Impact of Gully Erosion on Housing Accessibility: A Case of Ibadan Core Settlements

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Abstracts
Erosion, the loss of topsoil under the action of water or wind remains a threat to soil quality and quantity. Globally, it is identified as an endemic problem accompanied with various environmental, agricultural, social and economic impacts. The study examine the causes of gully erosion and its impact on housing accessibility within Ibadan metropolis. identify gully erosion within the study area and also examine its impact on housing accessibility across the three local governments selected within Ibadan metropolis. Random and purposive sampling techniques was employed to select three different locations namely Kudeti, Idi-Arere and Oja-oba within Ibadan South East Local Government Area namely. Primary data was collected through observational survey as pictures while the findings were descriptively analyzed. The study was conducted using a descriptive approach. The study found anthropogenic and natural factors as the major cause of gully erosion in the area. Meanwhile the anthropogenic factors were largely associated with poor management and maintenance of drainage system (channels/culverts) while the natural factor was due to the geologic characteristics of the area (climate and slope). The impact of gully erosion identified was directly on the environment which include soil loss degenerating into serious threat on accessibility to residential homes; destruction and damages of roads, pedestrian bridge and excavation of landscape within the study area. The study therefore recommends that more awareness be created on proper management and maintenance of drainage channels/culverts within the study area. Additionally, penalty should also be issued for poor management of drainage through dumping of refuse into the channel.

Keywords: Gully erosion, accessibility, Causes, Impact, Sustainability

Introduction
Floods in urban arrears constitute a severe risk and have become more frequent and severe along with rapid urban development (Dammalage & Jayasinghe, 2019). Floods reduce transportation network capacity, either directly through physical destruction, rendering roads unusable or through floodwater accumulation on the road surface rendering the road impassable (He, Thies, Avner, & Rentschler, 2020). Floods are the most frequent and costly natural hazard/disasters (Pasi, Viavattene, La Loggia, & Musco, 2018) with the tendency of inducing environmental impairment such as erosion. Erosion is the loss of topsoil under the action of water or wind remains a threat to soil quality and quantity (Mbaya, 2013). It is regarded as one of the natural processes which have lasted for a long period of time (Parikh & James, 2012). Globally, it is identified as an environmental and agricultural problem (Hassen & Bantider, 2020). Hence, one of the serious and continuous endemic environmental problems with various social and economic impacts (Asish, Palash, & Biswajit, 2018) as well as land degradation, soil fertility loss and river siltation (Wang et al., 2018).

Erosion is defined as steep-sided channels, often with steeply sloping and actively eroding head scarp landscape usually ranging from 30cm to 30m deep, caused by the intermittent flow of water, usually during and immediately following heavy rains (Poesen, Nachtergaele, Verstraten, & Valentin, 2003). According to (Sharda et al., 2012), 80% of degradation on agricultural land is due to soil erosion. Studies have identified four basic types of erosion with varying characteristics. Howbeit, Amangabara, Njoku, & Iwuji (2017) explained gully erosion as the terminal phase of a four-stage erosion process which involves splash, sheet, rill, and gully. Hence, Betis III (1983) defined gully erosion as a relatively deep, vertical-walled channel recently formed within a valley where no well-defined channel previously existed. It is an advanced stage of rill erosion where surface channels have been eroded to the point where they cannot be smoothened over by normal tillage (Hilborn, 1985). Gullies could be active (actively eroding) (Abdulfatai, Okunlola, Akande, Momoh, & Ibrahim, 2014) if the erosion is actively moving up in the landscap by head-cut migration (Poesen et al., 2003) or inactive (stabilized).

Previous literatures have described the impact of this menace on the environment which include disconnection of roads and bridges breakage, recession of water table and dislocation from residential areas (Shahrivar & Christopher, 2012), cuttings through homestead/residential areas that impedes accessibility (Kotana, 2017). Erosion by gullies can be an acute problem causing high sediment yield, removal of fertile soil, destabilization of hill slopes, and the lowering of water tables in alluvial aquifers (Jibo, Laka, & Ezra, 2020). Apart from the loss in soil fertility and continuous diminutions of cultivable land, there is additional loss of properties ranging from losses of homes, household belongings, farm crops and utilities (Danladi & Ray, 2014). Apart from its direct impact on the environment and existing properties, gully erosion also has impact on physical and socio-economic status of people. For instance, Hassen & Bantider, (2020) revealed loss of life for a 12year boy as a result of gully erosion and decline of yields throughout the year. Thus a threat to life and the economy. A study by Adediji & Felix (2013) on risk analysis of accelerated gully erosion in Ikpoba, Ohka local government of Edo State revealed that showed that accelerated gully erosion accounted for 2% (100466.57 m2) of the total areal extent of the study LGA (5189010.57 m2). Also examining the causes and consequences of gully erosion in Dangara area of Nigeria, (Mashi, Yaro, & Jenkwe, 2015) found that the main causes of gully erosion as reported by the respondents to include climate, land cover, hydrology, land use and topography while the impacts recorded are majorly on livelihood, infrastructure, economy and social life.

The alarming rate of this environmental menace has been associated with different driving factors identified to be either anthropogenic (human-induced) factors or natural factors. According to Mbaya (2013) and Okwu-Delunzu, Iwueke, & Aniagolu (2018), these factors include soil texture and structure, slope, rainfall and human activities such as deforestation, over grazing, excessive cultivation, bush burning and construction works. These correspond with findings of other studies (Jahantigh & Pessarakli, 2011; Tamene & Vlek, 2008; Van-Camp, et al., 2004) who in addition identified more factors which include high population growth, poor rangeland, lack of vegetation cover, intensive and short-period rainfall, improper land use (cultivation on steep slopes), improper irrigation design, wrong discharge of water in the channels, and soil characteristics, abandonment and diversification, forest fires, land leveling and soil displacement by tillage. Meanwhile, Kotana (2017) classified these factors into two basic categories namely land use types and climatic conditions subject to intensity, velocity of runoff. Ghosh & Maji (2011), submitted that gully erosion occurs when the rate of runoff exceeds a critical threshold.

Although several studies have dived into gully erosion such as examining the factors

causing gully erosion and its impact (Adediji & Felix, 2013; Mashi et al., 2015; Anzaku et al., 2016; Okwu-Delunzu et al., 2018) and geographically, erosion studies have been conducted in the different region of Nigeria such as southern and northern part (Jibo, Laka, & Ezra, 2020; (Egboka, Orji, & Nwankwoala, 2019) of Nigeria and have major on the broad impact of gully erosion while others (Jibo, Laka, & Ezra, 2020) have examine its effects on socio-economic activities however, little or none has been done on its effect on housing accessibility in the study area. Onyemesim, Sridhar, & Coker, (2017) examined the causes and prevention of flooding and erosion in Kube-Atenda community in Ibadan North LGA, using a qualitative approach (Focus Group Discussion, FGD and Key Informant Interview, KII), the study found that most of the road in the study area which were untarred were without drainage while where drainage exist, they were poorly sized and badly maintained. Thus, this study seeks to identify causes of gully erosion and evaluate its impact on housing accessibility within Ibadan South East.

Methodology

Study Area

Ibadan, the capital of Oyo state is the third largest city by population in Nigeria with a total population of 3,649,000 as at 2021. It lies between longitude $3^0 5$ East of the Greenwich Meridian and latitude $7^0 2$ North of the Equator and covers a total land area of 3,123.30 km^2 (Onyemesim et al., 2017). Ibadan is made up of eleven (11) local governments with 5 of them namely Ibadan North, Ibadan South-West, Ibadan North-East, Ibadan South-West and Ibadan North-West located within the metropolis. Ibadan metropolis has high relative humidity and experience two major seasons namely rain (March –October) and dry season (November- February) (Olarewaju, Tilakasiri, & Bello, 2018). According to Koppen's climate classification, Ibadan metropolis has a tropical climate with a relative annual rainfall of 1200mm to 1500mm (Wahab & A., 2018). There are two peaks for rainfall, June and September which often result into flood and much more aggravated by poor surface drainage (Onyemesim et al., 2017). There is no doubt that the excess of run off water will have impact on the topography of the environment. The flood experience during the period of peak rainfall will undoubtedly promote the speed of gully erosion. However, Ibadan South East was selected for this study being one of the largest local government within Ibadan metropolis.

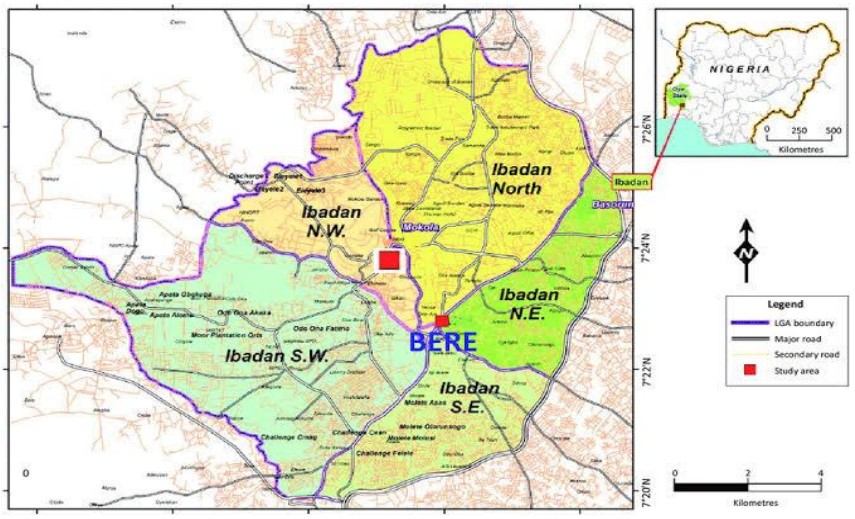

Figure 1: Map of Ibadan showing the local governments within Ibadan metropolis.

Material and Methods

This study adopts the descriptive design approach. Primary and secondary data were collected for this study. The primary source of the data collected was through naturalistic observation that is a direct observation within the study area. Random and purposive sampling methods were employed. Adopting random sampling, Ibadan South East was selected from the five LGA within Ibadan metropolis. Thereafter, three locations namely Kudeti, Idi-Arere and Oja-oba were purposively selected based on the long years of existence of these areas, inadequate public and social infrastructure and poor housing conditions (Oke, Atinsola, & Aina, 2013). The drainage and roads in these area were critically observed for occurrence of gully erosion, causes and impact most especially on accessibility of residential houses and other adjoining neighborhoods while the pictures were taken. The data collected were descriptively analyzed and presented.

Results and Discussion

Causes of Gully Erosion

Previous studies noted that gully erosion are caused by different mechanisms, modes and conditions of formation which are either natural (geologic such as climatic factors, soil properties etc) or anthropogenic such as farming, uncontrolled grazing, deforestation. (Abdulfatai et al., 2014). From the field observation as shown in figure 2, hence the causes of gully erosion can be classified into anthropogenic and natural causes. the major causes of gully erosion in the study area was anthropogenic in nature which was largely associated with poor management of the drainage systems. Such causes as identified include blockage of drainage channel as a result of refuse being dumped into the drainage channel, broken culvert with weed growing inside the culvert and also blockage of drainage by soil. Thus, anthropogenic in nature (Abdulfatai et al., 2014). Another observed cause of gully erosion was associated with the geologic setting of the terrain as shown in plate D. The steepness of the terrain promote runoff and evacuation through exceesive outwash of the topsoil across the environment. This findings corroborate Nwilo et al. (2011) result which using Geographic Information System (GIS) found the causes of gully erosion to be anthropogenic and natural which was associated with slope characteristics greater than 15^0. Similarly, the findings also correlate with Egboka et al. (2019) whose findings also confirmed the causes of gully erosion as geologic features and processes such as steep slopes or high terrain undulation. Hence, Nwankwo et al. (2015) noted that gully erosion is inevitable when the shear stress of runoff exceeds the soil sheer strenght.

Plate A: Poorly maintained drainage/culvert with growing weed

Plate B: Drainage system blocked with refuse

Plate C: Drainage channel completely blocked with sand

Plate D: Gully erosion aided by the geologic setting (Steepy terrain)

Figure 2. Plates showing the causes of gully erosion

Impact of Gully Erosion

The impact of gully erosion is enormous and cannot be underestimated. According to previous studies (Egboka et al., 2019, Nwilo et al., 2011), these impacts are measured by indicators that reveal and quantify the state of gully erosion and its effects across different environment. According to European Environment Agency (EEA,2000), these indicators are classified into direct and indirect and include loss of ecological function, loss of top soil, loss of soil fertility, contamination of surface water (direct indicators) while the indirect include changes in population size and distribution, changes of biodiversity (soil habitats and species), changes in crop yields, diversification and water stress. Similarly, Wang et al. (2018) indicated land degradation, soil fertility loss and river siltation as the major measures of soil erosion. The impacts identified from the observation conducted are as described below:

Soil Loss and threat on access to residential houses

One of the prominent impact of gully erosion is the removal of top soil known as soil loss which have constituted serious threat to residential houses as shown in figure 3. From figure 3, Plate A is a view of the impact of gully erosion at Idi-Arere showing an open space adjoining residential houses under the influence of gully erosion gradually. Plate B is a view of gully erosion

gradually eating up a residential apartment at Ososami Oke-Ado. Plate C gives the view of a foot path to residential houses that is gradually expanding under the influence of gully erosion while plate D gives the view of a culvert in front of a residential house which have gradually expanded into a gully and almost chopping off the frontage of the house at Kudeti. These pictures depict how badly degraded the landscape of these locations have been subjected to gully erosion. Thus a threat to accessibility of such buildings which in the long run may result to total displacement of the residents of those houses with the likelihood of such outcome as revealed in Abdulfatai et al. (2014) who reported that about ten houses were lost to gully erosion in Auchi area of Edo state.

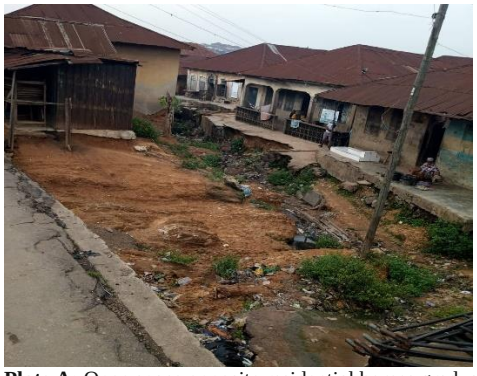

Plate A: Open space opposite residential homes gradually becoming gully due to surface runoff at Idi-Arere

Plate B: Gully erosion almost eating up a residential house at Oke-Ado

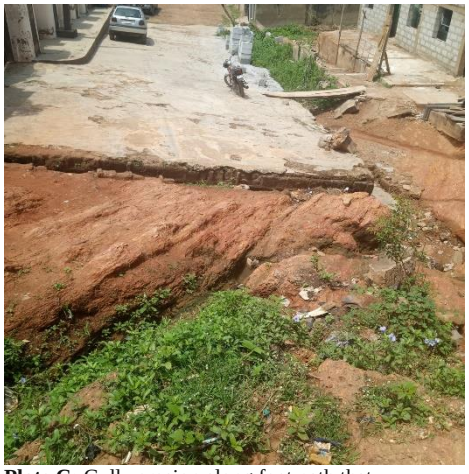

Plate C: Gully erosion along foot path that leads to residential buildings

Plate D: Expansion of culvert into gully directly in front residential buildings

Figure 3: Views of the impacts of gully erosion across the study areas.

Damages/Destruction

Other significant impact of erosion as observed in the study area is damages and destruction of infrastructures. Such damages include collapse of buildings, roads and drainage channels as shown in figure 4. Plate A is a view of a broken pedestrian bridge from the influence of erosion at Kudeti area, Plate B is a view of a collapsed building due to erosion at Kudeti area and Plate C is a view of a landscape eaten up by gully erosion Ososami Oke-Ado area. This is in coherence with Agyarko et al. (2012) who posited that at the household level, the onsite effects of gully erosion include damages to buildings, damages to drains and roads, destruction of landscape as well as flooding. The implications of these damages include complications of accessibilities from residential homes to areas of economic activities as well as displacement of residents from the area. Danladi & Ray (2014) attested to this in their findings which stated that gully erosion has led to damages of about 239 houses within the land use areas with the dispacement of 20,125 people from 1996 to 2011.

Plate A: destruction of the bridge pedestrian bridge at Kudeti

Plate B: A collapsed building as a result of erosion

Plate C: A landscape chopped by gully erosion

Figure 4. View of damages orchestrated by erosion.

Conclusion and Recommendation

Soil erosion has been identified as a destructive tool to effective land use, buildings and a major threat to life existence, and sustainable livelihood. This study adopts observational survey approach to identify the causes and impact of gully erosion within in Ibadan metropolis using Ibadan South East as a case study. The result revealed that the causes of gully erosion within the study area are associated with both anthropogenic and natural factors. The anthropogenic factors were mainly due to poor management of drainage system (channels/culverts) while the natural factor was largely due to the geologic characteristics of the area. Majorly, the impact of gully erosion was directly on the environment which include soil loss which degenerated into serious threat on accessibility to residential apartments, destruction and damages of roads, pedestrian bridge and excavation of landscape within the study area. The study therefore recommends that more awareness be created on proper management and maintenance of drainage channels/culverts within the study area. Additionally, penalty should also be issued for poor management of drainage through dumping of refuse into the channel.

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