INVESTIGATION INTO GULLY/LANDSLIDE OCCURRENCE AND ITS EFFECT ON SMALL SCALE FARMING IN ANAMBRA STATE

(CASE STUDY: NANKA COMMUNITY)

BY

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MATRIC NO: 2004/18374EA

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FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

FEBRUARY, 2010

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BEING A FINAL YEAR PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING

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FEBRUARY, 2010

DECLARATION

I hereby declare that this project work is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any university or institution. Information derived from personal communications, published and unpublished work were referenced in the text.

Ezenekwe, Ericson Elochukwu

10/02/10
Date

CERTIFICATION

This is to certify that "investigation into gully/landslide occurrence and its effect on small scale farming in Anambra state" by Ezenekwe Ericson Elochukwu, meets the regulations governing the award of the degree of Bachelor of Engineering (B. ENG.) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary presentation.

Engr. Peter Idah (Project Supervisor)	10/02/10 Date
Engr. Dr. A. Balami Head of Department	22/02/10 Date
External Examiner	10/2/2010 Date

DEDICATION

To the glory of Almighty God, this report is dedicated to my dear father, Mr. Ezenekwe Ebenezer Nkemjika.

ACKNOWLEDGEMENTS

For grace, mercy, total dependence, and abundant life I have had (particularly during my study), greatest thanks and gratitude to God Almighty; the source of all I have had, have, and can ever have.

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ABSTRACT

This study was aimed at investigating the root cause of the worsening gully erosion and landslide occurrences and its effect on the small scale agricultural activities in Anambra state, particularly in the Nanka community which was used as case study.

Soil samples were collected at two locations around one of the gully sites in Nanka and analysed for particle size distribution. Measurements of gully dimensions were made while field visits and questionnaires were utilized as well.

Findings from the questionnaire indicate with over 75% assurance that flood is mainly responsible for the gully activities; soil analysis shows that the soil is medium to coarse grained with high sand and low gravel content(which is of high susceptibility to erosion). The combination of the soil property and flood factor explains the existence of the intense gully activities in the area.

Among other negative effects identified, the study estimated that the gully erosion problem has devastated about 24.5% of the land which would have been useful for agriculture. It recommends that the gully walls be stabilized with heavy engineering structures, which could be achieved with the collaborative effort of the government, individuals, civil societies and international partners.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Soil and water are part of nature's free gifts to man, both of which to a great extent are responsible for life on earth. Whether for agriculture, housing, recreational activities or any other purpose, the consensus is that land and its resources is getting scarcer by the day. While only specialized people were aware and so much concerned about this issue in the past, it is becoming very obvious and as well, worrisome to the ordinary man.

For poorer nations in the world, it is not that the increasing shortage in land is entirely due to its wise but consistent use, so that land resources are continually developed to the extent that they become scarce. The scarcity of land results from one form of environmental degradation or the other which is directly or indirectly associated with unsustainable practices by man.

Global population explosion has not helped the issue as there has been dramatic increase in the demand for resources like land and water. For example, according to a 2001 estimate by DFID UK, global freshwater consumption rose six folds between 1900 and 2000. Microsoft Encarta (2009) gives an idea of how human population has increased. According to Encarta, between 1950 and 2000, the world population more than doubled to 6 billion people, having up to 80% of these people living in developing countries.

While only about 1.65 billion people lived on earth in 1900, more than 6 billion people lived by 1999 with a projected rise of up to 9 billion by 2050. These entire dramatic increases suggest more abuse of nature by man (through unsustainable practices) and increased pressure on resources like freshwater and land, yet they remain fixed in supply.

The human population of Africa has grown rapidly over the years. With Nigeria being Africa's most populous country and a major contributor to this growth, there is need for increased attention to environmental matters like degradation and conservation. This is also because Nigeria is prone to some land degradation problems of flooding, drought, erosion etc. For example, while flooding is a general seasonal phenomenon all over the country, far northern Nigeria is peculiar with desertification, and erosion (supposed to be the most devastating) occur in the entire south eastern part, especially in Anambra state.

Anambra is a state in the south-eastern geo-political zone of Nigeria and has a land area of about 4,844km². With thriving commercial activities in the state, the human population has grown leaving the state with a high human population density ranking among the highest in the country. The state has good potential for agriculture with its fertile soil for a wide range of crop production. The climate favours the cultivation of an array of different arable crops and the state also has some inland waterways and an extensive coastal region that is rich in fish and other marine products.

About 75% of the population are engaged in profitable agriculture, engaging themselves in the production of food crops, tree crops, livestock and fisheries. The predominant agricultural areas include Anambra East and West, Aguata, Awka North, Ayamelum, Oyi, Ogbaru, Orumba North and South local Government (Anambra State Government, 2008).

Although the states land area is very small, the effect of the accompanying high population density has been minimal as a notable proportion of the people in the state used to live in the rural area. However, the last two decades witnessed a change in this situation due to rural-urban migration.

Agriculture has a fair share in the employment of labour especially in rural areas where crop production is well at subsistence level, and the states economy is heavily dependent on its water, as well as land resources that host agriculture.

In the recent past, Agriculture in the state suffered so much neglect and this, coupled with industrialization and quest by the people for better living conditions resulted to loss of manpower. People in the rural areas have moved away from agriculture to find better sources of livelihood within the same rural community, or entirely in urban centres as in most cases.

The effect of this is felt both in the agricultural and non agricultural sectors of the states economy. For example, fewer raw materials are available to industries that depend on agriculture. These industries are forced to import raw materials and transfer the costs to consumers, thereby making products expensive and intensifying poverty in the state. Decrease in manpower for agriculture in the state has brought about decrease in food production which makes food scarce or even when available, expensive to purchase. To make better income, the remaining manpower in agriculture produce less of cheap food stuffs like tomatoes and green vegetables (which are good sources of nutrients), and more of crops like yams and cassava. This brings about unequal availability of the different classes of food, resulting to increased case of malnutrition and food insecurity.

Putting aside the shortage and consequent increased stress on water for domestic use, when freshwater becomes scarce, industries that must succeed look for other means of getting water– either transport from afar or dig boreholes– and transfer the cost to consumers, making products expensive and clearer, the margin between the rich and the poor.

This is just to appraise the synergy and significance of land and water resources for economic development and poverty alleviation in Anambra state.

The present state administration has involved itself in some projects aimed at the simultaneous development of different sectors in the state. Two of the projects include the Anambra Integrated Development Strategy (ANIDS), and the release of Government Cash Counterpart Contributions (GCCC) which qualified the state to benefit from the support of the World Bank in community-driven agricultural projects and programmes.

The state also participates in programmes like the National Programme for Food Security (NPFS), Fadama III project and the Root and Tuber Expansion. These are aimed at increased agricultural production and poverty alleviation through mechanising and fully commercializing the agricultural system in the state, in order to provide income for the teeming population and improve standard of living of the people.

Despite these efforts, Agriculture in Anambra state today still faces some challenges in meeting with the food requirements of the growing human population and hence, there exist case of food insecurity and increasing number of people at risk from hunger.

However, there seem to be no prospects for a better time in Anambra state due to the increasing devastating effects of the worsening gully erosion and accompanying landslide occurrences.

So much – including lives, agricultural lands, means of livelihoods and infrastructure – has been lost and still been destroyed.

This research focuses on investigating the root cause of the Nanka problems and underscoring its effects on small scale farming activities in the state.

1.2 Statement of Problem

Soil erosion with accompanying landslides has been a serious ecological problem affecting Anambra state. This has resulted to the continuous loss of lives, crops, agricultural soil, farms and infrastructure, means of livelihoods, etc.

1.3 Objective of the Study

This study aimed to:

- Investigate the root cause of the gully erosion and landslide problems in Nanka, and how it affects farming activities in the community.

Its specific objectives were to:

Understand (using questionnaire) which was the major causative factor responsible for the Nanka problems – between human activities and flooding.

Analyse soil samples collected from the site to check the their susceptibility to erosion

Provide estimate of agricultural land area claimed by selected gully site (s) in Nanka.

Discuss how it has affected agricultural activities.

1.4 Justification of the study

- This study will help in the understanding of the root cause of the gully erosion and landslide problems in Nanka.
- According to Scheyer (1998), soil erosion is a major process for which detailed data is lacking. This research will add to existing knowledge and data regarding gully erosion in Anambra state.
- It provides a clearer view of the gully's devastating effects on agriculture in Nanka

1.5 Scope of the Study

Generally the study refers to Anambra state but more of it will be limited to Nanka community in Orumba-North local government area of the state. This is because of the perceived predominance of Nanka community in the reports on erosion and landslide, which is of particular interest in this study.

The study will also be limited to the assumptions made and the amount of information and data collected at the time of writing.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This Chapter reviews earlier works or investigations related to agriculture, and the gully erosion and landslide problems in Anambra state. The rationale for this is to see what has been done so far by other researchers as regards the topics, and then know what contribution this work can make in terms of adding to existing knowledge.

1 Agriculture

Agriculture according to Wikipedia is the production of foods and goods through farming. The Helsinki Commission (HELCOM PITF) defines agriculture as the use of land for production of food, fodder, fibre, energy, medicine and for grazing.

Agriculture encompasses a wide variety of specialties and techniques, including ways to expand the lands suitable for plant raising, by digging water-channels and other forms of irrigation. Cultivation of crops on arable land and the pastoral herding of livestock on rangeland remain at the foundation of agriculture. In the past century there has been increasing concern to identify and quantify various forms of agriculture. In the developed world the range usually extends between sustainable agriculture (e.g. permaculture or organic agriculture) and intensive farming (e.g. industrial agriculture).

Cropping systems vary among farms depending on the available resources and constraints; geography and climate of the farm; government policy; economic, social and political pressures; and the philosophy and culture of the farmer. Shifting cultivation (or slash and burn) is a system in which forests are burnt, releasing nutrients to support cultivation of annual and then perennial crops for a period of several years. Then the plot is left fallow to regrow forest, and the farmer moves to a new plot, returning after many more years (10-20). This fallow period is shortened if population density grows, requiring the input of nutrients (fertilizer or manure) and some manual pest control. Annual cultivation is the next phase of intensity in which there is no fallow period. This requires even greater nutrient and pest control inputs. Further industrialization lead to the use of monocultures, when one cultivar is planted on a large acreage. Because of the low biodiversity, nutrient use is uniform and pests tend to build up, necessitating the greater use of pesticides and fertilizers. Multiple cropping, in which several crops are grown sequentially in one year, and intercropping, when several crops are grown at the same time are other kinds of annual cropping systems known as polycultures. (Wikepedia, 2009)

In tropical environments, all of these cropping systems are practiced. In subtropical and arid environments, the timing and extent of agriculture may be limited by rainfall, either not allowing multiple annual crops in a year, or requiring irrigation. In all of these environments perennial crops are grown (coffee, chocolate) and systems are practiced such as agroforestry. In temperate environments, where ecosystems were predominantly grassland or prairie, highly productive annual cropping is the dominant farming system.

Subsistence agriculture is self-sufficiency farming in which farmers grow only enough food to feed their families. The typical subsistence farm has a range of crops and animals needed by the family to eat during the year. Planting decisions are made with an eye toward what the family will need during the coming year, rather than market prices (Wikipedia, 2009)

Soil Erosion

Soil erosion according to the World Book Encyclopaedia (2004) is a natural process by which soil are broken loose from the earth's surface at one location and moved to another, and can be speeded up by human activities like farming, mining etc.

It is one form of soil degradation along with soil compaction, low organic matter, loss of soil structure, poor internal drainage, salinisation, and soil acidity problems. These other forms of soil degradation, serious in themselves, usually contribute to accelerated soil erosion (Ontario Ministry of Agriculture, Food and Rural Affairs, 2003).

According to the European Commission Joint Research Centre, Soil erosion is a natural process occurring over geological time, and is indeed essential for soil formation in the first place. With respect to soil degradation, most concerns about erosion are related to accelerated erosion, where the natural rate has been significantly increased mostly by human activity.

The processes of soil erosion involve detachment of material by two processes; raindrop impact and flow traction (USDA 2001, EU- JRC 2009); and transportation either through the air or by water flow. Soil erosion may be a slow process that continues relatively unnoticed, or it may occur at an alarming rate causing serious loss of topsoil. The loss of soil from farmland may be reflected in reduced crop production potential, lower surface water quality and damaged drainage networks.

Considering the above, soil erosion may be broadly grouped into:

- Natural or Geologic erosion, and
- Accelerated erosion

Natural erosion refers to those soil-forming and soil-eroding processes that keep the soil in balance without resulting to disaster. This type of erosion sees to the formation of soil and their distribution on the earth surface which happens over a very long period of time and determines various topographic features like valleys, stream channels etc. For example, according to the World Book Encyclopaedia (2004), the Grand Canyon was created over the cause of millions of years by erosion from Colorado River. "Erosion changes land by wearing down mountains, filling in valleys, and making rivers to appear and disappear" it notes.

Accelerated erosion is caused by both natural and human activities. It constitutes the most problem of the two erosional processes facing man and involves the removal of organic and mineral particles. Accelerated erosion occurs when the plant cover is depleted, the spaces between plants become larger, and soil structure is degraded by excessive disturbance or reduced inputs of organic matter (USDA, 2001).

The process of soil erosion involves weathering, where environmental factors break down soil into smaller pieces and loosen them from the earth's surface (World Book Encyclopaedia, 2004). After this, the loose materials are moved away to new locations by agents of erosion.

According to Ontario Ministry of Agriculture, Food and Rural Affairs (2003), the agents of soil erosion are water and wind. However, some literatures have included glacier and hence, agents of soil erosion can be categorized as:

- Water
- Wind , and
- Ice/glacier

Forces which are responsible for erosion may be grouped into:

i. Attacking force of agent which is responsible for the dislodge and transport of particles from one place to the other, and

ii. Retarding force which resists transport and brings about deposition of materials in transit.

Deposition of the sediment removed by erosion is likely in any area where the velocity of running water is reduced—behind plants, litter, and rocks; in places where slope is reduced; or in streams, lakes, and reservoirs (USDA, 2001)

Considering the means by which material are eroded, accelerated erosion can be sub-divided into:

- Water erosion, and
- Wind erosion

2.2.1 Water Erosion

Water erosion, according to the USDA (2001) is the detachment and removal of soil material by water. The erosion rate may be very slow to very rapid, depending on the soil, the local landscape and the weather conditions.

Dave (2005) explains that soil erosion by water is the result of rain detaching and transporting vulnerable soil, either directly by means of rain splash or indirectly by rill and gully erosion.

2.2.2 Factors that Influence Erosion by Water

Runoff is the most important direct driver of severe soil erosion by water (EU- JRC, 2009). According to Ontario Ministry of Agriculture, Food and Rural Affairs (2003), the rate and magnitude of soil erosion by water is controlled by the following factors:

a. Rainfall Intensity and Runoff

Both rainfall and runoff factors must be considered in assessing a water erosion problem. The impact of raindrops on the soil surface can break down soil aggregates and disperse the aggregate material. Lighter aggregate materials such as very fine sand, silt, clay and organic matter can be easily removed by the raindrop splash and runoff water; greater raindrop energy or runoff amounts might be required to move the larger sand and gravel particles.

Soil movement by rainfall (raindrop splash) is usually greatest and most noticeable during short-duration, high-intensity thunderstorms. Although the erosion caused by long-lasting and less-intense storms is not as spectacular or noticeable as that produced during thunderstorms, the amount of soil loss can be significant, especially when compounded over time. Runoff can occur whenever there is excess water on a slope that cannot be absorbed into the soil or trapped on the surface. The amount of runoff can be increased if infiltration is reduced due to soil compaction, crusting or freezing.

b. Soil Erodibility

Soil erodibility is an estimate of the ability of soils to resist erosion, based on the physical characteristics of each soil. Generally, soils with faster infiltration rates, higher levels of organic matter and improved soil structure have a greater resistance to erosion. Sand, sandy loam and loam textured soils tend to be less erodible than silt, very fine sand, and certain clay textured soils.

Decreased infiltration and increased runoff can be a result of compacted subsurface soil layers. A decrease in infiltration can also be caused by a formation of a soil crust, which tends to "seal" the surface. On some sites, a soil crust might decrease the amount of soil loss from sheet or rain splash erosion, however, a corresponding increase in the amount of runoff water can contribute to greater rill erosion problems.

Past erosion has an effect on a soils' erodibility for a number of reasons. Many exposed subsurface soils on eroded sites tend to be more erodible than the original soils were, because of their poorer structure and lower organic matter. The lower nutrient levels often associated with subsoils contributes to poorer crop cover, which in turn provides less crop protection for the soil.

c. Slope Gradient and Length

Naturally, the steeper the slope of a field, the greater the amount of soil loss from erosion by water. Soil erosion by water also increases as the slope length increases due to the greater accumulation of runoff. Consolidation of small fields into larger ones often results in longer slope lengths with increased erosion potential, due to increased velocity of water which permits a greater degree of scouring (carrying capacity for sediment).

d. Vegetation

Soil erosion potential is increased if the soil has very little or no vegetative cover of plants and/or crop residues. Plant and residue cover protects the soil from raindrop impact and splash, tends to slow down the movement of surface runoff and allows excess surface water to infiltrate.

The erosion-reducing effectiveness of plant and/or residue covers depends on the type, extent and quantity of cover. Vegetation and residue combinations that completely cover the soil, and which intercept all falling raindrops at and close to the surface are the most efficient in controlling soil (e.g. forests, permanent grasses). Partially incorporated residues and residual roots are also important as these provide channels that allow surface water to move into the soil.

2.2.3 Effects of Water Erosion

The effects of water erosion could be off-site or on-site.

a. Off-site effects

Water erosion's main off-site effect is the movement of sediment and agricultural pollutants into watercourses. This can lead to the silting-up of dams, disruption of the ecosystems of lakes, and contamination of drinking water. In some cases, increased downstream flooding may also occur due to the reduced capacity of eroded soil to absorb water. Rates of erosion do not have to be high for significant quantities of agricultural pollutants to be transported off-site. This is a shorter-term impact than loss of soil quality; in the more affluent areas of the world it can be the main driver for present-day soil conservation policy initiatives. A more minor off-site effect can occur in situations where eroded soil has a decreased capacity to absorb water: increased runoff may lead to downstream flooding and local damage to property (Dave, 2005).

Off-site impacts of soil erosion are not always as apparent as the on-site effects. Eroded soil, deposited down slope can inhibit or delay the emergence of seeds, bury small seedling and necessitate replanting in the affected areas. Sediment can be deposited on down slope properties and can contribute to road damage. Sediment which reaches streams or watercourses can accelerate ban erosion, clog drainage ditches and stream channels, silt in reservoirs, cover fish spawning grounds and reduce downstream water quality (Ontario Ministry of Agriculture, Food and Rural Affairs, 2003)

b. On-site effects

The main on-site impact is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil, and the reduced water-holding capacity of many eroded soils. Erosion's removal of the upper horizons of the soil results in a reduction in soil quality. Also, because the finest constituents of eroded soil tend to be transported furthest, eroded soils become preferentially depleted of their finer fraction over time; this often reduces their water-holding capacity. In other words, "Erosion removes the cream of the soil". The damaging on-site effects of erosion, in terms of decreased agricultural yields, are well known in the developing countries of Africa and Asia (Dave 2005)

The implications of soil erosion extend beyond the removal of valuable topsoil. Soil quality, structure, stability and texture can be affected by the loss of soil. The breakdown of aggregates and the removal of smaller particles or entire layers of soil or organic matter can weaken the structure and even change the texture. Textural changes can in turn affect the water-holding capacity of the soil, making it more susceptible to extreme condition such a drought (Ontario Ministry of Agriculture, Food and Rural Affairs, 2003)

2.2.4 Types of Water Erosion

Water erosion may be divided into:

a. Splash or raindrop erosion: the type of water erosion caused as a result of the direct impact of falling raindrops.

b. Sheet erosion: according to Wikipedia (2009), is the detachment of soil particles by raindrop impact and their removal down slope by water flowing overland as a sheet instead of in definite channels or rills

c. Rill erosion: refers to the development of small, ephemeral concentrated flow paths, which function as both sediment source and sediment delivery systems for erosion on hill slopes (Wikipedia, 2009). These paths are not too big and can always be removed by tillage operations, but if neglected, can develop into gullies.

d. Gully erosion: this is the removal of soil by excessive concentration of running water, resulting in the formation of very large channels which cannot be destroyed by normal cultivation. According to NRW (2006), gully erosion is a highly visible form of soil erosion that affects soil productivity, restricts land use and can threaten roads, fences and buildings. It occurs when running water erodes soil to form channels deeper than 30cm says the Northern Rivers CMA.

   According to David & Penny (1999), Gully erosion is the removal of soil along drainage lines by surface water runoff. Once started, gullies will continue to move by head ward erosion or by slumping of the side walls unless steps are taken to stabilise the disturbance. Repair work done in the early stages of newly formed gullies is easier and more economical than letting the problem go unchecked for too long. Large gullies are difficult and costly to repair.

Deyanira (2003) explains that studies on necessary kinetic energy to detach one kilogram of sediments by raindrop impact have shown that minimum energy is required for particles of 0.125mm, where particles between 0.063 to 0.25mm are most vulnerable to detachment. It further explains that soils with high content of particles into vulnerable range, for example loamy, silty loam, fine sandy and sandy loam are most susceptible to detachment.

Particle size is one of the key parameters that determine the susceptibility of a particular soil to erosion and which could control channel erosion (Casali et al, 2003; Robinson, 2007)

3 Gully Erosion in Nanka

The south-eastern states of Nigeria (which includes the states of Abia, Anambra, Ebonyi, Enugu and Imo) are confronted with serious problem of gully erosion and landslide, with some of the very intense occurrences in the Nanka community of Anambra state.

The cause of the problems is not clear. The newspaper holds that gully erosion is a product of unsustainable farming practices, deforestation, path and road construction, and poorly constructed drainage system. And some people in the rural areas still nurture superstitious believes as regards the cause of the gully erosion/landslide problems. Having about 540 active erosion sites, Anambra state is said to be existing at the mercy of erosion. Well know and described as most notorious are the erosion sites in Nanka. Nanka is a town in Orumba-North local government area of Anambra state that has had its people suffer as a result of intensive gully/landslide problems, dating back to the 1920s. In the Nanka community, lives, houses, crops and inestimable farmlands have been lost. This affects agriculture as some of the community people – who are very much engaged in agriculture, have lost their lives while some others have been made homeless; crops and farmlands are being lost to landslides, water courses which provide water for humans and farming are also lost, and some roads which are used to transport agricultural produce are cut. "Due to gully erosion, my people cannot farm anymore. The few who still farm don't have ways of evacuating their produce." – said Amara Chukwuka, a native of Nanka. "We are completely cut from civilization" (Sunday SUN 2009)

In response to the problem, there was an earlier but unsuccessful attempt by the British Colonial masters to hold the gully through massive tree planting. There has also been abandonment of houses by people living within the gully precincts, while some others cannot relocate because they have no place to go and cannot afford to pay rents elsewhere. The erosion problem is worsening as there are more frequent occurrences and far more active sites than there was when the gully was first noticed around 1920.

Several investigations have been made concerning the root cause of the problems and how they could be tackled.

According to Egboka (1984):

With the aim of describing the geology, hydrology, geotechnical characteristics and hydrogeochemistry of the Nanka-Agulu region and relating them to the prevailing erosion and gullying in the area, Egboka and Okpoko (1984) reported an investigation which covered review of earlier work and laboratory analysis. Geological investigations were carried out in the area to cover both rainy and dry seasons, but with more detailed study during the dry season when the slope failures were less. Water samples from some lakes were collected and analysed in the laboratory. Geochemical, lithological and stratigraphic studies were carried out and ground water flow patterns, effluent seepages and channel flow were observed and described. According to the work, the primary causes of the gully genesis and growth lie in the geotechnical and hydrogeotechnical properties of the aquifer system underlying the affected area. This was against previous researches which attributed the gully/landslide problems to human activities on the geomorphological processes. However, the report did recognize contribution to the problem, of human activities in the area.

According to Hudec et al (2006):

This work was aimed at explaining the widespread occurrence of gullies in the area and to design a strategy for the prevention and control of gully erosion. It included detailed mapping of the gully system at selected locations of south-eastern Nigeria, and revision of existing maps of superficial deposits and the solid geology at and around the sites of gully erosion. Geotechnical tests of soil samples, sediments and sedimentary rocks were also carried out. Collaboration was also made between the research team and the locals to make improvement to local approaches of gully remediation. The work discovered that in the project area, the bedrock consisted majorly of siliciclastic strata, which shows varying degrees of lithificaiton. Gully processes are localized in the fine-to-medium-grained coastal plain sands (Pliocene to recent) and Nanka sands. The Nanka sands contained subordinate shales and there exist local development of paleosol at Nanka which is responsible for landslides.

The erosion/landslide problems in Nanka started little by little, first as narrow channels which widened gradually and had had marked changes in the landscape of the area by the middle of the twentieth century. At this period, gully erosion became very noticeable and scattered all over Nanka. The perceived major cause of this gully initiation has changed over time. Initially it was thought to be majorly caused by human activities, but this perception changed as time passed and it is now clearer that the landslide problem is far more than and different from what human activities could cause. Egboka and Okpoko (1984) acknowledged this shift in what is believed to be the major causative factor of the gully genesis and growth. It tries to explain how earlier studies ascribed the problem to the influence of human activities on the structure and formation of the earth surface around the area, but agreed with a later investigation carried out by Egboka & Nwankwor (1982), which attributed the problem to the hydrogeological and geotechnical properties of the aquifer system underlying the affected area. Igokwe et al (2008) identified such other human factors which may be responsible for the problem as laterite excavations, bad farming practices, unplanned road construction and urbanization, wood harvesting for fuel and bush burning to clear lands for farming and others. That is to say that notwithstanding the explanation from the work by Egboka and Okpoko (1984), the contribution of mans activities (as stated above e.g. bad farming practices) to this problem still lingers. Although Nanka suffers most, the landslide/erosion problem is not just of Nanka but peculiar to the entire south-eastern region of Nigeria.

The geological formation of the Nanka sands consist of an arrangement of a cycle of unconsolidated and poorly consolidated sands that stretch about 305m deep and underlain by thick Imo shale formation. The soils (Nanka) are mostly sandy and include thin clay and siltstone bands. They are friable and poorly cemented, and are permeable (except for the shale layers which are not). The sands that make up the soil are medium to coarse grained, cross-bedded and poorly sorted. The cross-bedding takes the form of shale units alternating with siltstone and fine sand and occurring in beds of 40-50 cm thick (Egboka & Okpoko, 1984).

The hydrologic property of the area is also important. Due to the poorly consolidated nature of the sands, there is high percolation and flow rate occurrence which is experienced especially during the rainy season. When there is severe rainfall, the water table rises and coupled with the high vertical hydraulic conductivity of the free sands, get the sand saturated and hence, increase the flow rate of groundwater. This underground water flow contributes a lot to gully erosion in the area. During this season, the water table may sometimes rise to even project out to be seen in areas where the gully is very deep. The saturation of the soil by water leads to the presence of high pore water pressures which contribute to material flow and consequent gulling. These pore water pressures act to reduce the effective strength of the unconsolidated coarse sands along the seepage faces of the gully walls and the sands are gradually loosened and eroded.

The waters also affect the less permeable clayey layers and lubricate them. When the clays are saturated, they expand and loose strength.

The situation is not very similar during the dry season when there is less rainfall and fall of water table as a result of hydraulic head decay.

Alternating dry and wet seasons have impact on the behaviour of the interbedded shales which undergo considerable changes in volumes. When wet during the rainy season, they increase in volume, become plastic and sticky, while during the dry season, they dry up to form baked lumps. Dryness that comes with the dry season makes the clay and shale to contract and cause tension cracks. The cracks widen and with time – when another occurrence of groundwater saturation occurs – the clay minerals swell and develop a tendency to slide. Gravity, coupled with the weight of the large masses of sand on top of the clay mineral and the slippery nature of the clay minerals lead to large movement of sand deep down the gully in form of landslide (Egboka & Okpoko, 1984).

Saturday SUN Reports of heartbreaking stories of what erosion had done to vulnerable and hapless people and how it has left mind-bugling scars in states ranging from Abia to Imo, Anambra, Enugu and Ebonyi.

According to **Saturday SUN** (August 9, 2008):

Major erosions site was first noticed between Nanka and Agulu and was termed Agulu-Nanka erosion. However, Nanka harbours one of the sites with huge impacts which have recorded high disaster levels and casualties since when it was first officially recognized in 1920, and the Nanka erosion is regarded the most devastating in Sub-Saharan Africa. Neighbouring communities of Agulu and Ekwulobia, and other communities like Abba and Abagana (in Njikoka local government area) and Utuh (in Nnewi South local government area) also have their share of the problem. When the colonial masters discovered the Agulu-Nanka erosion, they devised two plans: to plant trees to check the erosion and also to relocate the two communities to either Calabar or Equatorial Guinea but was stopped by intervention form late Dr. Nnamdi Azikiwe. By the time of Shagari/Ekwueme administration, gully in Nanka was fully blown up and had submerged more than 100 houses and claimed many hectares of farmland. At Okpo village in Utuh, no fewer than 20 lives were reported to have been lost in the past 20 years. About seven streams have been lost to expanding gully, putting Utuh (a town naturally endowed with sources of potable water) into acute water shortage.

The site at Umuchiana Ekwulobia have rendered about 627 families homeless and destroyed a federal road. This prompted the federal government to respond with a donation of 1billion Naira to the state government. The Ekwulobia people have spent fortunes trying to check the erosion which has overwhelmed them and even the state government.

According to **Sunday SUN** (November 2, 2008):

Erosion site at Nanka was identified as most notorious and was reported to have claimed inestimable farmlands, roads and sources of potable water. Floodwaters wash away their farmland, destroy their crops and home, and cut access roads.

While Anambra state was described as a largely forest region and reputed for its lush and green vegetation, the report expressed fears that the devastating effects of gully erosion could make the land become an arid bad land unsuitable for cultivation. It cited that the problem is beyond what any state government can confront.

Some erosion sites at Nanka and information concerning them are given below.

<u>Isiakpuenu/Amaudo gully erosion</u>

This gully stretches from Umudalla village in Nanka to the boundary of Ifite village by Nanka/Oko boarder and ends few meters away from the Federal Polytechnic in Oko.

- Divided Amako village into two and makes it virtually unmotorable as it has cut the internal roads leading to the other side of the village.
- People living within the gully precincts have abandoned their homes except for those who have no place to go.
- Gully became active in the last three years (from 2008)

Statistics:

- Gully expanded towards the road for about 90-120 ft in three years
- Depth: 800-1000 ft
- Width: 1000-1800 ft
- Length: 40,000 – 60,000 ft

Udongwu gully erosion

Stretches from the border of Nanka/Agulu and ends at the Ubahu/Enugwu Nanka border.

- Gully became active in 2006

Statistics:

- Depth: about 1000 ft
- Width: about 3000 ft
- Length: about 30,000- 40,000 ft
- Number of homes at risk as at July 2007: 255

Obuagu-Ubahu gully erosion

- Newest in Nanka
- Started as self created flow channel for flash floods originating from neighboring villages
- Have cut one of the major internal roads and also displaced at least 50 families.

Statistics:

- Depth: about 600-1000 ft
- Width: about 400-600 ft
- Length: about 6,000 to 10,000 ft
- Expansion rate: 50-150 ft per rainy season
- Number of homes at risk: about 80, housing no fewer than 540 people

CHAPTER THREE

.0 MATERIALS AND METHODS

This chapter consists of the procedures used in this study which include laboratory analysis of soil samples, research design, area of study, instrumentation, and method of questionnaire data collection.

.1 Soil sample collection and laboratory analysis

The soil sample collection and analysis were done in collaboration with a colleague, Emeka Elvis Nsofor (Geology Department, Federal University of Technology Minna, Niger State). At the Isiakpuenu gully erosion site in Nanka, two different soil samples were collected from two different locations – inside the gully and at normal un-caved ground around gully wall.

From the gully edge, 4 m was measured into the gully and some soil collected at the gully wall. At the normal ground outside of the gully, the land was dug to 1.5 meter depth, after which some soil was collected.

Both soil samples were taken to the laboratory for analysis of particle size which was intended to show the soil's property and reveal its susceptibility to erosion.

.2 Research Design

This study utilizes a survey made using oral interview and questionnaire to get peoples opinion on the Nanka erosion. This became necessary as it was assumed that careful consideration of the opinion (out of experience) of people living around the area, coupled with the available research works on Nanka gully/landslide will provide a better and unbiased understanding of the situation surrounding the gully/landslide occurrences. Using a combination of the results from the questionnaire and reviewed literatures concerning the causative factors of the Nanka erosion problems, discussions are made so as to determine the root causative factor.

.3 Area of Study

The study area comprise of the Nanka community. It is situated in Orumba North local government area of Anambra state Nigeria. Its geographical coordinates are 6° 3' 0" North, 7° 5' 0" East and its original name (with diacritics) is Nanka

The climate of the area is typically an equatorial tropical rainforest type with two distinctive wet and dry seasons. Wet season otherwise known as rainy season is characterized with high rainfall, high temperatures, and high relative humidity and occur between the month of April and October. Also the dry season otherwise known as Harmattan is characterized by chilly dry wind, low relative humidity, and general dryness and extends from November to March. Annual rainfall is usually high, up to 2000mm and occurs with large runoff which is of significant environmental importance. Minimum and maximum temperatures are about 25°C and 32°C respectively.

Vegetation is composed of continuous canopy of wide leaves and tall trees, and oil palms and bamboo are common. The geology is of the Nanka formation/sands. The sands occur in subunits comprised of poorly cemented friable medium to coarse grained pebbly quartz sand.

.4 Instrumentation

An eight-question questionnaire was designed with the title "questionnaire to acquire public opinion on Nanka erosion and landslide problems". The questionnaire was basically used to get opinion of the public on Nanka erosion and landslide problems. A bio-data section was also provided to get some bio-data of respondents.

3.5 Method of Questionnaire Data Collection

The questionnaire was presented to some field experts who examined and ensured appropriateness of language and clarity of expression used. After this, they were administered in person by the researcher. Explanations aside the ones written in the questionnaire were given to respondents to ensure good understanding of the questions and how to complete the questions. Confidential treatment of information was assured and after the filling out exercise, questionnaires were collected and returned for analysis.

3.6 Measurement of Isiakpuenu gully erosion site

The isiakpuenu gully site was measured by the use of measuring tapes and pegs. However, only the width and depth of the gully site could be measured as the length spanned across communities (too long). Measurement of the length was gotten from Sunday Sun (November 2, 2008).

CHAPTER FOUR

RESULTS AND DISCUSSION

Results:

The summary of the results of the responses obtained from the administration of the questionnaire are shown in the following tables.

Table 4.1: Summary of responses on the combination of flood and other human factors

Factors	Response (number of respondents and their respective percentages)											
	SA	%	A	%	D	%	SD	%	U	%	N	%
Agricultural activities of the people	2	5.7	4	11.4	12	34.3	11	31.4	4	11.4	2	5.7
Improper construction activities (of roads, bridges and buildings)	11	31.4	10	28.6	5	14.3	7	20	1	2.9	1	2.9
Industrial effect (heavy machines vibration on soil)	3	8.6	1	2.9	12	34.3	14	40	1	2.9	4	11.4
Sand excavation	15	42.9	10	28.6	7	20	1	2.9	0	0	2	5.7
Flood (water)	22	62.9	8	22.9	1	2.9	2	5.7	1	2.9	1	2.9

Table 4.2: Cumulative responses on the various activities

Activity	No of Responses	Percentage (%)
Agricultural activities	0	0
Construction activities	3	8.6
Industrial effect	1	2.9
Sand excavation	3	8.6
Flood	24	68.6
Null	4	8.6

Table 4.3: Response on the severity of gully/landslide problem through history

Year	Responses	Percentage (%)
1905-1920	3	8.6
1926-1935	1	2.9
1926-1935	1	2.9
1971-1990	6	17.1
1991-2008	23	65.7
Null	1	2.9

Table 4.4: Response on the ability of the State to tackle the landslide problems

Opinion	Response	Percentage (%)
Strongly Agreed	4	11.4
Agreed	4	11.4
Disagreed	8	22.9
Strongly Disagreed	16	45.7
Undecided	2	5.7
Null	1	2.9

2 Discussion

Possible major factors responsible for gully/landslides in Nanka

Agricultural activities of the people:

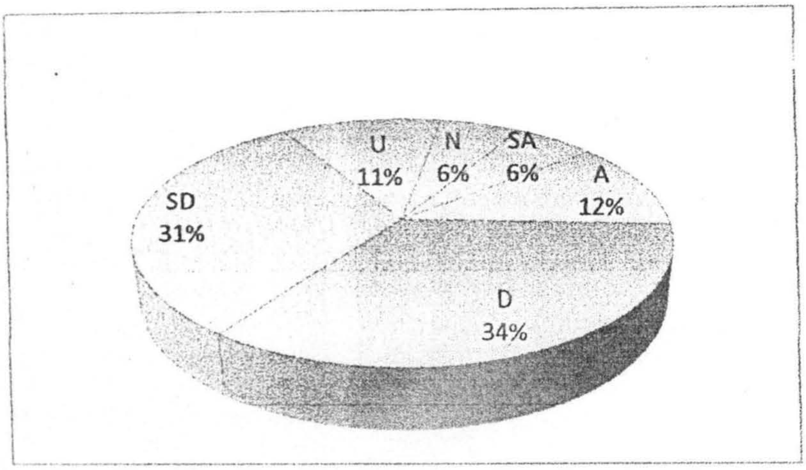

Fig 4.0: distribution of responses on Agricultural Activities as major causative factor

The findings reveal that for the option of *agricultural activity of the people* as major causative factor of the gully/landslide problems in Nanka, 6% of the respondents strongly agreed while 12% just agreed. 34% disagreed while 31% strongly disagreed. 11% of the respondents were undecided and 6% preferred to leave the question blank (See fig 4.1 above)

This means that about 18% of all the respondents were positive of the fact that agricultural activity practiced by the people in the area caused gully/landslide problems. However, 65% of the total respondents were rather negative of this option while 17% were neither positive nor negative. The result shows that although agriculture may be a possible cause of such kind of land degradation, it is not much applicable to the Nanka environment. Oral interview of the Nanka residents indicate doubt by the residents if the subsistence agriculture they practiced could cause such kind of devastation. This is probably what led to this kind of result.

Improper construction activities (roads, bridges and buildings):

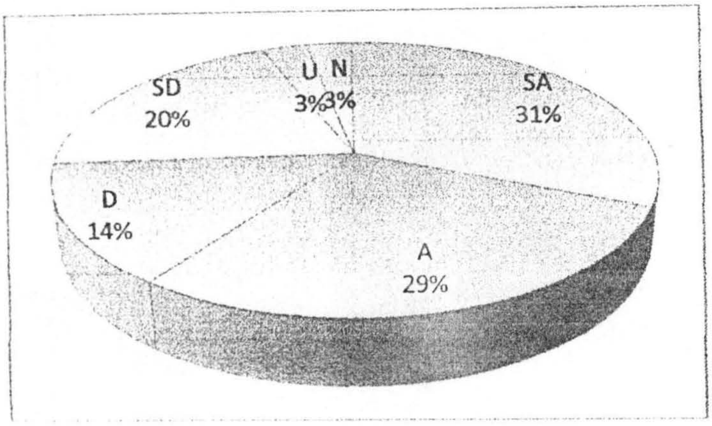

Fig 4.1: distribution of responses on Improper Construction Activities as major causative factor

Fig 4.2 shows that for the option of *improper construction activities* as a major causative factor of the gully/landslide problems in Nanka, 31% of the respondents strongly agreed, 29% just agreed, 14% disagreed while 20% strongly disagreed. 3% were undecided and another 3% did not fill anything. In other words, 60% of all the respondents were positive that improper activities caused the ecological problem in Nanka, 34% were negative of the statement, while 6% percent preferred to stand on the wall. The result shows that the option of *improper construction* is applicable to the situation in Nanka. Oral interview of the residents reveal that although was later controlled, at one period some road construction works were abandoned in one of the villages in Nanka and coupled with the action of flood, started developing gully channels. This is probably what led to this kind of result.

Industrial effect (heavy machines vibration of soil):

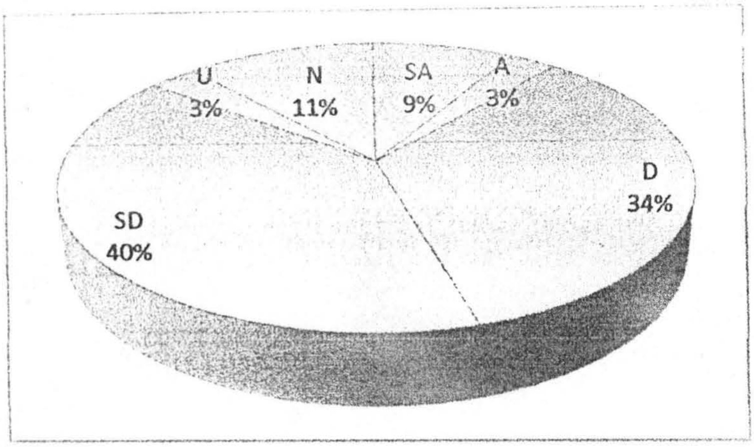

Fig 4.2: distribution of responses on Industrial Effect as major causative factor

The response for this factor shows that 9% of the respondents strongly agreed that the gully/landslide problem in Nanka is caused by industrial effects like vibrations from heavy machines. 3% also agreed to this, 34% disagreed while 40% strongly disagreed. 3% of the respondents were undecided while 11% left the space blank. The result indicates that 12% of all the respondents agreed to, or were positive of this idea. A total of 74% were negative of the idea that the problems in Nanka are related to effects from industries, while 14% were neither for nor against the idea. This result indicates clearly that this factor is not applicable as a major causative factor to the ecological problems in Nanka. Also, this result is in line with the response from informal interviews of Nanka residents, as they expressed disagreement in, for example, Nanka as an industrial area.

Sand excavation:

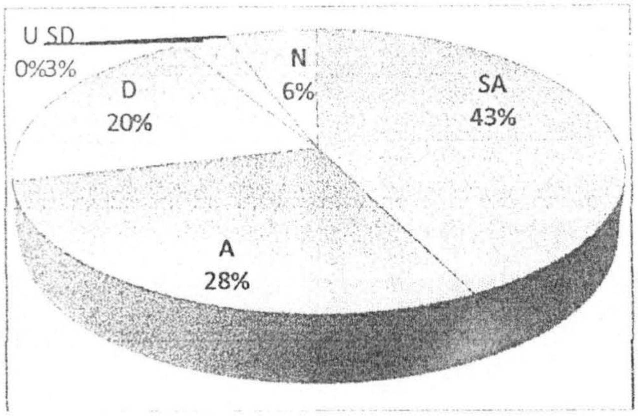

Fig 4.3: distribution of responses on Sand Excavation as major causative factor

This is an important factor which generally can instigate erosion. How applicable is this factor to the Nanka erosion problems. Fig 4.4 (above) is a pictorial presentation of the response from the questionnaire activity. From the figure, 43% of the respondents strongly agreed that sand excavation is a major contributor to the gully/landslides in Nanka community and 28% agreed. While 20% disagreed, 3% strongly disagreed and 6% didn't give an opinion. This indicates that where a total of 71% of all the respondents at least agreed that sand excavation is a major causative factor of the land degradation in Nanka, only about 23% were negative about this factor, while 6% offered no comment. It is therefore obvious that this factor is applicable to the problem in Nanka. From informal oral interviews conducted, it was gathered that at a period, the activity of sand excavation started in Nanka but was however controlled later by strict enforcement of laws. This is probably what led to this kind of result.

Flood (water):

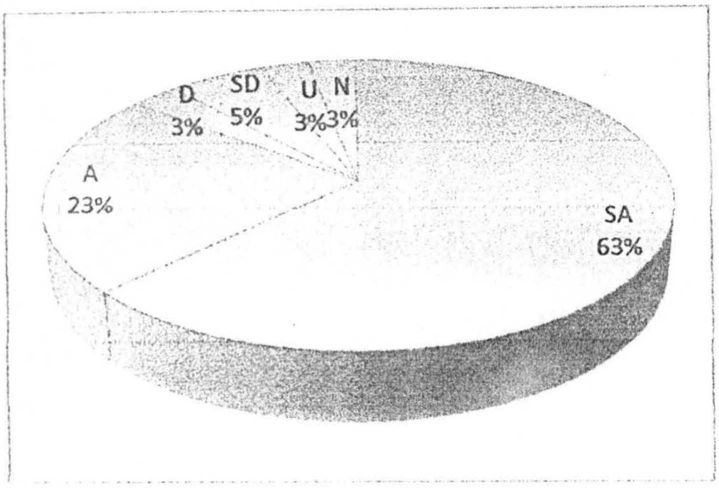

Fig 4.4: distribution of responses on Flood as major causative factor

Wind and water is a major agent of erosion. While wind can be responsible for some erosion occurrences and be so devastating, water is by far more common. How applicable is water as an important contributor to the problems in Nanka. Figure 4.5 (above) shows the opinion of respondents to water as a major causative factor of the gully/landslide occurrences in Nanka. According to the figure, 63% of the respondents strongly agreed, 23% agreed, 3% disagreed while 5% strongly disagreed. 3% were undecided and another 3% filled out nothing in this section. In another terms, the result indicates that a total of 86% of all the respondents were in support of the idea that water is the major causative factor of the problems in Nanka. 8% of all the respondents were negative and six percent were neither negative nor positive. This result shows that according to the respondents, water has a good role to play in the land degradation problems in Nanka. Informal oral interviews carried out show that the people were much particular about this factor as the major cause of their problem all the while. The influence of this is probably what reflected to give this kind of result.

The Major causative factor of gully/landslides in Nanka

Having looked at the possibility of attributing five different factors as majorly responsible for the problems in Nanka, it is worthwhile to consider – where the task is to find the major causative factor – the most important contributor of these five factors. This would require a deal of calculations from the above discussed points; however, the sixth question of this questionnaire was designed to save much of that stress. It requested the respondents to consider the aforementioned factors (referencing with serial number) and summarize their opinion so as to single out the most applicable. Figure 4.6 is a pictorial presentation of the results.

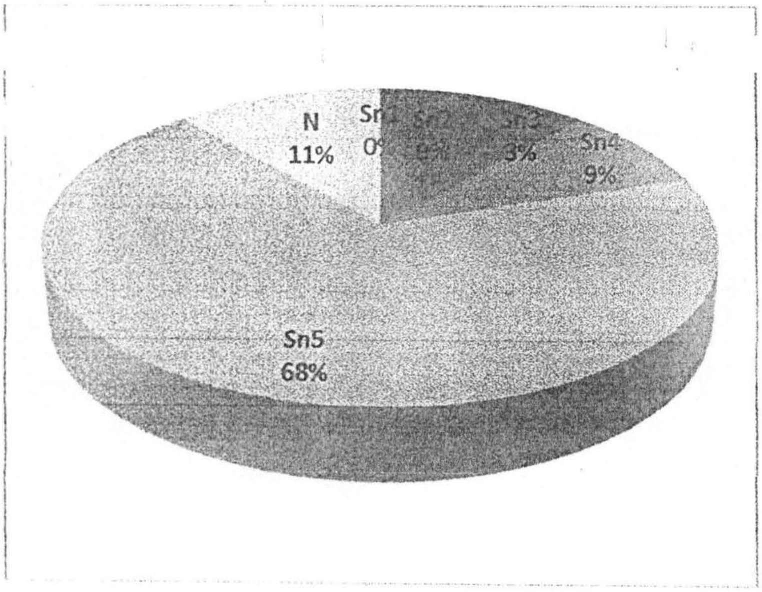

Fig 4.5: distribution of cumulative response of major collective factor

Where,

Sn5 = question 5 (for flood)

Sn4 = question 4 (for sand excavation)

Sn3 = question 3 (for industrial effect)

Sn2 = question 2 (for improper construction activities)

Sn1 = question 1 (for agricultural activities of the people)

The figure above shows that a total of 68% of all the respondents were of the opinion that flood (water) is the major causative factor of the gully/landslides in Nanka. 9%

went for sand excavation, 3% went for industrial effect and another 9% for improper construction activities. While none of the respondents thought that agricultural activities of the people is the major causative factor of the gully/landslide problems in Nanka, a total of 11% of all the respondents filed out nothing in this section. The latter (of 11%) causes a reduction in the percentage (100) rounding of the respondents that actually gave their opinion and it is therefore necessary to present the percentage of the different factors, neglecting the respondents that filled out nothing.

100% rounding of actual respondents, = 76.4%

The above discussion means that out of all the respondents that gave their opinion, 10.1% chose improper construction activities, 3.4% chose industrial effect and while another 10.1% chose sand excavation; at least 76% went for flood factor.

It was discovered in the informal oral interview conducted that almost all respondents particularly the Nanka residents were much particular about this factor. This is perhaps what led to this kind of result.

Severity of gully/landslide occurrences from initiation through history

Where record keeping is yet a very big problem, it was more a problem during periods past. There is very poor existing record of past gully/landslide occurrences and its pattern. Searching up these records was not easy and even when some were found; they were not coordinated and could not really reveal a defined trend in the distribution of severity of the gully/landslide activities over the years from period of inception. Question 7 was designed to assist in this problem as it required respondents to give their opinion of the period, out of some set periods (from 1905-2008), with the most gully/landslide occurrence.

Figure 4.7 shows a pictorial presentation of the results.

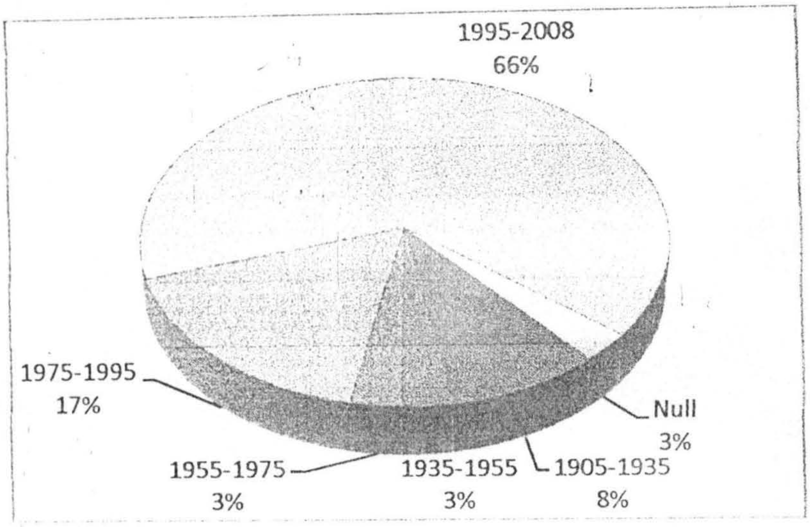

Fig 4.6: distribution of responses showing severity of gully problem through history

The above figure shows that 8% of the respondents believed that the period from 1905-1935 were the most important as regards gully/landslide activities in Nanka, 3% believed it was the period of 1935-1955 and another 3% believed it was from 1955-1975. A greater proportion of 17% thought 1975-1995 was the most important period; the greatest percentage thought that the period from 1995-2008 saw the greatest gully/landslide activity while 3% of the respondents gave no opinion. While the major task of this question was to know which period experienced the most activity of gully/landslide, the result seem to also give insight in the trend of the magnitude of the gully/landslides through the periods.

Ability to tackle the landslide problems

Gullies are scattered all over Anambra state and they keep being a source of serious worry for both the government and the people. Considering also the heavy destructions these expanding gullies keep causing and several failed efforts in controlling them, there begins to be doubt on the people's ability to contain the problem.

Question 8 tried to investigate into the perception of the people of how mighty a problem the gully activities are with respect to available resources to tackle them. Figure 4.8 shows a pictorial presentation of the response from the people.

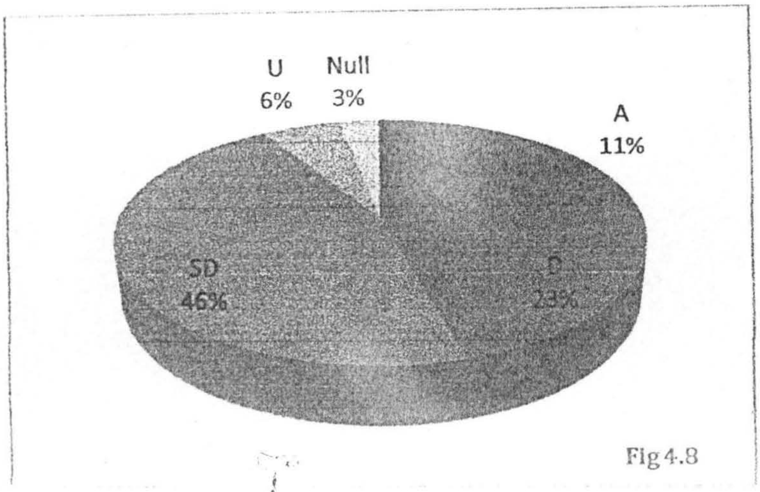

Fig 4.7: distribution of responses on ability of the state to tackle the gully problem

From figure 4.8 above, 11 % of the respondents strongly agreed that the Nanka community and entire Anambra state government are capable of handling the gully/landslide problems. Another 11% simply agreed, 23% of the respondents disagreed with the idea, while the greatest of 46% strongly disagreed that the gully/landslide problems are within what the Nanka community and the Anambra state government can handle. 6% and 3% were undecided and null respectively. This implies that a total of 22% of the respondents were positive about the statement, 69% were negative, and 9% preferred to be quiet.

The result indicates that the problems is above what the entire state can handle and is in line with observation, as the government of Anambra state has appeared umpteen times on National television to plead the support of both individuals, corporate organisations, the federal government and the international community.

Key **SA**= Strongly Agreed

A= Agreed

SD= Strongly Disagreed

D= Disagreed

U= Undecided

N= Null

4.3 Soil Analysis

The results of the analysis of soil carried out on the site are presented in table 4.5.

Table 4.5: Summary of sieve analysis and grain size description

Samples	Depth (m)	Gravel %	Sand %	Silt + clay %	Soil description
1.	1.5	2	77	21	Brown, gravelly, silty, clayey sand
2.	6	6	67	27	Dark brown, gravelly, silty, clayey sand
Range		2 – 6	67 – 77	21 – 27	
Mean		4	72	24	

From table 4.5 above, the first sample contained 2% gravel, 77% sand, and 21% silt clay. The second sample contained 6% gravel, 67% sand, and 27% silt clay. The average of the two soils samples analysed indicates 4% for gravel, 72% for sand, and 24% for silt clay.

The sieve analysis results show that sample 1 is made up of sands with low clays, while sample 2 contains sands with intermediate contents of silt. The soils are generally not well sorted, thus do not behave well as drained materials.

As against the assumption that human factors are responsible for the gully problems in Nanka, the questionnaire section shows that flood is in fact, the ultimate culprit for the problem. Also, the laboratory soil analysis indicates that the properties of the soil are that which are susceptible to erosion. The combination of the weak soils and the flood factor gives insight into the existence of the gully erosion and landslide problems. Hence, the possibility that whatever change that might have occurred to cause gully initiation and expansion in the area is likely related to change in magnitude of flood or simply in the hydrologic property. Perhaps the said *climate change* could be a contributing factor, but that is beyond the scope of this report.

.4 **Effects of Gully Erosion on Agricultural Activities in Nanka**

Nanka is a small community in Anambra state which has a rather rural status. The residents of the community engage in various economic activities ranging from civil service to crafts (welding, upholstery etc.), but most of them still involve themselves in agriculture for daily meal and livelihood.

Agricultural activities in Nanka are not of commercial scale and involves the planting of crops like vegetables at back yard, for immediate household consumption and sale of any remaining (usually little or nothing at all). Lands which are not inhabited are mostly occupied by tree crops and this serve a great source of

However, the ecological problems of gully erosion accompanied by landslides serve a great source of continual setback to the betterment of the standard of living of the people. The gully activities have been destroying a lot, but this report will only highlight a few ways in which this has affected the small farming activities of this people.

Lands which could have been useful agriculturally have been gullied and now lay waste. To provide an idea into the area of land which the gullies cover, measurement of the Isiakpuenu gully site was undertaken.

In this, only the width and depth of the gully could be measured.

The Isiakpuenu gully site measured about: 223 meters in width (0.233km), and

: 28 meters in depth

Reported length of the gully is about: 12,100 meters (12.1km)

Estimated land area of Nanka: $11km^2$

Assuming a rectangular shape for the gully,

Estimated area of gully $= 12.1km \times 0.223km$

$= 2.7km^2$

Percentage of land destroyed by gully $= \frac{2.7}{11} \times 100$

$= 24.5\%$

The above figures give an idea into what area of land has been devastated by the Isiakpuenu gully site in Nanka. It is worthwhile to note that Isiakpuenu is only one of the numerous gully sites ravaging agricultural lands in Nanka.

Plate 4.1: Gully activities destroy access roads

Plate 4.1 above shows another way in which the gully erosion problem affects agricultural activities in Nanka. In the plate, it can be seen that the gully expansion aided by landslide occurrences have cut the access road leading into one Nanka villages. This has both direct and indirect effects on agricultural activities in Nanka but most blatantly is that crops which have been cultivated cannot be moved to the market for sell. Or even when it is by trekking, the villagers will have to look for a less secure bush path to go through, indicating increase in trekking distance and risk of evil occurrences in the bush.

This makes fetching water for agricultural activities difficult.

Another effect of this is that the foodstuff coming from the people at the other side of the village will hardly be available in the market and can mean shortage in food supply (food insecurity).

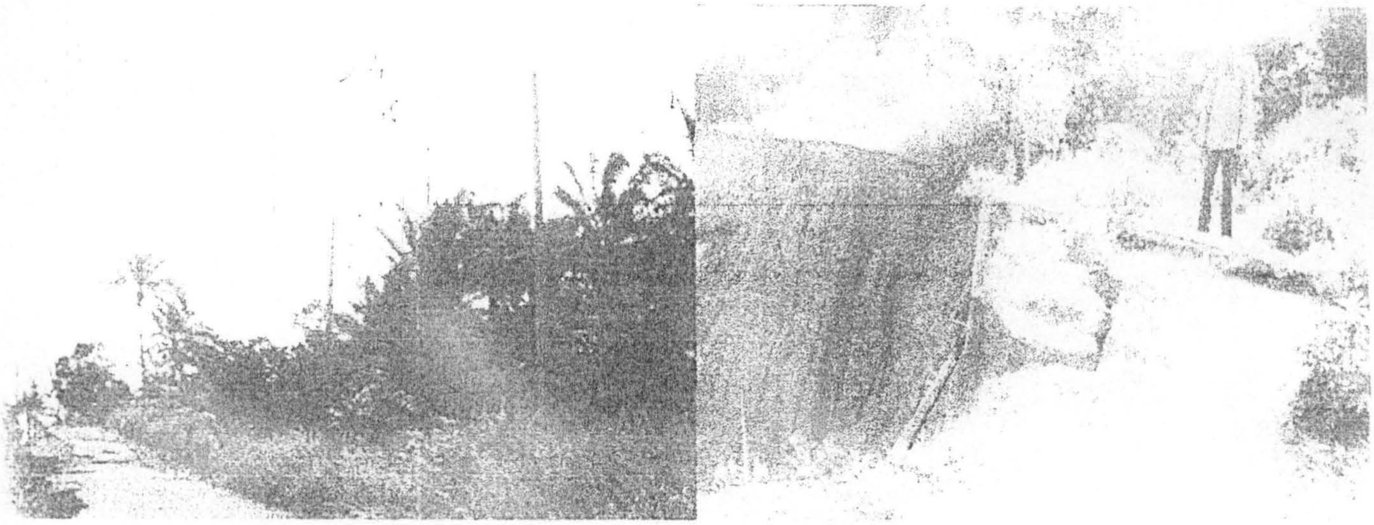

Plate 4.2: Gully activities destroy electric lines

Plate 4.2 above shows how the gully erosion and landslide activities have managed to destroy the electric lines leading to one of the villages in Nanka. This has got a lot in hindering agricultural activities in Nanka. For example, perishable crops which could normally be preserved till next morning for sale in the market (or even for consumption) can no longer be due to unavailability of power supply.

Another effect of this is that small scale processing industries which use electric power for processing of agricultural products have/will have to fold up.

All these will affect the standard of living of the farmers or villagers who have been affected by the ugly occurrences and this can have far reaching effects on the society in general.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In the questionnaire section, the respondents clearly were for the most part, uniform in their opinion of certain factors that are mostly responsible for the gully/landslide problems in Nanka, Anambra state.

The root cause of the Nanka problems is not clear. Some researchers attribute the problems to anthropogenic factors (human activities) and others attribute them to hydrologic properties and less-human-influenced soil properties.

Since over 75% of the questionnaire respondents supported flood as the major causative factor, it is clear that flood (in combination with the soil properties) is responsible for the gully problems in Nanka, Anambra state.

5.2 Recommendation

It is obvious that the gully/landslide activities are so much a problem that they have defiled previous control attempts through engineering structures and massive re-vegetation. However, it was observed that the structures were light and failed when stress acted upon them.

As an ultimate recommendation, state of the art engineering structures (in form of set back walls) should be built round the gully walls to check further expansion of the gullies, but with consideration of the full disaster risk management.

The recommendation above requires great financial and technological resources obviously beyond what the state can handle. It is also recommended – in addition to other options available to tackle the gully/landslide problems – that technical and financial assistance be sought from international organisations.

So as to reduce hardship and the effects (including psychological) of the disaster on the people, various other economic activities should be introduced to the community. And as it is clearly evident that the lands lay waste and can no longer be used for agriculture, entire shift to other economic activities is recommended.

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Date :
Location :
Remarks :

FIELD LIST

Eijkelkamp
Agrisearch Equipment
a Royal Eijkelkamp Company

A	B		C	D	E	F	G	H
Time	Water level		Cumulative time	Time interval	Infiltration	Infiltration capacity	Infiltration capacity	Cumulative infiltration
	before filling	after filling						
Reading hour min sec	*Reading* mm	*Reading* mm	*Determine from A* min	*Determine from A* min	*Determine from B* mm	*Calculate from D & E* mm/min	*Calculate from F* .. / ..	*Determine from E* mm
			start = 0					start = 0