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Gully Erosion in Anambra State, South East Nigeria: Issues and Solution

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ABSTRACT

Gully erosion in Anambra state, South East Nigeria has continued to pose a challenge to Geoscientist and other environmental scientist. The menace has taken its toll on the socioeconomic wellbeing of the people living in the affected area and the country at large such that lands used for aesthetic, agricultural and industrial purposes, ancestral homes, crops, livestock and other infrastructure are everyday lost to the hazard at alarming rate. Field studies showed that the environmental hazard has remained active over the years, defying control measures put in place by government, communities and individuals – no thanks to the peculiar geologic, geotechnical, hydrogeologic, hydrogeochemical, climatic and anthropogenic factors at play in the area. This paper reviews the causes and effects of gully erosion in Anambra State in particular and South East Nigeria in general. It also proposes specific and multidisciplinary approach to gully erosion control that will stand the test of time.

Keywords: Gully erosion, Environmental hazard, Climate, Geology, Nigeria,

1. Introduction

Gully erosion is a world-wide phenomenon. It is an enormous type of environmental degradation which leads to loss of valuable land used for agricultural, domestic, industrial and aesthetic purposes, as well as loss of property and even human lives.

Following the ordinary definition of the world gully (i.e. an erosion channel too deep to be crossed by a wheeled vehicle), the gullies in Anambra State in particular and South East Nigeria would modestly be described as catastrophic. With many of them having depth and width exceeding tens of kilometres, they would better be called canyon (Okagbue and Ezechi, 1988).

Several workers have attributed the development of gullies in Anambra State to the influence of human activities on natural and geologic processes while others suggested that gullies are linked with concentrated runoff processes. Nwajide and Hogue (1979) attributed the causes of gullies to the combination of physical, biotic and anthropogenic factors. Egboka and Nwankwor (1982) are of the opinion that gullies are caused by hydrogeological, hydrogeochemical and geotechnical properties of the rocks in the affected area. Okagbue (1986), Uma and Onuoha (1986) are in agreement with Nwajide and Hogue on the causes of gullies in South Eastern Nigeria.

This paper gives a comprehensive review of the causes, effects and control measures of gully erosion in Anambra State, SE Nigeria (figure 1) where the menace has continued to pose an enormous challenge to geologist and other earth and environmental scientist.

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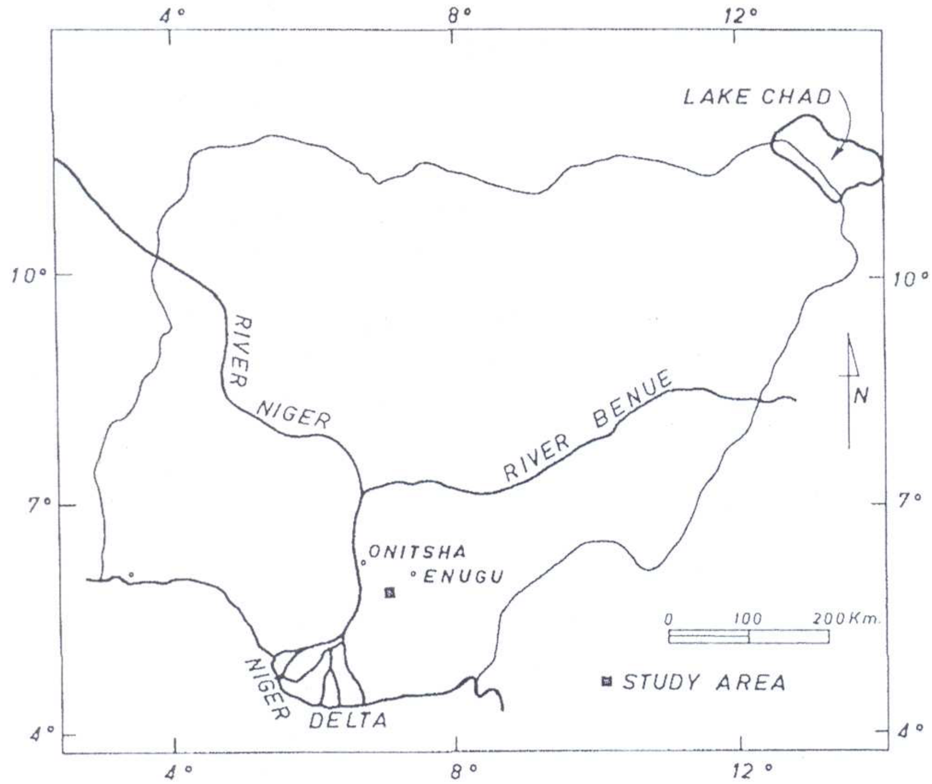

Figure 1: Map of Nigeria showing study area.

2. Physiography, Climate and Geology of Study Area

The study area lies within the humid tropical rainforest belt of Nigeria with an annual rainfall of about 2000-3000mm, average temperature range of about 25 – 27.50C, and mean annual sunshine hours of about 1750hours. Relative humidity varies with season with an average value of about 75 – 95% and a mean annual atmospheric pressure of about 1101±1.2mbars (Oguntoyinbo, 1978). The study area is dominated by two major seasons – rainy season and dry season. Rainy season ranges from March to October with its peak in July and September, and a short break in August. The dry season ranges from November to February with the influence of harmattan felt between the months of December and January. These seasonal changes with its attendant changes in temperature, runoff, humidity, atmospheric and pore pressure contribute to the disintegration and washing away of the soil and rock units in the study area.

The vegetation in the area is controlled by geologic factors of topography, relief and lithology as well as other anthropogenic factors. The vegetation ranges from light rainforest to savannah. Dense vegetal cover with high trees is prominent around stream and the shaley lowlands while savannah vegetation and isolated trees are prominent on sandy highland. The area supports extensive man-made vegetation community which comprises mainly cashew orchard and palm trees. Human activities such as bush burning, agriculture and construction works have greatly modified the natural vegetation in the area and contributed to the gully erosion problem that is prominent..

The geological setting in the study area is that of layered sequences in which a predominantly sandstone formation is underlain by a predominantly shale formation (Ezechi and Okagbue, 1989). The Imo Shale (Palaeocene – Lower Eocene) is a trangressive sequence of dark grey shale and outcrops on the plane of the Mamu River (figure 2). No active gullies are found in this formation (figure 3). The Ameki Formation (Middle – Upper Eocene) is a regressive sequence composed of sandstone units with intercalations of claystone, shale and limestone. The sandstone is expressed as a NW – SE trending cuesta with a north-east facing scarp slope. Active gullies of enormous magnitude are found in this unit (Ezechi and Okagbue, 1989). The general strike of the rock unit is approximately N – S with a gentle westward dip of less than 5^0. The soils of the study area are derived from the underlying Ameki Formation and Imo Shale and as such comprise mainly porous, red and brown sandy soils, and brown and pale clay soils (figure 4).

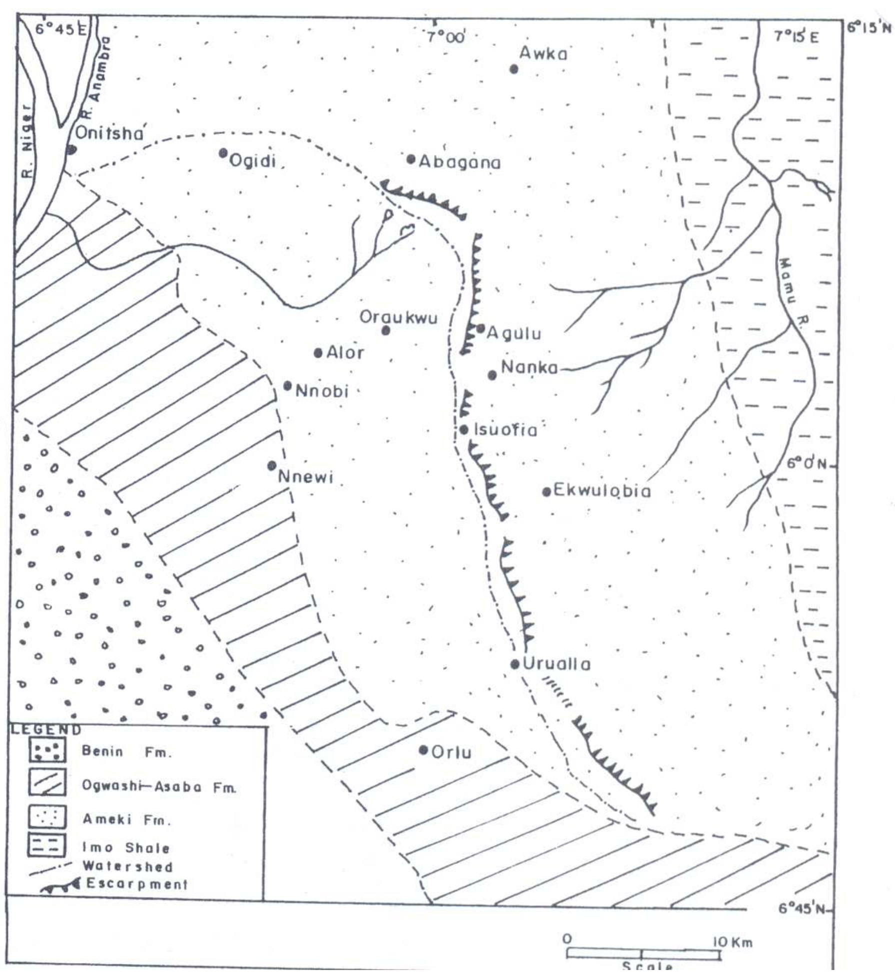

Figure 2: Physiography and general geology of study area (Ezechi and Okagbue, 1989).

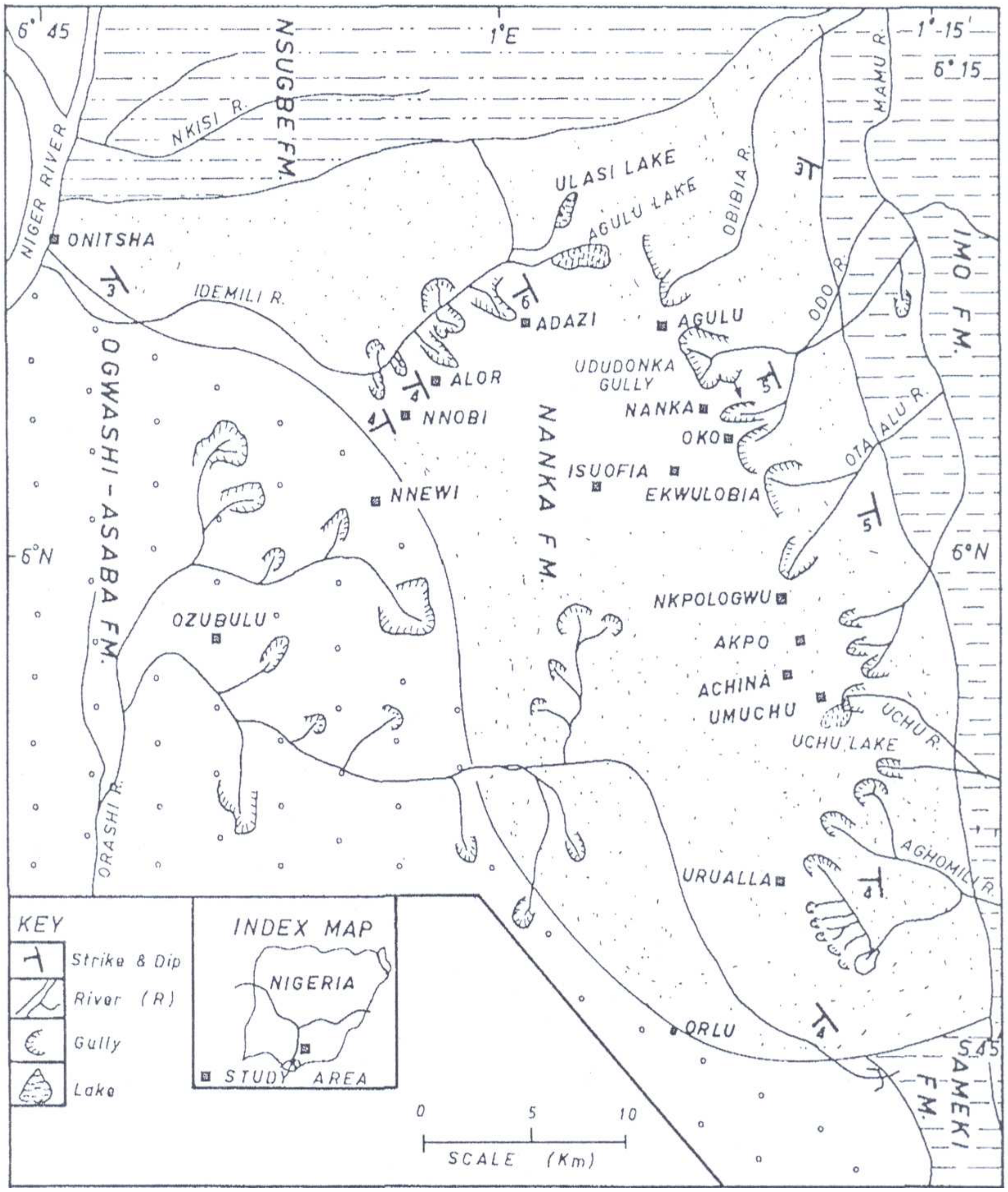

Figure 3: Geologic map of study area showing areas where gully erosion is common (Egboka and Okpoko, 1984).

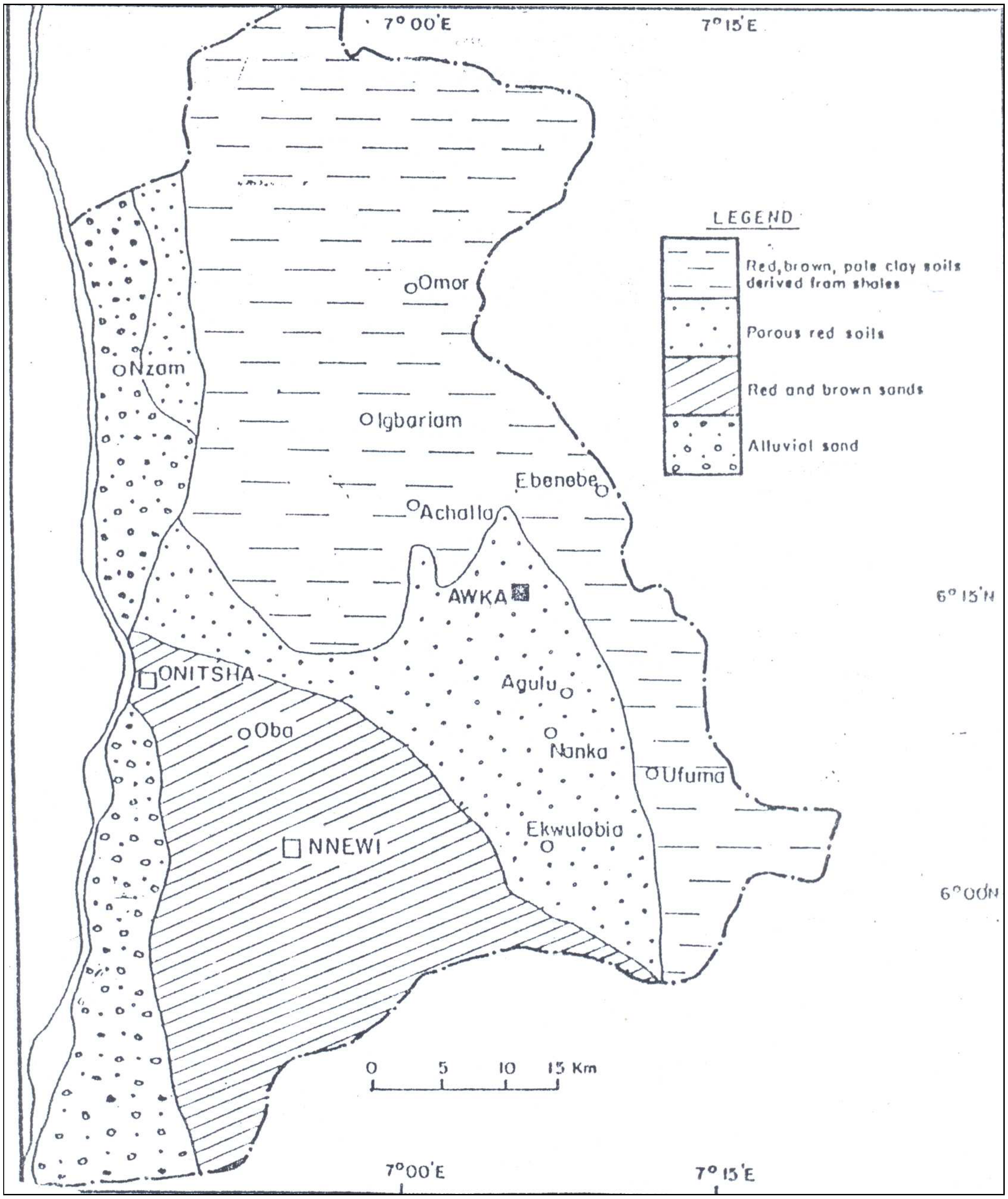

Figure 4: Distribution of soil types in Anambra State.

3. Method of Investigation

A comprehensive review of previous works was carried out with the aim of identifying sites, causes and extent of gully erosion in Anambra State as well as the control measures put in place to check the advancement of the devastating phenomenon. Field work was thereafter embarked upon to examine the gully site, measure its magnitude by way of its depth, length and width, and impact on the socio-economic wellbeing of the people in the locality; identify causative factors as well as appraise the effects of control measures already in place. Where there are no control measures in place, appropriate ways of checkmating the menace is suggested taking into consideration the physical, geological and anthropogenic factors at play in the system.

3.1 Gully Erosion Menace in Anambra State

Erosion usually start off with the relatively uniform removal of the soil surface by excess runoff aided by steep sloping topography, soil/rock types, removal of vegetative cover and poorly designed construction works. With time it becomes concentrated, forming channels and rills and if not properly checked, progresses into the monstrous gullies we find scattered all over the study area and other parts of the south eastern region of Nigeria.

Controlling the development of gullies has continued prove a very hard nut to crack as the monster has continued to defy attempts aimed at containing it from progressing and destroying more useful land and properties, and sometimes human lives. There are cases where dams, embankments, culverts and other engineering construction works as well as trees planted to check the development of gullies are carried away by the action of the gullies and used as tools to further wreck havoc on the soils and rocks within the area. This calls for a systematic approach to the control of gully erosion in Anambra State which will integrate and take into consideration causative factors responsible for the development of the environmental menace. The aim of this is to provide the appropriate and specific control measures for the varied nature of gullies rather than generalized remedial measures. The main geological formation in the study area is the Ameki Formation, underlain by the dark grey plastic Imo Shale and overlain by the lignite-clay bearing Ogwashi-Asaba Formation. The Ameki Formation is predominantly sandy with thin claystone and siltstone bands/laminations. The sand is poorly sorted, and medium to fine grained. These units, separated by shale-siltstone-fine sand layers, may be as thick as 30m in some places. The deposits also exhibit well developed patterns of alternating cross-bedded sands and layers of dark-grey shales. The shale units generally occur in beds 40-50cm thick alternating with fine sand and siltstone. The units generally have a low dip ranging between 70 and 90 west (Egboka and Okpoko, 1984). The sands are generally loose, friable and poorly cemented with thin shaley layers. The sands are also very permeable and saturated below the water table which affects its strength. Depth to the water table varies spatially and seasonally. During the rainy season, the area receives enormous amount of downpour of rain and the water table rises. The water table falls during the dry season as a result of hydraulic head decay. This results in decreased flow rates and an increase in the depth of the saturate zone. During the dry season, gulling activities are therefore at a minimum (Egboka and Okpoko, 1984). The expansion and growth of gully complex is enhanced by the high pore pressure, particularly during the peak recharge times of the rainy season. This high pore pressure reduces the effective strength of the unconsolidated sands. The sands are gradually loosened and eroded by runoff. The behaviour of the interbedded shales and clay, which undergo large changes in volume as a result of alternating wetting and drying, contribute to the growth of gully erosion. The shales increases in volume, becoming plastic and sticky when wet during the rains. During the dry season, they form a caked dry mass. Drying causes contraction of the clay and shale, resulting in the formation of extensive tension cracks. These cracks widen with time, and during the rains, they serve as channels for vertical flow of water to the underlying sand/shale boundaries. The shales and clays become thoroughly saturated after many days of rainfall, swells and develop tendency to slide. Large masses of sand underlain by these plastic shale and clay slide down dip into the gully, with the shale acting as lubricant. Dams, embankments and trees originally planted to control the menace as well as properties of people in the locality have been carried away by the sliding mass into the gullies.

The hydrogeochemical characteristics of the area are also important factors in the development and growth of gullies by way of chemical weathering (Egboka et. al. 1983). The surface and groundwater are slightly acidic, thereby facilitating the decomposition of the cements binding the rock particles together and making them vulnerable to erosion by mass wasting and excess runoff (Egboka and Okpoko, 1984). This same acidic water attack and disintegrate dams and other civil engineering works put in place to control the hazard. Human interference with the natural geologic system has also compounded issues. Most of the erosion sites are around small towns and villages that are well populated. Available lands are put to use for farming and construction works, most of which are without proper design. This leads to blockage/change in the natural water channel ways, concentration of excess runoff with high velocity and eroding potential. Deforestation, a common practice in Anambra State, exposes the soils and rocks to severe gulling (figure 5)

Gulling has persisted despite efforts by the federal government, state governing, local government, towns/community unions as well as individuals. In towns like Nanka, Nkpologwu, Agulu-Ezechukwu, Ekwulobia and Agulu, the gully extends for kilometers with width and depth in tens and hundreds of meter (table 1). Generally most of the gully sites investigated are still very active despite the control measures already in place. In Ekwulobia for example, the mass of rock, pavement, culvert and Bamboo trees used for the control of the gully was observed right at the base of the gully channel obviously dislodged by sliding. Massive civil construction works to contain the menace is on-going at the site and other sites visited (figure 6).

Figure 5: Onset of gully erosion triggered by deforestation and topsoil excavation.

Table 1: Quantitative analysis of gully erosion sites in Anambra State, SE Nigeria.

Gully Site	Coordinate	Elevation	Trend	Depth (m)	Length (m)	Width (m)	Stage / Geometry
Umuchiana	$N6^0$ 1.34' $E7^0$ 4.5'	278	160^0	18	1010	70	Active / U-shaped
Achina	$N5^0$ 57.2' $E7^0$ 7.3'	275	143^0	10	155	2	Active / V-shaped
Umuchu (A)	$N5^0$ 56.6' $E7^0$ 8.1'	222	252^0	10	1500	12	Active / V-shaped
Nanka	$N6^0$ 2.4' $E7^0$ 4.6'	249	275^0	66	2900	349	Active / U-shaped
Nkpologwu	$N5^0$ 59.1' $E7^0$ 5.5'	210	105^0	25	1800	73	Active / U-shaped
Agulu-Ezechukwu	$N6^0$ 0.1' $E7^0$ 6.6'	144	152^0	12	1200	23	Active / V-shaped
Ezinifite	$N5^0$ 58' $E7^0$ 3.3'	260	165^0	3	900	8	Active / V-shaped
Akpo	$N5^0$ 57.2' $E7^0$ 6.4'	200	300^0	17	25	18	Active / V-shaped
Agulu	$N6^0$ 6.5' $E7^0$ 3'	190	330^0	20	2100	86	Active / U-shaped
Umuchu (B)	$N5^0$ 56.2' $E7^0$ 8.1'	200	280^0	12	165	12	Active / V-shaped
Ekwulobia	$N6^0$ 1.8' $E7^0$ 5.6'	748		60	1010	42	Active / V-shaped

Figure 6: Control measure put in place to check gully erosion.

3.2 Control measures

There is the consensus among Geoscientist and other Earth scientists working on the gullies in South East Nigeria that the control of the disaster should be scientifically and systematically implemented rather than the common and general practice of channelization and embankment construction. Ezechi and Okagbue (1989) attempted a genetic classification of gullies and proposed specific control measures/method for the different classifications. Egboka and Okpoko (1984) is of the opinion that detailed pedological, geological, hydrogeological, geotechnical and hydrogeotechnical characterization of the region threatened by gullies be done as a prerequisite for adoption and design of the most efficient control method to be employed. Gully walls can be stabilized through civil engineering works such as the construction of embankment and grouting. Most gullies are associated with tension cracks which aggravates the devastation. Simple grouting and stabilization can arrest the progress of gullies especially when applied at a very early stage of development. Excess runoff can be channelized to local base level stream/river by the construction of drainage. These drainages must get to the local base stream/river level otherwise they form triggers at their discharge points (figure 7) Materials to be used for the construction work should be acid resistant especially where hydrogeochemical analysis of the surface and groundwater in the vicinity of the gully shows acidity. Groundwater level influences the development and growth of gully, therefore controlling groundwater level by installation of well and dewatering facilities at strategic locations is necessary to check this. The pumped water can be put to other domestic and industrial uses. Extensive afforestation program can be very effective in the control of gully erosion especially when well applied. This helps to protect the soil from the direct impact of raindrops and runoff as well as maintain the moisture content of the soil at responsible level during the dry season. Stability in moisture content is important to avoid the formation of tension crack which triggers erosion. Gully prone areas should be delineated and human activities such as agriculture and civil works controlled as these act as gully triggers and catalyst. The most effective control measure, when identified through scientific studies, should be extensively applied and monitored to achieve the desired objective.

Figure 7: Improper termination of drainage channel forming gully erosion triggers.

4. Conclusion

Anambra State, South East Nigeria can be said to have an unfair share of gully erosion. Field studies show that this environmental hazard has remained active and has continued to defy control measure put in place to checkmate it, no thanks to the peculiar geological, hydrogeological, geotechnical, hydrogeochemical, climate and anthropogenic factors at play in the area. The effects of this menace on the indigence has been enormous ranging from loss of access roads to neighbouring communities, farmland, and crops, ancestral homes, livestock and properties, and even human lives. Government, communities and individuals have continued to combat this monster with little or no success. This is attributed to the peculiar geology of the area and generalised and non-specific control method employed in combating gully erosion. A scientific and systematic approach which integrates the influence of all factors responsible for gully development and growth should be adopted for the control of gullies within the state and region. These control measures should be extensively applied and monitored for effectiveness.

5. References

1. Egboka, B.C.E and E.I. Okpoko (1984), gully erosion in the Agulu-Nanka region of Anambra State, Nigeria. Proceedings of the Harare symposium. IAHS Publication, 144, pp 335-347.

2. Egboka, B.C.E. and G.I. Nwankwor (1986), the hydrogeological and geotechnical parameters as causative agents in the generation of erosion in rain forest belt of Nigeria. Journal of African Earth Sciences, 3, pp 417-425.

3. Ezechi, J.I and C.O. Okagbue (1989), a genetic classification of gullies in eastern Nigeria and its implications on control measures. Journal of African Earth Sciences, 9, pp 711-718.

4. Floyd, B (1965), soil erosion and deterioration in eastern Nigeria. The Nigerian Geographical Journal, 8, pp 33-44.

5. Nwajide, C.S and H. Hoque (1979), gullying processes in south eastern Nigeria. The Nigerian Fields, 44, pp 64-74.

6. Obi M.E and B.O. Asiegbu (1980), the physical properties of some eroded soils of south eastern Nigeria. Soil Sciences, 1130, pp 39-48.

7. Ogbukagu, I.M (1976), soil erosion in the northeran parts of Awka-Orlu uplands, Nigeria. Journal of Min. and Geol., 13, pp 6-19.

8. Oguntoyinbo, J.S (1978), climate A geography of Nigerian development. Heinemann Education Books (Nig) Ltd., pp 45-70.

9. Okagbue, C.O and K.O. Uma (1987), performance of gully eroson control measures in south eastern Nigeria. Proceeding of the International Symposium on Forest Hydrology and Watershed Management, Vancouver, Canada. IAHS Publication, 167, pp 163-172.

10. Okagbue, C.O and J.C. Ezechi (1988), geotechnical characteristics of soils susceptible to severe gullying in eastern Nigeria. Bul. Of International Asso. Of Engineering Geology, No 38, pp 111-119.