysed with basic programmes developed from standard algorithme:

i) FREQUENCY COUNT and programmes (Appendix iii & iv) were used to determine the total number and proportion of each landuse class per stereo-model. The output was in the form of frequency tables and histograms.

ii) SIX - NUMBER SUMMARY programme (Appendix v) was used to determine the total number of non-zero models, mean, quartiles and extremes of each landused and land facet categories in the sample.

iii) BIVAR Programme(Appendix v) permits the calculation and the display of the correlation between land use category and land facet categories. The output is in form of tables and histograms.

iv) MAPDIST and TEMPMAPDIST Programmes (Appendix vi) permits the plotting and the spatial dot distribution of each class of landuse.

CHAPTER FOUR

4.0 RESULT AND ANALYSIS

4.1 The Spatial Distribution of the Landuse Types

There are variations in the proportion of the areas covered by the different landuse classes. The spatial distribution of the landuse are related to the geology and physiography of the area of study, apart from human activities.

The results obtained from photo-interpretation of the landuse types in the study area indicate these variations: Grassland cover 79.86% and rivers/lake beds amount to 11.11% while communications cover 3.4% of the total area in model Jacob 1 (henceforth J only for Jacob), as shown in table 4.1 below:

Frequency Table model J1

Class	Number	Percentage
Communication	5	3.47
Fadama	2	1.39
Grassland	115	79.86
Scrub/small trees	1	.69
Woodland	1	.69
Gallery forest	4	2.78
Rivers/lake beds	16	11.11

Fadama, scrub and small trees, woodland and gallery forest cover only a small proportion of the total area of this model.

The stereo model J2 (Table 4.2), 32.64% of its area is covered by unenclosed farmland; 28.47%

by grassland; 13.89% by scrub and small trees; 10.42% and 6.25% by wasteland as seen in the table.

Table 4.2 Frequency Table Model J2

Class	Number	Percentage
Settlements	1	.69
Communications	5	3.47
Unenclosed farmland	47	32.64
Fadama	3	2.08
Grassland	41	28.47
Scrub/small trees	20	13.89
Gallery forest	2	1.39
Bare rocks	15	10.42
Rivers/lake beds	9	6.25

It is apparent that settlements, fadama, gallery forest and of course river/lake beds account for a small proportion of the model area.

The stereo model J3 (Table 4.3), 62.5% of its area is covered by grassland; 17.36% by unenclosed farmland and 13.89% by scrub and small trees, communications and rivers/lake beds account for a small proportion of the area of study.

Table 4.3 Frequency Table Model J3

Class	Number	Percentage
Communications	4	2.78
Unenclosed farmlands	25	17.36
Grassland	90	62.5
Scrub/small trees	20	13.89
Rivers/lake beds	5	3.47

Stereo-model J4 (Table 4.4) has 52.08% of its area covered by grassland, 33.33% under unenclosed farmland, 8.33% under scrub and small trees while 4.86% of the area is covered by rivers and lake beds. Only 0.69% of the area is covered by communications.

Table 4.4 Frequency Table Model J4

Class	Number	Percentage
Communications	1	.69
Unenclosed farmland	48	33.33
Grassland	75	52.08
Scrub/small trees	12	8.33
Rivers/lake beds	7	4.86

Stereo-model J5 (Table 4.5) has 31.94% of its area covered by grassland, 20.14% by scrubs and small trees while Unenclosed farmland and rock outcrops account for 14.58% and 13.89% respectively. Because of the hilly nature of the area, about 10.42% is covered by streams and rivers, while settlements, communications, floodplains (Fadama), Gallery forests account for a relatively small proportion of the area.

Table 4.5 Frequency Table Model J5

Class	Number	Percentage
Settlements	2	1.39
Communications	5	3.47
Unenclosed farmland	21	14.58
Fadama	3	2.08
Grassland	46	31.94
Scrub/small trees	29	20.14
Gallery and Kuruni	3	2.08
Rock outcrop	20	13.89
Rivers/lake beds	15	10.42

Stereo-model J6 (Table 4.6), 85.33% of the area is covered by grassland, 25.69 by unenclosed farmland, 8.33% by rivers and lake beds, 3.47% by scrub/ small trees, while communications and flood plains account for 1.39% each and swamps/Marshes and woodland 0.69% each.

Table 4.6 Frequency Table Model J6

Class	Number	Percentage
Communications	2	1.39
Unenclosed farmland	37	25.69
Fadama	2	1.39
Grassland	84	58.33
Scrub/small trees	5	3.47
Swamps and marshes	1	.69
Woodland	1	.69
Rivers and lake beds	12	8.33

The stereo-model J7 (Table 4.7), 62.5% covered by grassland, 20.14% by scrubs and woodland, while

rivers, communications, unenclosed farmlands, gallery forest and fadama account for less than 10% of the total area each.

Table 4.7 Frequency Table Model J7

Class	Number	Percentage
Communications	6	4.17
Unenclosed farmland	6	4.17
Fadama	1	.69
Grassland	90	62.5
Scrub and small trees	29	20.14
Gallery forest and Kurumi	2	1.39
Rivers and Lake beds	10	6.94

Stereo-mode J8 (Table 4.8) has 36.81% of its area covered by grassland, 22.92% by woodland, 18.06% by Scrub/small trees and 12.5% by unenclosed farmland. Communications, gallery forests and rivers account for a small proportion of the area.

Table 4.8 Frequency Table Model J8

Class	Number	Percentage
Communications	2	1.39
Unenclosed farmland	18	12.5
Grassland	53	36.81
Scrub and small trees	26	18.06
Woodland	33	22.92
Gallery forest and Kurumi	2	1.39
Rivers and Lake beds	10	6.94

The stereo-model J9 (Table 4.9), 37.5% of the area is covered by inselbergs and barerock outcrop, 20.14% by scrub/small trees, 15.97% by grassland and 13.19% by unenclosed farmland. Communications, Gallery, woodland and rivers acount for small proportions of area.

Table 4.9 Frequency Table Model J9

Class	Number	Percentage
Communications	6	4.17
Unenclosed farmland	19	13.19
Grassland	23	15.97
Scrub/small trees	29	20.14
Woodland	3	2.08
Gallery forest	2	1.39
Rock outcrop	54	37.5
Rivers and lake beds	8	5.56

The stereo-model J10 (Table 4.10) has 46.53% of its total area under unenclosed farmland, 21.53% under grassland and 16.67% under scrub and small trees. Communications, fadama, Gallery forest and rivers account for a small portion of the study area.

Table 4.10 Frequency Table Model J10

Class	Number	Percentage
Communications	1	.69
Unenclosed farmland	67	46.53
Fadama	4	2.78
Grassland	31	21.53
Scrub/small tress	24	16.67

Gallery Forest	7	4.86
Rivers	9	6.25

Stereo-model J11 (Table 4.11), 49.31% under grassland cover, 25% under farmland (unenclosed) and 12.5% under scrub/small trees. Settlements, communications, woodland, Gallery forest and rivers account for the rest of the area.

Table 4.11 Frequency Table Model J11

Class	Number	Percentage
Settlement	1	.69
Communications	10	6.94
Unenclosed farmland	36	25
Grassland	71	49.31
Scrub/small trees	18	12.5
Woodland	4	2.78
Gallery forest	1	.69
Rivers	3	2.08

The stereo-model J12 (Table 4.12) has 29.17% of its area under grassland, 25.69% under scrubland, 9.72%, 9.03% are under unenclosed farmland and woodland respectively, while rivers account for 11.31%. Gallery forest cover 3.33%, while fadama and rock outcrop account for a small proportion of the area.

Table 4.12 Frequency Model J12

Class	Number	Percentage
Communications	3	2.08
Unenclosed Farmland	14	9.72
Fadama	2	1.39
Grassland	42	29.17
Scrubland	37	25.69
Woodland	13	9.03
Gallery forest	12	8.33
Barerock outcrop	4	2.78
Rivers	17	11.81

Stereo-model J13 (Table 4.13), 34.72% of the total area is covered by grassland, 16.67% covered by unenclosed farmland and 15.28% by scrub and small trees. Rivers and communications are 8.33% and 7.64% respectively while settlement, fadama, swamps, woodland, gallery and barerock outcrop account for small portion of the area.

Table 4.13 Frequency Table Model J13

Class	Number	Percentage
Settlent	3	2.08
Communications	11	77.64
Unenclosed farmland	24	16.67
Fadama	1	.69
Grassland	50	34.72
Scrub/small trees	22	15.28
Swamps and Marshes	3	2.08
Woodland	7	4.86

Gallery forest and Ruruni	5	3.47
Bare rock outcrop	6	4.17
Rivers	12	8.33

Model J14 (Table 4.14) has 43.75% covered by Grassland, 21.53% by unenclosed farmlands, 18.06% by scrub and small trees. Rivers account for 8.33% while communications, fadama, swamps and Gallery forest account for a small proportion of the area.

Table 4.14 Frequency Table Model J14

Class	Number	Percentage
Communication	4	2.78
Unenclosed farmland	31	21.53
Fadama	2	1.39
Grassland	63	43.75
Scrub/small tress	26	18.06
Swamps and Marshes	1	.69
Gallery forest	5	3.47
Rivers and lake beds	12	8.33

Stereo-model J15 (Table 4.15), 30.56% of the area is under unenclosed farmlands, 28.47 covered by grassland, 22.22% under scrub and small trees 8.33% of the area is under rivers while settlement, communications, fadama and gallery forests account for the rest of the area.

Table 4.15 Frequency Table Model J15

Class	Number	Percentage
Settlement	1	.69
Communication	4	2.78
Unenclosed farmland	44	30.56
Fadama	4	2.78
Grassland	41	28.47
Scrub and small trees	32	22.22
Gallery forest and Kurumi	6	4.17
Rivers and lake beds	12	8.33

The stereo-modelJ16 (Table 4.16), has 31.25% of its total area covered by grassland, 29.86% covered by scrub and small trees, while unenclosed farmland account for 14.58% of the area. Rivers account for 9.72% of the total area, fadama 5.56%, while communications, swamps and marshes and Gallery forests account for a small portion of the total area.

Table 4.16 Frequency Table Model J16

Class	Number	Percentage
Communications	4	2.78
Unenclosed farmland	21	14.58
Fadama	8	5.56
Grassland	45	31.25
Scrub and Small trees	43	29.86
Swamps and Marshes	2	1.39
Gallery forest and Kurumi	7	4.86
Rivers and lake beds	14	9.72

Stereo-model J17 (Table 4.17), 52.08% covered by grassland, 13.89%by rivers, while 9.03% and 7.64% are covered by fadama and gallery forest respectively. Scrub and small trees account for 11.81%, where as communications, unenclosed farmland and swamps account for a small portion of the total area.

Table 4.17 Frequency Table Model J17

Class	Number	Percentage
Communications	5	3.47
Unenclosed farmland	2	1.39
Fadama	13	9.03
Grassland	75	52.08
Scrub and small trees	17	11.81
Swamps and Marshes	1	0.69
Gallery forest and Kurumi	11	7.64
Rivers and lake beds	20	13.89

The stereo-model J18 (Table 4.18), has 57.64% of its area covered by grassland, 13.19% covered by unenclosed farmland, 10.42% covered by barerock outcrop, while Gallery forest account for 6.25% 3.47% of the total area is covered by rivers, 4.17% by scrub and small trees, 2.78% by fadama and 2.08% by communications.

Table 4.18 Frequency Table Model J18

Class	Number	Percentage
Communications	3	2.08
Unenclosed farmland	19	13.19
Fadama	4	2.78
Grassland	83	57.64
Scrub and small trees	6	4.17
Gallery forest	9	6.25
Bare rock outcrop	15	10.42
Rivers	5	3.47

Stereo-model J19 (Table 4.19), 49.31% is covered by barerock outcrop, 24.31% by grassland, 8.33% by unenclosed farmland, while scrub/small trees and Gallery forests account for 5.56% each. Fadama and Rivers account for less than 5% of the total area each.

Table 4.19 Frequency Table Model J19

Class	Number	Percentage
Unenclosed farmland	12	8.33
Fadama	4	2.78
Grassland	35	24.31
Scrub and small trees	8	5.56
Gallery fores and Kurumi	8	5.56
Inselbergs and bare rock outcrop	71	49.31
Rivers and Lake beds	6	4.17

The stereo-model J20 (Table 4.20) has 64.58% of its total area covered by grassland, 15.97% covered

by scrub and small trees, 6.25% covered by rivers, 5.56% covered by unenclosed farmland, while barerock outcrops, enclosed farmlands and communications account for the rest of the area.

Table 4.20 Frequency Table Model J20

Class	Number	Percentage
Communications	1	0.69
Enclosed farmland	1	0.69
Unenclosed farmland	8	5.56
Grassland	93	64.58
Scrub and small trees	23	15.97
Gallery forest and Furumi	5	3.47
Barerock outcrop	4	2.78
Rivers and lake beds	9	6.25

The Stereo-model J21 (Table 4.21) has 45.14% of its area under unenclosed farmlands, 25.69% under grassland, 14.58% covered by scrub and small trees, While barerock outcrop account for 7.64% of the area. Rivers covere 4.17% of the area and communications, 2.08% Gallery forests account for 0.69% of the area only.

Table 4.21 Frequency Table Model J21

Class	Number	Percentage
Communications	3	2.08
Unenclosed farmland	65	45.14
Grassland	37	25.69
Scrub and small trees	21	14.58

Gallery forest and Kurumi	1	0.69
Barerock outcrop	11	7.64
Rivers	6	4.17

Stereo-model J22 (Table 4.22), 48.61% of the area is covered by grassland, 16.67% covered by unenclosed farmland, and 9.72% of the area covered by scrub and small trees. Barerock outcrop and rivers account for 10.42% each while Gallery forests and communications account for 2.08% each of the total area of the model.

Table 4.22 Frequency Table Model J22

Class	Number	Percentage
Communications	3	2.08
Unenclosed farmland	24	16.67
Grassland	70	48.61
Scrub and small trees	14	9.72
Gallery forest and Kurumi	3	2.08
Barerock outcrop	15	10.42
Rivers and lake beds	15	10.42

The stereo-model J23 (Table 4.23), 34.03% of the area is covered by unenclosed farmlands, 31.25% by grassland, 7.64% each by communications and rivers, 6.25% by barerock outcrops and 4.86% by scrub and small trees. Settlements, enclosed farmlands (less than 10 ha) Swamps and marshes, and Gallery forest and Kurumi make up the rest of the area.

Table 4.23 Frequency Table Model J23

Class	Number	Percentage
Settlements	5	3.47
Communications	11	7.64
Enclosed farmlands	2	1.39
Unenclosed farmlands	49	34.03
Grassland	45	31.25
Scrub and small trees	7	4.86
Swamps and Marshes	2	1.39
Gallery forest Kurumi	3	2.08
Barerock outcrops	9	6.25
Rivers and lake beds	11	7.64

The stereo-model J24 (Table 4.21) has 35.42% of its total area covered by grassland, 25.69% covered by unenclosed farmland, 13.89% by communications, 9.03% by Scrub and small trees while 4.86% and 4.17% by rivers and barerock outcrops respectively. Settlements cover 3.47% while enclosed farmland (less than 10 ha.) and Gallery forests cover .69% each.

Table 4.21 Frequency Table Model J24

Class	Number	Percentage
Settlements	5	3.42
Communications	20	13.89
Enclosed farmland (less than 10 ha)	1	0.69
Unenclosed farmland	37	25.69
Fadama	3	2.08
Grassland	51	35.42

Scrub and small trees	13	9.00
Gallery forest	1	0.69
Bareroch outcrops	6	4.17
Rivers	7	4.86

Stereo-model J25 (Table 4.25), 22.92% of its total area is under grassland, 43.75% under barerock outcrops, 10.42% under rivers, 9.72 under unenclosed farmland and 6.25% under Gallery forests and Kurumi. 2.08% each is covered by communications and scrub and small trees, while settlements and fadama cover 1.39% each.

Table 4.25 Frequency Table Model J25

Class	Number	Percentage
Settlements	2	1.39
Communications	3	2.08
Unenclosed farmland	14	9.72
Fadama	2	1.39
Grassland	33	22.92
Scrub and small trees	3	2.08
Gallery and Kurumi	9	6.25
Barerock outcrop	63	43.75
Rivers and lake beds	15	10.42

The stereo-model J26 (Table 4.26), 37.5% of the area is covered by grassland, 24.31% under unenclosed farmland and 7.64% under rivers, and scrub and small trees each. 13.19% of the area is covered by communications while 8.22% is under settlements. 1.39% of this area is also covered by fadama.

Table 4.26 Frequency Table Model J26

Class	Number	Percentage
Settlements	12	8.33
Communications	19	13.19
Unenclosed farmland	35	24.31
Fadama	2	1.39
Grassland	54	37.5
Scrub and small trees	11	7.64
Rivers and lake beds	11	7.64

Stereo-model J27 (Table 4.27) has 50% of its total area covered by grassland and 22.22% under unenclosed farmlands. 14.58% of the area is also under scrub and small trees while 10.42 of the area is covered by rivers, communications, enclosed farmland (less than 10 ha.) and fadama covers a small portion of the area.

Table 4.27 Frequency Table Model J27

Class	Number	Percentage
Settlements	1	0.69
Enclosed farmlands (less than 10 ha.)	1	0.69
Unenclosed farmland	32	22.22
Fadama	2	1.39
Grassland	72	50.0
Scrub and small trees	21	14.58
Rivers and lake beds	15	10.42

The stereo-model J28 (Table 4.28), grassland account for 59.72% of the total area, rivers cover 13.89% and communications cover 8.33% unenclosed farmland

and fadama cover 4.86% and 4.17% respectively, while scrub and small trees account for 6.94% of the total area. Gallery forest cover only 2.08% of the area.

Table 4.28 Frequency Table Model J28

Class	Number	Percentage
Communications	12	8.33
Unenclosed farmland	7	4.86
Fadama	6	4.17
Grassland	86	59.72
Scrub and small trees	10	6.94
Gallery forest and Kurumi	3	2.08
Rivers and lake beds	20	13.89

The stereo-model J29 (Table 4.29) has 51.39% of its area covered by grassland, 10.42% covered by scrub and small trees and 18.06% covered by unenclosed farmland. 6.25% of the area is covered by rivers and lake beds, while 4.17% is covered by communications. Enclosed farmland (less than 10 ha.) and Gallery forests each account for 0.69% of the total area.

Table 4.29 Frequency Table Model J29

Class	Number	Percentage
Communications	6	4.17
Enclosed farmland (less than 10 ha.)	1	0.69
Unenclosed farmland	26	18.06
Fadama	12	8.33
Grassland	74	51.39
Scrub and small trees	15	10.42

Gallery forest and Kurumi	1	0.69
Rivers and lake beds	9	6.25

Stereo-model J30 (Table 4.30) is covered by 42.36% barerock outcrops, 15.97% grassland and unenclosed farmland each, 6.94% scrub and small trees and communications each, and 3.47% rivers and Gallery forest each. Fadama account for 4.86%.

Table 4.30 Frequency Table Model J30

Class	Number	Percentage
Communications	10	6.94
Unenclosed farmlands	23	15.97
Fadama	7	4.86
Grassland	23	15.97
Scrub and small trees	10	6.94
Gallery forest and Kurumi	5	3.47
Barerock outcrops	61	42.36
Rivers and lake beds	5	3.47

The area covered by stereo-model J31 (Table 4.31) is made up of 33.33% grassland, 27.78% unenclosed farmlands, 14.58% barerock outcrops and 9.72% communications. 1.39% is covered by Gallery forests and Kurumi while scrub and small trees, and settlements account for 0.69% each.

Table 4.31 Frequency Table Model J31

Class	Number	Percentage
Settlement	1	0.69
Communications	14	9.72

Unenclosed farmland	40	27.78
Fadama	5	3.47
Grassland	48	33.33
Scrub and small trees	1	0.69
Gallery forest and Kurumi	2	1.39
Barerock outcrop	21	14.58
Rivers and lake beds	12	8.33

Stereo-model J32 (Table 4.32) has 42.36% of its area covered by grassland, 31.25% covered by unenclosed farmland, 4.86% under rivers and 3.47% under scrub and small trees and communications each. 13.19% of the area is covered by rocks while enclosed farmlands (less than 10 ha.) and gallery forests cover a small portion of the total area.

Table 4.32 Frequency Table Model J32

Class	Number	Percentage
Communications	5	3.47
Enclosed farmland (less than 10 ha.)	1	0.69
Unenclosed farmland	45	31.25
Grassland	61	42.36
Scrub and small trees	5	3.47
Gallery forests and Kurumi	1	0.69
Inselbergs and barerock outcrops	19	13.19
Rivers and lake beds	7	4.86

The stereo-model J35 (Table 4.35), 35.42% of its area is covered by scrub and small trees, 23.61% is covered by grassland, 18.75% is covered by unenclosed farmland and 8.33% is covered by rivers. Communication cover 7.64% while rocks account for 6.25%.

Table 4.35 Frequency Table Model J35

Class	Number	Percentage
Communications	11	7.64
Unenclosed farmland	27	18.75
Grassland	34	23.61
Scrub and small tress	51	35.42
Rocks	9	6.25
Rivers	12	8.33

The stereo-model J36 (Table 4.36) is covered by 61.81% grassland, 13.89% rivers, 11.81% scrub and small trees and 7.64% unenclosed farmland. Communications, fadama and Gallery forests account for the rest of the model area.

Table 4.36 Frequency Table Model J36

Class	Number	Percentage
Communications	4	2.78
Unenclosed farmland	11	7.68
Fadama	1	0.68
Grassland	89	61.81
Scrub and small trees	17	11.81
Gallery forests	2	1.39
Rivers	20	13.89

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Stereo-model J37 (Table 4.37) has 61.81% of its total area covered by grassland, 18.75% covered by scrub and small trees and 9.72% covered by rivers. Also 6.25% of the area is covered by communications and 3.47% by rocks.

Table 4.37 Frequency Table Model J37

Class	Number	Percentage
Communications	9	6.25
Grassland	89	61.81
Scrub and small trees	27	18.75
Rocks	5	3.47
Rivers	14	9.72

Stereo-model J38 (Table 4.38), 65.28% of the area is under grassland, 9.72% covered by scrub and small trees and communications each, 6.25% covered by Gallery forest, and 3.47% covered by unenclosed farmland. Tree plantation and settlements each occupy 0.69% of the area.

Table 4.38 Frequency Table Model J38

Class	Number	Percentage
Settlements	1	0.69
Communications	14	9.72
Unenclosed farmland	5	3.47
Tree plantation	1	0.69
Grassland	94	65.28
Scrub and small trees	14	9.72
Gallery forests and Kurumi	6	4.17
Rivers	9	6.25

The area under stereo-model J39 (Table 4.39) is covered by 52.08% grassland, 13.19% unenclosed farmland, 11.81% scrub and small trees and 7.64% communications. Others are 6.94% covered by rivers, 4.17% by Gallery forests, 3.47% by rocks and 0.69% tree plantation.

Table 4.39 Frequency Table Model J39

Class	Number	Percentage
Communications	11	7.64
Unenclosed farmland	19	13.19
Tree plantation	1	0.69
Grassland	75	52.08
Scrub and small trees	17	11.81
Gallery forest and Kurumi	6	4.17
Rocks	5	3.47
Rivers	10	6.94

Stereo-model J40 (Table 4.40) has 71.53% of its area covered by grassland, 13.19% by rivers and 5.56% by communications. Unenclosed farmlands cover 5.17% of the area, Gallery forests 2.78%, scrub and small trees 1.39% while fadama and rocks account for 0.69% each.

Table 4.40 Frequency Table Model J10

Class	Number	Percentage
Communications	8	5.56
Unenclosed farmland	6	4.17
Fadama	1	0.69
Grassland	103	71.53

Scrub and small trees	2	1.39
Gallery forests	4	2.78
Rocks	1	0.69
Rivers	19	13.19

Under stereo-model J41 (Table 4.41) 56.25% of the area is covered by grassland, 16.67%by scrub and small trees, 9.72% by rivers and 6.25% by unenclosed farmlands. 4.86% by communications. Woodland account for the rest 2.78%.

Table 4.41 Frequency Table Model J41

Class	Number	Percentage
Communications	5	3.47
Unenclosed farmlands	9	6.25
Grassland	81	56.25
Scrub and small trees	24	16.67
Woodland	4	2.78
Gallery forests and Kurumi	7	4.86
Rivers	14	9.72

The total area under stereo-model J42 (Table 4.42) is covered by 46.53% grassland, 14.58% rocks, 13.19% rivers and 9.72% scrub and small trees. 6.25% and 5.56% are covered by Gallery forest and unenclosed farmlands respectively, and communications and fadama cover 2.00% each.

Table 4.42 Frequency Table Model J42

Class	Number	Percentage
Communications	3	2.08
Unenclosed farmlands	8	5.56
Fadama	3	2.08
Grassland	67	46.53
Scrub and small trees	14	9.72
Gallery forests	9	6.25
Rocks	21	14.58
Rivers	19	13.19

The stereo-model J43 (Table 4.43) has 29.86% of its area covered by grassland, 26.39% by unenclosed farmland and 13.89% by rocks and rivers each. 9.72% of the area is under communications, 4.17% woodland while scrub and small trees, enclosed farmland (less than 10 ha.) and settlements cover a small portion of the area.

Table 4.43 Frequency Table Model J43

Class	Number	Percentage
Settlement	1	0.69
Communication	14	9.72
Enclosed farmland (less than 10-ha.)	1	0.69
Unenclosed farmland	38	26.39
Grassland	43	29.86
Scrub and small trees	1	0.69
Woodland	6	4.17
Rocks	20	13.89
Rivers	20	13.89

Under stereo-model J44 (Table 4.44), 37.5% of the area is under grassland, 27.78% under rocks, 12.5% covered by rivers, 11.81% by unenclosed farmlands and 4.17% by scrub and small trees. Fadama and settlement account for 1.39% each.

Table 4.44 Frequency Table Model J44

Class	Number	Percentage
Settlement	2	1.39
Communication	5	3.47
Unenclosed farmland	17	11.81
Fadama	2	1.39
Grassland	54	37.5
Scrub and small trees	6	4.17
Rocks	40	27.78
Rivers	18	12.5

The stereo-model J45 (Table 4.45) has 26.39% of its area covered by grassland, 24.31% covered by unenclosed farmland, 14.58% by rocks and 10.42% by communications. 7.64% of the area is under scrub and small trees, 5.56% under woodland, 4.86% covered by rivers and 4.17% covered by gallery forests. Fadama and settlement account for a small portion of the area.

Table 4.45 Frequency Table Model J45

Class	Number	Percentage
Settlement	1	0.69
Communication	15	10.42
Unenclosed farmland	35	24.31
Fadama	2	1.39
Grassland	38	26.39

Scrub and small trees	11	7.64
Woodland	8	5.56
Gallery forest and Kurumi	6	4.17
Rocks	21	14.58
Rivers	7	4.86

The stereo-model J46 (Table 4.46), 31.25% of the area is covered by scrub and small trees, 27.08% by grassland, 22.92% by rocks, 6.25% by rivers and 4.86% by unenclosed farmlands. Gallery forests and communications cover 2.78% each and woodland account for the rest 2.08%.

Table 4.46 Frequency Table Model J46

Class	Number	Percentage
Communications	4	2.78
Unenclosed farmland	7	4.86
Grassland	39	27.08
Scrub and small trees	45	31.25
Woodland	3	2.08
Gallery forest	4	2.78
Rocks	33	22.92
Rivers	9	6.25

The area under stereo-model J47 (Table 4.47) is mostly covered by rocks. Infact rocks account for 69.44% of the total area under this model, while unenclosed farmland and rivers account for 15.28% and 7.64% respectively. Communications account for 4.17% while woodland and grassland account for 1.39% each. The small portion of 0.69% of the area is covered by enclosed farmland (less than 10-ha.).

Table 4.47 Frequency Table Model J47

Class	Number	Percentage
Communications	6	4.17
Enclosed farmland (less than 10-ha.)	1	0.69
Unenclosed farmland	22	15.28
Grassland	2	1.39
Woodland	2	1.39
Rocks	100	69.44
Rivers	11	7.64

Stereo-model J48 (Table 4.48), 42.36% of its area is covered by grassland, 15.28% by rivers, 14.58% by rocks and 9.03% by communications and unenclosed farmlands each. Fadama covers 4.86% of the area and 2.78% is covered by scrub and small trees while settlement account for 2.08%.

Table 4.48 Frequency Table Model J48

Class	Number	Percentage
Settlement	3	2.08
Communications	13	9.03
Unenclosed farmlands	13	9.03
Fadama	7	4.86
Grassland	61	42.36
Scrub and small trees	4	2.78
Rocks	21	14.58
Rivers	22	15.28

The stereo-model J49 (Table 4.49) has 41.67% of its area covered by grassland, 24.31% by rocks and 9.72% by rivers and communications each. 8.33% of the area is covered by unenclosed farmland, 4.86% by scrub/small trees and 0.69% by woodland and enclosed farmland (less than 10-ha.) each.

Table 4.49 Frequency Table Model J49

Class	Number	Percentage
Communications	14	9.72
Enclosed farmland (less than 10-ha.)	1	0.69
Unenclosed farmland	12	8.33
Grassland	60	41.67
Scrub and small trees	7	4.86
Woodland	1	0.69
Rocks	35	24.31
Rivers	14	9.72

The area under stereo-model J50 (Table 4.50) is basically a grassland area. Grassland account for 71.53% of the area while scrub/small trees and rivers/lakes beds cover 15.28% and 12.5% respectively. Gallery forests account for only a small portion of the area.

Table 4.50 Frequency Table Model J50

Class	Number	Percentage
Grassland	103	71.53
Scrub and small trees	22	15.28
Gallery forests and Kurumi	1	0.69
Rivers	18	12.50

Another basically grassland area is the area under stereo-model J51 (Table 3.51). Grassland here accounts for 64.58% of the total area, with woodland accounting for 20.14%, rivers 5.56% and scrub 4.17%. 3.47% of the area is covered by gallery forests while 0.69% is covered by fadama and communications each.

Table 4.51 Frequency Table Model J51

Class	Number	Percentage
Communications	1	0.69
Fadama	1	0.69
Grassland	93	64.58
Scrub and small trees	6	4.17
Woodland	29	20.14
Gallery forests and Kurumi	5	3.47
Rivers	8	5.56

The area under stereo-modelJ52 (Table 4.52) is covered by 47.22% rocks, 43.75% grassland and 7.64% scrub and small trees. Gallery forests and rivers cover only a small portion of the area.

Table 4.52 Frequency Table Model J52

Class	Number	Percentage
Grassland	63	43.75
Scrub and small trees	11	7.64
Gallery forests and Kurumi	1	0.69
Rocks	68	47.22
Rivers	1	0.69

In the final analysis therefore, settlement occupies about 0.55% of the total area under study, communications 4.43%, Industries 0% and Enclosed farmlands (less than 10-ha.) 0.13%. Enclosed farmland (greater than 10-ha.) covers 0%, Unenclosed farmlands 16.17% while tree plantation occupy 0.03% of the total area. Fadama accounts for 1.62%, grassland 42.9% and scrub and small trees 11.57%. 0.13% of the total area is covered by Swamps and marshes, 1.54% by woodland and 2.3% by Galley forests and Kurumi. Rocks account for 10.59% and Rivers 8% of the total area under study. (See Table 4.53).

Table 4.53

Summary Landuse Frequency Table for the Total Area

Category	Non-Zero Models	Percentage
Settlements	107	0.55
Communications	141	4.43
Industry	0	0.00
Enclosed farmland (less than 10-ha.)	101	0.13
Enclosed farmland (greater than 10-ha.)	0	0.00

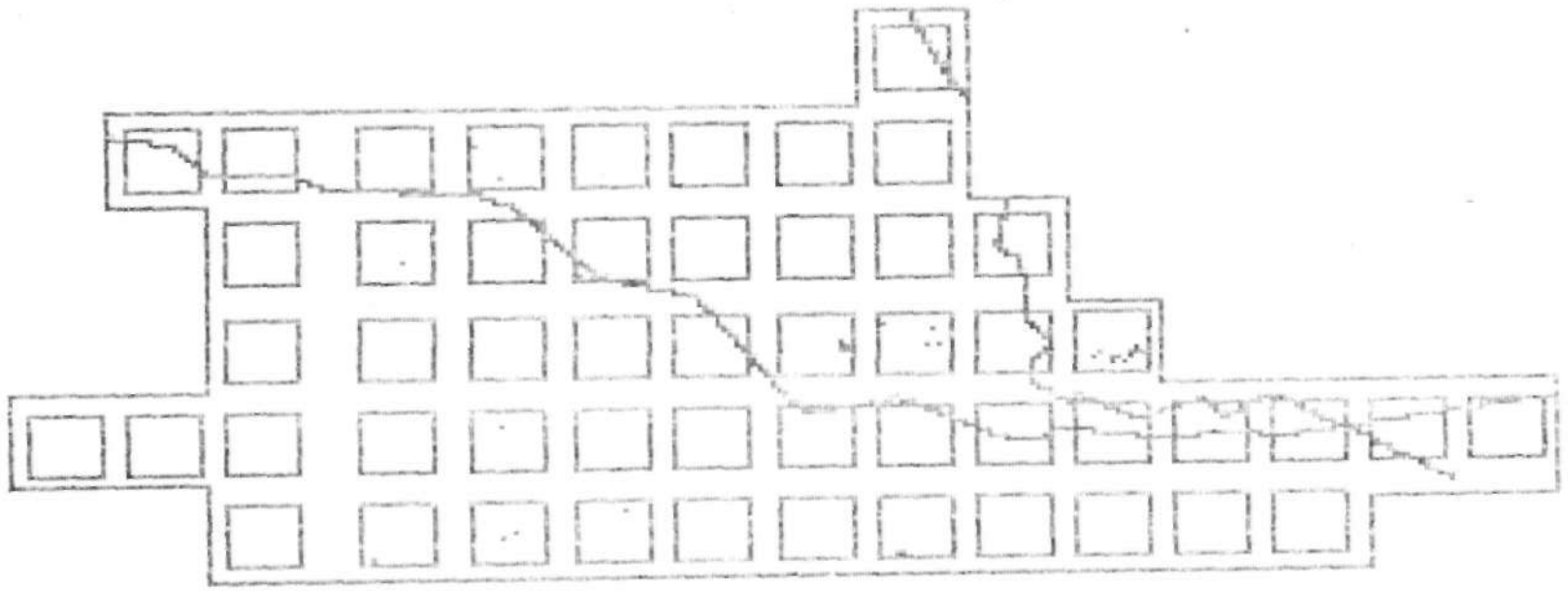
Unenclosed farmland	139	16.17
Tree plantation	94	0.03
Fadama	123	1.62
Grassland	141	42.9
Scrub and small trees	127	11.57
Swamps and Marshes	101	0.13
Woodland	116	1.54
Gallery forest and Kurumi	131	2.3
Inselbergs and barerock outcrops	122	10.59
Rivers and lake beds	137	8.00

Spatial distribution of some of the landuse categories can be seen in the Figs. 4.1 - 4.12 below.

3.2 The spatial Distribution of the Land Facets

From analysis, it is revealed that, 7.73% of the total area under study is occupied by Rock outcrop and rocky hills, 1.64% by Iron cap, 17.79% by Interfluve crest, 23.36% by valley side slope and 8.29% by steepened convex or planar lower slope. Also 5.97% is occupied by more gent;e concave or planar lower slope, 2.55% by valley head, 5.37% by Narrow concave valley bottom and 8.88% by wide concave valley bottom. Flat valley bottom including local flood plain occupy 12.7% of the total area while terrace and Ridges does not occur 5.7% also is covered by colluvial debris slope. (See Table 4.54).

Fig. 4.1 Spatial Distribution of Landuse category II— Settlements



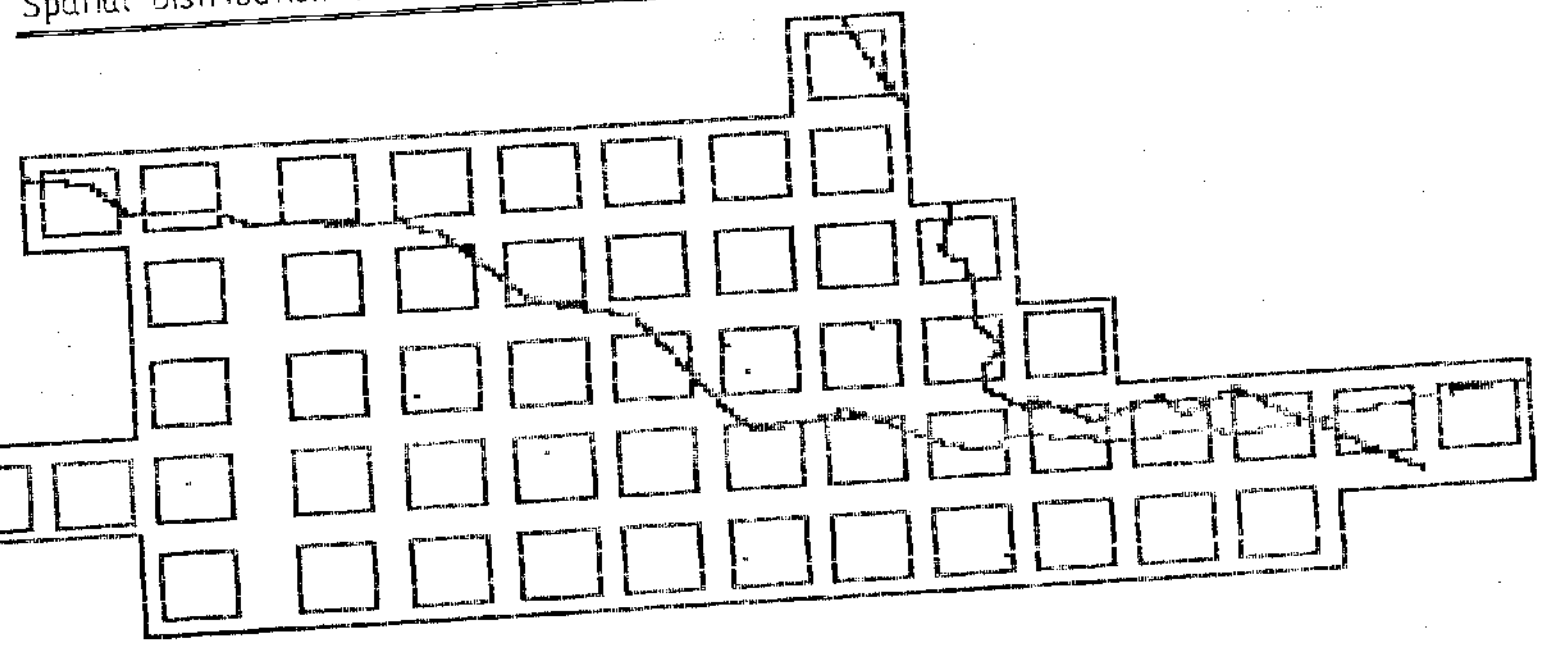
Settlement.

Fig. 4·2 Spatial Distribution of Landuse category 12 — Communications.



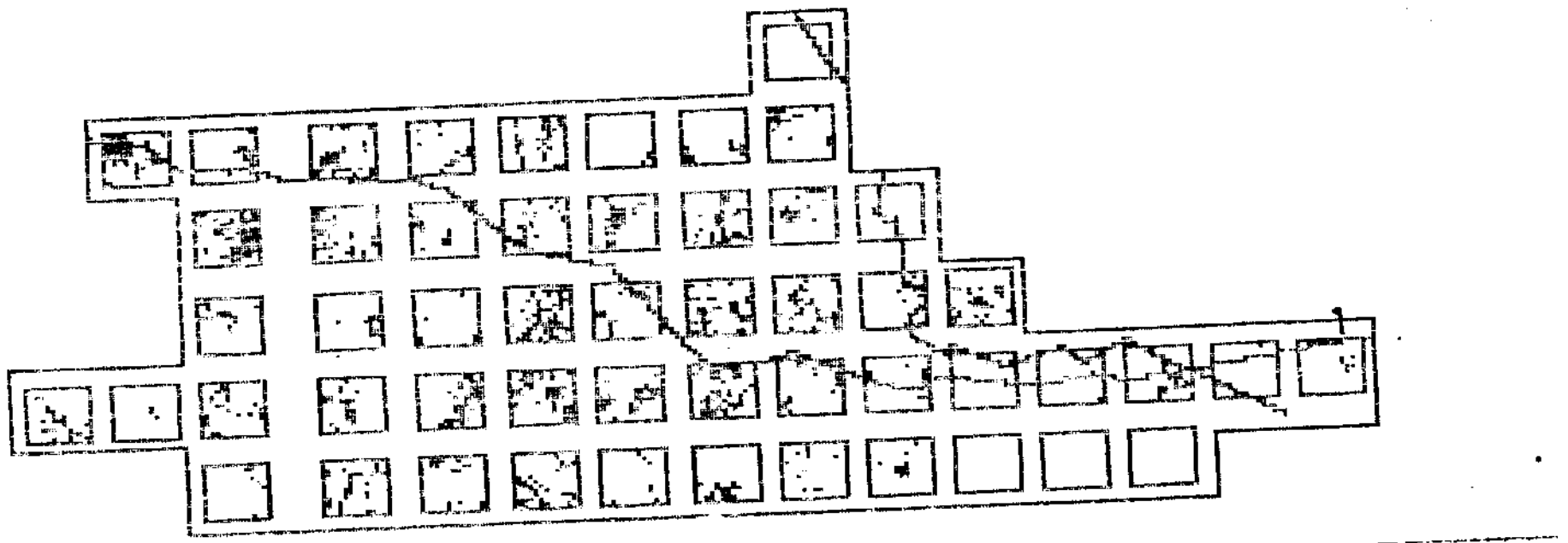
Communications

Fig. 4.3 Spatial Distribution of Landuse category 21 — Enclosed Farmland(less than 10 -ha).



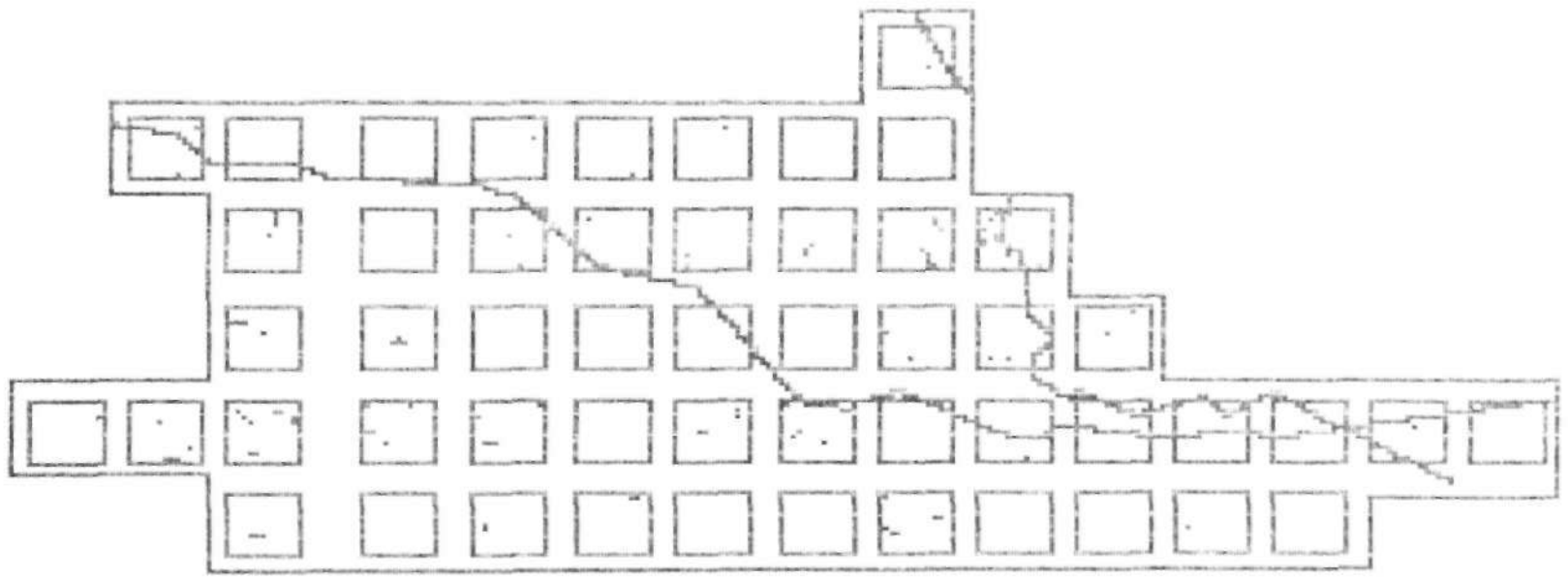
Farmless land.

Fig. 4.4 Spatial Distribution of Landuse category 23 – Unenclosed Farmland



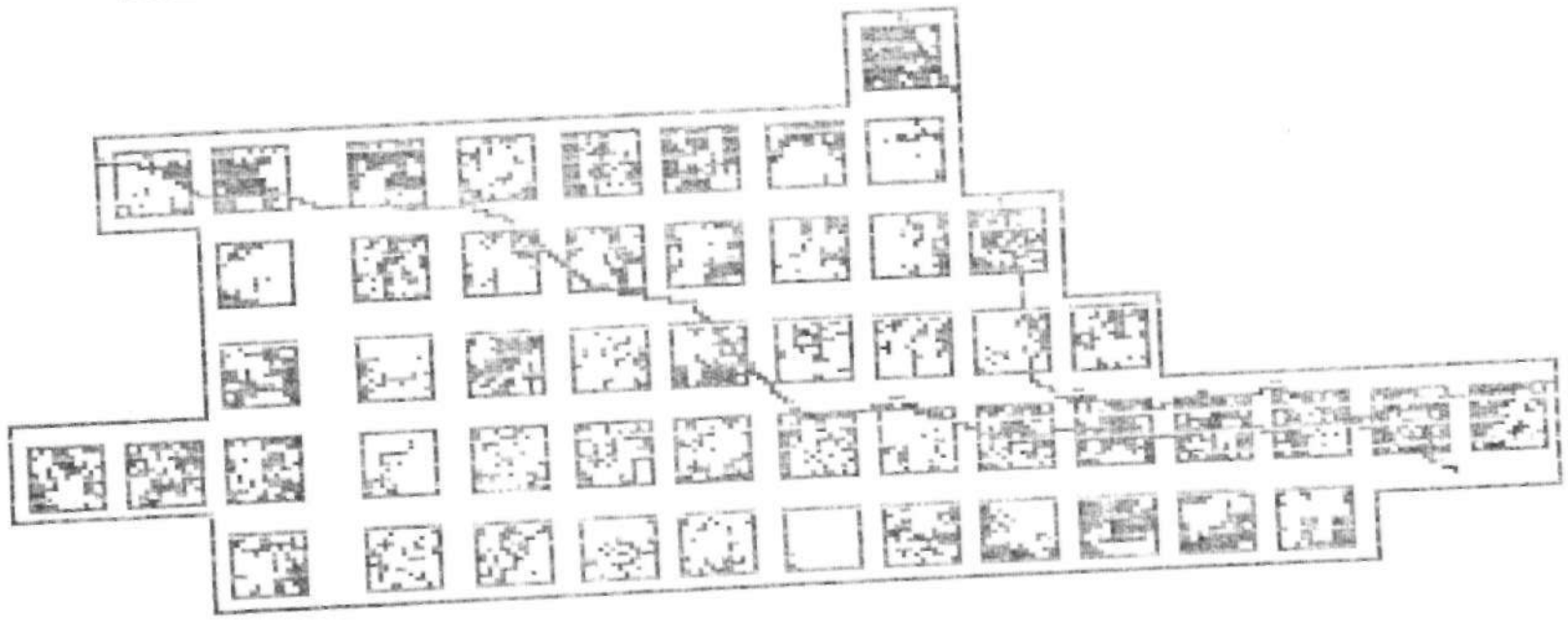
Farm.

Fig. 4·5 Spatial Distribution of Landuse category 31 — Fadama (floodplains)



Fadama

Fig. 4.6 Spatial Distribution of Landuse category 32— Grassland (not fadama)



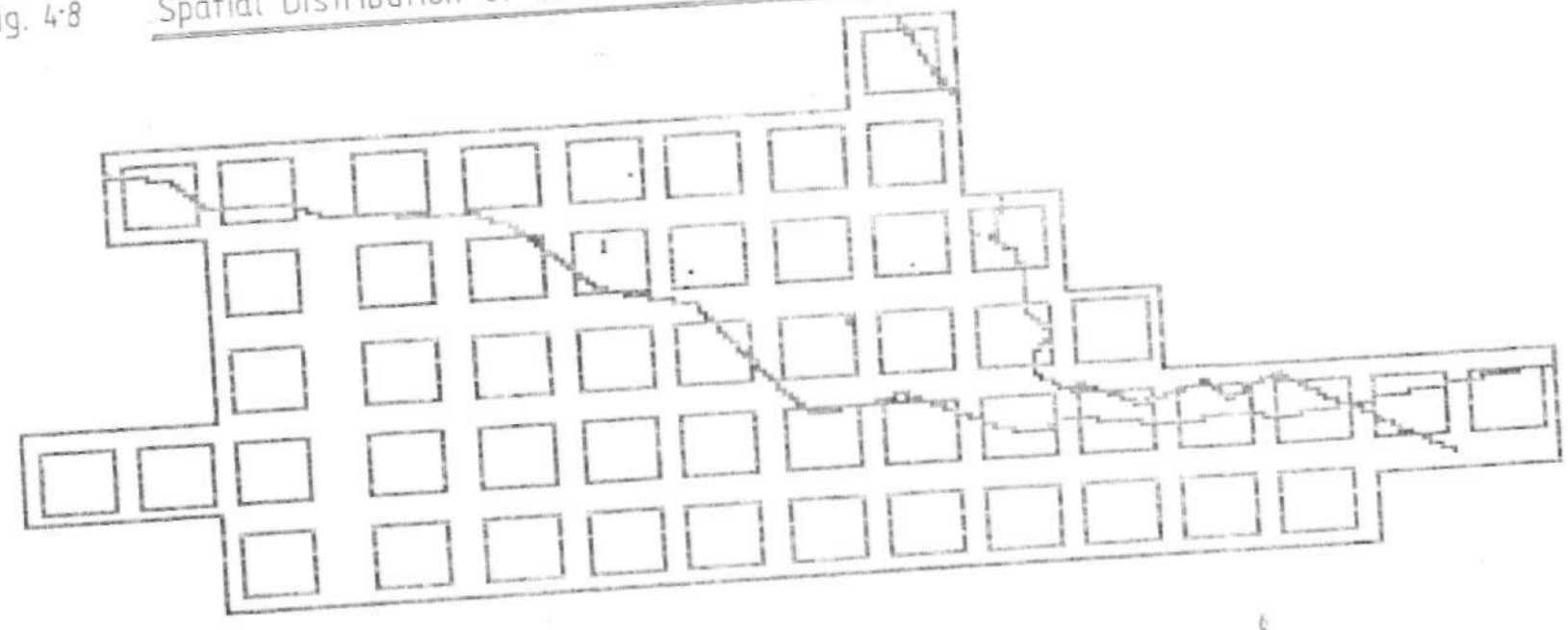
Grassland

Fig. 4.7 Spatial Distribution of Landuse category 33 — Scrub and Small trees.



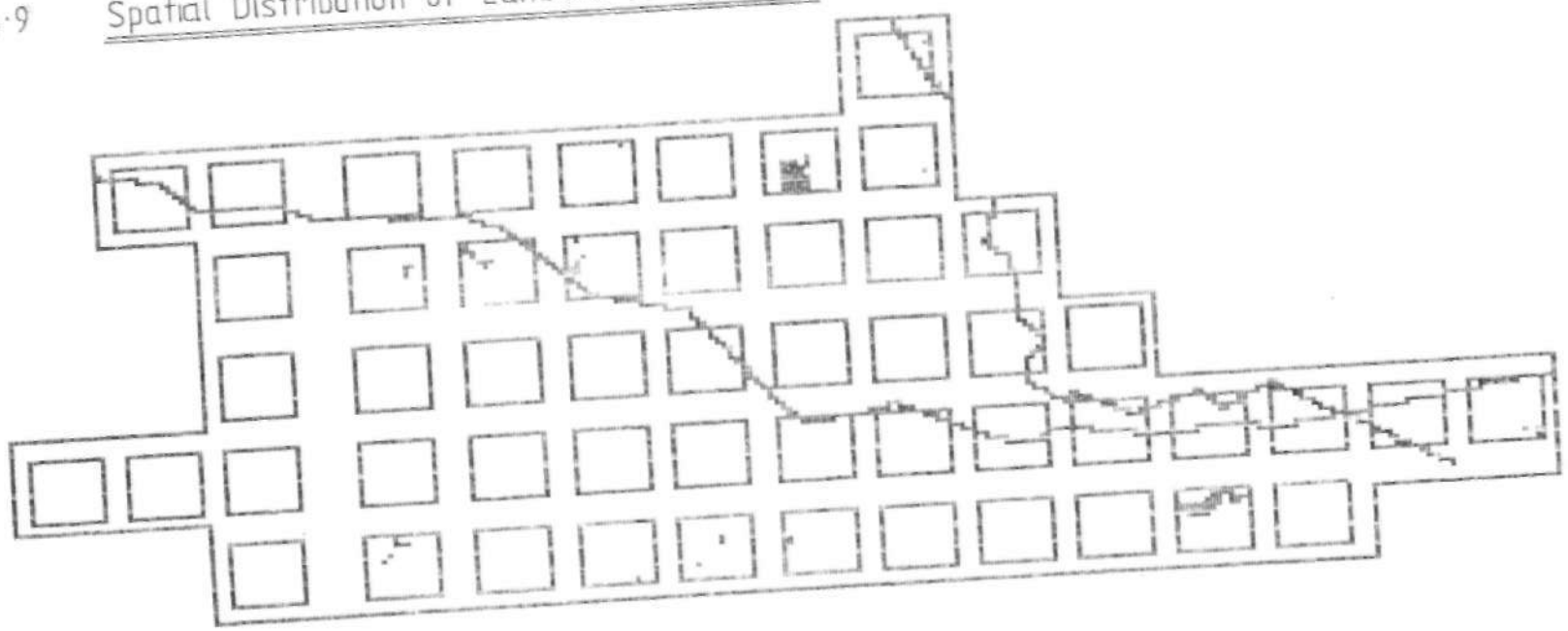
Scrub

Fig. 4·8 Spatial Distribution of Landuse category 34— Swamps and Marshes.



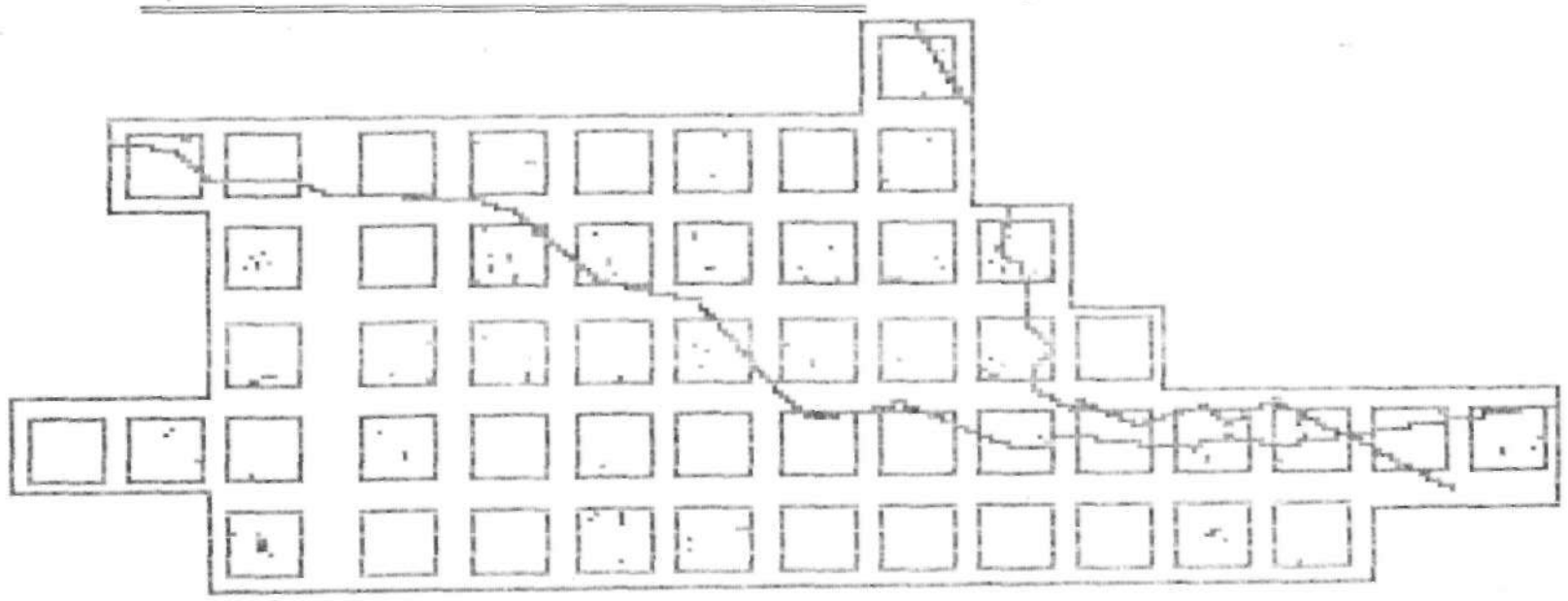
Swamps

Fig. 4·9 Spatial Distribution of Landuse category 35 — Woodland



Woodland

Fig. 4·10 Spatial Distribution of Landuse category 36 — Gallery forest and kurumi



Gallery

Fig. 4.11 Spatial Distribution of Landuse category 41—Inselbergs and Barerock outcrop.



Fig. 4·12 Spatial Distribution of Landuse category 42 — Rivers and Lakebeds.



Table 4.54

Summary Frequency Table of Land Facets for the Total Area.

Land facet	Non-Zero Models	Percentage
Rock outcrop and rocky hills	116	7.73
Iron cap	105	1.64
Interfluve crest	136	17.79
Valley side slope	141	23.36
Steepend convex or planar lower slope	132	8.29
More gentle concave or planar lower slope	111	5.97
Valley head	105	2.55
Narrow concave valley bottom	109	5.37
Wide concave valley bottom	134	8.88
Flat valley bottom including local flood plain	135	12.7
Terrace	0	0.0
Colluvial debris slope	110	5.7
Ridges	8	0.0

3.3 The Relationship of each Landuse Category with Land Facets

Land facet as explained earlier reveals the forms and nature of the topography of area under study. The relative heights, changes in the degree of slopes, and the nature of the land form surfaces has a generic relation with the types and distribution of the land use categories in the study area.

From Table 4.55, it can be seen that settlements are mostly on Interfluve crests and valley side slope but not on rock outcrops or areas of Iron cap. Indeed

36.585% of the area under which settlement occur is on interfluve crests, while 26.829% on more gentle valley side slopes. 7.317% are on more gentle planar lower slopes, flat valley bottom on flood plains and on colluvial debris slope. It is therefore apparent that settlements are chosen where agriculture is very viable. (See Fig. 4.13).

Table 4.55 Frequency Table Model Jacobs 1

Land facet	Number	Percentage
Rock outcrop and rocky hills	1	2.439
Interfluve crest	15	36.585
Valley side slope	11	26.829
Concave planar lower slops	3	7.327
More gentle concave planar lower slopes	1	2.439
Mode valley bottom	4	9.756
Colluvial debris slope	3	7.317

Table 4.56, communications is mainly found on areas with uniform slopes and of low gradients. The table reveals that they are located in areas of Interfluve crests, more gentle Valley side slopes and in valley bottoms and flatlands (See also Fig. 4.14)

Table 4.56 Frequency Table Model Jacobs 2

Landuse category - Communications

Land facet	Number	Percentage
Rock outcrop and rocky hills	16	4.82
Iron cap	4	1.21
Interfluve crest	86	25.90
Valley side slope	64	19.28

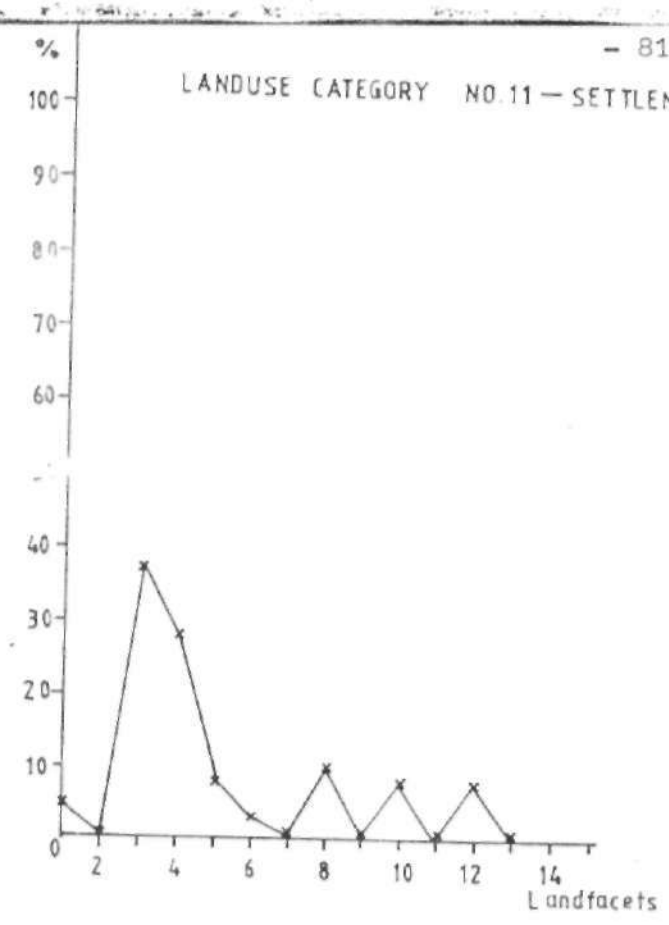
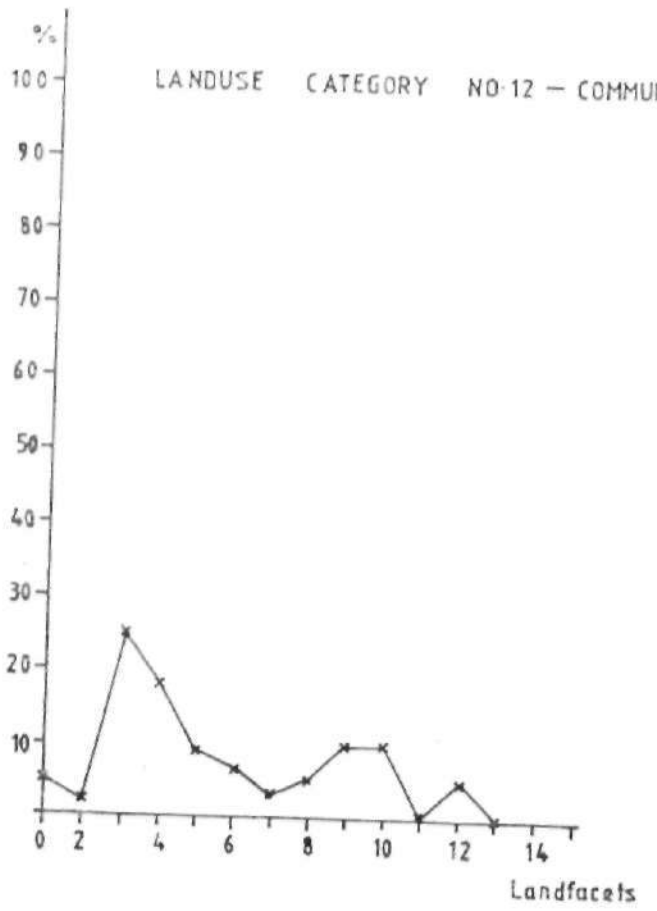


Fig. 4·13



F Fig. 4·14

Convex or planar lower slope	31	9.34
More gentle concave or planar lower	24	7.23
Valley head	11	3.31
Narrow concave valley bottom	15	4.52
Wide concave valley bottom	32	9.64
Flat valley bottom	33	9.94
Colluvial debris slope	16	4.82

The farmlands in the study area are mostly on interfluve crests (Table 4.57 and 4.58), valley side slopes and the floodplains. This indicates abundance of small self contained farm lands that are annually cultivated with few irrigated fadama farms.
(See Fig. 4.15 and 4.16)

Table 4.57 Frequency Table Model Jacobs 3

Landuse Category - Enclosed Farmland (less than 10-ha.)

Land facet	Number	Percentage
Interfluve crests	3	30
Valley side slope	2	20
Steepened covex or plannar lower slope	1	10
Wide concave valley bottom	1	10
Flat - valley bottom (local flood plain)	2	20

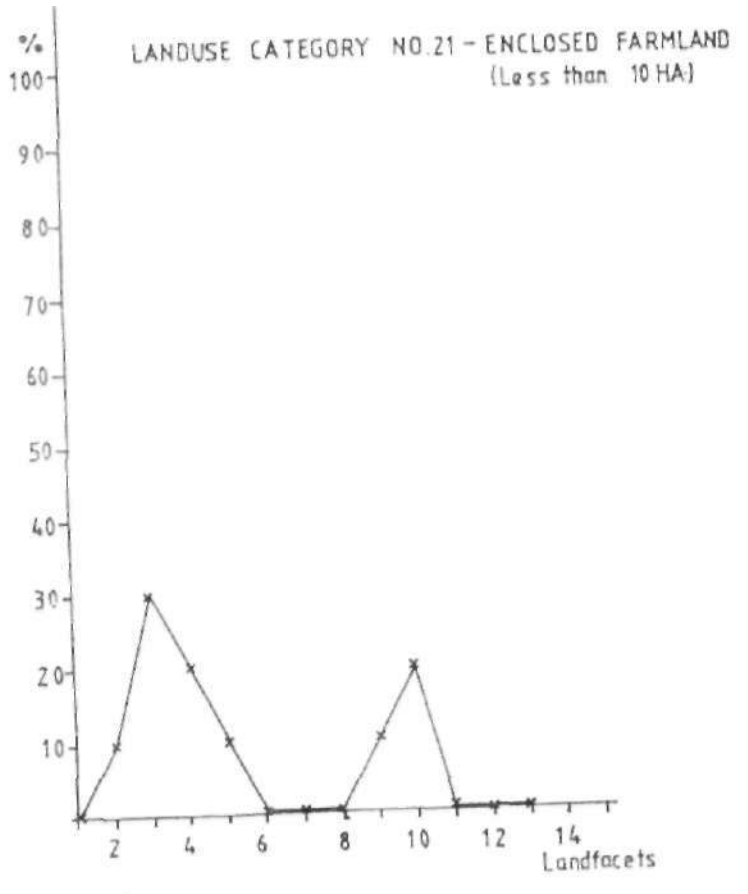


Fig. 4.15

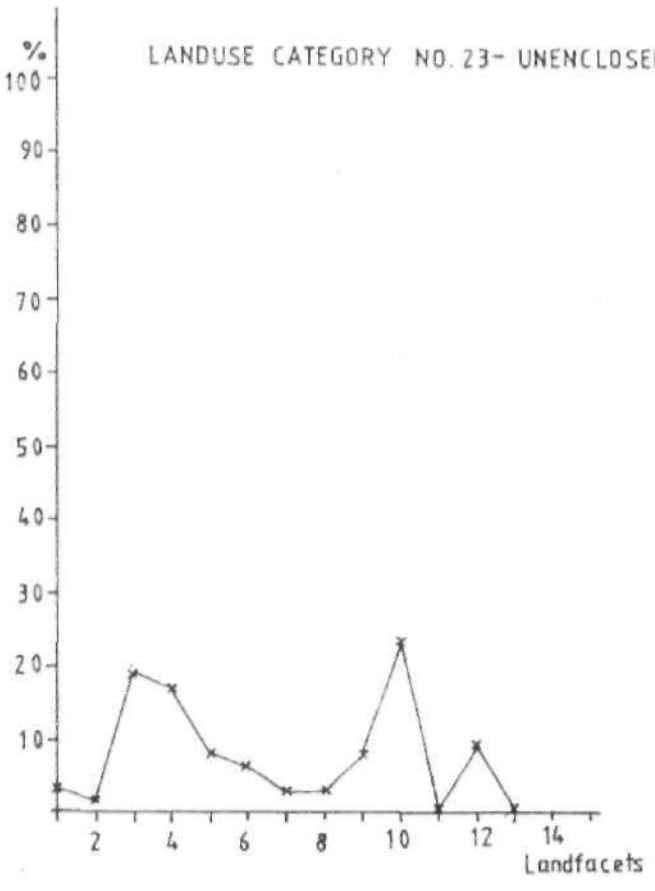


Fig. 4.16

Table 4.58 Frequency Table Model Jacobs 4

Landuse Category - Unenclosed Farmland

Land facet	Number	Percentage
Rock outcrop	41	3.39
Iron cap	11	0.91
Interfluve crest	229	18.91
Valley side slope	222	18.33
Steepened convex or planar lower slope	95	7.85
More gentle concave or planar lower slope	83	6.85
Valley head	27	2.23
Narrow concave valley bottom	23	1.90
Wide concave valley bottom	92	7.60
Flat valley bottom (local floodplain)	281	23.20
Colluvial debris slope	107	8.84

100% of tree plantation occurred on valley side slope as revealed by Fig. 4.17, and Table 4.59.

Table 4.59 Frequency Table Model Jacobs 5

Landuse Category - Tree Plantation

Land facet	Number	Percentage
Valley side slope	2	100

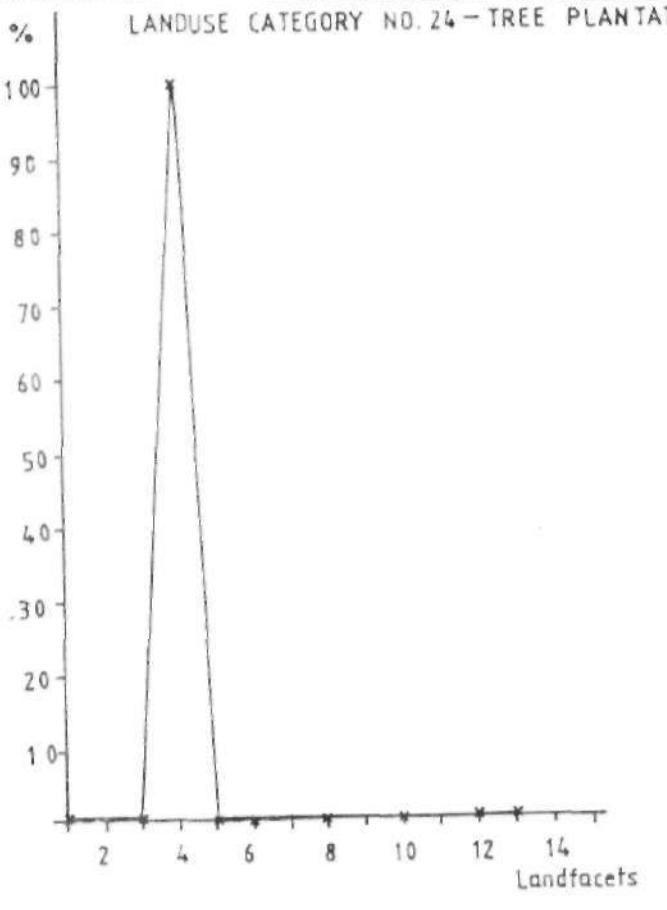


Fig. 4·17

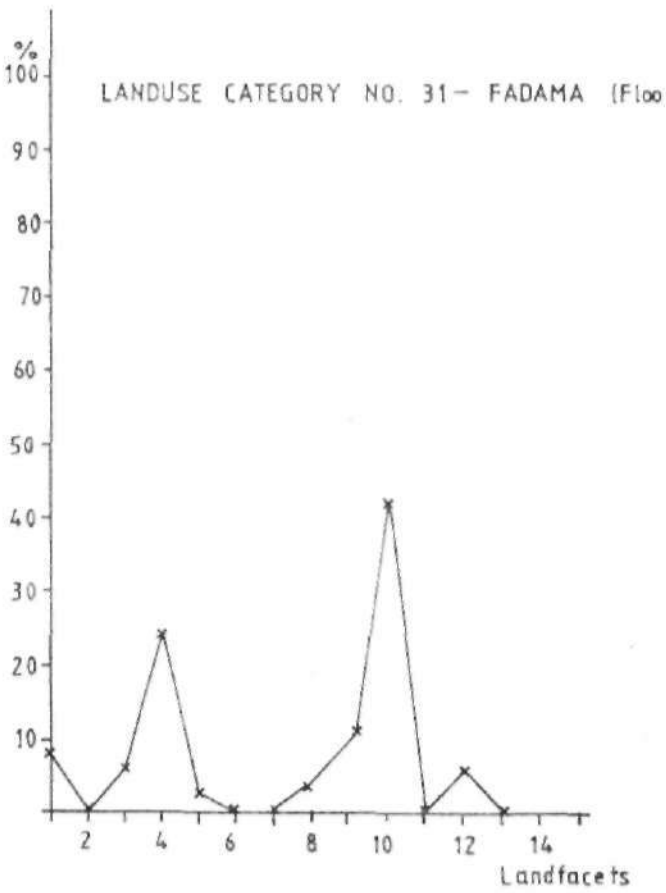


Fig. 4·18

The fadama grassland correlates strongly with floodplains Table 4.60. It is concentrated on flat areas near rivers/stream beds (Fig. 4.18). This then implies that fadama lands are confined to areas of even slopes and low relief, that are seasonally water logged.

Table 4.60 Frequency Table Model Jacobs 6

Land facet	Number	Percentage
Rock outcrop	11	9.09
Interfluve crests	7	5.79
Valley side slope	29	23.97
Steepened convex or planar lower slope	2	1.65
Narrow concave velley bottom	3	2.48
Wide concave valley bottom	13	10.74
Flat valley bottom (flood-plain)	49	40.50
Colluvial debris slope	7	5.79

The proportion of areas covered by open grassland vegetation correlate with interfluve crests as well as valley side slopes. This indicates that the wide open interfluves of good soils favours growth of grass species. It should also be noted that interfluve crests are most suited for settlements, thus forest degradation is active. The activities of man against forests encourage the growth of grasses at the expense of trees. (See Table 4.61 and also Fig. 4.19).

Scrubland small trees mainly occur on interfluve crests and valley side slope as can be seen

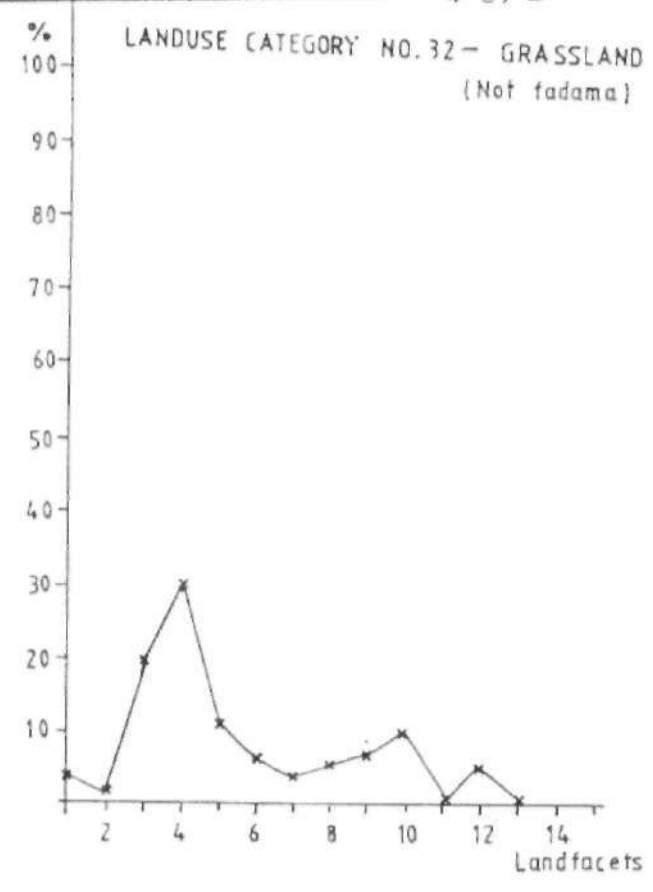


Fig. 4·19

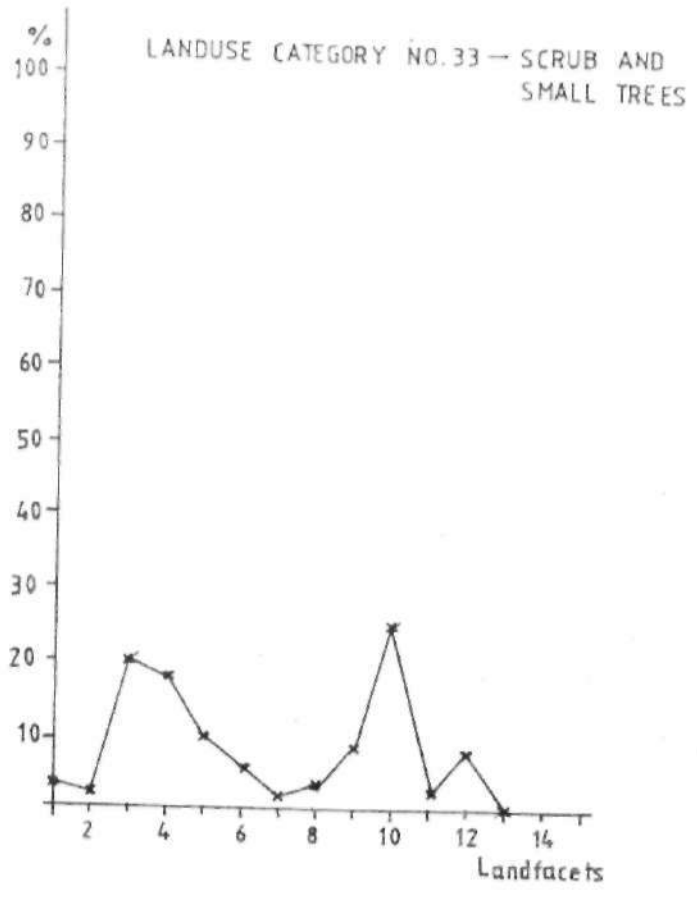


Fig. 4·20

in Table 4.62 (also Fig. 4.20). This also reveals that remote interfluve crests are mostly scrub lands while the steep valley side slopes that are prone to seasonal surface erosion are usually not cultivated because of the risks involved, and perhaps the availability of alternative cultivable lands. Therefore, such surfaces are covered with scrub vegetations and small trees.

Table 4.61 Frequency Table Model Jacobs 7

Land Category - Grassland

Land facet	Number	Percentage
Rock outcrop	103	3.21
Iron cap	26	0.81
Interfluve crest	632	19.68
Valley side slope	916	28.52
Steepened convex or planar lower slope	353	10.99
More gentle concave or planar lower slope	229	7.13
Valley head	119	3.71
Narrow concave valley bottom	195	6.07
Wide concave valley bottom	217	6.76
Flat Valley bottom (flood plain)	277	8.62
Colluvial debris slope	145	4.51

Table 4.62 Frequency Table Model Jacobs 8

Landuse Category - Scrub and small trees

Land facet	Number	Percentage
Rock outcrop	38	3.0
Iron cap	12	1.0

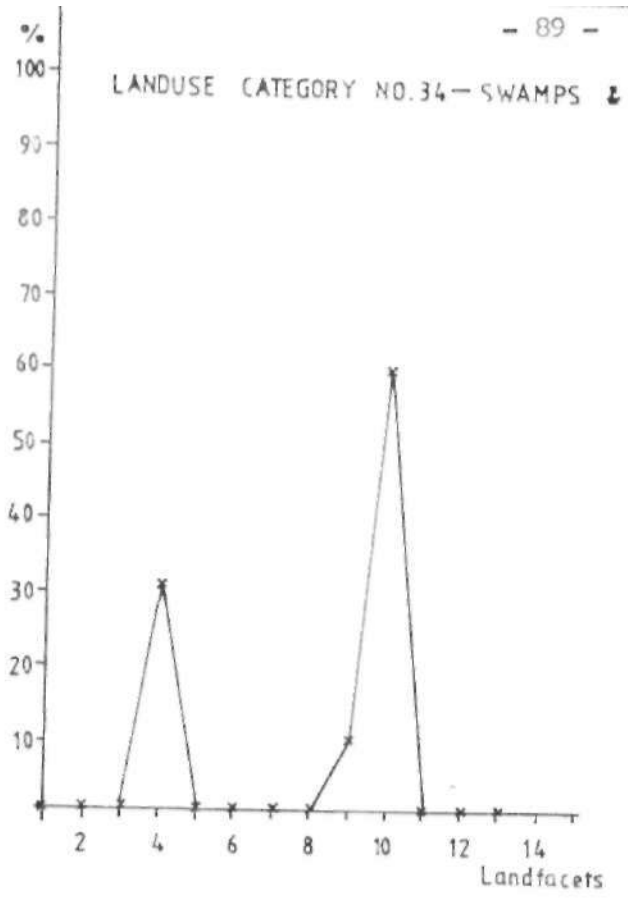


Fig. 4·22

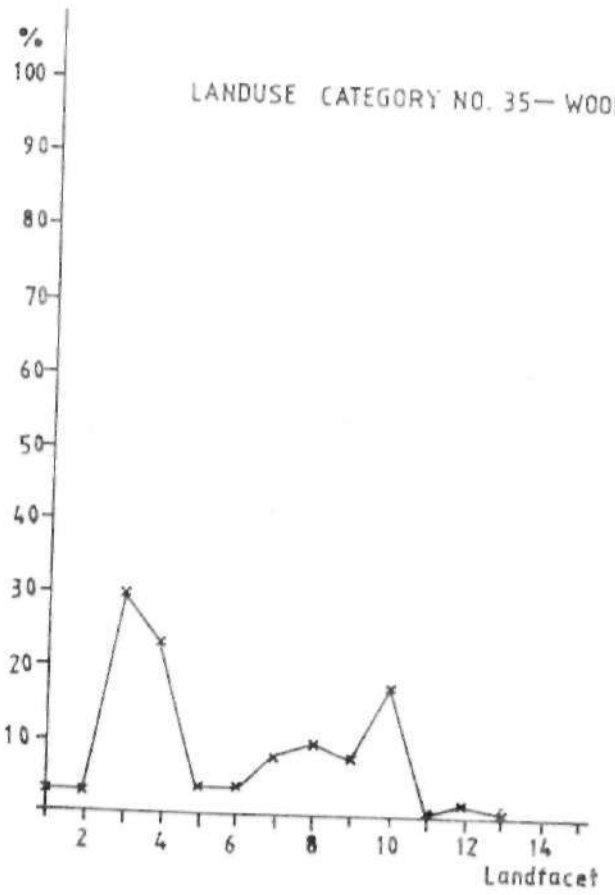


Fig. 4·21

Interfluve crest	230	19.0
Valley side slope	221	18.0
Planar lower slope (convex)	98	8.0
Planar lower slope (concave gentle)	93	7.0
Valley head	25	2.0
Valley bottom (narrow)	25	2.0
Valley bottom (wide)	98	8.0
Flood plain	280	23.0
Terrace	0	0.0
Colluvial debris slope	108	9.0

Woodland occur mainly in the flat valley bottoms, valley side slope and wide valley bottoms. This indicates fertile, stable and moist surfaces. (See Table 4.63 and Fig. 4.21).

Table 4.63 Frequency Table Model Jacobs 9

Landuse Category - Woodland

Land facet	Number	Percentage
Valley side sope	3	30
Valley bottom (wide)	1	10
Flat valley bottom (flood plains).	6	60

Swamps and marshes mostly occur in flat valley bottoms (floodplains), valley side slope and interfluve crests. This indicates that such areas are water prone and reservoirs are available not only for agriculture but also consumption during dry seasons. (See Table 4.64 and Fig. 4.22).

Table 4.64 Frequency Table Model Jacobs 10

Landuse Category - Swamps and Marshes

Land Facet	Number	Percentage
Rock outcrop	2	1.74
Iron cap	2	1.74
Interfluve crest	34	29.57
Valley side slope	26	22.61
Planar lower slope (Steep Convex)	5	4.35
Planar lower slope (more gentle concave)	4	3.48
Valley head	7	6.09
Valley bottom (narrow)	12	10.44
Valley bottom (wide)	7	6.09
Flat valley bottom (flood plain)	15	13.01
Colluvial debris slope	1	0.87

The gallery forests occur mostly in the moist areas along rivers/streams, interfluve crests and along valley side slope. (See Table 4.65 and Fig. 4.23)

Table 4.65 Frequency Table Model Jacobs 11

Landuse Category - Gallery forests and Kurumi

Land Facets	Number	Percentage
Rock outcrop	14	8.14
Iron cap	1	0.58
Interfluve crest	18	10.47
Valley side slope	42	24.42
Planar lower slope (convex)	9	5.23
Valley head	2	1.16

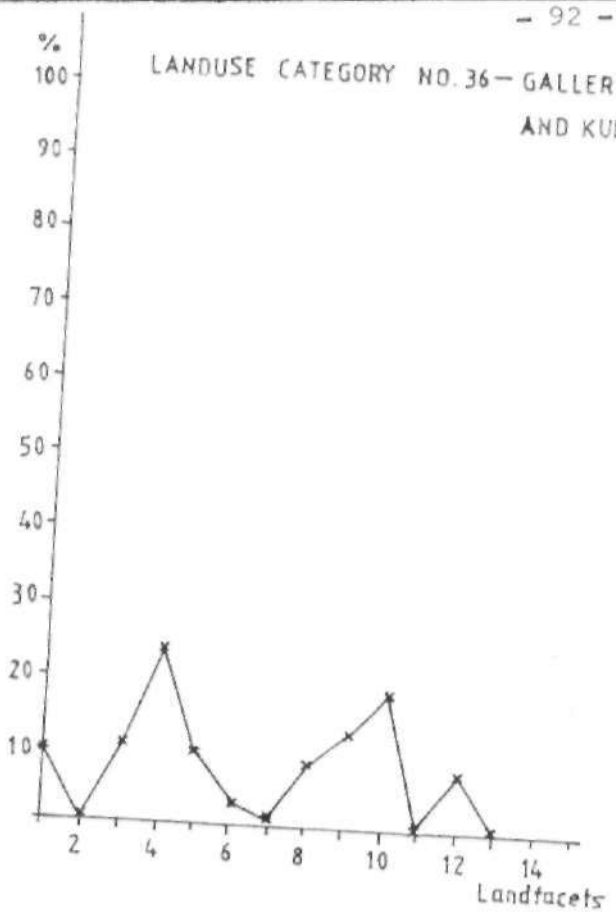

%
100
90
80
70
60
50
40
30
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10
2
4
6
8
10
12
14
Landfacets
LANDUSE CATEGORY NO. 36 — GALLERY FOREST
AND KURUMI

Fig. 4·23

Valley bottom (narrow)	15	8.72
Valley bottom (wide)	21	12.21
Flat valley bottom (flood plain)	33	19.19
Colluvial debris slope	13	7.56

Most rock surfaces does not coincide with other landuse classes but stand on their own. However, some occur in the interfluve crest areas - signifying that agriculture may not be the sole determinant for settlement but perhaps defense also. It should be noted that these are rural population. (See Table 4.66 and Fig. 4.24) Rivers and streams on the other hand correlate with valley side slopes, flat valley bottoms and colluvial debris slopes. This then means that most of these rivers have narrow and incised channels except in areas of floodplains (See Table 4.67 and Fig. 4.25).

Table 4.66 Frequency Table Model Jacobs 12

Landuse Category - Rocks

Land facet	Number	Percentage
Rock outcrop	329	41.49
Iron cap	69	8.70
Interfluve crest	95	11.98
Valley side slope	42	5.30
Planar lower slope (convex)	24	3.03
Planar lower slope (more gentle concave)	27	3.41
Valley head	6	0.76
Valley bottom (narrow)	23	2.9
Valley bottom (wide)	77	9.71

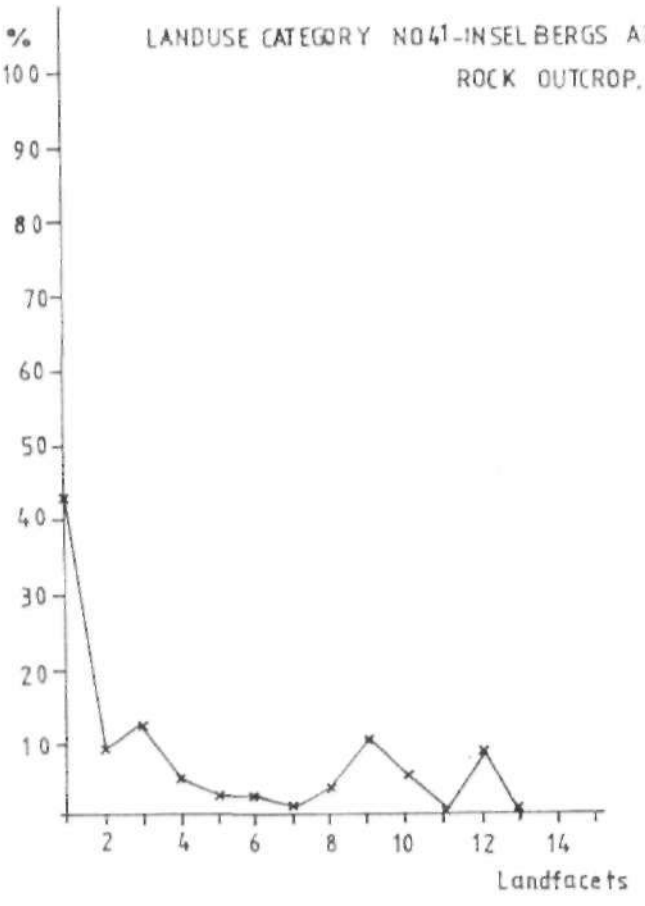

%
LANDUSE CATEGORY NO41-INSELBERGS AND BARE ROCK OUTCROP.
100
90
80
70
60
50
40
30
20
10
2
4
6
8
10
12
14
Landfacets

Fig. 4·24

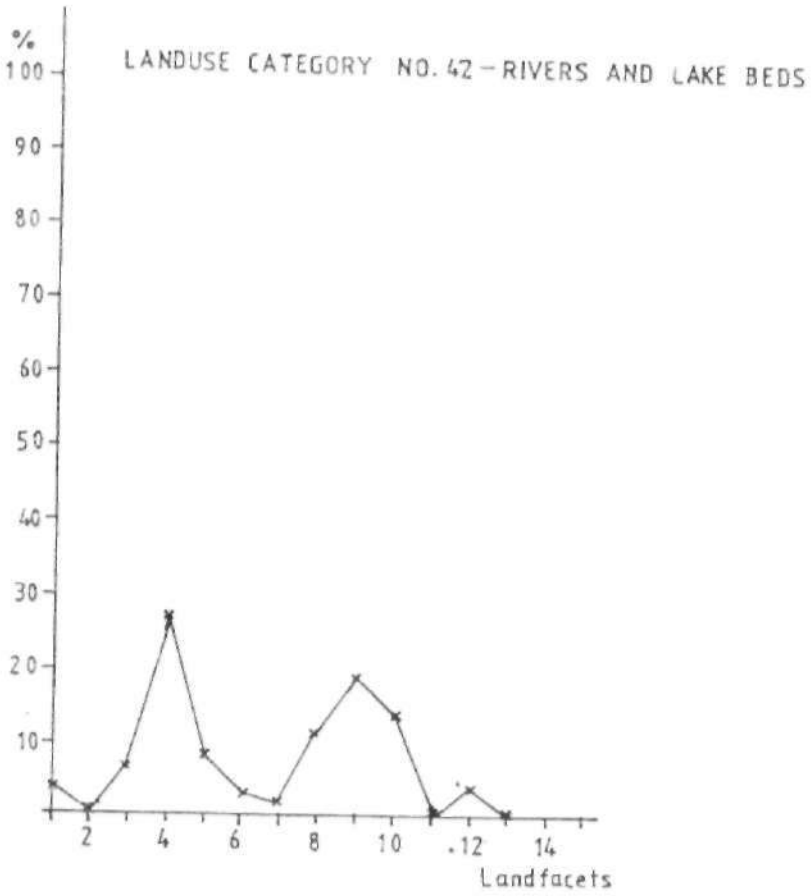

%
100
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80
70
60
50
40
30
20
10
LANDUSE CATEGORY NO. 42 – RIVERS AND LAKE BEDS
2
4
6
8
10
12
14
Landfacets

Fig. 4·25

Flat valley bottom (floodplain)	41	5.17
Colluvial debris	60	7.57

Table 4.67 Frequency Table Model Jacobs 13

Landuse Category - Rivers/Streams

Land facet	Number	Percentage
Rock outcrop	23	3.84
Iron cap	1	0.17
Interfluve crest	45	7.51
Valley side slope	159	26.54
Planar lower slope (convex)	23	3.84
Planar lower slope (gentle concave)	10	1.67
Valley head	5	0.84
Valley bottom (narrow)	67	11.19
Valley bottom (wide)	112	18.70
Flat valley bottom (floodplain)	132	22.04
Colluvial debris	22	3.67

CHAPTER FIVE

5.0 CONCLUSION

The landuse classification scheme used has indeed permitted the assessment and evaluation of land surface features in this part of the savannah, and this can easily be adopted for use in photo interpretation in other parts of the savannah. What is very fascinating about the classification scheme is the fact that it reflects the field situations, the scale of photography and the degree of image interpretation and analysis, as well as the cultural settings of the people such as their agricultural practices and their settlement patterns.

The employment of the basic principles of photointerpretation which include the combination of tone and texture, shape, size and location of object, as well as pattern was very useful in the interpretation of the various classes of vegetation cover in the study area. Fadama and grassland were actually interpretated on the basis of their location and texture, while shape, size and pattern were basically employed in woodland and scrub land interpretation. The combination of all the principles helped in interpreting settlements and communications as well as rocks and rivers.

From the analysis, it is apparent that settlements, communications and unenclosed farmlands are closely related to each other. Rivers and streams are continuous topographical features of uniform tone and distinctive patterns.

The railway line is quite small and narrow, and its long gradual curves easily distinguishes it from the major road and other transportation routes.

Under the stereoscopic view of the aerial photos, it was easy to identify and interprete lines of break in the degree of slope as well as the relative heights and form of the land surface.

The final analysis of the landuse categories indicate that the study area is basically rural and under grassland vegetations. The scattered settlements subsist on small land holdings and have footpaths and minor roads as their main transport routes. This situation may not be unconnected with man's influence on his environment i.e. forest destruction. Most land surfaces in the area of study guarantees the growth and formation of various vegetation types, and thus the area has a potential for intensive large scale agricultural practices - that is yet to be exploited. It is also to be noted that the study area lack adequate accessibility, and perhaps this has contributed to the area's non-exploitation.

It is also to be noted that human activities particularly settlement and farming activities are controlled by the topography. The bare rock outcrops and iron pan cappings are barely settled or cultivated. But most settlements occur at the foot or near such hills. This could be for defence reason. As such the farmlands correlate with interfluve crests, more gentle valley side slopes and floodplains of major

rivers such as river Sarkin Pawa. Such areas also support abundant grasslands. The woodland correlate significantly to interfluve crests, valley side crests and wide valley bottoms, particularly in such areas wetter part. The gallery forests are mainly along the course of the major rivers and streams.

The dot grid method of sampling used permitted sampling, interpretation and area determination of the landuse categories from a set of medium scale aerial photographs without prior depiction. It also permitted the measurement of the area of each landuse class at an accuracy level of less than or equal to 5% at 95% confidence level, and kept the level of error relatively constant. The interpreted landuse categories were recorded on a simple data sheet, in a form suitable for computer assisted storage, processing and display. The results obtained from this study may be used for monitoring and comparism purposes when a similar study of this study area is done at a later date.

"The remote sensing method employed in the research illustrated a fast and reliable means of surveying and monitoring landuse types of an area, such as the Guinea savanna region"(Abdu, 1987). Landuse monitoring programmes by remote sensing involves the use of several generations of aerial photos, land-sat images and other images of the area, including verifications and accuracy assesment through field work.

The execution of such programme involves the use of appropriate and skilled manpower, which we earlier mentioned are in short supply especially in Nigeria. But from this work, it is possible to collect, analyse and synthesis landuse informations from aerial photographs. Indeed we can go further to establish product moment correlations and bivariate relationships from such informations, and over time, a trend of activities might be revealed which would be helpful for planning purposes. And we should not forget the fact that there are lots of aerial photographs in our survey departments today which were used for topographic mapping projects and can be obtained cheaply and easily.

When the advantages of this method is gathered, and the informations obtained are integrated with other environmental informations, they can be used to establish and/or assess relationships and controls of the instruments of development in the area of study. I will not hesitate therefore to say that this is one of the technologies Nigeria needs, cheap and easily accessible, and very effective too.

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LINE 22 72874

	1	2	3	4	5	6	7	8	9	10	11	12	
1	32	32	32	32	32	32	32	32	32	32	32	32	1
2	32	32	32	12	32	32	32	32	32	32	42	42	2
3	32	32	32	32	32	32	32	32	32	32	32	36	3
4	32	32	32	32	32	32	32	32	32	22	32	32	4
5	32	32	32	32	32	32	32	32	32	32	32	32	5
6	32	32	32	32	32	32	32	32	32	42	32	32	6
7	32	32	32	42	32	32	32	42	31	32	36	36	7
8	32	32	12	42	32	32	32	31	32	32	32	32	8
9	42	42	42	32	42	32	42	32	32	32	32	32	9
10	42	12	32	42	32	32	32	32	32	32	32	32	10
11	32	35	42	32	42	32	32	32	32	42	12	32	11
12	32	32	36	33	32	32	32	32	31	12	32	32	12

PHOTOINTERPRETATION RECORD SHEET

```
]LOAD ACCDATA
]LIST

10  REM  ** INPUT - DATA ARRAY **

20  REM  * PROGRAMME TO INPUT DAT
    A LINES *
25  HOME : VTAB 12: HTAB 16: PRINT
    "ACCDATA": PRINT : PRINT
30 D$ =  CHR$ (4)
35  PRINT D$;"MON C,I,O"
38 N1 = 12
40  DIM Y(N1)
50  INPUT "TYPE MODEL NUMBER   ";
    NO
60 T$ =  "ACCT" + STR$ (NO)
80  INPUT "TYPE IN LINE NUMBER ?
    ";Q
90  FOR J = 1 TO N1: PRINT "COL "
    ;J;"  ";: INPUT Y(J): NEXT J

100  PRINT "LINE ";Q;" NOS ENTERE
     D "
110 N2 = 0
120  FOR J = 1 TO N1
130 N2 = N2 + 1
140  PRINT "COL ";J;"  ";Y(J);" "

150  IF N2 < 4 THEN 180
160 N2 = 0
170  PRINT
180  NEXT J
190  PRINT
200  PRINT "IFCORRECT TYPE Y"
210  PRINT "OTHERWISE TYPEN"
220  INPUT A$
230  IF A$ = "Y" THEN 270
240  IF A$ <  > "N" THEN 200
250  INPUT "LABEL OF NUMBER TO BE
     CHANGED?";I1
260  INPUT "WHAT IS THE CORRECT N
     UMBER?";X
270 Y(I1) = X
280  GOTO 100
290  REM  $OUTPUT: DATA X(.), NUM
     BER OF DATA N$
300  REM   $TITLE T$ $
320  IF Q <  > 1 THEN 360
330  PRINT D$;"OPEN";T$: PRINT D$
     ;"DELETE";T$
340  PRINT D$;"OPEN";T$: PRINT D$
     ;"WRITE";T$
350  GOTO 370
360  PRINT D$;"APPEND";T$: PRINT
     D$;"WRITE";T$
370  FOR J = 1 TO N1: PRINT Y(J);
      NEXT J
380  PRINT D$;"CLOSE"
400  INPUT "ANOTHER LINE ? ";Q$
410  IF Q$ = "Y" THEN 80
420  IF Q$ <  > "N" THEN 400
425  PRINT D$;"NOMON C,I,O"
430  END
```

```
]LOAD CREATE FRDATA
]LIST

 10  REM  ** CREATE FRDATA FILE **

 20  REM  * INPUT DATA X(.),NUMBER
       OF DATA N *
 30  HOME : VTAB 12: HTAB 13: PRINT
      "CREATE FREQUENCY DATA FILE"

 40 D$ =  CHR$ (4):N = 144:F0 = 2
 50  DIM F(47),X(N
 60 FL$ = "FRDATA"
 70  PRINT D$;"MON C,I,O"
 80  FOR K = 1 TO 52
 90  FOR I = 1 TO 42:F(I) = 0: NEXT
     I
100 A$ = "JACOB" +  STR$ (K)
110  PRINT D$;"OPEN";A$: PRINT D$
     ;"READ";A$
120  FOR I = 1 TO N: INPUT X(I): NEXT
     I
130  PRINT D$;"CLOSE ";A$
140  FOR I = 1 TO N
150 W = X(I)
160 F(W) = F(W) + 1
170  NEXT I
180  IF K <  > 1 THEN 220
190  PRINT D$;"OPEN ";FL$: PRINT
     D$;"DELETE ";FL$
200  PRINT D$;"OPEN ";FL$
210  GOTO 230
220  PRINT D$;"APPEND ";FL$
230  PRINT D$;"WRITE ";FL$
240  FOR I = 11 TO 42: PRINT F(I)
     : NEXT I
250  PRINT D$;"CLOSE ";FL$
260  NEXT K
270  PRINT D$;"NOMON C,I,O"
280  END
```

```
]LOAD FREQUENCY COUNT$
]LIST

 10  REM  ** FREQUENCY COUNT **
 20  REM  * INPUT DATA X(,),NUMBER
       OF DATA N *
 30  HOME : VTAB 12: TAB 12: PRINT
     "FREQUENCY COUNT": PRINT : PRINT

 40 D$ =  CHR$ (4):N = 144:F0 = 2
 50  DIM F(49),X(N),C(20,2)
 60  DEF  FN R(X) =  INT (X * (10 ^
     F0) + 0.5) / (10 ^ F0)
 70  INPUT "TYPE MODEL NUMBER ";A
 80 A$ = "JACOB" +  STR$ (A)
 90  PRINT : INPUT "PAPER OUTPUT ?
      ";Q$
100  IF Q$ = "N" THEN 120
110  IF Q$ <  > "Y" THEN 90
120  PRINT D$;"PR#1"
130  HOME : PRINT  TAB( 6);"FREQU
     ENCY TABLE MODEL  ";A$: PRINT

140  PRINT "CLASS ";TAB( 10);"NUM
     BER";: TAB( 20);"PERCENT"
150  PRINT D$;"OPEN";A$: PRINT D$
     ;"READ";A$
160  FOR I = 1 TO N: INPUT X(I): NEXT

170  PRINT D$;"CLOSE"
180  FOR I = 1 TO 49:F(I) = 0: NEXT

190  FOR I = 1 TO N
200 W = X(I)
210 F(W) = F(W) + 1
220  NEXT
230 J = 0
240  FOR I = 10 TO 42
250  IF F(I) = 0 THEN 310
260 W = F(I)
270 W1 =  FN R(W / N * 1E2)
280 J = J + 1
290 C(J,1) = I:C(J,2) = W1
300  PRINT "  "I; TAB( 12);W; TAB(
     22);W1
310  NEXT
320  REM  ** HISTOGRAM **
330  INPUT "HISTOGRAM DISPLAY ? "
     ;Q$
340  IF Q$ = "N" THEN 440
350  IF Q$ <  > "Y" THEN 330
360  FOR I = 1 TO J
370  PRINT C(I,1);"  ";
380 W = C(I,2)
390 W =  INT (W / 1.5)
400  FOR K = 1 TO W: PRINT "*";: NEXT
     K
410  PRINT
420  NEXT I
430  PRINT D$;"PR#0"
440  END
```

```
]LOAD SIX-NUMBER SUMMARY
]LIST

10 D$ = "SIX-NUMBER SUMMARY"
20 D$ =  CHR$ (4):F0 = 2
30  REM  ** FREQUENCY COUNT **
40  HOME : TAB 5: HTAB 13: PRINT
    D$; PRINT : PRINT
50 C = 144::C0 = 100 / N:N0 = 52
60  DEF  FN A(X) =  INT (X * C0 *
    10 ^ F0 + 0.5) / (10 ^ F0)
70  DIM X(N0),B(N0,42),A(N0),D%(N
    0)
80  PRINT D$;"OPEN FRDATA": PRINT
    D$;"READ FRDATA"
90  FOR I = 1 TO N0
100  FOR J = 11 TO 42: INPUT B(I,
    J): NEXT J
110  NEXT I
120  PRINT D$;"CLOSE FRDATA"
130  PRINT  TAB( 10);"CATEGORY NO
    . ";: INPUT A1
140  PRINT  TAB( 10);"PRINTOUT
      ";: INPUT P$
150  PRINT : PRINT
160  FOR I = 1 TO N0:X(I) = B(I,A
    1): NEXT
170  REM  *OUTPUT:DATAX(.),NUMBER
     OFDATAN*
180  REM  PUT X(.) INTO A(.FOR SO
    RT
200  FOR I = 1 TO N0
210  LET A(I) = X(I)
220  NEXT I
230  REM  **EXCHANGE SORT**
290  FOR I = 1 TO N0 - 1
300  LET J1 = I
310  FOR J = I + 1 TO N0
320  IF A(J) >  = A(J1) THEN 340
330  LET J1 = J
340  NEXT J
350  IF J1 = I THEN 390
360  LET W = A(I)
370  LET A(I) = A(J1)
380  LET A(J1) = W
390  NEXT I
410  REM  *OUTPUT:DATA IN INCREAS
    ING ORDER IN A(.)*
430  LET Q = 4
440  FOR P = 1 TO 3
450  GOSUB 730
460 Q(P) =  FN A(Q0)
470  NEXT P
```

```
480  REM  LABEL EXTREMES
490 L =  FN A(A(1))
500 U =  FN A(A(N0))
510 N1 = 0
520 MEAN = 0
530  FOR I = 1 TO N0
540  IF A(I) = 0 THEN N1 = N1 + 1

550 MEAN = MEAN + A(I)
560  NEXT I
570 MEAN =  FN A(MEAN / N0)
580  REM  OUTPUT SIX-NUMBER SUMMA
     RY
590  HOME : VTAB 5
600  IF P$ = "Y" THEN  PRINT D$;"
     PREI"
610  PRINT  TAB( 20);V$: PRINT
620  PRINT  TAB( 13);"CATEGORY ";
     A1: PRINT : PRINT  TAB( 15);
     "PER CENT": PRINT
630  PRINT
640  PRINT "NON ZERO MODELS "; TAB(
     20);N - N1
650  PRINT "MEAN"; TAB( 20);MEAN
660  PRINT "MEDIAN"; TAB( 20);Q(2
     )
670  PRINT "QUARTILES"; TAB( 20);
     Q(1);"  ";Q(3)
680  PRINT "EXTREMES"; TAB( 20);L
     ;"  ";U
690  PRINT D$;"FREQ"
700  PRINT : PRINT : PRINT : INPUT
     "DIAGRAM ? ";Q$: IF Q$ = "Y"
      THEN  GOSUB 870
710  INPUT "ANOTHER ? ";Q$
712  TEXT : HOME
713  IF Q$ = "Y" THEN 130
720  END
730  REM ##QUANTLES##
740  REM #INPUT:DATA A(.)IN INCRE
     ASING ORDER#
750  REM  #NUMBER OF DATA N;P,Q F
     OR P-TH Q-TILE#
760  REM #VARIABLES:J1,J2,Q0#
770  REM  ##QUANTILES##
780  REM #INPUT:DATA A(.)IN INCRE
     ASINGORDER#
800  REM #VARIABLES:J1,J2,Q0#
810  LET J1 =  INT (P * N0 / Q) +
     1
820  LET J2 = N0 -  INT ((Q - P) *
     N0 / Q)
830  LET Q0 = (A(J1) + A(J2)) / 2
```

```
840  REM  ¥OUTPUT:QQ,THE P-TH Q-T
     ILE¥
850  REM ¥OUTPUT:QQ,THE P-TH Q-TI
     LE¥
860  RETURN
870  REM  ¥¥ FREQUENCY DIAGRAM ¥¥

880  INPUT "LOWER LIMIT ? ";L0
890  INPUT "UPPER LIMIT ? ";U0
900 L1 = L0:U1 = U0
910 L0 =  INT (L0 / C0 + 0.5):U0 =
      INT (U0 / C0 + 0.5)
920  FOR I = 1 TO N0:X(I) = B(I,A
     1):D%(I) = 0: NEXT
930  FOR I = 1 TO N0
940  IF X(I) < L0 THEN 970
950  IF X(I) > U0 THEN 970
960 D%(I) = 1
970  NEXT
980  GR
990 L = 0
1000  FOR J = 0 TO 32 STEP 9
1010  FOR I = 1 TO 26 STEP 6
1020 L = L + 1: COLOR= D%(L)
1030  FOR K = J TO J + 6
1040  PLOT I,K: PLOT I + 1,K
1050  NEXT K
1060  NEXT I
1070  NEXT J
1080  HOME
1090  VTAB 23: PRINT "CATEGORY ";
     A1;" :";L1;" TO ";U1
1100  RETURN
```

```
]LOAD MAPDIST
]LIST

10 V$ = "##MAPDIST##"
20  TEXT : HOME : PRINT " PROGRAM
    ME : ";V$;" MENU ##": PRINT
    : PRINT
30  HIMEM: 8192
40  DIM A%(7,14),X%(72),T$(5),Y%(
    72),U$(3),C$(3),E(3)
60 X$ = "NUMBERSL510R172"
70  REM  #FILL A%(..)#
80  FOR I = 1 TO 7
90  FOR J = 1 TO 14:A%(I,J) = 0: NEXT
    J
100  NEXT I
110  FOR I = 1 TO 7
120  READ J1,J2
130  FOR J = J1 TO J2:A%(I,J) = 1
    : NEXT J
140  NEXT I
150 A%(7,13) = 1:A%(7,14) = 1
160  DATA     3,14,1,14,2,14,1,13
    ,          1,13,1,13,1,9

170 D$ =  CHR$ (4):N = 89
180  FOR I = 1 TO 3: READ U$(I),C
    $(I),E(I): NEXT
190  FOR I = 1 TO 2: PRINT  TAB(
    10);I;". ";U$(I): NEXT
200  INPUT "WHICH DO YOU WANT?E
    ";I.
210  DATA  "1950 & 1972","FROM ",
    0,          "CHANGES ","TO
    ",141," ","UNCHANGED ",60
220  REM  #INPUT TITLES#
230  PRINT D$;"OPEN";X$;",L510": PRINT
    D$;"READ ";X$;",R1"
240  FOR I = 1 TO 5: INPUT T$(I):
     NEXT
250  PRINT D$;"CLOSE"
260  REM  #CHOICE OF CLASS#
270  TEXT : HOME : PRINT  TAB( 12
    );V$: PRINT  TAB( 16);U$(D1)
    : PRINT
280  FOR I = 1 TO 5: PRINT  TAB(
    10);I;". ";T$(I): NEXT
290  INPUT "WHICH DO YOU WANT?E
    ";C2: PRINT
300  IF D1 = 1 THEN 330
310  FOR I = 1 TO 3: PRINT  TAB(
    10);I;". ";C$(I): NEXT
320  INPUT "WHICH DO YOU WANT?E
    ";D2
330  REM    # MAP #
```

```
350  IF D1 = 2 THEN 420
360 E0 = E(1)
370  GOSUB 880
380 E0 = E(2)
390  GOSUB 880
400  VTAB 21: PRINT  TAB( 5)"1950
     ";: TAB( 15);T$(C2); TAB( 31
     ); 1972"
410  GOTO 450
420 E0 = E(3)
430  GOSUB 880
440  VTAB 21: PRINT  TAB( 10);C$(
     D2);T$(C2);" 1950/72"
450  PRINT D$;"OPEN ";X$;",L510"
460 R1 = 0
470  FOR I = 1 TO 7
480  FOR J = 1 TO 14
490  IF A%(I,J) = 0 THEN 790
500 X1 = 10 * (J - 1) + 1:Y1 = 20
      * (I - 1) + 4
510 X2 = X1 + E(C)
520  IF D1 = 2 THEN X1 = X1 + 60
530 R1 = R1 + 2
540  PRINT D$;"READ ";X$;",R";R1
550  FOR I1 = 1 TO 72: INPUT X%(I
     1): NEXT I1
560  PRINT D$;"READ ";X$;",R";(R1
      + 1)
570  FOR I1 = 1 TO 72: INPUT Y%(I
     1): NEXT I1
580  FOR K = 1 TO 67 STEP 6
590  FOR L = K TO K + 5
599 X = X%(L):Y = Y%(L)
600  IF D1 = 1 THEN 710
610  IF D2 = 3 THEN 690
620  IF D2 = 1 THEN 660
630  IF Y <  > C2 THEN 750
640  IF X = C2 THEN 750
650  GOTO 740
660  IF X <  > C2 THEN 750
670  IF Y = C2 THEN 750
680  GOTO 740
690  IF X <  > Y THEN 750
691  IF X <  > C2 THEN 750
700  GOTO 740
710  IF X = C2 THEN  HPLOT  X1
720  IF Y = C2 THEN  HPLOT  X1 '
730  GOTO 750
740  HPLOT X1,Y1
750 X1 = X1 + 1:X2 = X2 + '
760  NEXT L
770 X1 = X1 - 6:Y1 = Y1 + ' '2 =
     X2 - 6
780  NEXT K
790  NEXT J
800  NEXT I
```

```
]LOAD TEMPMAPDIST
]LIST

10  REM ### GRAPHICS PROGRAMME ##
    #
20  HOME : TEXT
30  INPUT "SELECT LAND USE TYPE "
    ;X0
40  DIM Y(12,12)
50 D$ =  CHR$ (4)
880  HGR
890  REM  #BORDER#
900  HPLOT 141,5 TO 159,5 TO 159,
    41 TO 175,41 TO 175,51 TO 19
    6,61 TO 190,77 TO 154,77 TO
    154,100 TO 224,100 TO 224,11
    4 TO 35,114 TO 35,95 TO 3,95
     TO 3,77 TO 35,77 TO 35,41 TO
    19,41 TO 19,23 TO 141,23 TO
    141,5
905  REM  # RAILWAY #
910  HPLOT 19,27 TO 20,28 TO 22,2
    8 TO 30,30 TO 35,35 TO 38,35
     TO 48,35 TO 54,38 TO 80,40 TO
    85,42 TO 100,56 TO 115,60 TO
    130,60 TO 132,82 TO 143,80 TO
    145,79 TO 165,88 TO 170,88 TO
    172,96 TO 186,98 TO 195,87 TO
    206,83 TO 218,36 TO 254,80
915  REM  # ROADS #
920  HPLOT 150,5 TO 155,12 TO 159
    ,22
930  HPLOT 161,41 TO 165,42 TO 16
    7,50 TO 167,53 TO 168,56 TO
    168,65 TO 172,69 TO 169,73 TO
    170,78 TO 172,79 TO 175,81 TO
    176,79 TO 185,84 TO 196,80 TO
    200,84 TO 208,79 TO 218,86
931  HPLOT 218,86 TO 224,89 TO 23
    7,97
940  HPLOT 144,8 TO 156,8 TO 156,
    20 TO 144,20 TO 144,8
950  HPLOT 22,26 TO 34,26 TO 34,3
    8 TO 22,38 TO 22,26
960  HPLOT 38,26 TO 50,26 TO 50,3
    8 TO 38,38 TO 38,26
970  HPLOT 60,26 TO 72,26 TO 72,3
    8 TO 60,38 TO 60,26
980  HPLOT 78,26 TO 90,26 TO 90,3
    8 TO 78,38 TO 78,26
990  HPLOT 95,26 TO 107,26 TO 107
    ,38 TO 95,38 TO 95,26
1000  HPLOT 111,26 TO 123,26 TO 1
    23,38 TO 111,38 TO 111,26
1010  HPLOT 128,26 TO 140,26 TO 1
    40,38 TO 128,38 TO 128,26
1020  HPLOT 144,26 TO 156,26 TO 1
    56,38 TO 144,38 TO 144,26
1030  HPLOT 38,44 TO 50,44 TO 50,
```

```
     56 TO 38,56 TO 38,44
1040 HPLOT 60,44 TO 72,44 TO 72,
     56 TO 60,56 TO 60,44
1050 HPLOT 78,44 TO 90,44 TO 90,
     56 TO 78,56 TO 78,44
1060 HPLOT 95,44 TO 107,44 TO 10
     7,56 TO 95,56 TO 95,44
1070 HPLOT 111,44 TO 123,44 TO 1
     23,56 TO 111,56 TO 111,44
1080 HPLOT 128,44 TO 140,44 TO 1
     40,56 TO 128,56 TO 128,44
1090 HPLOT 144,44 TO 156,44 TO 1
     56,56 TO 144,56 TO 144,44
1100 HPLOT 160,44 TO 172,44 TO 1
     72,56 TO 160,56 TO 160,44
1110 HPLOT 38,63 TO 50,63 TO 50,
     75 TO 38,75 TO 38,63
1120 HPLOT 60,63 TO 72,63 TO 72,
     75 TO 60,75 TO 60,63
1130 HPLOT 78,63 TO 90,63 TO 90,
     75 TO 78,75 TO 78,63
1140 HPLOT 95,63 TO 107,63 TO 10
     7,75 TO 95,75 TO 95,63
1150 HPLOT 111,63 TO 123,63 TO 1
     23,75 TO 111,75 TO 111,63
1160 HPLOT 128,63 TO 140,63 TO 1
     40,75 TO 128,75 TO 128,63
1170 HPLOT 144,63 TO 156,63 TO 1
     56,75 TO 144,75 TO 144,63
1180 HPLOT 160,63 TO 172,63 TO 1
     72,75 TO 160,75 TO 160,63
1190 HPLOT 176,63 TO 188,63 TO 1
     88,75 TO 176,75 TO 176,63
1200 HPLOT 6,81 TO 18,81 TO 18,9
     3 TO 6,93 TO 6,81
1210 HPLOT 22,81 TO 34,81 TO 34,
     93 TO 22,93 TO 22,81
1220 HPLOT 38,81 TO 50,81 TO 50,
     93 TO 38,93 TO 38,81
1230 HPLOT 60,81 TO 72,81 TO 72,
     93 TO 60,93 TO 60,81
1240 HPLOT 78,81 TO 90,81 TO 90,
     93 TO 78,93 TO 78,81
1250 HPLOT 95,81 TO 107,81 TO 10
     7,93 TO 95,93 TO 95,81
1260 HPLOT 111,81 TO 123,81 TO 1
     23,93 TO 111,93 TO 111,81
1270 HPLOT 128,81 TO 140,81 TO 1
     40,93 TO 128,93 TO 128,81
1280 HPLOT 144,81 TO 156,81 TO 1
     56,93 TO 144,93 TO 144,81
1290 HPLOT 160,81 TO 172,81 TO 1
     72,93 TO 160,93 TO 160,81
1300 HPLOT 176,81 TO 188,81 TO 1
     88,93 TO 176,93 TO 176,81
1310 HPLOT 192,81 TO 204,81 TO 2
     04,93 TO 192,93 TO 192,81
1320 HPLOT 208,81 TO 220,81 TO 2
     20,93 TO 208,93 TO 208,81
1330 HPLOT 224,81 TO 236,81 TO 2
     36,93 TO 224,93 TO 224,81
1340 HPLOT 240,81 TO 252,81 TO 2
     52,93 TO 240,93 TO 240,81
1350 HPLOT 38,99 TO 50,99 TO 50,
```

```
    111 TO 39,111 TO 38,99
1360  HPLOT 6?,99 TO 72,99 TO 72,
    111 TO 60,111 TO 60,99
1370  HPLOT 72,99 TO 90,99 TO 90,
    111 TO 78,111 TO 78,99
1380  HPLOT 95,99 TO 107,99 TO 10
    7,111 TO 95,111 TO 95,99
1390  HPLOT 111,99 TO 123,99 TO 1
    23,111 TO 111,111 TO 111,99
1400  HPLOT 128,99 TO 140,99 TO 1
    40,111 TO 128,111 TO 128,99
1410  HPLOT 144,99 TO 156,99 TO 1
    56,111 TO 144,111 TO 144,99
1420  HPLOT 160,99 TO 172,99 TO 1
    72,111 TO 160,111 TO 160,99
1430  HPLOT 176,99 TO 188,99 TO 1
    88,111 TO 176,111 TO 176,99
1440  HPLOT 192,99 TO 204,99 TO 2
    04,111 TO 192,111 TO 192,99
1450  HPLOT 208,99 TO 220,99 TO 2
    20,111 TO 208,111 TO 208,99
1460  REM
                        PLOT THE
    DOTS
1470  PRINT D$;"MON C"
1480  FOR M = 1 TO 5
1490  READ P1,P2
1495 A$ = "JACOB" + STR$ (M)
1500  PRINT D$;"OPEN ";A$
1510  PRINT D$;"READ";A$
1520  FOR I = 1 TO 12
1522  FOR J = 1 TO 12
1523  INPUT X(I,J)
1524  NEXT J
1525  NEXT I
1530  PRINT D$;"CLOSE";A$
1540  FOR I = 1 TO 12
1550  FOR J = 1 TO 12
1560  IF X(I,J) = X0 THEN  HPLOT
    P1 + I,P2 + J
1570  NEXT J
1571  NEXT I
1572  NEXT M
1573  DATA   144,8,22.26,38,26,60
    ,          26,78,26,95,26,
    111,26,128,26          ,14
    4,26,38,44,60,44,78,44,95
           ,44,111,44,128,44,1
    44,44,160          ,44,38,
    63,60,63,78,63,95
1574  DATA  63,111,63,128,63,144,
    6          3,160,63,176,63
    ,6,81,22,81,3          8,8
    1,60,81,78,81,95,81,111,8
           1,128,81.144,81,160
    ,81
1580  DATA  176,81,192,81,208,81,
    224,81,240,81.38.99,60,99,78
    ,99,95,99,111,99,128,99,144,
    99,160,99,176,99.192,99,208,
    99
1585  PRINT D$;"NOMON C"
1590  END
```