THE APPLICATION OF REMOTE SENSING TECHNIQUES IN ASSESSING GULLY EROSION IN ANKPA AREA OF KOGI STATE

BY

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A PROJECT SUBMinED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A DEGREE OF MASTER OF TECHNOLOGY IN REMOTE SENSING APPLICATION TO THE

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ABSTRACT

A Survey of remote sensing application in gully erosion in some parts of the Guinea Savanna area of Kogi State is attempted here. The problem of gully erosion has been adequately identified as a major impediment to developmental efforts in Ankpa Local Government Area. It therefore becomes clear that gully problems in this area draws one's attention for possible actions to be taken in good time.

Some causes of erosion especially in agricultural land areas were identified, surveyed and monitored using remote sensing techniques.

Firstly, the extent of erosion was established by tracing from the photographs all the lengths and all clearly identifiable major land use and settlements. The traced overlays from 1964 and 1978, were compared with each other. In this way, the rate of increase was noted.

Also the erosion w\'6P r- was then super- imposed on land use map to show the relationship between gully in the area and the land use factors.

Many issues emergfat " the end of this study: There were increases in both gully locations and lengths between 1964 and 1978.

Also, that land under cultivation in 1964 either remained cultivated or probably abandoned due to gully encroachment.

Again areas that are inhabited by people are mostly proned.

Above all, areas that are continuously cultivated are the zones mostly eroded.

Finally, from the observation of the result of the findings, it is concluded that, if all the curative measures are adhered to, the danger of erosion risk will be drastically reduced if not total eradication.

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Also, I will forever be grateful to everybody and if I have not mentioned your name, this is not because I have not remembered or I consider you anyless important but because constraints of time and space make this impossible.

Finally, lowe my greatest regards to the various Authors whose work I have used one way or the other in writing my project. Thank You All.

ILYAS, '97

DEDICATION

This project is dedicated to God Almighty for saving my life and to those who had made it possible to discover more of the world through Remote Sensing.

ILYAS '97

CERTIFICATION

This is to certify that this study was carried out by

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EXTERNAL EXAMINER

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND:

The removal of soil materials and/or soil nutrients by surface runoff from their different points of origin to other locations is known as soil erosion. This geomorphic event may degenerate into sheet, rill or gully type of erosion. Whichever form erosion assumes, it constitutes a menace in the environment of man; and this has been acknowledged world-wide.

For instance, in Canada, the menace of erosion is well understood and documented in the works of Sutherland and Bryan, (1987) among others. In Australia, records of erosion problems are intact in the works of CSIRO; (1966), Abraham; (1972) among others. similarly, in Britain, the works of Walling and Quaine, (1991) fuller, (1985,1991) among others equally acknowledged the ravages of erosion on farmlands. And back home here in Nigeria, the works of Flyod (1965,1969), Ologe, (1972,1974,1977), Ofomata (1973, 1980), Oyegun (1980, 1987) Olofin, (1982), Jeje and Agun (1990), among others, have confirmed the problems of erosion as it affects foundation of houses, road networks, football pitches and farmlands in Nigeria.

Gullies are deep grooves on the ground whose occurrence and destructive role threaten all form of land use on the ground. The decisive epoch of the development of gully erosion began when man 1st settled down and began turning pasture land into farmland. The intensive exploitation of the land disturbed the natural soil vegetative cover and exposed its surface to the effects of erosive agents. Only rarely did man succeed in overpowering the erosive agent and to introduce such forms of agriculture that did not destroy the land. Throughout the world, land is subject to erosion by water if the soil is uncovered during rains.

In consonance with population increase, an unprecedented increase in the demand for agricultural products has led to a surge in land utilization for agricultural purpose in recent years. The use of land has therefore been stepped up both in terms of area extent and intensity. All agricultural activity involves some disturbance of the natural vegetation ranging from its total removal and replacement of commercial crops, to the selective removal of some parts of the natural cover, for example, timber cropping or grazing (Finlayson and stalhan, 1980). In the end the land is exposed to and left to the mercy of rain and fluvial erosion. The annual spectacles of bush fire, especially in the savanna regions also expose the soil to wholesale erosion of the surface layer, by the first rains (Fagbami, 1984).

The soil lost through erosion is usually the most fertile, containing the plant nutrients, humus, and any fertilizers that the farmer has applied. Millions of forms of fertile surface soil can be lost forever if it is washed into the sea. What is left is less productive, and may become completely barren. Such severely eroded land is difficult to work because it crusts and cracks and will not absorb water.

L	=	Slope length factor
S	=	Slope factor
C	=	Crop management factor
p	=	Conservational practice factor

This empirical equation contains factors relating to the natural soil, slope as well as land use factors prevalent in a given area (Finlayson and Stalhan, 1980).

In the first phase of erosion, factors such as the erosive power of the rain drop (erosivity) and the nature of the soil (erodibility) are important and influence the quantity of soil materials detached.

The second phase is influenced by slope length and angle which determine the velocity of runoff and the nature of the soil, which influences the infiltration capacity and rate of runoff.

Vegetation cover affects both the erosive power of rain drops (through interception) and the velocity of run-off.

Rainfall erosivity is believed to be very high under the climatic condition of the savanna (Jones and Wild, 1975; Kowal and Kassam 1978), and is accompanied by a correspondingly high rate of detachment and transportation of soil materials by the exceptionally high kinetic energy in addition to the frequently high intensity and volume of rains.

Similarly, the erodibility of savanna soils is believed to be very high (Jones and Wild 1975) and such soils are mostly sandy, low in organic matter and of unstable structure. The ease with which particles of such soils dispense in water renders savanna soils particularly vulnerable to accelerated (gully) erosion, Kowal and Kassam, 1978). Jones and Wild (1975), observed that in general, the clearing of land from natural savanna vegetation results in accelerated erosion, that is some 20-100 times greater than the rate of erosion under the natural environment.

Such conditions and such soil erosion have been found in Ankpa area in Kogi State of Nigeria. Here, very severe soil erosion is prevalent in large areas to the extent that today, the name Ankpa certainly brings to mind gully erosion. Where is this town in Kogi State? Why has its gully erosion most pronounced and Why has it defied all solutions so far despite all efforts ?

A survey of gully erosion employing remote sensing methods will be attempted here. Major causes of soil erosion (gully), especially in agricultural land areas will be identified, surveyed, assessed and possible measures to be taken are suggested.

1.2 THE STUDY AREA

1.2.1 LOCATION:

Ankpa is one of the Local Government Headquarters in Kogi State. It is located in the southern Guinea Savanna belt of Nigeria. Defined by Latitude 7.4°N and Longitude 7.6°E, it has an area of approximately 30 sq km. It could also be located on Landsat 4; path 188, Row 0.55 and also on landsat 2, path 201, Ro.:tj 55: n terms of-direction, it is located south

MAP OF THE STUDY AREA

N

4

SCALE :- 1 : 40,000 Source:- New School Atlas For West Africa
Harold Fullard (M.Se).

LEGEND

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171 Roorj~

Towns

[B1 Rivers

Eastern direction of Lokoja, the state capital. The bearing of Ankpa from Lokoja is therefore 135^{o} (See figure 1)

1.2.2 CLIMATE:

Like most parts of the state, the area lies within the tropical hinterland climate. The climatic region is characterised partly by double and single maxima rainfall pattern, with about four months of wet season. The relative humidity, generally rises to over 80% in the morning and falls to between 50% and 70% in the afternoon during the wet season (Ileoje, 1981).

The dry and wet seasons in this area as in other parts of the country, are greatly controlled by the annual migration of inter tropical convergence zone (ITCZ) The annual mean rainfall for the study area shows a high variability in the monthly total rainfall characteristics of the entire region (Udo, 1981). Rainy season occurs between April, and October and reaches its peak in September. Rainfall here is seasonal, which means that it is not all year round. Extreme variations in total rainfall for July and August is also a general charcteristics of the rainfall here. Heavy rains of conventional type fall here and this sometimes amount up to 978.5mm but it may be more. The pattern of raindays (mean) follows basically the same pattern as for mean rainfall amount. The mean raindays for the area is approximately between 73 to 90 days.

In general, the rate decreases inland from the Southern part of the study area.

The study area comes under the trade winds for a part of the year. Temperature here, therefore, is very high. The mean monthly temperature usually ranging between 21DC and 32uC in some years. The daily range of temperature ia about 6°C and the annual variations is about 3°C (CRIN, 1987). The highest temperature occurs just before the rainy season begins i.e April.

Finally, the climate in this area can be said to have hot, wet summers and cooler, dry winters.

1.3 RELIEF

The study area falls into the low land category in Nigeria and specifically it is the lowland and scarp land of the south Eastern Nigeria (1Ieoje,1981). It lies at the Western part of Enugu where the two Plateau-like cuesters are being separated by the Anambra/Oji River valley. The area is on the south-west dipping layers of the crateceous sandstone which stretches in the south west direction. The relief region is also composed of rounded to flat-topped hills that was seen as ferrruginised sandstone.

1.4 GEOLOGY AND SOILS

Ileoge, (1981) noted that geologically the study area is made up of cretaceous sandstone deposits. The geology is characterised by the presence of lower coal measures, false bedded sandstones and upper coal measures of the lower paleocene.

Furthermore, there is no exposure of any bedrock to the surface during the time of investigation and the area is entirely covered by impoverished soil due to the actions of erosion.

Soils here therefore, are the weakly consolidated sediments of the tertiary to cretaceous lignite formation. The Bende Ameke clay shale groups, the false bedded sandstone, the lower and upper coal measures which are subjected mainly to severe gully erosion are found here.

1.5 VEGETATION

The study area is located within the southern Guinea savanna zone although species common to the northern Guinea savanna also occur (Keay, 1959). The distribution of actual or contemporary vegetation type is determined by factors such as fire, demographic pressure, patterns of cultivation, clearing and relief, e.t.c

A complex patch work of vegetation has resulted, particularly in the more densely populated areas. It is therefore not easy to give details of the actual vegetation of the area under study. Instead an attempt is made here to describe what obtains under present conditions. Trees found here (some) do adapt to dry conditions (decidous) as they shed their leaves in the dry season to control evaportranspiration. These trees are however small and widely spaced with thick/thin leaves and barks because conditions are not as favourable as those found in the southern zones of Nigeria. Such trees are Afzelia Africana, soberlinia, Swartzia, butyrospermum parki, Adanzonia digitate etc.

Thus, it is clear that much of the study area has a reasonably thick vegetation (especially in rainy season). However in areas with little grass undergrowth, the soil is exposed to leaf falls and occasional raindrop impact thereby facilitating the break up of soil surface and subsequent transportation by run-off.

1.6 LAND USE

A greater proportion of the inhabitants of Ankpa depend primarily upon farming as their means of livelihood. landuse, within the study area therefore is mostly agricultural.

Three types of cultivated land use, based on F.A.O. (1976) classification, have been identified. The three types are:

(I) Intensive cultivation (80% recurrent cultivation)

(ii) Scattered or locally dense cultivation (35 to 60% recurrent cultivation of short term).

(iii) Scattered to sparse cultivation of medium - long term.

Because the growing season as relatively long (about 8 months) a range of crops (eg yams, cassava, maize, groundnut, melon, guinea corn, beans etc) with different growing periods can be cultivated.

The farmer is, therefore, occupied for about 10 months of the year. Also, the continuous cultivation of crops on the land offers it a good cover against erosion for the period. Despite this practice, most farms are not free from the danger of soil erosion in the area. The annual burning of vegetation as a means of clearing the land for cultivation and other activities also devoid the land of its vegetative cover, so that the first rains are often accompanied by devastating soil erosion. Other types of landuse in the study area include grazing of animals, hunting, forestry and settlements etc.

1.7 STATEMENT OF RESEARCH PROBLEM

The problem of soil erosion has been adequately identified and recognised by the Kogi State Government and the Local Government as a major impediment for many of its developmental efforts in Ankpa Local Government Area. I have personally surveyed some parts of the erosion prone areas in Ankpa town and I am convinced that gully locations or spots, all things being equal, will increase with time.

From the above assertion, it becomes clear that gully problems in this area has gone to a stage that draws one's attention for possible actions to be taken in good time.

This is specifically what this project stands to undertake. This also is an important aspects of agricultural land utilization. The methods used previously in identifying the gullied locations lrack certain qualities and therefore will be replaced with an improved high technology procedure known as Remote Sensing Systems.

This goes to mean that the study will provide a basis for proposing solutions to this problem in the study area.

1.8 JUSTIFICATION

The damage so far caused by erosion in Ankpa town has reached a magnitude that is beyond the financial control of the local Government and even that of the State Government. It should therefore attract same from the Federal Government as does desert encroachment in the Sahel region of Nigeria.

The environmental conditions in the study area are favourable for erosion. This is because agriculture is often practiced without conservative measures. The potential danger of soil erosion is therefore very high. For this reason, there is the need to establish for the Farmer, the rate at which land is likely to be degraded and put out of production if he does not adopt conservation practices. A study such as this therefore, is important.

It is therefore concluded that if this study is adequately conducted employing remote sensing techniques, then the danger of erosion risk areas can be easily detected and proposal for possible solutions recommended.

1.9 THE OBJECTIVES OF THE STUDY

As far as the scope of this study is concerned, three specific objectives will be considered. These are:

(a) To determine the efficacy of Remote Sensing as a tool for identifying gullies in Ankpa town.

(b) To establish some causes of gullying in the study area; and

(c) To make recommendations towards solving the problem of gullies in Ankpa.

1.10 RATIONALE FOR THE USE OF REMOTE SENSING:

Remote Sensing of the earth is the science and art of deriving information about the earth's land and water areas from images acquired at a distance. It relies upon measurements of electromagnetic energy reflected or omitted from the features of interest.

One of the most powerful modern techniques for erosion investigation is remote sensing. This is because remote sensing detects changes occurring in the environment. Also, its greatest advantage is that it provides a permanent synoptic, spatial and temporal records of an environment. These qualities permits rapid in-house assessment of erosion with reduced field work, highly verifiable and consistent result.

Finally, changes occurring in a region can be monitored by comparing sequential coverages. These among others are the reasons for employing remote sensing systems for this study

1.11 ORGANISATION:

This thesis will contain five chapters in all. The first chapter introduces the background to the study and the preliminaries of the write-up itself. Chapter two focuses related literature consulted. These are researches hitherto undertaken using similar approaches. Chapter three (i.e. methodology)discusses the ways of carrying out the study and the instruments to be used. Analysis of the data, results and observations are carried out in the fourth chapter.

Finally, the last chapter (Five) summarises the major findings, suggest possible solutions and make recommendations.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 DATA FROM REMOTE SENSING

Remote Sensing offers an alternative, often more efficient and cost affective techniques for mapping, assessing and predicting land degradation especially on our agricultural plots, HOIZ (1985). A study undertaken by JO. Akinyede (1990) shows that a variety of Remote Sensing images, such as thematic mapper, spot, SIAR and aerial photographs were used to collect terrain data. The potentials of the images for this survey were discussed. The study found that in areas with marked topographical variations SLAR was a useful tool to map morphological, geological characteristics. But aerial photos in both cases became more useful tools to map land use, soils, characteristics of erosion and slope features. Satellite images became more useful in identifying geologic boundaries and surface moisture characteristics.

The California, in the area of urban and rural degradation. Colwell (1985) employed spot, landsat Mss and infra-red photographs (1:24,000) to monitor erosion, flood and heat problems. He found that spot image was the overall' better tool than landsat Mss and it comes close to infra-red photographs. In addition, Dinc (1986) used landsat 3 Mss data bands 5 and 7 to monitor flood hazards in Seyhan-Ceyhan in Turkey. According to

Dwivedi (1985), a combination of data from landsat and false colour photographs in India can be manipulated to reveal useful information for assessing land conditions including erosion and flood hazard for agriculture. Again, Norman et al (1975), used aerial photograph to monitor factors that affect slope instability in an area near seven oaks in Kent. The application of landsat imagery to soil degradation mapping was advocated by the FAO (1978. It was found that mapping enhancement can be better achieved using 1;500,000 scale and optical enlargement, especially in area with less dense cover. Despite this limitation of landsat, it is still recognised and used as a powerful and reputable tool.

In West Africa, charraeu (1972), generalised the impact of run-off in surface cover. Similarly, a successful study was carried out in Zimbabwe by Jones and Keech (1966) where stereoscopic locations of African huts in addition to gullies was conducted. It was found that a direct relationship existed between gully intensity and population. Also, Garland (1982); uses panchromatic and black and white infra-red photograph to map erosion in some agricultural land in south Africa. he noticed a high spectral with panchromatic photographs which yielded more data for cultivated and uncultivated areas.

Since the main source of energy for gully erosion in an environment is runoff and the topographic characteristics, it can then be established that more runoff occurred from bare plots than from grass covered ones.

Accelerated erosion has been studied in Eastern Nigeria among others by Ofomata (1965), Floyd (1965) and Grove (1952). In most of these studies, soil erosion has been related to the local geology, the physical and chemical properties of the soils, rainfall intensity, high population density and the attendent pressure on the land in the form of deforestation. Factors of soil erosion have not been sufficiently analysed however, in a way to show their individual contributions to the total amount of soil erosion in the affected areas. This being the case, it is easy to understand why the various conservation measures in the severely eroded parts of the country have not been quite successful. To achieve any success at all, it is necessary to be conversant with the variables determining soil erodibility. Experimental studies in United States of America (Wischmeier, 1959), Rhodesia (Hudson, 1961) and Nigeria (Lal 197~), to mention but a few places, have provided useful data on important erosional factors.

A survey of Remote Sensing application in land degradation was attempted by Abdulkadiri (1993) and it was found that unlike conventional survey methods, remote sensing provides a more reliable, fast and convincing alternative means of assessing land degradational hazards. In Nigeria, cater (1958) used vertical photography to study sheet and gully erosion in Eastern Nigeria around River Njaba. He found that large potential agricultural lands were damaged due to the nature of slope, run-off and human activities. He concluded that these conditions of the land can be monitored through frequent aerial photography and photo interpretation. In the same vain, Patrick (1987) used aerial photographs and rainfall data to assess the impact of gully erosion on farms in Gongola and Bauchi States. He also concluded that aerial photographs are useful tools for monitoring erosion and land cover. In another development, parry et al (1971) employed the use of infrared photographs to monitor changes in catchement characteristics. Koopmans (1982) carried out a comparative assessment of SLAR and aerial photograph images for geomorphic and geological interpretation. He found that both photographs and image are important tools for mapping land features, and they can complement one another.

In another study by Ginther (1985), infra - red false colour photography was used to monitor slope instability. He concludes that soil cover, morphology and damage can easily be assessed using infra-red false colour photos. He observed that tonal differences in vegetation related with hydrologic conditions of the soils making the assessment easier. Ihemadu (1985), on his own part concludes that aerial photos are capable of satisfying most of the mapping assessment and predicting of environmental hazards accurately, reliably, timely, cost effectively and can be available as and when required.

in a related development, the use of aerial photographs in mapping and predicting floods, water logging and erosion risk has also been discussed in the work of Abdulkadir (1986). The work of Fagbami (1986) in Makurdi area in Nigeria demonstrated how landsat and aerial photos can be used to map and assess the conditions of soils in the area, including the physical limitations such as erosion and sedimentations as well as flood hazard problems. He found aerial photos having an advantage of spatial resolution and landsat with a good enhancement makes images more interpretable.

In the area of urban and rural land degradation, Essiet (1989), in the study of the impact of irrigation on soil properties in Kano Nigeria concludes that there has been some decline in the physical and chemical properties of the soils, mainly due to erosion and leaching as a result of irrigation.

In the landoviri drainage basin of Taraba State, the valley side gullies have apparently continued to be initiated and fast growing. Evidence from aerial photos has shown that between 1964 and 1975 gullies grew in length from about 25,000 meters to about 100,000 meters (Patrick, 1987). The result is that some gullies have become largely vegetated and stabilised for some time and there are others which are actively eroding at both their heads and sides. Recent field studies have confirmed that new gullies are continuing to be formed at very rapid rates (Patrick, 1987).

Ologe, (1971) found that gullied areas are distinguishable even on non-stereoscopic photos by their pattern, slopes and tonal expression, due partly to lack of vegetation and the irregularity of their edges. Where the gullies become vegetated, it becomes more difficult to recognise them on non-stereo photographs. On stereoscopic photographs, on the other hand, most gullies can easily be identified even in thick ground cover because of their distinctive morphological expression and especially their sharp and clear-cut side scarps and head scarp. They can therefore be mapped and used in planning conservation measures

From the examples above, it may be pointed out that world-wide remote sensing application in the mapping, assessing degradation and related phenomena is on the increase; as such exercises which would have otherwise been executed through conventional methods are now done with easeusing Remote Sensing Methods

CHAPTER THREE

RESEARCH METHODOLOGY

Methodology is a vital aspect of land evaluation and different methods have been put forward and used for different purposes in different areas at different intensities (FAO. 1976).

Remote Sensing methods offer the possibility of collecting and translating data on environmental degradation into useful information required in resources management and environmental conservation. The use of remote sensing was formerly exclusively for military purposes. Fortunately, its use has spanned into other fields such as studying and solving environmental problems.

The three prominent remote sensing data sources in use in Nigeria at present are the aerial photographs, satellite and radar imagery. The three systems employ electromagnetic energy of various wavelengths as a means of detecting and measuring target characteristics.

3.1 RESEARCH INSTRUMENTS AND DATA CHARACTERISTICS

For the purpose of this study, aerial photographs were employed in conjunction with topographical maps. These were acquired from both lands and survey Department, Lokoja, Kogi State and the Remote Sensing unit of the Federal Geological Survey, Kaduna. Visual interpretation was preferred to digital image interpretations because of the constraints of environmental complexities, Land management, practices and finance. More importantly during interpretation, elements such as colour, texture, pattern, size, shape and site/association were put in use.

For the purpose of this study, two sets of photographs flown In November/December 1964 at scale 1:40,000 and November/December 1978 at scale 1:40,000 and topographical map of 1977 at scale 1:50,000 were available to conduct the study within the shortest possible time. Because of the need for accurate sets of data, and the time consuming nature of channel deleanation, the drainage network of the area was investigated using secondary data sources mainly in the form of maps and photos.

The major data characteristics for the application of remote sensing techniques for this study purpose are outlined in table 1.

TABLE 1
DATA CHARACTERISTICS

DATA SOURCE	DATE	SCALE	TYPE OF DATA
Aerial Photos	Nov.1964	1:40,000	Panchromatic
Aerial Photos	Nov.1978	1:40,000	Panchromatic
Topographical Map	1977	1:50,000	Panchromatic

The first requirement was to establish the extent of the erosion. This was traced directly from the topographic map (1977) and details within the demarcated area were transferred to a tracing overlay. A base map was then drawn at a scale of 1;50,000. On each photograph, all the length and ground depression lines were mapped and all clearly identifiable major landuse features such as arable and non-arable areas were also marked. Foot paths and settlements were identified and recorded.

All these were then transferred to transparent overlays and map of the area was produced. The base map and photographs were then checked in the field. Again, the traced overlays were compared with each other and efforts were concentrated on identifying gullies and other features not previously mapped were identified and incorporated appropriately.

Furthermore the erosion map was then super-imposed on landuse map to show effects of landuse factors on erosion in the area.

Several sets of data generated included: landuse type and changes over the years, channel length within different land change categories e.t.c; for 1964 and 1978.

3.2 LIMITATIONS OF THE STUDY

In general, certain problems tended to test my patience in the course of carrying out this study. These ranged from non-availability and cost of procuring imageries.

In assessing and monitoring environmental degradation of this type, there is the need for time-based data. The main reason for the restriction of aerial photos to two given dates is the non-availability of recent photographic coverage of the study area. This is also responsible for the ages of the photographs.

Finally, there was also an acute shortage of equipment for digital image interpretation. Where these were available, it was either in accessible or too expensive and this therefore called for visual or manual interpretations.

3.3 GROUND TRUTHING

This is often carried out to verify the dileanated boundaries, check doubtful features and verify the accuracy of the interpreted data.

In carrying out such study, time was taken to go for ground truth confirmation. All the gully channels were examined both in terms of lenght (to some extent) and depths. This is always done to make comparisms between what is on the ground and what one has on the photographs.

The field check for this work was carried out between January and February, 1996. Errors detected were immediately corrected.

Because of the time lag between the time the image was taken and the field check, care was taken so that changes will not be taken as interpretation error.

CHAPTER FOUR

ANALYSIS OF RESULT

4.1 OBSERVATIONS:

It has been identified from field observation that only two types of gully development are found in the study area, namely: the youthful and intermediate stages. Gullies in this area have not reached the old stage because the frequent interference of the works department of the local government council has not allowed the gully to stabilize or become dormant. Both the youthful and the intermediate stages are associated with active downcutting and lateral expansion of the gullies. In the youthful stage, the gullies slope are actively down-cutting and have V-shaped valleys with high shape angles.

4.2 PATTERNS OF GULLYING

The patterns of gullying in this area depends on the nature of flow surface, nature of the soil and the underground water. For instance, loose, friable, fine and unconsolidated sands are easily eroded, while coarse and consolidated shales are poorly eroded. Permeable, saturated and cohesionless sands are easily washed and carried away by running water. The gradient of the ground surface is a determining factor for velocity of running water.

Based on the best favoured factors, three gullying processes were observed on the field.

4.2.1 RILL YING TO GULLYING

This is the process of gulling which occurs especially in a bare soil or scanty vegetation which is also sloppy. It is initiated by overland flow which develops into concentrated run-off. This concentrated run-off working on the bare sloppy lands cut into channel or rill erosion. If this is not protected the concentrated runoff using its tools (debris) eats into the sides of the channel which will later develop into gully erosion. This process of gulling is seen on the campus of the college of education Ankpa. (See figure 2)

FIG: 2 [illegible] OF SOIL EROSION

Source - Agbola ; Orojioko, [illegible]

4.2.2 BLOCK FAILURE

This occurs at locations where parallel tension fractures or cracks run ahead with advancement of the gully fronts. This is common where gullying is rapid especially if the clayey and topsoil is thin with very thin vegetation or bare surfaces. When this fracturing develops in the gully front. large bodies of earth materials are often affected and slide down into gully. This was observed at Okaba site (See figure 3)

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FIG:3 MODE OF BLOCK FAILURE

4.2.3 INCIDENTAL GULLIES

Incidental gullies result from the direct human interference with the environment. Civil engineering works, particularly road construction contributed immensely to the development of incidental gullies. Road cutting which expose the cohesionless sands ultimately lead to gully erosion. The seasonal scarping of local roads remove the cohesion topstratum and most often give rise to road side gullies. The haphazard construction of culverts and drainage channels results in the development of run off which, with adequate slopes acquires enough monentum which is used by the flood to work on the unprotected weak sands. This leads to extensive gullying as found along Emere and Ojoku sites.

4.3 GULLY GROWTH BETWEEN 1964 AND 1978.

Figures four and five show the drainages of the basin as at 1964 and 1978 respectively. It would be seen that very large increases in both gully numbers and lengths have occurred within the period. The overall increases were measured.

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SETTLEMENT AND DRAINAGE OF ANKPA AREA AS AT NOVEMBER 1964

N

. Based on Air Photographs
(19 64)

SCALE:- 1: 4

LEGEND

Forest Res er ve

Sondston e Li neation

\ Eroded Scrids tone

Study ~~HQa(Ankpa)

~ Towns

Roads

Foot paths

Rivers·

~j

SETTLEMENT AND DRAINAGE OF ANKPA AR A AS
AT NOVEMBER 1978

o sed on Air Photographs
(\978)

SCALE:-l: 40,000

LEGEND

Fo rest Rescr v e

Sandstone Li neati on

Eroded San dstone

Study Area (Ankpa)

~ Settlements

Tar red Roads

Rivers

~ Boundary of Eroded Sandstone
~. and Sandstone Lineation

A summary of the increases within each landuse class are presented in table two,

TABLE 2
INCREASES IN GULLY NUMBERS AND LENGTHS BETWEEN 1964 AND 1978

LAND USE CHANGE CLASS	uc-u	uc-c	c-c	OTHERS
Actual Length in Metres	17,395,00	17,637,50	27,979,50	7,140.00

Source: AP1 Federal Surveys, Lagos 1:25,000

What is of interest in table two is the fact that areas devoid of vegetal cover due more to the effects of cultivation are being eroded faster than those that remained uncultivated, Also the heavy rainfall recorded here contributed in no small way to increasing gully lengths (See Table 3)

TABLE 3
RAINFALL DATA FOR THE STUDY AREA FOR THREE YEARS

YEARS	M O N T H S												NO.OF RAINY
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL	DAYS
1964		OJ	II /	10~U	OJ	1:~0	131 ~	1f,0 5	17~:1	111/	/1 ~		\I/O ~	011
1970	uu ~		OU	02/	UOU	11/0	01 1	230 ~	362 U	13U~			14230	rs
1978			232	505	1840	1236	188 5	2500	1168	106 8	400		1,0834	78

SOURCE:AADP ZONE B. AYANGBA

4.4 DIRECTION OF LAND USE CHANGES

From preliminaries the 1978 photos was placed or super-imposed on that of the 1964 traced overlays, At this point, it was discovered that lands under cultiva ion in 1964 had either been brought into cultivation or remained uncultivated as the case may be. Thus, the possible changes that could have taken place between the period are as follows:-

(a) Uncultivated and cultivated to settlement (UC/C-S).

(b) Uncultivated to uncultivated (UC-UC).

(c) Uncultivated to cultivated (UC-C).

(d) Cultivated to cultivated (C-C)

(e) Cultivated to uncultivated (C-UC)

See Landuse/Landcover maps (1964/1978) as shown in figures Six and Seven, respectively.

IAND-USE/LAND-COVER MAP OF ANKPA AREA (1961.)

-Bcsed on Air Photographs
(1964)'

S'CAL E:- 1: 40,000

LEGEND

Settlements

Farmland

Forest Re~erve

Thick Forest

Shrub Land

Roads

Footpaths

Rivers

- Boundaries'
Major La nd-:

LAN 0 USE I LAN 0 COVE R MAP OF AN KPA ARE A (1 97B)

SCAL E:- 1; 4QOOO

LEGEND

Sczt tlflm lZnt 5

Cuttlvct eo Land

Forflst Rcs erve

Thick FOflZS t

Shrub Land

Bare Ground

Roads

River'»

— Boundaries o Major Land -U:

A table incorporating these landuse changes as shown on the maps was drawn up in table 4

Percentage (%) of Landuse changes over 1964-78

CHANGE	UN/C-S	UC-UC	UC-C	C-C	C-UC	TOTAL
Percentage of Total (%)	15	33	20	22	10	100

Source: AP1 Federal Surveys, Lagos 1:25,000

It is shown from table 4 that 22% of the land was being continuously cultivated within the period (1965-78) and 20% more lands had been brought into use during the same period. The dominance of forest in the area is also clearly revealed (33%)

4.5 DISCUSSION

From the foregoing analysis, it is clear that the source of energy for gully erosion In these environments IS run-off water and the soil/topographic characteristics. it must be noted, however, that areas that are bare of vegetation generate more run-off than areas with thick vegetal cover. Thus the gullies within predominantly cultivated catchments receive more run-off and hence experience more erosion.

The analysis further reveals that farming practices in the area are such that areas between moulds and ridges create favourable zones for concentrating surface run-off, The effects of these have been demonstrated in Patrick (1990).

In addition, the influence of human landuse changes especially through persistent cultivation of the same piece of land is not limited to increasing erosivity alone. They affect the erodibility of the soils as well. This is because erodibility is influenced more by management than by any other factors. Cultivation affects soil structures as well by reducing the clay and organic matter content of soils.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

In general, farming has proved most harzadous in the Guinea Savanna Belt of Northern Nigeria chiefly because of the difficulty of controlling water erosion on sloping land. Also, landuse changes contributed to the escalation of gullying in this part of Nigeria.

However, gullying in Ankpa area of Kogi State is one of the numerous gully areas in the Guinea savanna zone of Nigeria. Gullying here has constituted a problem requiring attention because cropping and grazing are carried out without taking into congnisance their effects on the environments. Presently, in this area, the destructive effects of gullying have rendered many people homeless and caused loss of properties and agricultural Lands. Several houses here have been swept while strong buildings lie precariously at the edge of the gully waiting for their turn.

Plate; Part of the devastated gully site

Desperate and confused control programmes by individuals and groups in the affected areas are almost in vogue. The causative effects are not yet fully undertstood and appreciated by environmental planners and managers. Nevertheless, this study is an attempt to explain the trend and/or rate of growth and to probably propose possible solutions to bring it to its barest possible level.

With steady and conscientious implementation of some control programmes as regards this menace, there is high optimism in bringing the problem to a minimal level if not total eradication.

One way of minimising this escalation is to be able to identify the danger areas more accurately. The danger areas could then be remedied with adequate conservation measures. Also, to be able to predict future areas of erosion will require the use of more than one sets of photographs flown regularly and at suitable scales and seasons.

The ways of checking erosion is by knowing the causes. The inhabitants of the area under study should cultivate the habit of maintenance of the vegetal cover and planting of new trees for replacement. Here, vetiver grass could offer the best weapon in this regard. When planted in rows, it forms a thick hedge which slows down rainfall run-off. This can be used in sloppy areas on the campus of the state college of Education in Ankpa.

Efforts should also be made towards minimising the collection of run-off from a wide area by creating diversions at intervals. This means in effect shortening the stream length so as to diminish drainage density.

Burning of sites for purposes of farming is destructive to the soil. Farmers should be made to know that natural forests, plantations and farms should therefore as a necessity, be protected from fire.

Furthermore, civil engineering works especially road construction should be carried out in recognition with the hydrometeorological, geomorphic nature and geologic setting.

Finally, socio-psychological aspect of the control programme must include public involvement and enlightenment activities whereby the inhabitants of Ankpa are properly educated on the dangers of erosion caused through anthropogenic factors and effective participation in post constructional maintenance.

5.2 RECOMMENDATIONS FOR FURTHER RESEARCH

At the end of such a study like this, it is pertinent to make recommendations for further studies.

Gully erosion studies are multi-disciplinary in nature and for the combined efforts of hydro meteorologist, geomorphologists, geologist etc. Intensive research work on the three main soil degradation (splash, sheet and gully erosions) should be pursued allover the country so that their influences on our various environments might be understood.

The various factors involved in gullying should be completely identified. This call for further work in line with the present study. Most recent aerial photographs, the use of computer for interpretation in order to forcast the future trend of gully erosion. Federal and state Governments as well as interested private organisations should be involved in the funding of these researches.

Conclusively therefore, the prospects of remote sensing application in Nigeria are very high and promising once governments, and users remain commmited in their effort to establish a comprehensive Remote Sensing centres. This will ease data acquisition, processing and will provide a unique opportunity for training of experts.

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