"AN APPRAISAL OF VEGETATION DEGRADATION IN AKAMKPA, CROSS RIVER STATE, USING REMOTELY SENSED DATA"

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CERTIFICATION

This is to certify that this thesis is an original work undertaken by IWUJI MARTIN CHIDINMA (M.TECH./SSSE/99/2000/340) under the supervision of Prof. J. M.BABA and is consistent with the postgraduate school requirement for the award of a Master of Technology (M. Tech.) degree.

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APPROVAL PAGE

This thesis, certified by the candidate's supervisor has been read and approved for the partial fulfillment of the award of Master's Degree of Technology in Remote Sensing Application in the Postgraduate School, Department of Geography, Federal University of Technology, Minna.

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DEDICATION

This thesis is dedicated to the fountain and sustainer of my life – JEHOVAH GOD. By whose manifold grace I am where and what I am today. And to Dr F.E. Bisong who ignited the flame of environmental concern in me.

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ABSTRACT

Over the years remote sensing has been applied to the study and updating of information on several facets of the environment including mineral exploration, desert encroachment, flood monitoring, vegetation change, urban growth, water pollution etc.

It was based on this that this research set out to look into the problem of ascertaining the relationship and hence the impact of the agricultural practice of the people of Akamkpa L.G.A on the degradation of vegetal resources in the place. This is in view of the fact that there is a general dearth of information on the status of the country's vegetation and especially for the study area which 'houses' about 90% of what can still be described as virgin tropical rainforest.

In order to achieve maximum and reliable result, the technique of remote sensing was applied making use of aerial photographs covering the study area for two separate years 1972 and 1991. Six different land/vegetation classes were identified and their area duly delineated and calculated to reflect the variations in each class. Other forms of information on the study was acquired through ground-truthing, use of questionnaire and oral interviews to appreciate the indigenous perception of the problem at hand and their response towards it. All these were meant to be a backup for the information extracted from the aerial photographs.

Summarily, the research was able to come up with facts showing that there has been a remarkable downward change in vegetation status of the study area mostly attributable to expansion in agriculture as a response to population growth. Thus, the virgin forest within the demarcated study area has been depreciating at such a fast rate that if no positive actions are taken to reverse the trend, the entire high forest in the area would have vanished before the end of 11 years from 1991. Indigenous appreciation of the problem confirms that so far about 16 specie of flora comprising of timber and non-timber forest resources are either extinct or are seriously endangered within the study area.

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CHAPTER ONE

INTRODUCTION

In recent times there has been a growing global concern over the rate at which the forest resources and vegetation cover of the earth are fast disappearing. This trend of degradation has led to the raising of several questions on the justifications for the various human activities that in no small measure contributed to the reduction of the vast 'sea' of floral specie on the earth's surface.

Amongst the various forms of human activities that have seriously affected vegetal cover is agriculture. This research will therefore examine the agricultural practise of the people of Akamkpa Local Government area of Cross River State and having a knowledge of that go ahead to take a retrospective glance at past and present trends in vegetal cover distribution using appropriate and relevant remote sensing techniques. For the purpose of this research the term forest and vegetation shall be used interchangeably even though there is a line of divide between the two. Consequently deforestation and degradation will be used synonymously.

1.1 THEORITICAL FRAMEWORK

Before going any further into this section it is important to define three important keywords in this research namely; Agriculture, Vegetation and Degradation.

Agriculture can be defined as the act of breeding plants and animals for the purpose of domestic consumption and economic advancement. Thus, the agriculturist (farmer) is seen not just as a mere producer of crops and animals but also as a channel for meeting the dietary demand of people in several other areas.

Vegetation on the other hand is the floristic make-up of an entire forest area, while ***Degradation*** refers to an induced change from a higher level or form unto a lower or simplified level or form.

Vegetation degradation can therefore be defined as the induced change in form of the floristic make-up of an entire forest area from a higher complex level or form unto a lower or simplified level.

As earlier noted a very common form of human activity that induces floral change across the globe is agriculture. This has been practised in various forms and scale in different places ranging from the simple shifting cultivation method using such implements as hoe, cutlass, digging stick etc., to the more advanced use of machine otherwise known as mechanised agriculture. In the tropics and particularly in Africa, agriculture has advanced at a slow pace as many areas still indulge in the most rudimentary agriculture system - shifting cultivation, using such crude implements as the digging stick, cutlass, hoe, etc. (Grigg, 1974). This fact is lent support to by Eyre (1968) who observes that the primitive type of small scale shifting cultivation is still practised in some tropical rainforest areas where there is only a sparse cultivating population.

The inherent question here now becomes what is shifting cultivation? Grigg (1974) described shifting cultivation as an agricultural system in which a farmer chooses a patch of forest – secondary or primary – cuts down some of the trees with an axe leaving only the larger and economically useful ones, clears the undergrowth with a knife or cutlass and burns the debris. Crops are sown with minimum land preparation and minimum attention is given during their growth period. Usually after one or two years the land is left uncropped and is taken over by natural vegetation while the farmer seeks for a fresh clearing. Implicit in the above

description is an agricultural practice that encourages specie migration through cutting and extinction through bush burning. A constant feature of shifting cultivation in areas where the frequency has become too high for full recovery of forest before the next cropping break is the development of savanna or scrub vegetation in place of forest – a glaring case of degradation. As Grigg (1974) observed, it is obvious that in forest areas or woodlands where shifting cultivation is carried on for a long time, the cleared and burnt area will experience in the long run, a degradation of the vegetation, where previous forest area will be taken over by scrub and grass. This has given rise to a fallow system, which Boserup (1965) and Morgan (1969) described as bush fallow, which is distinct from forest fallow system where the fallow break is long enough to allow for re-establishment of trees. But in the typical traditional method the cleared portion of land is cultivated until nutrient depletion and pest invasion necessitates abandonment of the plot for new clearing.

Thomas and Middleton (1994) attributes the widespread degradation of vegetation arising from agriculture to the clearing of forest and woodland in order to create agricultural and pastural land. However, increasing human population has warranted over intensive cultivation of cleared land with the consequent loss in fertility, which has led to the clearing of more forest. For as Hinckley (1980) puts it, increase in population pressure leads to a situation where long fallow are now difficult or totally impossible to practise.

With the advent of mechanised agriculture involving the use of both machinery and irrigation, the scale of vegetation clearance has greatly increased. With those technical skill man has been able to sweep away much of the wild vegetation, replacing it with what Eyre (1968) described as "orderly planted patches of specie he has come to esteem highly as food." The purpose could also be for economic gain e.g plantation. Implicitly vast expanses of forest with

diverse floristic composition have been degraded to such an extent that what remains is more or less a man – made monoculture vegetation that is easily susceptible to attack by pests and diseases. In fact during the past fifty years vast areas of forest have been cleared in Nigeria, Ghana and other West African countries as far as Sierra Leone to such an extent that the prolonged extensive interference of man has led to doubts as to the possibility of actually identifying what the climatic climax formation distribution would be if interference were to cease (Eyre 1968).

So far we have been trying to account for the cause or rather reasons behind the fast rate of vegetation degradation especially in the tropics. However an unfortunate irony exist here in the sense that most people especially in the developing tropical countries who are directly involved in this act are more or less ignorant of the impact of their agricultural activities on the vegetation. Most of them innocently assume they are merely making a living as Hinckley (1980) terms it, "hewers of wood", oblivious of the fact that their activities reduces their own chances of survival and rob future generations of a precious legacy. The gravity of this trend is brought to light by Hinckley (1980) who reports that in the Amazon basin, the completion of the trans – Amazon highway and other exploratory roads in Brazil has led to the settlement of farmers along every side road. Large ranches are being developed on the Northern and Southern borders such that an estimated 800,000km^2 representing 12% of the total forest area would have been converted to gardens and pastures by the year 2000. And in the event of an accelerated development, the whole of the forest would have been destroyed by the year 2100. This is lent credence to by the fact that on a global scale an estimated $^2/_3$ of the world original forest has been cleared – undergoing several forms of depletion and degradation.

This study will therefore be built around evaluating vegetation degradation on a local scale taking into cognisance the peculiarities of the local environment in which degradation has been taking place.

1.2 PROBLEM STATEMENT

This research work will focus on finding

Solution to the following questions:

(i) Can an actual relationship be drawn between forest degradation in the study area and the prevalent agricultural practise?

(ii) If actaully there is a link, what is the strength of this link?

(iii) What are the materials available for deriving a measurable data and upon what time frame can such measurement be carried out?

(iv) Can remotely sensed data be of any use to this kind of research? If it can, what type of remotely sensed data will be most useful? Where remotely sensed data are not enough to generate the required data, what other methods can be employed to achieve maximum result as to the situation on ground?

This research work is important because it seeks to unveil the salient impacts that the agricultural system of Akamkpa has on the vegetation based on the fact that looking at it peripherally, agriculture seems to have little or no effect on vegetation. At least it ensures that almost all through the year there is some form of plant cover on the ground. But on a closer look from a different perspective, it is evident that some form of harm may be done to vegetation one way or the other. The significance of this research therefore stems from the fact that not just a

theoretical study will be carried out but a practical research using available remotely sensed data to validate the authenticity of derived data.

1.3 AIM AND OBJECTIVES

This research is aimed at using remotely sensed data (imagery) to evaluate the extent of vegetal cover degradation over a period of time as a result of clearing for agricultural purpose.

The specific objectives include:

(i) To examine the components of the people's agricultural system.

(ii) Investigating possible trends in the expansion of agriculture.

(iii) To investigate indigenous efforts towards specie preservation.

(iv) To identify specie of flora that are either endangered or have become extinct as a result of the disappearance of their original habitat – the forest.

(v) To ascertain the reliability of the use of remotely sensed data in monitoring this aspect of environmental change – vegetation degradation.

1.4 LIMITATIONS / JUSTIFICATION

This research will be restricted to making use of available data for necessary analysis, comparisons, and predictions on only the dimension in which agricultural has affected or contributed to vegetation degradation. This is informed by the fact that so many forms of human activities encourage vegetation degradation hence agriculture is singled out. Though seemingly exciting as the research may be, it would be improper to overlook the fact that there will be likely difficulties in data acquisition from various sources especially the required imageries. This is not unconnected to the fact that for many area in the country there are no existing air photos or

satellite imageries, because most state government are not able to afford the cost of obtaining these materials. Where the imageries are available the various government agencies in charge are not willing to release them and when they do, the cost is often prohibitive for the research student to obtain. Equally, the study area is located in the heart of the tropical rainforest, which is characterized by thick vegetation that proves to be inaccessible in most areas. This might be a serious impediment to the ground-truthing exercise.

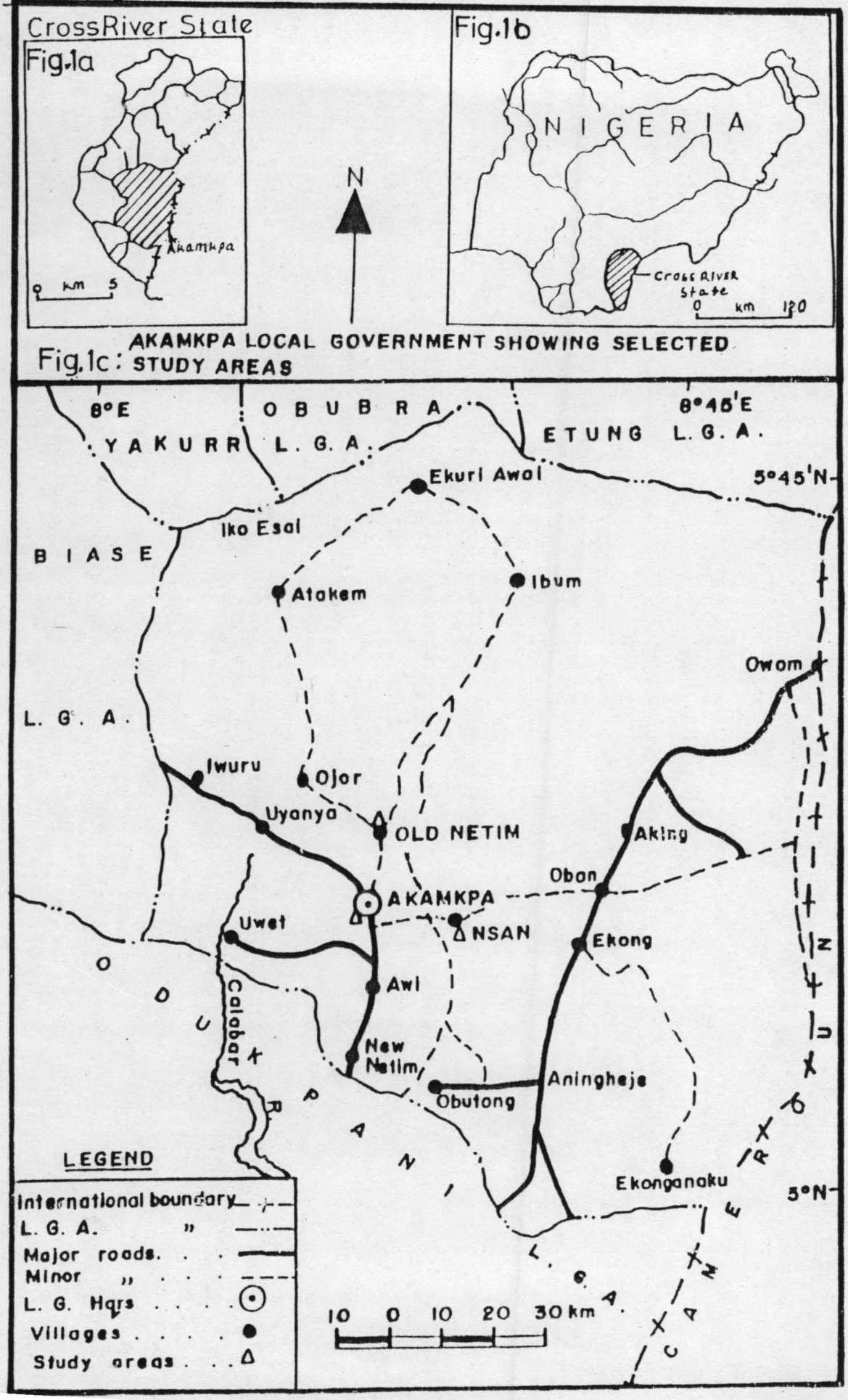
The dearth of information on and proper monitoring of the effects of various forms of human activity in the country on the environment forms a strong basis for the execution of this research. It is important to know that in this era of serious calls for environment – friendly actions that will ensure sustainable development and utilization of environmental resources, one can't but have first – hand information on the impact of activities such as agriculture on the forest so as to know possible areas where mitigating action would be taken.

1.5 STUDY AREA

The area chosen for this study is Akamkpa local government area of Cross River State. This is a State lying in the South-Eastern part of Nigeria along a geographical block popularly referred to in Nigeria as the South-South.

Akamkpa local government is located at the South –Eastern part of Cross River State within longitude 8^0E and $8^0$45'E of the Greenwich meridian and latitude 5^0N and $5^0$45'N of the Equator. It is bounded in the East by the Cameroon Republic, in the West by Biase local government, in the south by Odukpani local government and in the North–East, North–Central and North- West by Etung, Obubra and Yakurr Local Government areas respectively (See fig 1).

Fig. 1 LOCATION OF STUDY AREA.



It is located within the tropical rainforest belt where according to Leong and Adeleke (1978:158), it records an annual rainfall of between 1524 to 2699mm spread almost throughout the entire year with a double maxima in July and September and a mean monthly temperature of 27^0C (80^0F). The main vegetation type is the evergreen forest with diverse specie of flora forming a dense canopy with the characteristic three – layer formation of the trees, while there is little or no undergrowth at the floor except for creepers that use the stems of the trees to access sunlight.

The topography of the area is slightly sloppy with an average relief of 300 – 400 metres above sea level with some rock outcrops rising as high as 500 metres. The soil of the area is slight to moderate humus whose fertility is constantly replenished by litters of leaves and the dead remains of plants.

Occupation in the area is majorly farming due to the large expanse of fertile land available to the populace. However the operation of quarry industries by some firms such as Hitech, crushed rock industry etc., provide a means of employment for a good number of the people especially the youths.

Settlements in Akamkpa take advantage of the major and minor roads running through the area. This concentration of settlement along existing routeways leaves a large expanse of the community land under forest cover and agricultural use.

The economy of Akamkpa revolves mainly around agriculture in its various farms i.e. food crop production, plantations e.g. rubber, gmelina, oil palm, etc. and the activities going on at various quarries located in such communities as old Netim, Nsan, etc. All these serve to provide the necessary income the people require to meet their various needs.

Based on the figures of the 1991 population census, the population of Akamkpa Local Government was 114,924 persons. The Local Government headquarters is located in Akamkpa town, one of the constituent communities of the area.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Singh, Marzoli, Fischer & Drigo defines deforestation as an event in a geographical area associated with a change of land use from forest to non–forest category. This change is evaluated by two possible values of "no change" or "change". It can also be expressed in terms of a complete clearing of tree formations either closed or open and their replacement by non–forest land uses. In the light of this, forest degradation is associated with continuous changes in the state or processes of a forest ecosystem which lowers it's capacity to render productive functions and or environmental services. In some other cases degradation can be seen in the gradual reduction of biomass, changes in specie composition or soil degradation.

Having highlighted the above terms, it is pertinent to recall that as earlier noted the term deforestation and degradation would be used synonymously. This chapter will therefore focus on examining literature on trends in deforestation due to agriculture at both local and international scale and instances where remotely sensed data has been applied in monitoring the areal extent and rate of deforestation.

2.2 TRENDS IN DEFORESTATION

FAO cited in Loetsch & Haller (1964) recognised forest as "all lands bearing a vegetation association dominated by trees of any size, exploited or not, capable of producing wood or other products, of exerting an influence on climate or on the water regime or providing shelter for livestock and wildlife.

According to a report by NEST, Nigeria previously was covered by three major types of vegetation viz.

(a) Tropical rainforest, covering 39% of the southernmost part of the country

(b) Tropical decidous forest, immediately to the North and also covering about 39% of the country

(c) Tropical xerophytic woodland covering the northernmost 22% of the country.

However, human activities such as bush burning, farming, grazing and urbanization over the years have changed this vegetation cover. Fig 2.1a shows the extent of vegetation cover of Nigeria for the period of 1976/78 while Fig 2.1b shows the extent of vegetation cover for the period 1993/95. A comparative look at these two figures shows that there has been an appreciable overall decrease in the areal extent of undisturbed forest from 29,951km^2 to 12,114km^2 and especially in the study area which is encircled. The vegetal resource of Nigeria has been on the decrease while land utilization for other purpose has been on the increase.

Generally, the tropical and sub–tropical rainforest are the most diverse and productive ecosystem which despite its relatively small area provide habitat to 50% of all vertebrates, 60% of non plant specie and about 90% of the worlds total specie (Bisong, 1994). Thus the presence of the tropical rainforest could be seen as having both economical and ecological importance. However, the fast rate at which this 'sea' of floral resource is diminishing is alarming. Bisong (1994) reports that about 200 million hectares of tropical rainforest is cut down annually on the global level. The rate of tropical forest removal since the 1980's is about 1%, for Africa it is about 0.8% while Nigeria is losing 5.2% of forest annually. For Nigeria about 90% of the natural rainforest is already lost. He identified two basic factors that have contributed majorly to this trend as

Fig. 2.1a 1976/78 Vegetation cover

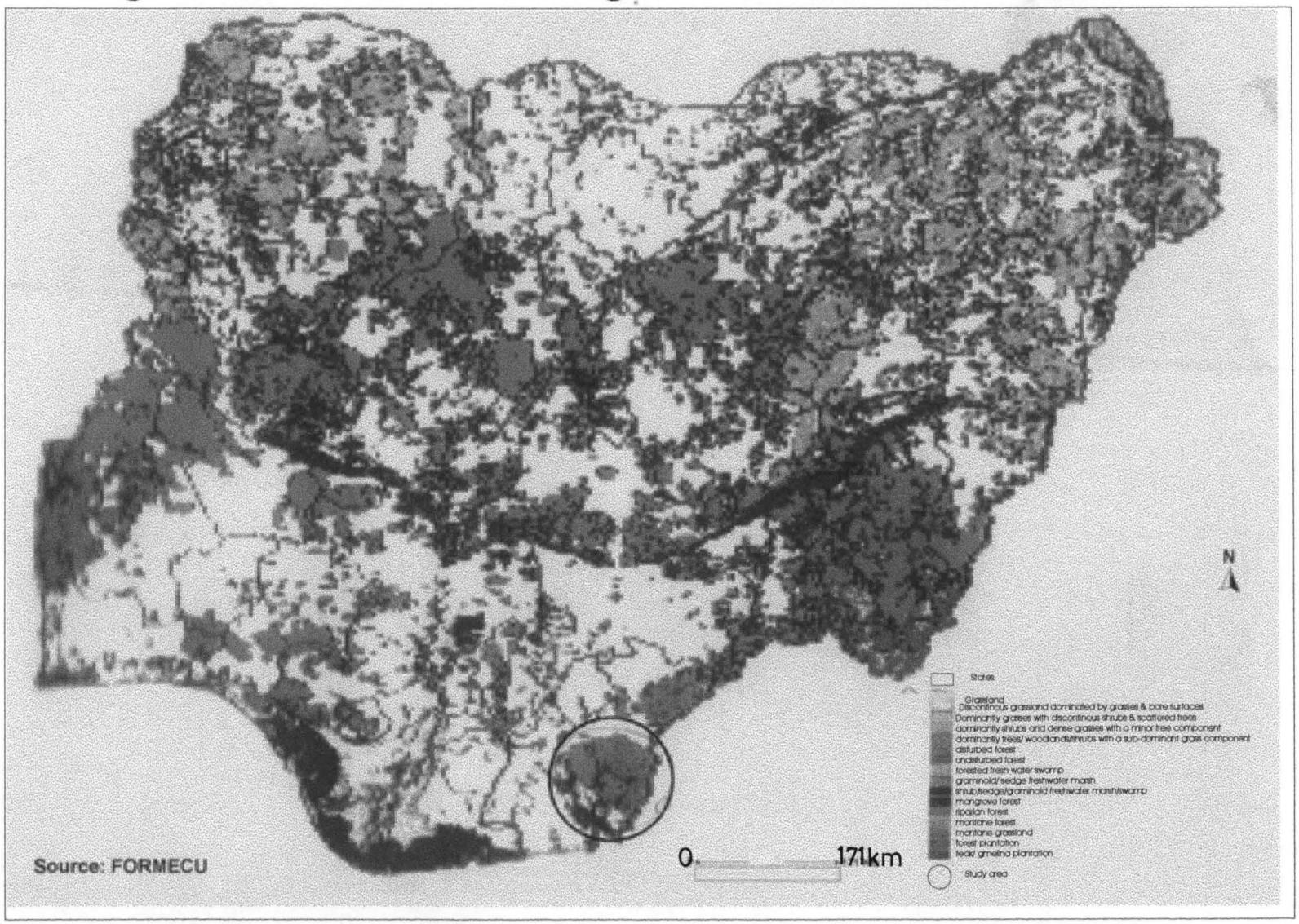
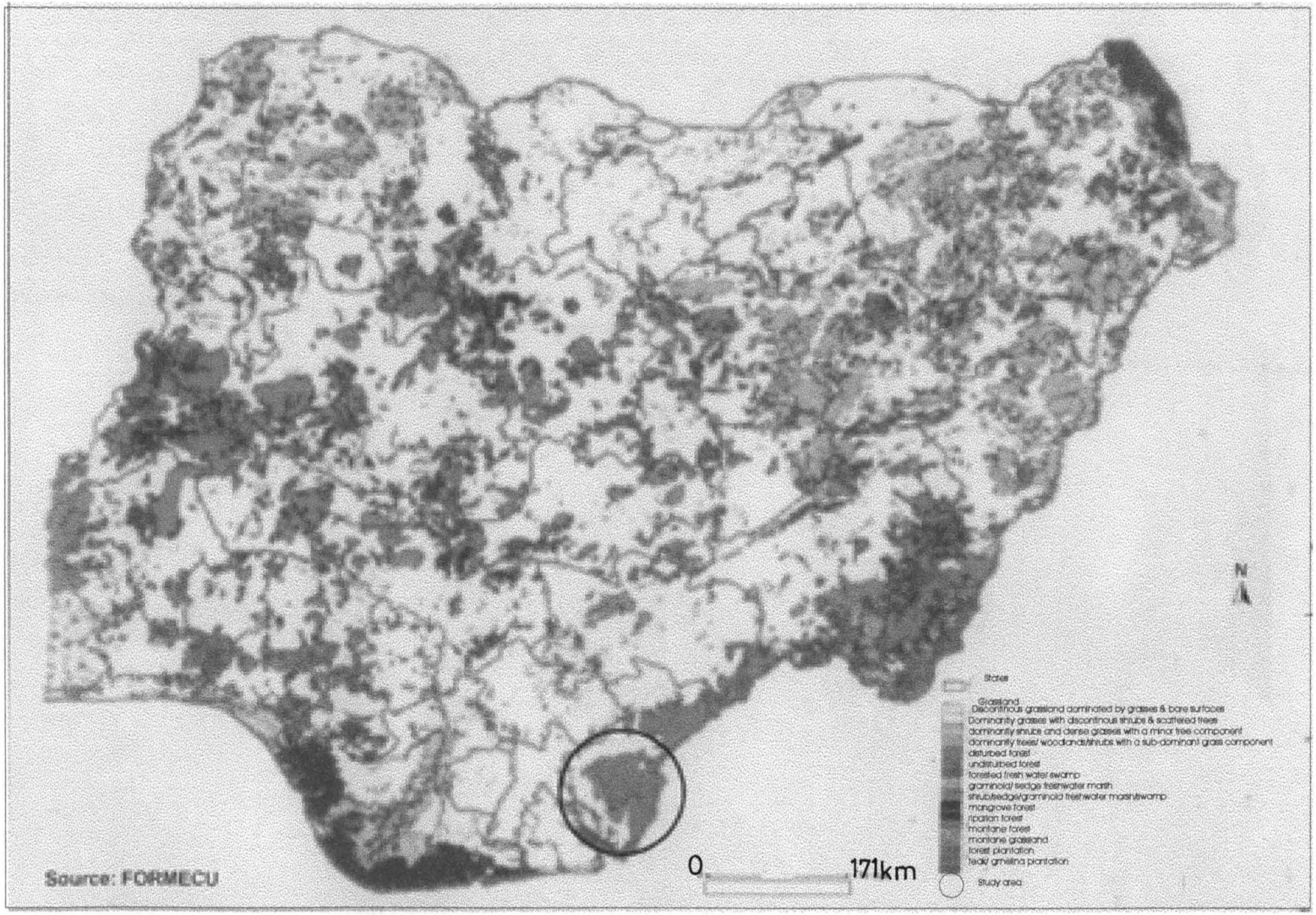


Fig. 2.1b 1993/95 Vegetation cover



(a) Tropical agricultural expansion – identified as the leading factor includes all forms of commercial agriculture and shifting/bush fallow cultivation. Figures 2.2a & 2.2b show intensive agricultural landuse in Nigeria for the period 1976/78 and 1993/95.

(b) Commercial logging

Bisong (1997) argues that the expansion of cash crops and plantation agriculture for exports such as groundnuts, cocoa, cotton, coffee, rubber, etc in many African countries has displaced a sizeable tract of tropical rainforest. He cites an FAO estimate that 50% of recent disappearance of closed forest in Africa can be attributed to conversion to agricultural use. Going by these figures, it is estimated that almost all of the tropical rainforest will be removed by the middle of the next century.

In Nigeria, Cross River State has the largest area of tropical highforest, accounting for about 8,506km^2 of mostly undisturbed virgin forestland – about 2.4% of Nigeria's total land surface (CRSFP 1994 CITED IN Bisong 1999). Of this figure about 29.5% (2,150km^2) is under community ownership hence subject to prevailing use characteristics. Estimate of forest loss in this area stands at 19% and according to a CRSFP estimate cited in Bisong (1999), going by this rate of depletion, the forest reserves would be gone by the year 2014 while other forest will follow suit by the year 2035 AD.

As earlier noted a major cause of the loss of the tropical forest is agriculture (Hadley & Lanley, 1983). Especially of the shifting cultivation type which is estimated to account for 45% of global forest depletion (FAO 1982). According to Hauck (1973) about 36 million km^2 of global area is under shifting cultivation. These include the hill regions of humid tropics in India, highland areas of South America, South Asia, Manchuria, Korea, South West China and Africa (Schlippe 1956; Conklin 1957). In the North East Region of India alone about 0.45 million

FIG. 2.2a 1976 / 1978 INTENSIVE AGRIC. LAND USE

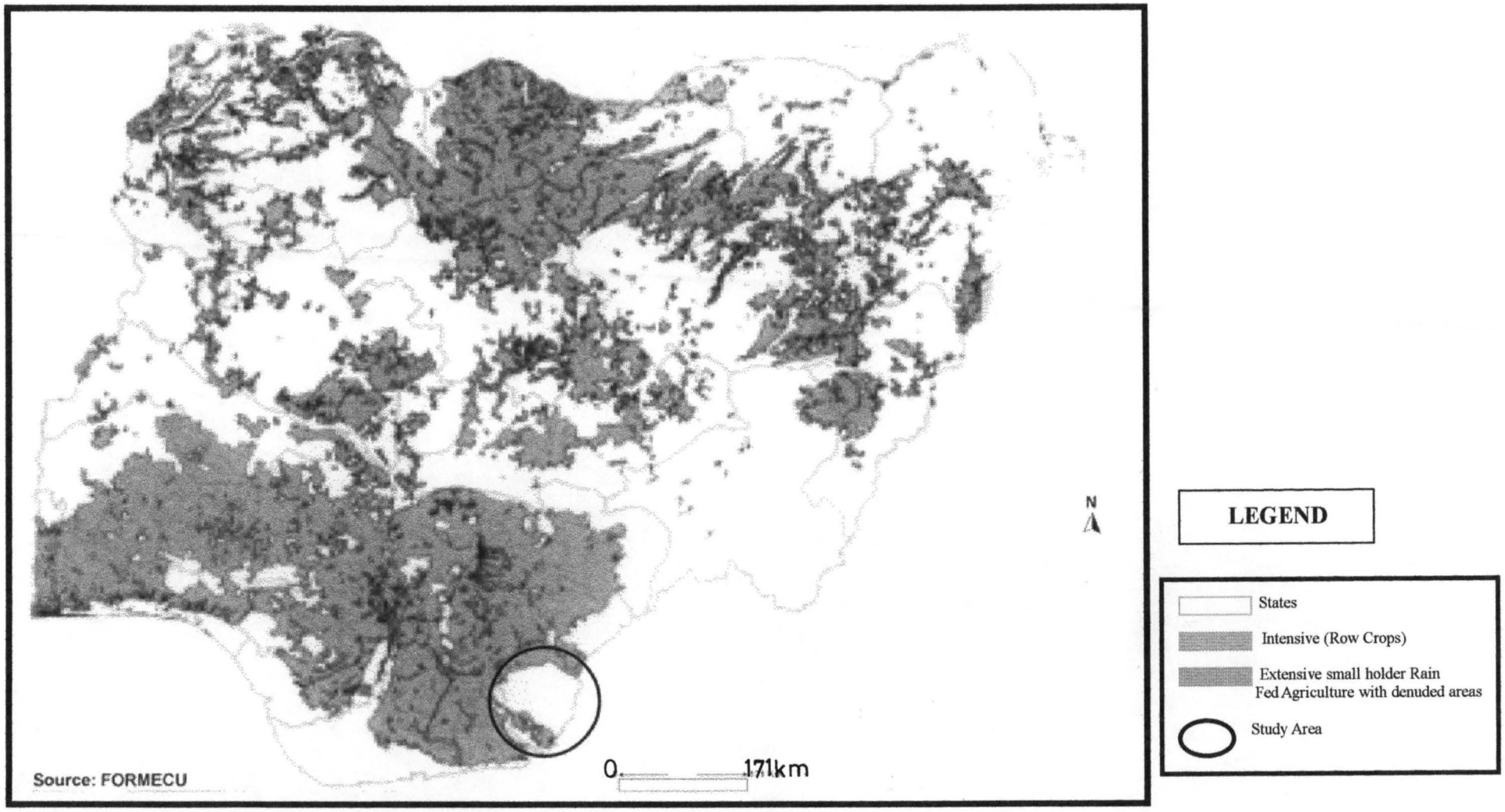
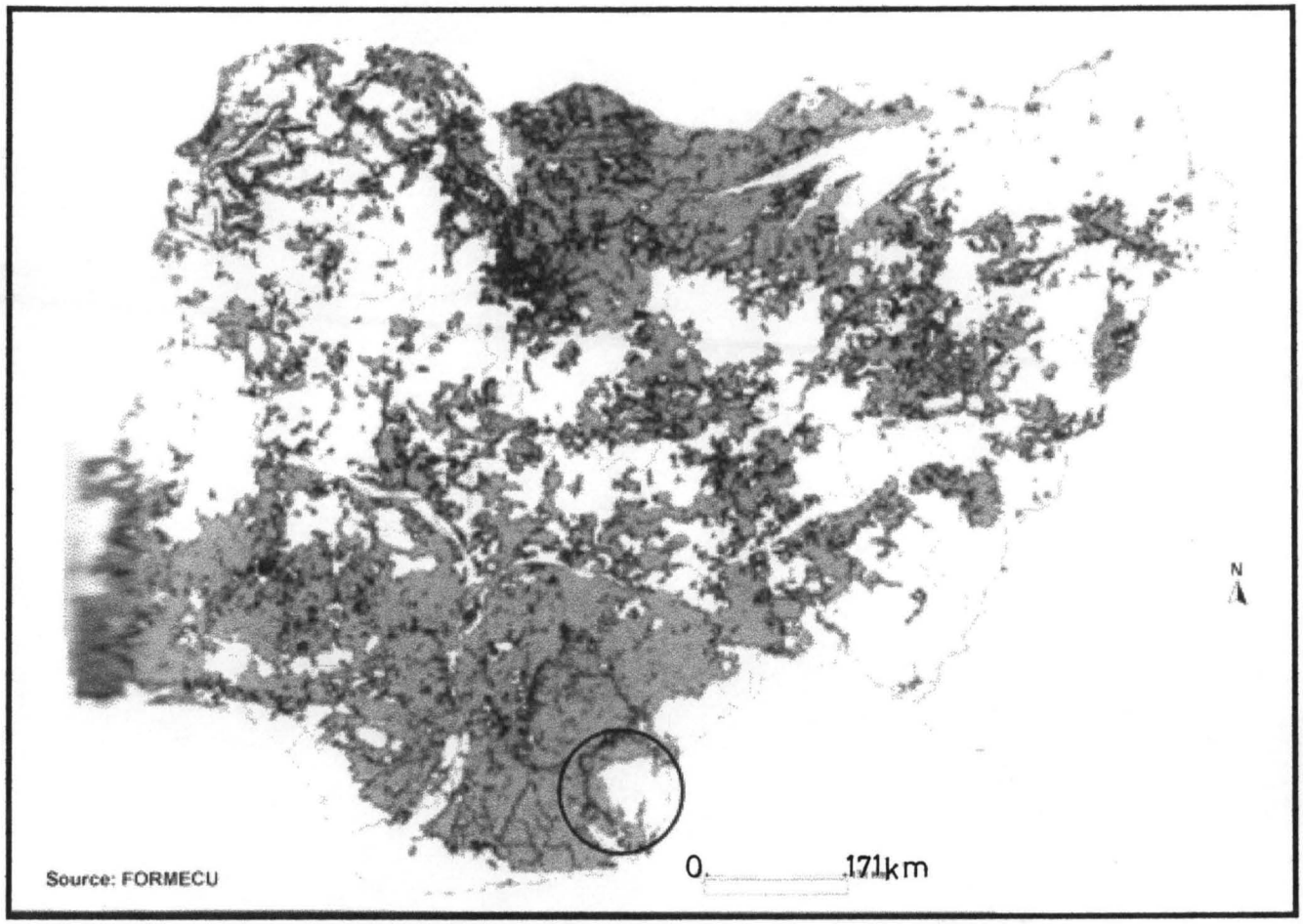


FIG. 2.2b 1993 / 1995 INTENSIVE AGRIC. LAND USE



families annually cultivate 0.49 million hectares of forest land whereas the total area affected by shifting cultivation is 2.695 million hectares.

In all there seems to be an agreement by a good number of authors as to the factor that usually triggers off or rather facilitates deforestation in agriculture. This common factor has been identified as population pressure. Myers (1991) and Ajaegbu (1992(a)) cited in Bisong (1994) opines that forest degradation and biodiversity depletion in the tropics comes in as a response to population pressure with respect to the nature of man – environmental interface. Hauck (1973) argues that under low population pressure, shifting cultivation is an ecologically stable form of agriculture but increase in population changes it from that to a wasteful form of agriculture. This is attributable to the fact that increasing population especially in the peasant subsistence setting means that more forestland has to be cleared in order to increase food production that can support the population. Howard (1991) consents that in the tropics many types of forest cover are now rapidly declining due to mismanagement and the slash–and–burn practices of the increasing human population. In his opinion Lowe (1990:19) cited in Bisong (1994:18) on the role of agriculture in deforestation and biodiversity decline in Nigeria identifies the following factors as being responsible:

(1) increase in area of subsistence farming resulting from the need to feed a growing population

(2) Spread of cash crop by peasant farmers to obtain income e.g. cocoa, rubber, oil palm, cola, etc.

Such cash crops all meant for exports have taken over a substantial amount of the total forest cover in the high zones of Nigeria. Equally downward trend in the nation's economy has also led to the increased cost of foodstuff resulting in what Lowe (ibid.) terms competition of arable

crops for forest lands. Bisong (1999) is of the view that the breakdown of traditional institution via modern state consolidation, opening of the closed traditional economy, high influx of rural–rural and rural–urban migration and a generally expanding population have all combined with the traditional farming method which is slow at production intensification to accelerate resource degradation in sub–saharan Africa. He equally identifies the deliberate state policy of converting reserved forest to government agricultural plantations in state controlled lands in the Cross River State as another major contributor to forest degradation.

From the above paragraph, it is very evident that one factor stands out as a common cause for the fast rate of the depletion of the tropical rainforest, that is population pressure.

So far in this section we have been able to examine trends in tropical forest degradation especially that which is attributable to agriculture, at both the global and local scale. We have picked out a very critical factor associated or rather responsible for this trend which is expansion in peasant practice of shifting cultivation due to population increase. We shall go ahead in the next section to examine certain instances where remotely sensed data has been applied in monitoring vegetal cover degradation.

2.3 APPLICATIONS IN VEGETATION STUDIES

Parker (1962) defines remote sensing "as covering the collection of data about objects which are not in contact with the collecting device". The manual of remote sensing (1983) defines remote sensing as "in the broadest sense, the measurement or acquisition of information of some property of an object or a phenomenon by a recording device that is not in physical or intimate contact with the object or phenomenon under study.

For the purpose of collecting these data, the collecting or recording device is known as sensor, which is usually categorised into airborne and spaceborne, or satellite sensors. The airborne sensors consist of the aerial camera whose types include (i) the single lens frame camera (ii) strip camera (iii) panoramic camera (iv) multilens camera systems and the radar sensors. These sensors are the most useful in vegetation studies, with their aid several works have been carried out in the assessment of change in areal extent of floral cover over various parts of the globe.

Howard (1991) reports that at the international level bodies such as FAO of the United Nations have been interested in appraising global forest resources since 1948. Hence, when the United Nations Environment Programme (UNEP) oriented its global environmental monitoring systems (GEMS) after the 1972 conference on the environment in Stockholm, there was a joint FAO/UNEP world forest resources appraisal in 1981 which for the first time included the use of remotely sensed data. Landsat imagery was visually interpreted to provide information on the forest cover and the forest vegetation types of several African countries that had none or unreliable data. Estimates of forest change for the period 1976 – 80 were made and extrapolated to the end of 1985 for the international year of the forest. Table 2.1 shows the total continental/regional forest cover sub–divided between coniferous and non–coniferous and further between closed and other wooded land.

TABLE 2.1 FOREST AREA OF THE WORLD (1980) DIVIDED REGIONALLY INTO FOUR CLASSES (FAO 1985)

	CONIFEROUS				**NON – CONIFEROUS**			
REGIONS	closed		other wooded land		closed		other wooded land	forest % of land use
World	1,120,805	1,463,562	342,757	4,320,503	1,827,486	2,856,941	1,025,455	32.3
Africa	7,776	13,891	8,115	743,713	228,088	729,822	501,734	24.5
North Central America	312,830	533,075	220,245	807,092	218,794	274,017	55,223	36.6
South America	17,474	20,474	1,000	215,019	647,498	894,545	247,047	51.4
Asia	56,552	102,238	15,688	468,230	275,270	385,992	90,722	18.5
Europe	86,552	97,989	9,576	158,902	48,592	60,913	12,321	30.5
Oceania	12,060	15,995	3,935	295,947	211,344	282,952	71,608	27.9
USSR	593,700	679,900	86,200	928,600	197,900	248,700	50,800	41.5

SOURCE: HOWARD J. A. (1991:9) FOREST AREA (x100ha)

In a country–wide remote sensing survey conducted by the federal department of forest, NEST reports that this study gave a fair picture of the actual cover of the country's 92.4 million hectares of land area by vegetation types and different land uses as indicated by table 2.2.

Table 2.2 LAND USE IN NIGERIA AS DETERMINED BY SIDE–LOOKING AIR–BORNE RADAR (SLAR)

FORMATION	AREA (Ha)	% OF TOTAL
Grassland	12,821,302	14.1
Grassland/Shrubland transition	1,779,382	2.0
Shrubland/Thicket	2,288,311	2.5
Wooded Shrub Grassland/Wooded Transition	23,747,306	26.1
Woodland	4,197,209	4.6
Forest	8,874,255	9.8
Farmland	35,876,552	39.5
Plantations and Agricultural projects	276,500	0.3
Waters, Rivers, Built–up areas	1,024,231	1.1
TOTAL	90,879,048	100

Source: NEST (pp. 137) FAO, Landuse Area data for Nigeria

In another survey or mapping of shifting cultivation in the North East Indian region by the National Remote Sensing Agency in 1977, Kushwaha (1991) reports that using Landsat MSS data and digital classification techniques, shifting cultivation lands were broadly classified into two namely, current and abandoned – the latter being a much generalised class made up of post shifting cultivation forests of varied density, height or age. A further attempt at classifying shifting cultivation lands and secondary forest using both visual and digital (hybrid) techniques was made in Maghalaya State where the spectral

seperability of the different categories facilitated further categorisation of forest into 'Sal (Pure), Sal dominated' and 'degraded types'. However, spectral responses of the pixel representing a class varied widely thus making the per–pixel classification algorithms or hybrid interpretation techniques ineffective beyond certain level, hence creating the need for considering spatial information contents of the satellite data also in order to achieve higher classification standards. To this end a software program using first order statistical attributes (standard deviation and mean) to utilize contextual information of Landsat MSS data and a texture image was generated which facilitated the differentiation of younger vegetation from the older ones.

Muka, Nakayama & Maeda (1991) in their study on change detection of vegetated areas in Kanchanaburi neighbourhood in Thailand using two multitemporal and multi sensor data of pathrow 30 – 50 Landsat MSS of December 31 1984 and pathrow 43 – 99 MOS–1 MESSR of January 20 1989. They were able to register Landsat MSS image to MOS–1 MESSR image after extracting the test area from both original images. The Normal vegetation index (NVI) of the test site was generated from Landsat MSS by the equation

They went further to produce a scaled NVI image from the NVI image using the equation below

$$NVI = \frac{MSS7 - MSS5}{MSS7 + MSS5}$$

Scaled NVI $= \alpha x NVI + \beta$

Where $\alpha = 370$, $\beta = 22.2$

Two land cover classification were produced of the test site for 1984 by level slicing of the scaled NVI image from Landsat mss and for 1989 using the supervised maximum likelihood classification method using MOS–1 MESSR image. Table 2c shows the changed patters and their areas from 1984 – 89.

TABLE 2c

No	Change Pattern	Area
1	Grass → Bare soil	167km^2
2	Forest → Bare soil	28 km^2
3	Forest → Grass, Bush	33 km^2
	Total Area	228 km^2
Ratio of Changed Area (%)		9.12%
Ratio of Deforested Area (%)		2.44%

In a study of the upper catchment area of the Mazoe valley Rhodesia, (now Zimbabwe), Whitlow (1974) used vertical black and white aerial photographs of scale 1:25,000 to identify and delimit vegetation units based on most appearance and structure as it is visible on the aerial photographs (Photo – physiognomy). He was able to classify vegetation units identified on the photograph by grouping similar units together using the method adopted by Poore (1955) where photo – physiognomy differences between vegetation classes exceed those within a vegetation class. Thus he differentiated seven vegetation categories viz.

(1) Riverine forest (2) Closed woodland (3) Woodland (4) Open woodland and or Bush Scrub (5) Grassland with occasional trees (6) Grassland (7) Cultivated land.

There was a time lapse of 5 years between the period of photography (June 1967) and the mapping and field checking (1972) which provided a good indices for evaluating apparent change in the nature of vegetation as it was discovered that previously wooded areas had been subjected to clearance, burning and subsequent regeneration of the vegetation.

Kushwaha (1991) reports that recent studies have been carried out on secondary forest delineation using Landsat Thematic Mapper false colour imagery with results showing that

medium resolution data were useful in accessing forest degradation to a limited extent. Other recent studies suggest annual monitoring of shifting cultivated lands for change detection. However, Singh (1987) in his study on the spectral seperability of tropical forest cover of Northeast India observed that it was difficult separating the secondary forests from open forests or grassland. Kushwaha therefore suggest that more work on complete differentiation mapping and monitoring of shifting cultivation and secondary forests in the area of using higher resolution satellite data and in the interpretation and classification approaches. This he expects to be done using IRS Satellite with a 10metre resolution and stereo viewing capability. He also suggests the need for discrete spectral resolution in order to differentiate smaller species association qualitatively and quantitatively. The fact that the textural properties of data seen to have useful information for discriminating purpose implies the need to develop features for texture since a texture image could be used directly for visual interpretation or in combination with other bands for classification using any existing classification algorithms. There is however a difficulty in ascertaining textures features or a combination of features that may be useful.

Skole and Tucker (1994) carried out a study on deforestation and habitat fragmentation in the Amazon using Landsat satellite imagery from 1978 to 1988. The images totaling 210 on a scale of 1:500,000 covered the entire forested portion of the Brazilian Amazon Basin and was used to measure deforestation, fragmented forest and edge effects into forest from adjacent areas of deforestation. A geographic information system (GIS) was used to create a computerised map of deforestation and evaluate it's effect on forest fragmentation and habitat degradation. They went further to digitize deforested areas into the GIS and the forest fragments and edge effects that result from spatial pattern of forest conversion were determined. Through this they were able to ascertain that tropical deforestation increased from 78,000km^2 in 1978 to 230,000km^2 in 1988 while tropical forest

habitat, severely affected with respect to biological diversity depletion increased from 208,000km^2 to 588,000km^2.

In a NIRAD project interpretation and mapping of vegetation in Nigeria using SLAR Imagery at a scale of 1:100,000 of the Benin area including the Sapoba forest reserves, it was discovered that four vegetation units dominate the area namely:

1) Logged high forest (mature forest)
2) Areas of small holder rubber forest
3) Farmland under the Taungya system
4) Raffia palm

These demarcations were made based on the spectral signature or reflectance characteristics produced by these classes through their tones and textures. Areas of mature forest had a relatively coarse texture and tone as different from the image characteristics of a light grey tone on the images. This was attributed to the fact that the images were acquired during the dry season period when the rubber trees were leafless. Thus creating room for increased microwave penetration and reflection from the ground flora and tree branches. Equally the radar signature of regenerated vegetation was found to be darker than that for fresh clearings making distinction between clearings of different ages possible. The tonal and textural differences in these images were used in digital discrimination and quantification of data.

Adefolalu (1986) used Landsat data combined with data from SLAR and ground – truth method using the four-pixel quadrant method to map out land use (vegetation) situation in West Africa with special emphasis on Nigeria. He distinguished 5 major vegetation cover viz. grassy/woodland, Shrubland, farmland, forest and bare ground. He noted that Borno and Sokoto States located near the desert are facing the harsh effects of desertification where the arable land has been decimated to 19.29% and 41.89% respectively, grassland and Shrubland

were 59.97% and 38.35% respectively. He went ahead to forecast that Kano and Kaduna States using a higher percentage of their land for intensive agriculture would have their arable land turned into Shrubland and Sahel proper by 1991 – 2000.

Bisong (1994) in an assessment of deforestation rate in the Cross River State rainforest of Nigeria used aerial photographs of 1972 and 1991 to deduce that significant changes has taken place in the areal extent of original as compared to fallow, forest and cultivated land which invariably has led to a decline in forest cover and inverse increase in fallow and cultivated plots of land. He was able to deduce that about 15.874km^2 of forest is lost annually in the study area. Based on his air photo analysis he concluded that aerial photograph analysis could be said to proceed along 3 major trajectory viz.:

(1) Deforestation is higher in forest reserved areas as this becomes ready sites for the establishment and development of government agricultural plantation and projects.

(2) The population size of settlements is found to be positively related to the size of forest cover loss around settlements. Population size however does not affect the rate of change or magnitude in the loss of forest cover.

(3) Agricultural land use characteristics evidenced by the crop and fallow areas are found to be positively related to the rate of deforestation.

So far this chapter has been trying to take a look at previous works done both in evaluating vegetation degradation and using remote sensing techniques to ascertain areal extent of degradation through comparative analysis, delineating and demarcation hence subsequent classification of vegetation types according to their various stages of degradation or regeneration. There have also been efforts by some of the authorities to make probable futuristic predictions as to what the situation would be like if the present trend and rate of forest degradation due to agricultural expansion persists. This present study would more or less tow the same line that previous researches in this area has gone especially as it pertains

to the basic tools such as imageries and techniques applied in their interpretation and analysis. However, a deviation from the normal would be in the area of application of the ground truthing method which is aimed at enabling the research obtain first hand information on what actually is obtainable on the ground especially through the use of indigenous knowledge in eliciting information which may not necessarily be easily deduced from the imageries. To this end the participatory rural appraisal (PRA) system of research would be used to complement information from the available remotely sensed data.

CHAPTER THREE

METHODOLOGY

For the purpose of efficiently carrying out this research, the following method covering both the data collection and analysis stage is used.

3.1 SAMPLING UNIT/SIZE/PROCEDURE.

The study area delineated covered a total of 420.42km^2, which is just a part of the entire Akamkpa local government area. Using the simple random sampling method, three settlement communities within the delineated study area namely; Akamkpa, Old Netim and Nsan were selected. The choice of this technique is hinged on the fact that any other technique may have ended up selecting areas too wide apart from each other thus increasing both time of accessibility and cost.

Based on the fact that the random sampling technique eliminates bias or prejudice by removing the personal behaviour or idea of the investigator, the random systematic sample system using age as a criterion was adopted in administering questionnaires to 150 persons in the three communities. Age range of respondents was between 21-60 years and above. By reason of variations in the settlement sizes, the questionnaires were issued as follows; Akamkpa-70, Old Netim-50 and Nsan-30.

3.2 SOURCES OF DATA AND MATERIALS

Primary and secondary data were sought for and obtained for this research. The primary data source consisted of information obtained from respondents through the use of questionnaires, oral interview method otherwise known as the participatory rural appraisal (PRA) research method and from direct observations. While the secondary source consists of

information pertaining to the study as drawn from the works of other authors of both published and unpublished materials such as textbooks, magazines, journals, articles etc. Materials required for this research that formed the vital research instrument include;

3.2.1 QUESTIONNAIRE

The unmailed questionnaire designed to establish contact with respondents contained 29 questions majorly of the close ended type with multiple choice answers and some open-ended type giving the respondent freedom to express his/her views was used. The close ended questions were meant to aid the respondent eliminate his/her own bias. The first part of the questionnaire comprising of questions 1-6 aims at locating the respondent. The second part of questions 7-13 is on farming practices, part three of questions14-21 deals with the nature and status of land resources while part four of questions 22-29 seeks to discover the nature and status of vegetal resources. (See appendix 1).

3.2.2 PERSONAL INTERVIEW

As earlier mentioned this method is also known as the participatory rural appraisal system meant to elicit oral information from individuals, community leaders and farmers involved in agriculture. A major highlight of this method is the focus group discussion (FGD). Based on this a checklist was drawn to investigate on farming system, land resources, vegetation resources including extinct/ endangered specie, indigenous efforts at specie conservation etc (see appendix II).

3.2.3 MEASUREMENT/OBSERVATION

This involved the use of materials such as air photographs, base topographic maps and observation made during transect walk to the forest for ground –truthing some of which were

recorded on camera. Infra – red aerial photographs obtained were for 1972 on a scale of 1:40,000 and those for 1991 on a scale of 1:33,000. A base map of Uwet North – East for 1967 was also used as a check in confirming information on the air photo. The study therefore covers a period of 19 years in between the two air photograph. These materials were obtained from the cartography section of the Cross River State forestry project.

3.3 METHOD OF DATA ANALYSIS

Data obtained for this research were discrete in nature and were analysed using descriptive statistics of tables, charts and simple percentages. Equally calculations to determine extent of change in the demarcated vegetation classes were made to ascertain the extent of vegetation degradation.

3.4 METHOD OF AERIAL PHOTO INTEPRETATION

The choice of aerial photographs as the remotely sensed data for this research stems from the fact that it is the data available for the area as at the time of this study. Equally the high cost of obtaining satellite imagery and their scarcity leaves this research with no option than using what is readily available.

However, the use of air photographs sufficiently serve the purpose for as Coombe (1977) observes, air photograph is an indispensable aid in providing information on the vegetal cover of the earth. This is in the light of the increased awareness of the fragile expendable and diminishing nature of world vegetation. He goes on to highlight some advantages of air photography for vegetation mapping to include avoidance of damage to fragile vegetation and provision of visual record of areas difficult to access, it can also highlight the causes of patterns in vegetation distribution. This assertion is backed up by the encyclopedia of science and technology, which describes photography as the most useful

remote sensing system because it has the greatest number of applications including vegetation extent study.

As stated ealier photographs used for this research were those of 1972 and 1991 for Calabar.For 1972 photo numbers 145-148 of flight run 20 and numbers 100-102 of flight run 21 were used, while for 1991, numbers 72-75 of flight run 14 and numbers 101 -10 4 of run 15 were used. The flight line of the 1972 photographs ran from East to West while that of 1991 ran from South to North. In order to interprete them, they were first oriented so that the flight line and the north direction could be ascertained. The study area of Akamkpa was identified on the photograph using a chart supplied by the Cross River state forestry, which depicted towns, covered by the air photos and the photo strip and image number along such strip. A base map of Uwet North-East was then used to compare features identified on the map and those on the photograph. Features on the map having similar shape were used as principal points on the photos. In this case the plantations at the West and South-Western part of the 1972 air photo was reconciled to that on the base map.

This was followed by a stereoscopic annotation such that a photo mosaic was created using the semi-controlled mosaic system to form a composite view of the area covered by the photographs. The visual analysis method of interpretation was then used to identify and delineate features on the photograph; a mirror stereoscope aided the actualization of this process. Subsequently a transparency overlay (tracing paper) was placed on the photographs through which features delineated were traced out on the tracing paper. Through this vegetation maps were produced.

3.5 PRINCIPLES AND ELEMENTS OF PHOTO INTERPRETATION

Adegbola (1997) identifies the following principles as governing the Interpretation of images on a photograph.

Sensor image is a pictorial representation of the landscape.

Image is made of patterns, indicators of things that show physical, sociological and cultural components of landscape.

Similar patterns in similar environment reflect similar conditions and vice versa.

The quality and quantity of information derivable is a function of the knowledge, skill, experience and motivation of the interpreter, efficiency of methods and ability to know limitations imposed on the analyst by the sensor system, data format and analytical method

For the purpose of recognizing, differentiating and quantifying objects on the image, the following characteristics are necessary;

Texture: This is an expression of the visual impression of roughness or smoothness of photo objects. It results from tonal representation of objects in groups usually too small to be differentiated individually.

Pattern: This is the arrangement of objects as they occur on the photograph and can be equated to the spatial arrangement of objects in a group..

Size: This depicts the length, breadth, area and volume of an object. It is useful in differentiating items in the same class.

Shape: This is indicative of the form, configuration or outline of an individual object.

Site: This is an important tool in manipulating and identifying an object as it shows the location of an object in relation to other features.

Association: The presence of certain objects or features invariably means or confirm the presence of some other features that is associated to it.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF RESULTS

4.1 INTRODUCTION

In its original state, the typical tropical rainforest is characterised by a three-layer vegetation formation whose crown cover renders the penetration of sunlight to the ground storey or floor impossible. There is equally an abundant supply of creepers hanging on the various trees in the forest and using them to get to the top where they have access to sunlight. These creepers make penetration or access into the forest a very difficult task. Plates 4.1a, b & c shows the typical state of a virgin tropical rainforest as observed during a transect walk to the forest at Nsan.

However for most places in Akamkpa this ideal situation is either completely absent or fast depreciating. The vegetation cover has seriously undergone a very appreciable change that is quite alarming especially in the light of the fast rate of disappearance of the diverse specie of flora and fauna in the forest.

This chapter will now go ahead to make some analysis on the air photographs interpreted for this research work and report on other investigations made in the field.

4.2 COMAPARATIVE ANALYSIS OF 1972 AND 1991 AIR PHOTOS

In order to carry out a successful analysis of the air photographs, the vegetation of the study area was first classified using a modified version of Bisong (1999) vegetation and land use classification criteria which identified four landuse and vegetation classes. Two more classes (plantation and quarry) were added to this classification scheme as shown in table 4.1.

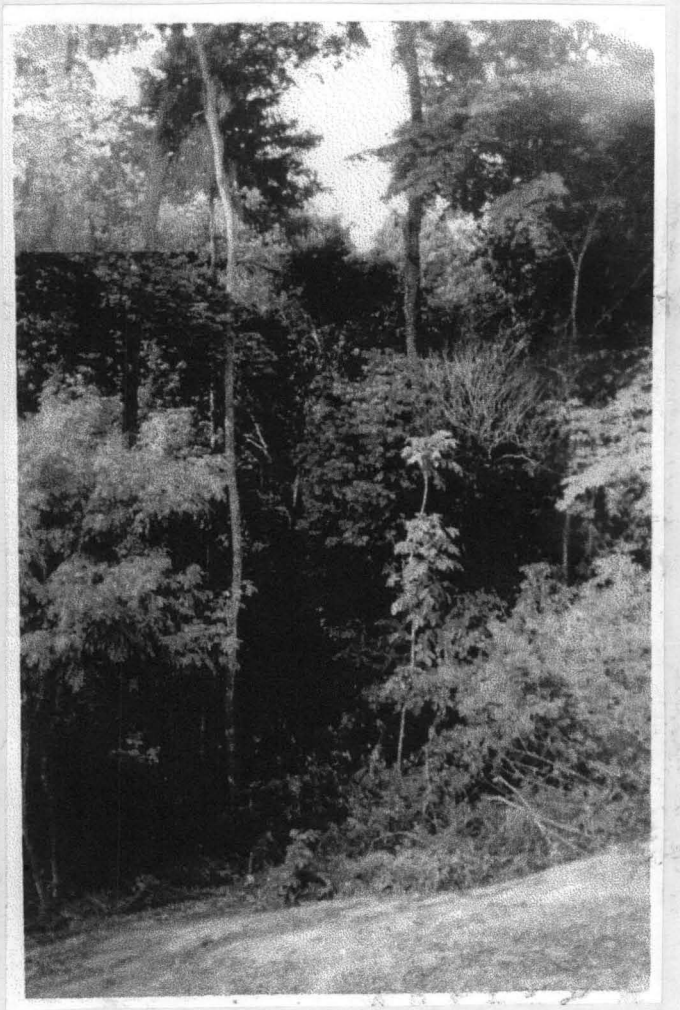


Plate4.1a: A typical virgin forest in Nsan.This forest encloses a rock outcrop which is being opened up presently for exploitation by construction industries. Note the zero penetration of sunlight into the forest.

SOURCE: Field work by Author (2001).

Plate 4.1b: Another section of a virgin forest in Nsan The road in the foreground is an access road being opened to the rock quarry in (a) above. SOURCE: Field work by Author (2001).

Plate 4.1c. Another section of virgin forest jn Nsan. Note the cluster of creepers which use the big trees to make their way to the top for exposure to sun light.

SOURCE:Field work by Author (2001).

TABLE 4.1 VEGETATION AND LANDUSE CLASSIFICATION

VEGETATION/LANDUSE CHARACTERISTICS	DELINEATION CRITERIA BASED ON EXTENT OF TREE COVER (%)
Woodland/farms/settlement/fallow	20 – 40 %
Dense Woodland	40 – 80%
Disturbed forest	80%
High forest (closed canopy)	100%
Quarry	0%
Plantation	Areas with regular features

SOURCE: Modified after Bisong 1999: 244

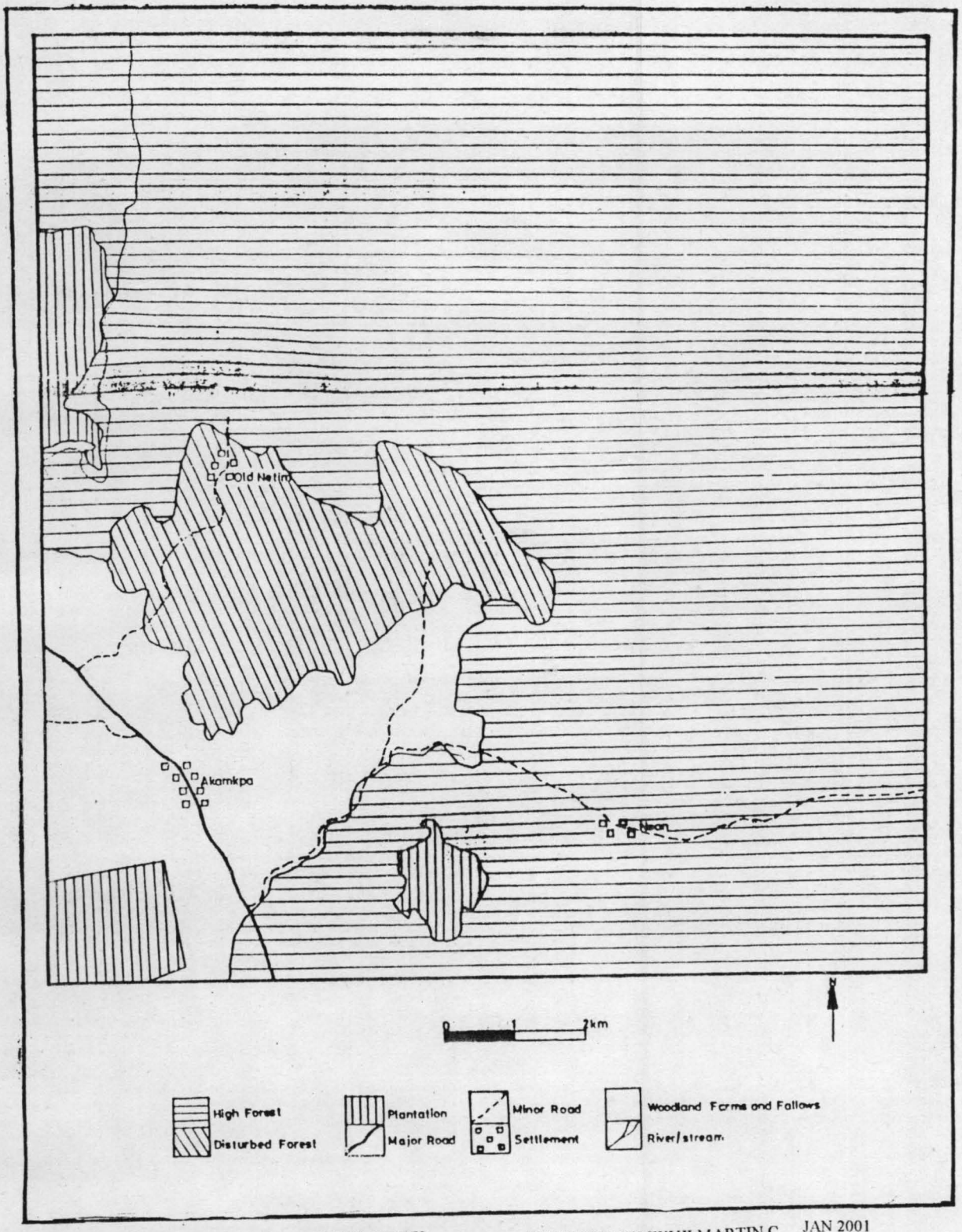
The part of Akamkpa local government under study covers a total of 420.42km^2. Fig 4.1 and 4.2 are vegetation maps of Akamkpa delineating the study area and showing the various classes of vegetation cover and land use as interpreted from the aerial photographs of 1972 and 1991 respectively. From these maps the vegetation cover extent of the study area is given below in table 4.2.

TABLE 4.2 VEGETATION/LANDUSE EXTENT

VEGETATION CLASS	1972 (Ha)	1991 (Ha)
Quarry	0	363
Woodland/farm/settlement/fallow	4,680	17,721
Dense woodland	3,680	5,907
Disturbed forest	0	2,904
High forest	32,000	11,121
Plantation	1,680	4,026
TOTAL	42,040	42,042

SOURCE: Air photo interpretation by author (2001)

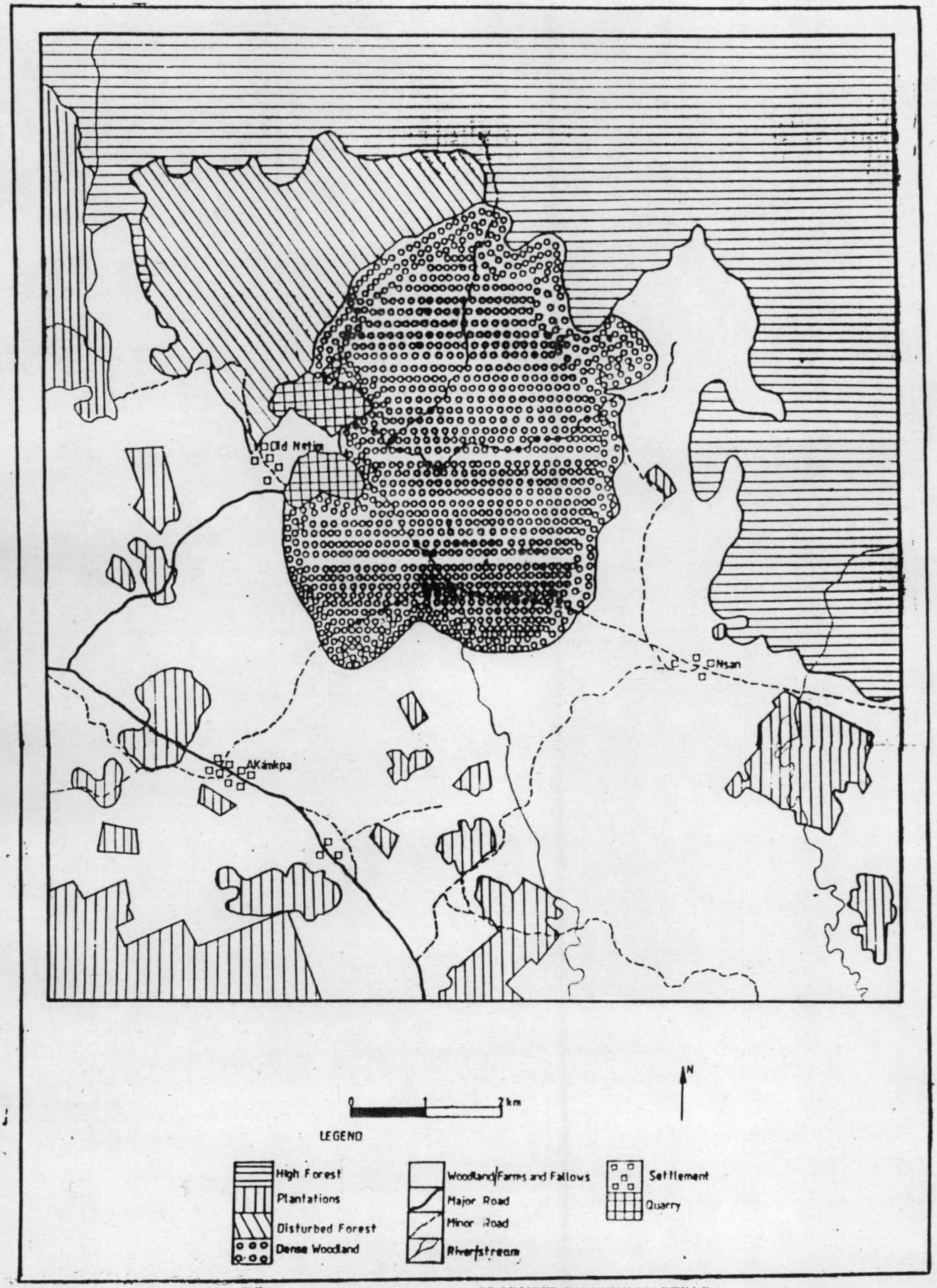
Fig 4.1 VEGETATION COVER MAP OF AKAMKPA L.G.A. SHOWING THE STUDY AREAS OF AKAMKPA, OLD NETIM AND NSAN



SOURCE: INFRARED AERIAL PHOTOGRAPH OF 1972

PRODUCED BY IWUJI MARTIN C. JAN 2001

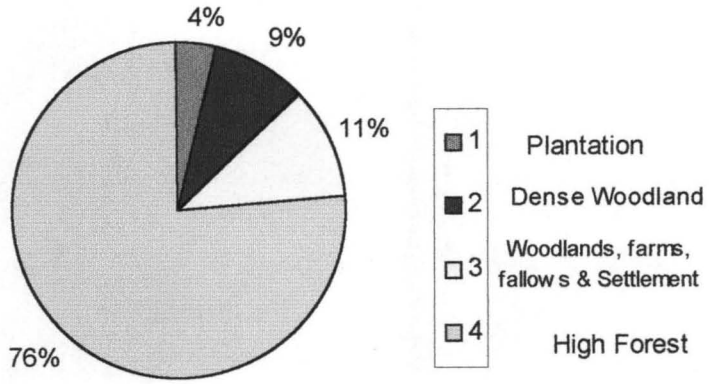
FIG 4.2 VEGETATION COVER MAP OF AKAMKPA L.G.A. SHOWING THE STUDY AREAS OF AKAMKPA, OLD NETIM AND NSAN



SOURCE: INFRARED AERIAL PHOTOGRAPH OF 1991 PRODUCED BY IWUJI MARTIN C. JAN 2001

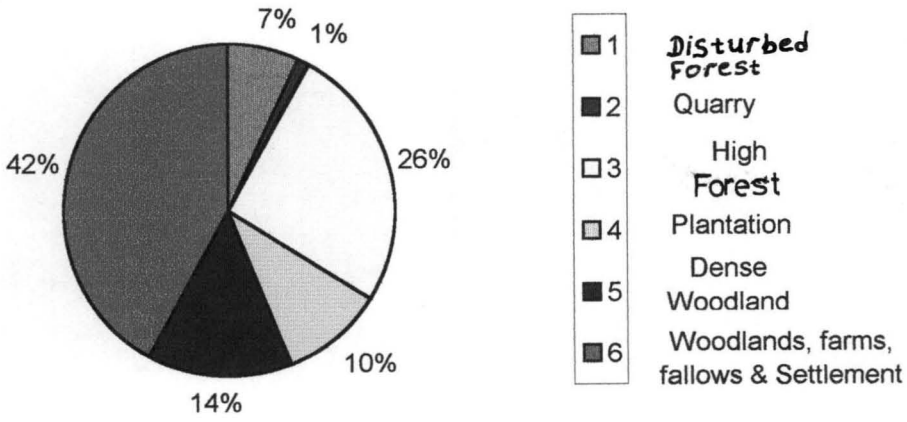
A look at this raw data simply shows that while there has been an increase in other forms of land use and vegetation class between 1972 and 1991 there has been a considerable decrease in the areal extent of high forest with closed canopy. Detailed calculations of these figures are given in appendix 3. Fig. 4.3 is a pie chart showing the vegetation cover distribution pattern for the area in 1972 while fig. 4.4 is a pie chart showing same for 1991.

Fig. 4.3: VEGETATION/LAND COVER DISTRIBUTION FOR 1972



Source: Fieldwork by Author (2001)

Fig. 4.4: VEGETATION/LAND COVER DISTRIBUTION FOR 1991



Source: Fieldwork by Author (2001)

Table 4.3 shows the percentage magnitude of overall change in vegetation distribution in the study area.

TABLE 4.3 PERCENTAGE MAGNITUDE OF VEGETATION CHANGE

VEGETATION/ LAND CLASS	A 1972 Area in Hectares	B 1991 Area in Hectares	C Magnitude of change (Ha) (B – A = C)	Percentage change (100 – C/Total)	Direction of change
Quarry	0	363	363	0.87	+
$W/f_1/s/f_2$	4,680	17,721	13,041	31.23	+
Dense woodland	3,680	5,907	2,227	5.33	+
Disturbed forest	0	2,904	2,904	6.96	+
High forest	32,000	11,121	20,879	50.00	-
Plantation	1,680	4,026	2,346	5.62	+
TOTAL	42,042	42,042	41,760	100.0	

Data Source: Fieldwork by Author (2001)

Table 4.4 goes on to show the percentage distribution of each vegetation/land class and the percentage magnitude of change.

TABLE 4.4 PERCENTAGE DISTRIBUTION AND MAGNITUDE OF CHANGE

VEGETATION/ LAND CLASS	1972 % Distribution	1991% Distribution	Percentage change (100 x C/CTotal)	Direction of change
Quarry	0.00	0.86	0.87	+
$W/f_1/s/f_2$	11.13	42.15	31.23	+
Dense woodland	8.75	14.05	5.33	+
Disturbed forest	0.00	6.91	6.96	+
High forest	76.12	26.45	50.00	-
Plantation	3.99	9.58	5.62	+
TOTAL	100.0	100.0	100.0	

Data Source: Fieldwork by Author (2001)

From the above calculations, it is very obvious that over the years there has been a steady decline in vegetal cover distribution in Akamkpa especially of the high forest (virgin) type while other forms of vegetation/land use type have been on the increase. Table 4.5 shows the average annual rate of change expressed in hectares of the various vegetation classes over the 19 years period.

TABLE 4.5 AVERAGE ANNUAL CHANGE RATE FOR VEGETATION

VEGETATION/ LAND CLASS	Average Annual Rate of Change
Quarry	19.11 ha
$W/f_1/s/f_2$	686.37 ha
Dense woodland	117.21 ha
Disturbed forest	152.84 ha
High forest	1098.9 ha
Plantation	123.47 ha

Data Source: Fieldwork by Author (2001)

* * *

W – Woodland S – Settlement

F_1 – Farm F_2 – Fallow

It is very obvious that woodland, farms, settlement and fallow class of vegetation cover has witnessed the highest amount of positive change having an annual gain of 686.37 hectares. Going by this it is quite agreeable that all things being equal and if the rate of deforestation in the study area is maintained, the remaining 11,121 hectares of virgin forest would be gone in the next 11 years except some measures are taken to put a check to uncontrolled clearing of virgin forest.

4.3 FARMING SYSTEM AND LAND ACQUISITION/TENURE IN AKAMKPA

The dominant farming system in Akamkpa is the slash and burn method of shifting cultivation (rotational bush fallow) where a plot of land is cultivated for an average of two farming seasons and abandoned to fallow for at least four years. The period of rest for the land depends on the quantity of land available to the farmer. This system of shifting cultivation has metamorphosed into what can be presently called rotational bush fallow as a result of the growing demand for food due to increasing human population that needs to be fed. In Akamkpa this system entails the clearing of the forest and felling of trees. At times fire is set around the base of the tree and it is left to shed its leaves before it is cut down and used as firewood. Basically before fire is set on a piece of cleared farm the vegetation is left to dry and then lopped together so that a clear demarcation is made between the cleared plot and surrounding forest to avoid incursion of fire into standing forest.

Despite the 1978-land use act, which vested right of ownership of land upon the state government, land is held in custody in the area by the community, which is ruled by a clan head and the council of chiefs. However the right of acquisition of farmland is vested on individuals depending on their ability to clear virgin forest. Hence except for farmland acquired through inheritance most other land acquisition by indigenes is through clearing of virgin forest while the non–indigenes either purchase or acquire land through leasing. Based on the status significance of land in the area, individuals embark on indiscriminate clearing of forest to increase their number of plots and to leave behind an inheritance for their children. Table 4.6a and b show a summary of the response obtained from respondents from the sampled settlements on land tenure and acquisition respectively in the community.

TABLE 4.6a: LAND TENURE SYSTEM

OPTIONS	RESPONSE	%
Private ownership	79	52.6
Communal ownership	18	12.0
Family ownership	52	34.6
Others	1	0.6
TOTAL	150	100

Data Source: Field work by Author (2001)

TABLE 4.6b: LAND ACQUISITION SYSTEM

OPTIONS	RESPONSE	%
Inheritance	53	35.5
Purchase	20	13.3
Clearing of original forest	67	44.6
Leasing	3	2.0
Communal/Government Allocation	7	4.6
Others	0	0.0
TOTAL	150	100

Data Source: Field work by Author (2001)

From the above tables private and family ownership are the most common land tenure system while inheritance and clearing of virgin forest are the most common land acquisition system.

Table 4.8 is a summary of the trend in farmland expansion over the 25 years period.

TABLE 4.8: EXPANSION TREND IN FARMLAND

NUMBER OF FARMPLOTS	1975		2000	
	NO. OF RESP.	%	NO. OF RESP.	%
1 – 3	99	66	6	4.0
4 – 6	43	28.6	79	52.6
7 – 9	8	5.3	52	34.6
10 – 12	0	0.0	13	8.6
	150	100	150	100

Data Source: Field work by Author (2001)

Prominent among agricultural practices that have impacted the trend in vegetal decline is crop production and the increasing venture into plantation agriculture. In some cases of crop production farmers embark on clear cutting of the forest such that no trees are left standing. Reasons for this practice include allowing sunlight to reach the soil and young plants and for proper ventilation in the farms. Plate 4.2 shows a farm in Akamkpa settlement. Note that for such crops like vegetables (waterleaf in the right background), no trees are left to stand in the farm. Expansion in plantation agriculture obviously due to economic reasons has seriously affected the forest cover of the area. A look at fig 4.1 and 4.2 reveals that over the years so many plantations by government and individual farmers who have gone into cultivation of oil palm, rubber, gmelina and cocoa have sprung up. Table 4.3 shows an increase of 2,346 hectares between 1972 and 1991 from 1,680 to 4,026 hectares of plantation. Plate 4.3a shows a section of a palm plantation in Akamkpa settlement while plate 4.3b shows a section of a gmelina plantation at Nsan settlement.

Plate 4.2: A waterleaf farm in Akamkpa. For such farms as this, it is necessary to cut down all trees in the farm.

SOURCE: Field work by Author (2001)

Plate 4.3a: Section of an Oil Palm plantation in Akamkpa.

SOURCE: Field work by Author (2001).

Plate 4.3b Section of a Gmelina Plantation in Nsan

SOURCE: Field work by Author (2001).

Obvious in the practice of plantation agriculture is the introduction of a monoculture cultiver system, which is easily susceptible to pest and disease attack. This leads to decline in both flora and fauna specie as against the multicropping system or the original nature of the tropical rainforest with its abundant variety of flora.

It is for some of these reasons mentioned above that the forest of Akamkpa has been steadily undergoing serious decline over the years. In some cases constant and continuous cultivation on a piece of land eventually culminated in impoverishment of the soil to the extent that it becomes difficult for it to sustain vegetation – a case of serious degradation of both soil and vegetation. Plate 4.4 shows a section of a degraded farmland almost bare of vegetation except for grasses.

4.5 USES OF FOREST RESOURCES IN AKAMKPA

Because of the wide variety of plant specie existing in the tropical rainforest of Akamkpa, the people have come to appreciate and put to use these resources to their advantage, though to some extent they have been ignorant of the effect of this on the forest. The forest resources are divided into timber forest products (TFPs) and the non-timber forest products (NTFPs).

The timber forest products such as Mahogany, Ebony, Walnut, Iroko, Edo, etc are felled and sold to timber merchants. Consequently they are used in the construction industry for building houses, furniture, construction, canoe building, chewing stick, canes for weaving chairs, etc. Basically their importance to the community is economical, as they are also a good source of meeting the fuel need of the local people.

The non–timber forest products such as Salad, Bush Mango, Afang, Achi, Obogho, Bushnut, etc are usually harvested for food, while some of the climbers are used as rope for building and for tying of things.

Plate 4.4 Section of a degraded farmland in Akamkpa which can hardly support vegetation. Such land is exposed to erosion forces.

SOURCE: Field work by Author (2001).

Harvest of these forest products is done by the indigenes though sometimes harvesting is leased out to non-indigene farmers for a certain period and for a fee as stipulated by the community. Essentially the economy of Akamkpa is hinged to a very reasonable extent on the forest and the use of its products.

4.6 SPECIE EXTINCTION AND CONSERVATION EFFORTS

Generally it is an established fact that the loss of forest cover usually leads to decline in specie diversity within the affected area either through migration or total extinction. Some specie are equally endangered. For Akamkpa the situation has remained the same as the natives reported on a number of plant specie that are either endangered or have become extinct. They are no longer seen easily around the village settlement as it was 25 years ago except one goes into the forests which takes a trekking time of not less than two hours from any part of the sampled settlements. Table 4.9 shows the endangered/extinct plant specie in Akamkpa.

TABLE 4.9: ENDANGERED/EXTINCT PLANT SPECIE

Common Name	Botanical Name	Description
*Nyore/Inoi		Palm species with hard shell and oil extract like groundnut oil. Also eaten raw.
*Nkat/Ekporo		A delicious plant with sugary tasting fruit that is eaten when boiled. It climbs on big trees.
Edo	Teak	
Edeng	Mamia Africana	
Poga Tree		
Bush Cola	Plunkenetia Conophora	

Hot leaf	Piper Guinensis	
Nkong		A plant with a sugary tasting fruit called Nkap Ogbon. The fruit affects the taste of water and is used to nurse motherless babies
Salad		
Afang	Gnetum Africanum	
Opepe	Naudea Didenidii	
Bush Mango	Irvingia Gabonesis	
Ebony	Diospyros Species	
*Nkum/Ekono		A tree with round fruit that can be eaten raw or dried
Achi	Brachystegia Kennedii	
Camwood	Pterocarpus Oshun	

Data Source: Field work by Author (2001)

* The first names are local names in Ejagham language while the second are local names in Efik language.

As a response to declining forest resources due to agriculture, there has been some indigenous approach towards saving the forest. Apart from the usual fallowing of farmland to allow for vegetation regeneration the natives selectively fell trees in the farmland during clearing of forest. Trees left to stand include those useful as shade for plants and soil from direct sunlight, those that can support the tendrils of yams and vegetables climbing on it and those that are useful for food e.g. Bush Mango, Achi, etc. These trees are also left standing to help check soil erosion by wind and water, supply organic manure to plants through their leaf fall and for the purpose of conserving especially those specie discovered to be extinct or endangered.

Equally very big trees which cannot be felled with cutlass or axe and at the same time will not hinder plant growth are left standing. However for some farmers clear–cutting of forest is necessary to enhance penetration of sunlight into the soil and on plants.

A prominent conservation practice amongst the people in their home gardens is that stumps of trees cut down in the farms are not burnt off, this gives room for the regeneration of the tree stump thus ensuring that they are not completely destroyed. Plate 4.5 is a home garden in Nsan, scattered over the farm are regenerating stumps of felled trees. Equally, some of the endangered species are purposely planted and nutured by he natives especially those that are consumable as food, now that access into the forest where they may be found is becoming increasingly difficult.

At the community level conservation efforts include restriction of access into protected areas, that is forest area where the community is free to carry out farming activities as against Government reserved areas. This ensures that on a yearly basis the community through the clan head and the council of chiefs map out a certain portion of forest that can be cleared for farming. Restriction is also placed on the harvesting of both timber and non–timber forest species which are endangered. Fines for unpermitted harvesting or clearing range from money, wine, goat, colanut, etc, to expulsion or excommunication from the community, depending on the gravity of the offence, the decision of the council of chiefs and the offender's response. Migrant tenant farmers are not permitted to clear forestland for farming except with permission from the village council which allocates a certain portion to them or they may acquire such through leasing from indigenous land owners.

4.7 CONSEQUENCES OF VEGETATION DEGRADATION

The loss of forest in Akamkpa has come with its consequences on the people and their general way of life. Some of the negative effects, which they have observed, include:

Plate 4.5 A home garden at Nsan. Note the tree stumps left to regenerate. One of the peoples effort at conservation of declining species.

SOURCE: Field work by Author (2001).

(i) Increase in farm labour as a result of longer travel time to farmlands.

(ii) Opening of hitherto closed channels for runoff, hence increasing the rate of soil erosion by running water.

(iii) Extinction of valuable specie of plant such that even when farms are left to fallow the predominant specie there is the palm tree and a few other species of grasses. Plate 4.6 shows a farmland under fallow in Old Netim.

(iv) Sequel to the above has been a diminished yield in timber resources which has affected fuelwood supply and other local industries requiring timber.

(v) The fast rate of forest degradation has deprived the people access into reserved areas hence limiting their access to forest resources.

(vi) Thee has been apparent reduction in stream flow due to farming activities that have removed gallery forest thus exposing the watershed to the vagaries of the weather. A comparative examination of fig 4.1 and 4.2 reveals that deforestation has exposed quite a number of streams in 1991, which were not visible in 1972.

Plate 4.6: Farmland under fallow in old Netim. Compare the vegetation here with that in plate 1.

SOURCE: Field work by Author (2001).

CHAPTER FIVE

SUMMARY, RECOMMENDATION AND CONCLUSION

5.1 SUMMARY

So far we have been assessing vegetation degradation as a response to agriculture in Akamkpa. Aerial photographs have been analysed to show that the vegetation of the area under study has undergone considerable change, such that land use for quarry increased from 0% to 0.86%, woodland, settlement, farms and fallow increased from 11.13% to 42.15%.An important fact to note here is that this category of vegetation is made up of mostly farms and fallow because the settlements in this area are concentrated along existing roads. Dense woodland- areas of longer fallow with regenerating forest increased from 8.75% to14.05%, disturbed forest increased from 0% to 6.91%, plantations increased from 3.99% to 9.58%, while high forest decreased from 76.12% to 26.45% over a 19 year period.

The increasing size of farmplots and consequent increasing distance to farms have been examined, the farming system, forest resources use, conservation efforts based on indigenous appreciation of the gravity of the situation and observed consequences of the prevailing situation have all been highlighted. Indications are that the vegetation of the area has seriously been affected and degraded to a very reasonable extent.

5.2 IMPLICATIONS OF FINDINGS

Having examined the consequences that agriculture as practised in Akamkpa L.G.A. has had on the vegetation in terms of its degradation, it is pertinent to note that urgent action needs to be taken to address this trend before it becomes a totally hopeless situation. Granted that all variables remain constant and equal as indicated earlier on in chapter four, the result of this research shows that in the next eleven years from 1991, which is the year of

acquisition of the most recent air photograph, the study area of 420.42km^2 will have all of its virgin forest gone leaving the entire area under farms and fallow. The consequences of this on biodiversity and the watershed in this area are better imagined than experienced. More farmland are likely to be exposed to the vagaries of weather resulting in increased rate of erosion which ultimately will silt up the rivers that serve to meet the local water needs of the people for both domestic and agricultural purpose.

Also implicit in this research is the fact that the slash and burn method of shifting cultivation which was observed to have reduced to the rotational bush fallow type has over the years proved a very useful tool in the degradation of forest in the study area. That means that if no measures are adopted to curb it's effect especially in the face of increasing population that necessitate agricultural expansion which in the tropics is believed to be achievable only through clearing of more forest land, then the forest will continue to give way to what has been earlier on described as orderly planted rows of crops that man has come to esteem highly as food.

Where the above trend is left unchecked, it can be rightly asserted that no matter the extent of fallow period allowed for vegetation regeneration which at present does not exceed four years on the average in Akamkpa L. G. A., vegetation degradation will be a continuos process whose end is not in sight.

5.3 RECOMMENDATIONS

In the interest of curbing vegetation degradation and for the purpose of policy formulation in line with findings of this research, I make the following recommendations.

(i) Expansion of existing forest reserves so that more areas of forest come under government protection thus facilitating specie conservation.

(ii) In view of the need for increased food production in the face of increasing population, farmers should be encouraged to embark on more intensive use of available farmland through the use of organic and inorganic manure and other forms of mechanised agriculture as the environment may permit. This will to a great extent reduce unbridled intrusion into virgin forests.

(iii) Bearing in mind the fact that vegetation degradation comes as a response to other forms of human activities and not just agriculture, stricter laws and tariffs should be imposed on commercial logging. This will increase the monetary value of timber products from the study area, thus people will be forced to source for alternatives to timber products or embark on recycling of timber products so as to save our forest. Equally at the community level, the village heads should be used to check the activities of their subjects in relation to farming and the degradation of forest resources.

5.4 CONCLUSION

This study was aimed at using remotely sensed technique in appraising the extent of vegetation degradation due to agriculture. From the interpretation of the aerial photographs used that is for 1972 and 1991, it is very evident that there is a strong relationship between the rate of agricultural expansion and degradation of vegetation in Akamkpa L. G. A. as evidenced by the gain of + 31.23% and +6.96% by farms, fallow and disturbed forest respectively while the high forest has experienced a loss of –50% over the same period under study. Equally, the use of questionnaires and the PRA system has helped bring to light the basic features of the peoples agriculture and their own perspective of it's contribution to vegetation degradation through shortened fallow period and clearing of more virgin forest in a bid to increase food production to meet the nutritional needs of the growing population.

This method gives a more comprehensive picture of what the situation looks like, as we've been able to catch a glimpse of endangered/extinct flora specie in the area.

5.5 SUGGESTIONS FOR FURTHER RESEARCH

In view of the various limitations imposed on this research, I do make suggestions for improvement in research in the following areas;

(i) Use of more recent imageries to assess what the situation of forest in the study area looks like. This is in considering the fact that the most recent imagery employed for this study was obtained in 1991 – a time interval of 10 years, during which some obvious change may have taken place in the vegetation of the area.

(ii) The use of coloured satellite or radar imagery in combination with panchromatic black and white aerial photographs for this kind of study so as to make use of the combined advantage of colour and panchromatic imagery in differentiating and delineating various vegetation classes. This will at the same time enhance digital analysis of data obtained from the imageries.

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APPENDIX 1

FEDERAL UNIVERSITY OF TECHNOLOGY

MINNA, NIGER STATE.

GEOGRAPHY DEPARTMENT.

Dear Respondent,

This questionnaire is designed for the special purpose of gathering information on vegetation degradation due to agriculture in your Community. In that case I would like to know the most common type of agriculture you practise and how you think it has affected the natural vegetation. Kindly furnish me with the necessary information as indicated by the questions below. Be rest assured that any information you provide here would be held in confidence and used strictly for the purpose of this research.

Thank you.

IWUJI, MARTIN C.

1. Name of your village (Community) _____
2. Age of Respondent : (a) 21 – 30 yrs (b) 31 – 40 yrs (c) 41 – 50 yrs
   (d) 51 – 60 yrs (e) 61 yrs and above
3. Marital Status: (a) Single (b) Married.
4. Sex: (a) Male (b) Female
5. Educational Status: (a) No formal Education (b) Primary School (c) Secondary School
   (d) Higher Institution (e) Others (Specify) _____
6. Occupation: (a) Farmer (b) Trader (c) Civil Servant (d) Artisan/Craft
   (e) Others (Specify) _____

7. How long have you been farming (a) 5 – 15 yrs (b) 16 – 25 yrs (c) 26 –35 yrs

   (d) 36 – 45 yrs (e) 46 – 55 yrs

8. What type of Agriculture do you practise? (a) Crop Production (b) Animal rearing

   (c) Plantation agriculture (d) Others (Specify)

9. How do you prepare your farmland for cultivation?

   (a) Clearing and burning (b) clearing without burning

   (c) Burning before clearing (d) Others (specify) _____

10. What are your reasons for any of the system you use in No. 9?

    _____

    _____

    _____

11. Do you cut down all the trees in your farm when clearing the farmland?

    (a) Yes (b) No

12. What are the reasons for your answers in No. 11?

    _____

    _____

    _____

13. What is the land tenure systems practised in your community

    (a) Private ownership (b) Communal ownership

    (c) Family ownership (d) Others (specify) _____

14. How is farmland acquired by individuals in your community?

    (a) Inheritance (b) Purchase (c) Clearing of original forest (d) Leasing

    (e) Communal/government allocation (f) Others (specify) _____

15. Who has the right to acquire land in your community?

    (a) Husband (b) Wife (c) Children (d) Migrant tenants

    (e) Others (specify) _____

16. How many farm plots did you own 25 years ago? (a) 1 – 3 (b) 4 – 6

(c) 7 – 9 (d) 10 –12

17. How many farm plots do you own now? (a) 1 – 3 (b) 4 – 6 (c) 7 – 9

(d) 10 - 12

18. If there has been an increase in your farmland, what are the reasons for this?

(a) Purchase of more land (b) Clearing of more virgin forest (c) Inheritance of more land (d) getting more through leasing others (specify) _____

19. How long do you plant on a piece of land before you abandon it to fallow?

(a) 1 farming season (b) 2 seasons (c) 3 seasons (d) 4 seasons

20. How long do you abandon your farmplot after cultivation before coming back to it 25 years ago? (a) 2 yrs (b) 4 yrs (c) 6 yrs (d) 8 yrs (e) 10 yrs

21. How long do you abandon your farmplot after cultivation before coming back to it now?

(a) 2 yrs (b) 4 yrs (c) 6 yrs (d) 8 yrs (e) 10 yrs

22. How long does it take you to get to the forest edge from your house 25 yrs ago?

(a) 20 mins (b) 30 mins (c) 40 mins (d) 50 mins (e) 1 hr

23. How long does it take you to get to the forest edge from your house now? (a) 30 mins (b) 1 hour (c) 1 hr 30 mins (d) 2 hrs (e) 2 hrs 30 mins

24. How long does it take you to get to your farms near the forest 25 yrs ago?

(a) 20 mins (b) 30 mins (c) 40 mins (d) 50 mins (e) 1 hr

25. How long does it take you to get to your farms near the forest now?

(a) 30 mins (b) 1 hour (c) 1 hr 30 mins (d) 2 hrs (e) 2 hrs 30 mins

26. When your farm is no longer fertile what do you do to increase food production?

(a) Add fertilizer (b) Use compost and organic manure (c) clear a fresh plot of land (d) Others (specify) _____

27. What has been the biggest cause for clearing of forest in the community?

(a) Building of houses (b) Building of roads (c) Farming

(d) Others (specify) _____

28. Are there government reserved forest areas in the Community? (a) Yes (b) No

29. Are there any plants you knew were in your forest 25 yrs ago that are no longer there now? (list them) _____

_____

APPENDIX II

PRA CHECKLIST

A) FARMING SYSTEM

- what type of agriculture is practised in the area
- Basic features peculiar to this system in the community
- Observed changes in practise over time
- Reasons for changes
- Peoples' response to these changes

B) LAND RESOURCES

- What method of land ownership/acquisition is in place
- Common tenure practices
- Community response towards land owners having very large plots
- Method of communal land management
- Reasons for increase/decline

C) VEGETATION RESOURCES

- Examine knowledge of a forest
- Extent of original forest in the community 25 years ago as compared to present extent in terms of distance from village centre to the forest
- Reasons for decline/increase of forest
- Agricultural projects that has necessitated large scale forest clearing
- Extent of forest cleared for it
- Any vegetation species extinction/endangered

- Reasons foe extinction
- Common trees/plants found in the community
- Use of timber and non–timber forest products

D) EFFORTS AT CONSERVATION

- Community rules and regulations in forest conservation
- Possible penalty to defaulters
- Methods of harvesting timber and non–timber forest products
- Possible farm practices that aid conservation of species
- Examine knowledge of forest benefit
- Consequences of loss of forest

APPENDIX III

CALCULATION OF AREAL EXTENT OF VEGETATION CLASSES

FOR 1972 AND 1991

1972

Using the square method each square = $1cm^2$

Total no of squares = 1051

Total land area = $1051 \times \frac{40,000}{100,000} = 420.40km^2$

High forest = $800cm^2 \times \frac{40,000}{100,000} = 320.0km^2$

Converting to hectares : 100 ha = $1\ km^2$

= $100 \times 320km^2$ = 32,000 hectares

Plantations = $42cm^2 \times \frac{40,000}{100,000} = 16.8km^2$

= $100 \times 16.8km^2$ = 1680 hectares

Dense Woodland = $92cm^2 \times \frac{40,000}{100,000} = 36.8km^2$

= $100 \times 36.8km^2$ = 3,680 hectares

Woodland/farms/settlement/fallow = $117cm^2 \times \frac{40,000}{100,000} = 46.8km^2$

= $100 \times 46.8km^2$ = 4,680 hectares

1991

Total no of squares = 1274

Total land area = $1274 \times \frac{33,000}{100,000} = 420.42km^2$

Quarry = $11cm^2 \times \frac{33,000}{100,000} = 3.63km^2$

$= 100 \times 3.63km^2 = 363$ hectares

High forest = $337cm^2 \times \frac{33,000}{100,000} = 111.21km^2$

$= 100 \times 111.21km^2 = 11,121$ hectares

Plantations = $112cm^2 \times \frac{33,000}{100,000} = 40.26km^2$

$= 100 \times 40.26km^2 = 4,026$ hectares

Disturbed forest = $88cm^2 \times \frac{33,000}{100,000} = 29.04km^2$

$= 100 \times 29.04km^2 = 2,904$ hectares

Dense Woodland = $179cm^2 \times \frac{33,000}{100,000} = 59.07km^2$

$= 100 \times 59.07km^2 = 5907$ hectares

Woodland/farms/settlement/fallow = $537cm^2 \times \frac{33,000}{100,000} = 177.21km^2$

$= 100 \times 177.21km^2 = 17,721$ hectares

ORAL INTERVIEWS/FOCUS GROUP DISCUSSION

Ntufam Michael Ogar (Clan Head of Nsan)

Ntufam Saviour Edem

Ntufam Solomon Attah

Ntufam Pius Ekpe

Ntufam Francis Ekpe

Ntufam Prince Nyong Agu Okey

Mr. Ignatius Okon Ndifon