

## **An Assessment of Gully Erosion in Dutse Sahelian Zone of Jigawa State, Nigeria, and its Adverse Consequencies on the Socio-Economic Development of the State**

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### **Abstract**

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Over the years, human activities on the environment such as intensive farming practice, deforestation and overgrazing of livestock has in some ways triggered off flooding and soil erosion by both water and wind, deforestation through clearance of the surrounding woody biomass for the creation of new settlements and expansion of the existing ones, resulted in the permanent degradation of the land surface, similarly due to intensive farming practice, deforestation and overgrazing the natural stability of the soil has been under constant degradation. Soil erosion in the form shallow gullying, rill erosion, sheet erosion and river bank erosion is prevalent in the study area. However, due to badland topography coupled with poor sandy soil type of origin, dry with poorly unconsolidated surface material encouraged an increase in erodibility, hence the formation of the gullies is more rapid. It was observed that there was rapid enlargement of the gullies and the rate of increase has remained constant, a drip of discharge flowing down the gully was also observed. The gullies have caused considerable soil losses and water about 3.15 and 2.10 kg m year<sup>-1</sup> of soil losses was observed from the gullies. Furthermore, the resultant soil losses were due to heavy rainfall experienced during the last year raining season and associated rate of sediment production caused by gully erosion. The study concludes that the menace of gully erosion caused a severe damage to farm lands, routes of communication and settlements creating untold hardship to the rural population.

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**Keywords:** Gully erosion, soil erosion, human activities, rainfall, Sahelian zone

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## Introduction

Over the years, tremendous contributions were recorded in understanding the behavior of gully erosion and its controlling factors by many scholars using different criteria, such as Cassali *et al.* (2009), Valentin *et al.* (2005), Poesen *et al.* (2003), Marzolff and Poesen (2009), James *et al.* (2007), Li *et al.* (2003), Casasnovas (2003) *e.t.c.* Poesen (2011) observed that gullies are among the morphological indications of long periods of soil erosion revealing the effects of atmospheric adjustment *e.g.* heavy rain fall and land use practices in the landscape. This phenomenon is the principle geomorphic feature to loosen human environment relations brought about by particular socio-economic circumstances. Gully erosion is the most important factor responsible for generating of sediments, approximately about 10 and 95% of the overall sediments were produced at catchments level while a reduced amount of 5% of the entire catchments area often occupied by gully channel. In addition, the enlargement of gully channel enhances the overflow of sediment in the landscape and these consequently add to the menace of natural calamity such as flooding.

Ehiorobo and Audu (2012) investigated gully erosion in an urban area and reported that gully erosion occurs due to extreme overflow of fluid with a very high speed and energy to remove and transmit soil particles down hill slope. In Nigeria, several of the gullies that occurred in towns were due to inappropriate termination of drains and stream paths, the increase in gullies pool by the side of a few water courses resulting from changes in land use practice remained a source of worry. Many scholars have examined the vulnerability of soil to inter-rill and rill erosion but little research explored the propensity of soils to gully erosion.

Shit and Maiti (2012) argued that gully erosion is one of the major devastating catastrophes that speed up soil erosion. The incidence of this hazard signifies a severe type of land degradation that deserves a very exceptional consideration. Rill-gully erosion represents an essential basis of sediment in various environments.

The impact of gully erosion has attracted the attention of many scholars including Conoscenti *et al.* (2014), Dube *et al.* (2014), Torri *et al.* (2014), Boardman (2014), Casali *et al.* (1999), Baets, *et al.* (2014), and Paolo *et al.* (2014) with emerging views that gully erosion caused significant soil losses and water, decrease crop yield, degradation of ecosystem, roads and bridges, farmlands as well as settlements.

The study area is characterized by badland topography and the nature of the soil is predominantly sandy, dry with poorly unconsolidated surface material encouraged an increase in erodibility, hence the formation of the gullies is more rapid. Gullies developed through the unconsolidated sand drift which is eroded by flood flows and enables head scarps of gullies to recede very rapidly once initiated

There has not been any research on gully erosion in the study area. This study has discovered a serious hole regarding the menace of gully erosion in the study area and the potential threat posed to human lives, roads, bridges and farmlands. However, in reaction to this well-known fissure and, as a prelude for an accurate scientific remedial action to ensure amelioration and plan for a consistent management technique, this study is considered desirable. The aim of this study, therefore, is to examine the Gully erosion and its adverse consequences on the socio-economic development of the study area.

### **The Study Area**

The study area is Dutse Local Government Jigawa, State (Northern part of Nigeria). The area is located between latitude 11°44.2N and longitude 09°21.58E with an elevation of 780m. Dutse Local Government has a population of about 251,135 people; while the total population of Jigawa State stands at 4,361,002. Statistical analysis revealed that the mean annual temperature is about 27°C with an annual rainfall of 1000mm. The rainfall season usually commence from May- September lingering up to early October in some occasions. Relative humidity is normally between 90%, but a thorough assessment of this condition suggests that the humidity fluctuate over time around July decreasing to 60-80%.

The nature of the soil is predominantly sandy, dry with poorly unconsolidated surface materials. Therefore, the area is vulnerable to the impact of erosion.

The typical texture of the soil at the research site consists of sandy silt loam 37.4% (2000-40  $\mu\text{m}$ ), silt 53.6% (40-2  $\mu\text{m}$ ), clay 6.3% (< 2  $\mu\text{m}$ ) and soil organic matter content is 3.7% by weight. The pH level is 1.5.

## Methodology

The methodology adopted in this study is content analysis of information which helped to explore data from a large body of existing literature. Stemler (2001) defined content analysis as, "any technique for making inferences by objectively and systematically identifying specified characteristics of messages." Reconnaissance survey of the areas affected by gully erosion as well as field measurements involving morphological parameters of the gully such as length, width and depth were carried out and recorded manually.

## Results and Discussion of Findings

Investigation revealed that human activities on the environment such as intensive farming practice, deforestation and overgrazing of livestock has in some ways triggered off flooding and soil erosion by both water and wind. Similarly, deforestation through clearance of the surrounding woody biomass for the creation of new settlements and expansion of the existing ones, resulted in the permanent degradation of the land surface, due to intensive farming practice, deforestation and overgrazing the natural stability of the soil has been under constant degradation. Soil erosion in the form shallow gulying, rill erosion, sheet erosion and river bank erosion is prevalent in the study area. With provision of temporary cover crops as a palliative or a remedial action, such aforementioned remedies applied are not holistic enough to deal with one of the principle causes.

Valentin *et. al.* (2005) reported a similar finding in a study of gully erosion where he found that, that in most instance, the development of gulying are cause by overgrazing, road construction and urbanization, log haulage, improper farming and irrigation practices.

Slope in one way or the other contribute to the formation of gully erosion in the study area and consequently facilitate its formation to a very large extent as it affect the current and speed of running water. These by implication, exert a serious effect on land development such as water supply and agriculture. However, non appearance of plants on slope to seize the immediate weathered materials makes the formation of gully possible. Daba *et. al.* (2003) noted that these gullies are vigorously increasing in to agricultural land at a very frightening pace.

They are also the main foundation of sediment causing siltation of sea which teemed up to form the basis of irrigation and human consumption.

Wang *et. al.* (2014) observed that soil erosion is currently an important environmental problem with frequent worry facing the entire world. Soil loss and water ensuing has become one of the central cause limiting local economic growth. However, being a familiar form of soil erosion, though not as of broad series of surface erosion, and because of its great quantity of high speed, gully erosion due to its nature, cuts and reduce the gradient in to an area of minute sloping, diminishing farmland area causing very severe damage to agricultural production which has become source of river sediment.

In a related development, Woodward (1999), in his study, cited an example in United State where erosion of farm land due to intense surge creates a stern on isolated meadow. Little waterways can easily roll in to hefty gullies if no meaningful and reliably management techniques were taken to avert the threat. These tiny waterways are usually removed by the combined action of regular farm operation and other usual tillage of the field.



**Figure 1: Gully Erosion Showing Slumping of Soil due to Water Flow**



**Figure 2: Gully Erosion Showing Rubble from Washed Out Portion Showing Narrow Section with Trees Left Standing. Had the Heavy down Pour Continued, This Portion Would also have been Washed Out**

The resultant flood had succeeded in opening up a large gully of about 160m long, 18m wide and 2.5m deep (figure 3.1) resulting in loss of soil fertility as well as a rapid decline of agricultural productivity, at least  $2.10 \text{ kg m year}^{-1}$  of soil losses was observed from the gully, it does pose a potential threat to the inhabitants. However, a preliminary assessment of the gully was conducted on 18<sup>th</sup> September, 2013 with a view to study the pattern of behavior and compared with the present condition of the gullies. It was observed that the gully was about 140m long, 14m wide and 1.6m deep, indicating that there was rapid enlargement of the gully due to the combined action of heavy rainfall and flood. During the period of this study, it was also observed that the gully floor had a drip of discharge flowing down it. However, Torri, *et. al.* (2014) observed that the expansion of the gully signify a major geomorphic progression in a varieties of broad environments.

Valentin *et. al.* (2005) argued that the enlargement of the gullies leads to thrashing of crop yields and obtainable land. It can also alter the medley patterns among cultivated meadow and uncultivated, increasing hill slope erosion in a feed back circle.

The gully has caused considerable soil losses (figure.3.2) and about 3.15 kg m year<sup>-1</sup> of soil losses was observed from the gully, the gully was about 152m long, 16m wide and 2.3 m deep. Furthermore, the resultant soil losses were due to heavy rainfall experienced during the last year's raining season and associated rate of sediment production caused by gully erosion. Bartley *et. al.* (2014) argued that it is not recognize whether management of ground cover will minimize sediment deliver to ecologically suitable point is an issue of debate among scholars. However, the gully channel are currently eating deeper in to the upland areas causing a lot of damage to farmlands, routes of communication and settlements resulting to a forced migration to a near by settlement called Sabuwar Maranjuwa where the dwellings have now resettled.

### **Adverse Consequences on the Socio-economic Development of the Area**

- (i) Vast reduction of agricultural land resources including obliteration of crops by large flooding and erosion and this is inconsonance with the observation of Wang *et. al.* (2014) where he argued that gully erosion cut farm land area causing very severe damage to agricultural production, which has become the most important source of river sediment.
- (ii) Cutting of communication link between Maranjuwa and Yina village generating myriad hardship to the rural population who currently have to use a meandering route Galadanci village through Shuwari to bring in agricultural input and sell their goods.
- (iii) Demolition of infrastructural facilities and utilities.
- (iv) Loss of soil fertility.

### **Prevention Techniques**

- (i) Erosion along the roads and other affected settlements may be control through the provision of appropriate drains and in the case of roads through sufficient maintenance.
- (ii) Planting of trees on slope to seize the immediate weathered materials and on the other hand minimize the force of erosion. Baets *et. al.* (2014) noted that roots play a vital role in directing the velocity of soil erosion particularly when the above-ground biomass vanish for instance, animal grazing, drought, fire, harvest.

Roots influence soil properties including aggregate strength, wetness substance, infiltration rate, coarseness of the soil, soil structure and organic matter content, all these teamed up to controlled soil erodibility to a certain extent.

- (iii) Construction of abridges across the gully which makes communication difficult for the rural population.
- (iv) Provision of boulders in major areas affected by ecological degradation with a view to alleviate the impact of gully erosion.

## Conclusion

human activities on the environment such as intensive farming practice, deforestation and overgrazing of livestock has in some ways triggered off flooding and soil erosion by both water and wind, deforestation through clearance of the surrounding woody biomass for the creation of new settlements and expansion of the existing ones, resulted in the permanent degradation of the landsurface. Similarly, due to intensive farming practice, deforestation and overgrazing the natural stability of the soil has been under constant degradation. However, soil erosion in the form shallow gullying, rill erosion, sheet erosion and river bank erosion is widespread in the study area. It was found that due to badland topography coupled with poor sandy soil type of origin, dry with poorly unconsolidated surface materials encouraged an increase in erodibility, hence the formation of the gullies is more rapid. It was observed that there was rapid enlargement of the gullies and the rate of increase has remained constant, a drip of discharge flowing down the gully was also observed. The gullies have caused considerable soil losses and water about 3.15 and 2.10 kg m<sup>-1</sup> year<sup>-1</sup> of soil losses was observed from the gullies. Furthermore, the resultant soil losses were due to heavy rainfall experienced during the last year raining season and associated rate of sediment production caused by gully erosion. The study concludes that the menace of gully erosion caused a severe erosional damage to farm lands, routes of communication and settlements creating untold hardship to the rural population who presently have use a circuitous route Galadanci village through Shuwari to bring in agricultural in put to market their products.

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