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Resident's Perception of the Effects of Erosion on Streets and Roads in Jalingo Metropolis, Taraba State, Nigeria

BY

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Abstract

The study examined the residents' perception of the effects of erosion on the streets and roads in Jalingo Metropolis, Taraba State. The aim and objectives of the study were to determine the effects of erosion in the study area, to examine the causes of erosion on streets and roads, to determine the severity of erosion on roads as well as resident's perception of the effects of erosion on the streets and roads in the study area. A reconnaissance survey of the study area was carried out to assist in the identification and accurate delimitation of the study area. The survey was done to collect proper information on the causes and effects of erosion occurrence on streets and roads Extent of the erosion damage in the study area was examined through visual inspection. In this area were viewed as natural causes and human causes. The natural causes include rainfall, topography, and soil condition. While human causes include land-use patterns and waste disposal methods, poor maintenance practices and poor construction activities. The study recommended that among others, the need for regular maintenance to keep ditches, drains and culverts clear. The study concludes that the causes of erosion on streets and roads range from natural factors such as the topography of the terrain, soil nature, rainfall and human factors such as kind use patterns, poor waste disposal methods, poor construction and maintenance activity.

Keywords: Erosion, Roads, Streets Perception, Jalingo, Taraba

Introduction

Erosion is a severe environmental problem that is threatening the greater parts of Jalingo Metropolis, most especially the infrastructural base which in turn causes social and economic problem. Erosion creates dangerous conditions on pathways and roads ways; it can undercut and cause bank failure on pedestrian and vehicle routes, increasing risk of and death.

Roads and streets are created because of changing interactions between people and their environments. They are created to facilitate access to natural resources, to connect human communities, to move goods to markets, and to move people to work and back home. Roads are built to facilitate the transport of people and goods and to promote development (Robinson and Thagasen, 2004). Roads and streets, however, can be degraded by erosion which makes them incapable of performing optimally the reason for creating them. The menace of erosion on roads has made some of it not to fulfill the purpose for which it was built or to do so partially.

Erosion is a severe environmental problem worldwide. It threatens virtually all aspects of human endeavours, most especially the infrastructural and agricultural base which in turn causes social and economic problem (Razali et al., 2018; Pimentel and Burgess, 2013). Although soil erosion is frequently linked to the degradation or loss of water resources, and may probably be the most serious and least reversible form of land degradation in tropical environments, there is little or no documentation of the magnitude, impact, or causes of erosion in these areas especially as it relates to the destruction of roads and streets in a particular region. However, the need for such documentation is crucial because it is in these places that the majority of the world's human population lives, experiences constant serious food and energy shortages, and is growing at the fastest rate. As a result, there is rising demand in tropical countries to cultivate forest lands that currently function as key watersheds and provide an essential food source (Wang et al., 2020).

The mechanism of running water on the land surface was thought to take essentially three forms early in the study of erosion: sheet, rill, and gully erosion (Bennett, 1939). Sheet erosion, also known as interrill erosion, is the least visible type of erosion, including the relatively equal removal of layers of soil from an entire length of sloping terrain. Rill erosion is caused by the concentration of water in surface depressions, which then flows down the slope along the route of least resistance, generating microchannels or rills.

Gully erosion refers to channel erosion that has developed to the point where the land can no longer be used for conventional farming. While the significance of overland flow was stressed in this perspective of erosion, it was also recognized that the energy associated with raindrop impact is a significant influence (Cook, 1936).

Raindrop splash research in the past suggested that the raindrop was the one who started the erosion process (Ellison, 1947). Ellison divided the erosion process into two parts: soil material dissociation and transportation. He stated that soil particle separation can be triggered by raindrop splash or surface (overland, sheet) movement (Ellison and Ellison, 1947; Horton, 1945). Overland flow is the most common method of transporting soil particles; however, raindrop splash can also be used (Ellison, 1944). Despite dispute among erosion experts about the language used to describe water erosion (Hudson, 1971), all of the phrases listed above are still widely used.

The use of the word "interrill (prerill) erosion" to characterize erosion caused by overland flow of runoff as it moves at shallow depth for short distances until it concentrates in tillage marks, depressions, or already eroded grooves is a recent improvement in terminology (Meyer et al., 1975, Wang et al., 2020).

There is therefore the need to study the nature (morphology) and processes of these erosion formations as well as the attitude of the people towards the hazard. Such perceptions are certain to guide the making of effective environmental policies with a view to combating the erosion menace. Hence, water erosion in Jalingo metropolis has increased in magnitude and frequency over the years and as a result, many infrastructural facilities such as roads, electricity poles, and houses are being damaged (Auzet, 2013).

Runoff and soil erosion are two of the world's most serious environmental problems, and they occur under a wide range of situations, depending on interactions between land use, climate, soils, and terrain (Auzet, 2005), Water erosion, in particular, is a major environmental issue in many places of the world (Smith et al., 2003). The removal of soil from the earth's surface by flowing water is known as water erosion (Schwab et al., 1992). Soil water erosion is an important environmental issue because it is caused by mechanical abrasion induced by suspended particles (Lister and Cook, 2006; Franco et al., 2010).

It could be the result of soil structure degradation, particularly the functional qualities of soil pores to transport and retain water and encourage root growth (Lujan, 2003). Only when the rate of precipitation surpasses the rate of water infiltration into the soil does runoff occur (Musa et al, 2010). Runoff and soil loss prediction, on the other hand, has been widely utilized to inform conservation planning (Lujan, 2003).

Erosion puts pedestrians and vehicles in danger by undercutting and causing bank failure on pedestrian and vehicle routes, increasing the risk of injury and death (Pineo and Barton, 2009). When rain falls on the earth's surface, it moves according to gravity; some of it seeps into the ground to replenish the earth's groundwater, but the majority of it runs off as runoff (Musa et al., 2010). Soil particles are transported by overland broad sheet flow, which is aided by flow turbulence generated by raindrop impact (Franco et al., 2010).

Soil credibility is the reciprocal of its erosion resistance, indicating its susceptibility to erosion at various rates as a result of physical, chemical, and mineralogical factors (Franco et al., 2010). Furthermore, water movement requires kinetic energy to remove and carry soil particles, as well as opposing forces to prevent erosion (Schwab et al., 1992). As cities grow, most of the vegetation is replaced by impervious surfaces, reducing the area where groundwater infiltration can occur (Musa et al., 2010). The importance of runoff cannot be overstated. It not only serves rivers and streams, but it also alters the environment through erosion (Musa et al., 2010).

Flowing water has enormous force; it may move boulders and carve canyons (Aneke, 1985), causing environmental destruction (Arabameri, et al., 2021)

To preserve motorable roads, crop productivity, and sedimentation and stream pollution, water erosion must be regulated. Erosion is mostly caused by human exploitation of natural resources and the removal of natural vegetation's protective cover (Schewad et al., 1992; Wassie, 2020). Runoff is defined as the part of precipitation that falls on uncontrolled surfaces such as streams, rivers, drains, sewers, or roadways, and can be classed as direct or base runoff depending on how quickly it appears following rain or melting snow (Boardman et al., 1990). As greater development and urbanization occurs, impermeable surfaces such as roads, parking lots, and buildings replace natural landscapes, lowering the rate of water infiltration into the ground and increasing runoff to ditches, streams, and drainages (Musa et al., 2010).

In our society, erosion has been a problem. It is a problem in the agricultural and engineering industries. It has been a concern on both highways and city streets, with highway erosion being the most commonly reported and studied. Erosion on streets and roads that give people with access to their homes has been a problem that has gone unnoticed. However, the persistent problem of gully on the road, cutting in on bridges, swelling of pavement foundation, and crater, resulting in road failure, demanded an investigation into the origins, effects, and ways of providing a solution to the problem of road erosion. As a result, this study examined citizens' perceptions of the consequences of erosion on the streets and roads in Jalingo, Taraba State., Nigeria.

Majority of the communities in Jalingo metropolis are ravaged and are seriously threatened by erosion of the streets and roads; an example is found in Sabon-Layi, Angwan Sarki, Lasandi, and Mayo-Dassa.

Erosion on city streets and roads has remained a serious environmental issue that threatens almost every aspect of human endeavor, particularly the infrastructural and agricultural basis, causing social and economic problems in most emerging countries. It is a serious ecological and environmental problem that requires immediate attention because it is the primary cause of land degradation in many ecosystems on a global, regional, and local scale; Jalingo has been heavily impacted by this environmental problem because of its hydrogeological and topographic attributes such as the interaction between hard and soft rocks, extreme rainfall and temperature over the years, and vast savannah land devoid of trees, sloping landscape.

The threat of soil erosion on Jalingo's roads and streets is wreaking havoc on the city's roads, streets, and drainage systems, causing untold hardship for motorists who use these connecting roads and streets to get to their offices and homes, as they must constantly and frequently visit mechanic workshops for repairs. Roads and streets in the Jalingo metropolis that have been eroded make it difficult to drive at greater speeds; people, commodities, and services are slowed, and transferred goods occasionally fall off the vehicles transporting them. Even people's freedom of movement is limited, particularly during the rainy season when various channels have been built on the roads and streets. By implication, delays, loss in man-hour, and unplanned expenditures are the hallmark of the challenges being faced by residents as a result of the environmental problem of soil and street erosion.

To support the threat of soil erosion, Oyedepo and Oluwajana (2013) discovered that runoff and soil erosion are serious environmental concerns in most Nigerian states, including Jalingo. They exist in a wide range of situations, depending on how land use, climate, soils, and topography interact. The persistent difficulties of erosion on streets and roads in the Jalingo metropolis, as evidenced in the aforementioned issues, demanded an investigation of residents' perceptions of erosion's impacts, causes, and potential solutions. Hence, this research evaluates the resident's perception of the effects of erosion and runoff on street and roads in Jalingo metropolis.

Materials and Methods

Empirical Review

Jibo, et al. (2020) used both qualitative and quantitative data on physical structures, gullies location and extent of coverage (distribution), effects of gulling on physical and socio-economic activities, physical and socio-economic components affected by gulling, and gully erosion control strategies in their study on the effects of gully erosion on physical and socio-economic activities in Akko Local Government Area of Gombe State, Nigeria. To supplement the quantitative and qualitative data, questionnaires were distributed using a systematic sampling strategy to obtain information from residents of the study region. Furthermore, in order to address some concerns about the distribution, effects, and management strategies of gullies within the study region, the observation checklist method was employed in data gathering through field visiting and appraisal of gullies.

According to Jibo et al., (2020), all respondents acknowledged that gullies exist and that gullies affect virtually all types of physical infrastructural facilities in their communities, with housing being the most affected physical facility, indicating that human shelter is the most threatened by gullies in the study area. Guling has an impact on a variety of socioeconomic activities, including farming, trading, artisan labor, and hunting. Gully erosion has devastating consequences on physical buildings and socio-economic activities, according to the conclusions of this study, and the impact of gully erosion is obvious on residential houses, bridges, road networks, and culverts.

This study though on gully erosion was focused on social economic activities and buildings unlike the present study focused on streets and roads.

In their study of the factors influencing rill erosion on roadcuts in the southeastern region of South Africa, Seutloali and Beckedahl (2015) identified roadcuts of interest by first traveling main and regional routes in the southeastern region of South Africa on Google Earth. Field inspections were done on designated areas to assess the actual state of the roadcuts, as described above. To obtain actual sizes for detailed research, roadcuts were numbered and random samples were picked using random number tables. The roadcuts were then divided into two categories: degraded and non-degraded.

Appendix 1: Locations and nature of devastation by erosion

Plate 2: An eroded street at Angwan Sarki   Plat 3: Erosion problem at Sabon-Layi

Plate 4: an eroded street at Lasandi   **Plate 5**: an eroded street at Mayo-Dassa


Plate 6: Eroded Street at Mile Six Plate 7: An eroded street at NTA area


Plate 8: An eroded street at Dorowa Malamjoda Plate 9: erosion problem at


Plate 10: An eroded street at Sabon-Gari **Plate 11**: Erosion problem at Angwan Kasa


Plate 12: Erosion Problem at Sabon-Layi **Plate 13**: An eroded street at Turkur


Plate 14: Erosion Problem at Abuja phase II **Plate 15**: Erosion problem at NEPA Office Side

Roadcuts that had rills or flutes were considered degraded, whereas those without rilling were considered non-degraded. There were 29 degraded and 20 non-degraded roadcuts as a result of this. Based on the mean percentage cover of rills per square meter plots established on the roadcuts, the degraded roadcuts were further classified into three erosion categories: (1) slight: less than 25%; (2) moderate: between 25% and 50%; (3) extensive: between 50 and 75 percent; and (4) very extensive: above 75 percent. On the degraded and non-degraded roadcuts identified in South Africa's southeastern region, the gradient, length, percentage of vegetation cover, and soil texture (i.e. percentage of sand, silt, and clay content) were also measured.

Using an Abney level, a ranging rod, and a measuring tape, slope profile measurements were taken along three cross-profile transects on each roadcut. From the top to the bottom of the roadcuts, transects were formed, with the first transect running along the greatest slope length. The next two transects were placed on both sides of the first and midway across the roadcut width.

Slope profiles were calculated by recording a series of measured lengths along a transect and the related angles. The average of averages for each transect was used to calculate the slope gradient for each roadcut. The overall lengths of the roadcuts were calculated using the maximum lengths of the roadcuts. The Statistical Package for Social Sciences (SPSS) version 21 software was used to conduct the statistical analysis. The Kolmogorov–Smirnof test was performed to determine whether the data was normal. To see if there were any significant variations between the slope characteristics of the deteriorated and non-degraded roadcuts, a proportions test was used. To see if there were any significant differences between the slope characteristics of the slightly, moderately, substantially, and very extensively damaged roadcuts, a one-way analysis of variance (ANOVA) with a 95 percent confidence level (P 0.05) was utilized. The Pearson correlation was also utilized to see if there were any correlations between rill dimensions and slope features (gradient, length, percentage of vegetation cover, and soil texture). To see if there were any significant differences in rill diameters upslope, midslope, and downslope of the roadcuts, a one-way ANOVA (P 0.05) with a Tukey's HSD post-hoc test was utilized.

The results demonstrate that the degraded roadcuts had a greater mean slope gradient (52.51) than the non-degraded roadcuts (28.24). Similarly, when compared to non-degraded roadcuts, the mean length of degraded roadcuts was larger (10.70 m) (6.38 m). Degraded roadcuts had a low mean percentage of vegetation cover of 24.12, whereas non-degraded roadcuts had a greater mean percentage of vegetation cover of 91.71. Degraded roadcuts had a 66 percent sand concentration, while non-degraded roadcuts had a 39.5 percent sand content. In addition, degraded and non-degraded roadcuts had mean silt concentrations of 22 and 20.4 percent, respectively. Furthermore, the average clay concentration of degraded roadcuts was 8.7%, compared to 39.1% for nondegraded roadcuts. The purpose of this study was to assess the characteristics (gradient, length, and vegetation cover) of degraded and non-degraded roadcuts in the southeastern region of South Africa, as well as to investigate the relationship between the characteristics of roadcuts and the dimensions (width and depth) of rills. Though the study used multi-methods to investigate a comparable phenomenon, erosion, and roadcuts, it differs from the current study in that the aspect of erosion on streets and roads was not investigated.

Arabameri et al., (2021) projected gully erosion susceptibility using a hybrid computer education solution termed genetic algorithm-extreme gradient boosting (GE-XGBoost), which is a hybrid computer education solution for spatial mapping of gully erosion susceptibility. According to preliminary findings, the suggested GEXGBoost model outperforms the other benchmark solution in terms of prediction precision (89.56 percent). As a result, the newly developed model could be a potential tool for mapping gully erosion susceptibility on a broad scale. This study differs from the existing one in that a new type of tool was utilized instead of GEXGBoost modeling.

In a related study, Nyssen et al (2006) examined gully erosion rates in northern Ethiopia through interviews and measurements, utilizing four gully systems, each located in a different habitat and representative of the Tigray Highlands in terms of dimensions and location in the terrain. The AGERTIM method (Assessment of Gully Erosion Rates Through Interviews and Measurements) was created for this project. It includes measurements of current gully volumes, long-term monitoring of gully evolution, and semi-structured interview approaches. The result of the study showed that gullying in Dingilet began around 1965 as a result of slow environmental changes (removal of vegetation from agriculture in the watershed and eucalyptus plantation in the valley bottom); rill-like incisions evolved into a gully, which rose significantly in the dry period between 1977 and 1990. In various places, the anticipated evolution of the overall gully volume shows trends comparable to the Dingilet gully. Over the last 50 years, the average gully erosion rate has been 6•2 t ha−1a−1. The utilization of interviews and measures was similar in this study, although other variables were explored.

Soil erosion has been the biggest environmental disaster bedeviling the township of Lafia in Nasarawa State, according to Tasi'u et al., (2021), as it hasn't spared an inch of interred surface inside the city area, in fact, numerous neighborhoods have been entirely under siege. They went on to say that the threat has been claiming and threatening lives, properties, daily activities, and the general health of the physical environment for years. According to Tasi'u et al., (2021), officials prefer to neglect the situation, resulting in astronomical soil erosion in Lafia.

Study Area

The Jalingo Local Government Area is roughly located between 8° 45′ and 9° 10′ north latitude and 11° 09′ and 11° 30′ east longitude (Figure. 1). Lau Local Government Area borders it on the north, Yorro Local Government Area on the east, and Ardo-Kola Local Government Area on the south and west.

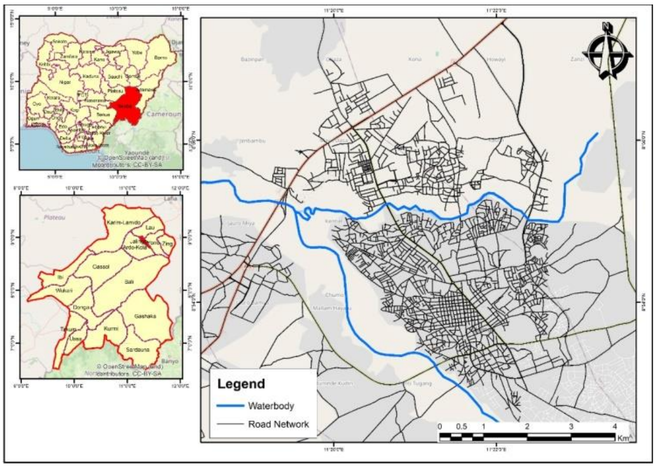

Fig 1: Map of the Study Area

The relief of Jalingo L.G.A is made up of undulating plains and mountain ranges. This dense mass of rock outcrops (mountains) stretches from the Jalingo and Lau L.G.As to Yorro and Ardo-Kola L.G.As, forming a periscopic semi-circle that acts as a shield for Jalingo town (Oruonye, 2012). The climate in Jalingo L.G.A. is tropical continental, with distinct wet and dry seasons. The dry season normally lasts from November to March. The average annual rainfall in the research region is around 1.200mm, and the average annual main temperature is around 29°C (Oruonye, 2012). The relative humidity fluctuates from 60-70 percent during the rainy season to 35-45 percent during the dry season (Oruonye, 2012).

Method:

In this study, a qualitative approach using a case study design (multiple methods) was employed (Figure 2). The design involved two major components for gathering necessary information. The first component of the research methodology involved field observation aimed at collecting information from the residents. The second and the major component of the research methodology was residents, using structured questionnaires. However, informal interviews with the residents was also conducted for firsthand information on the resident

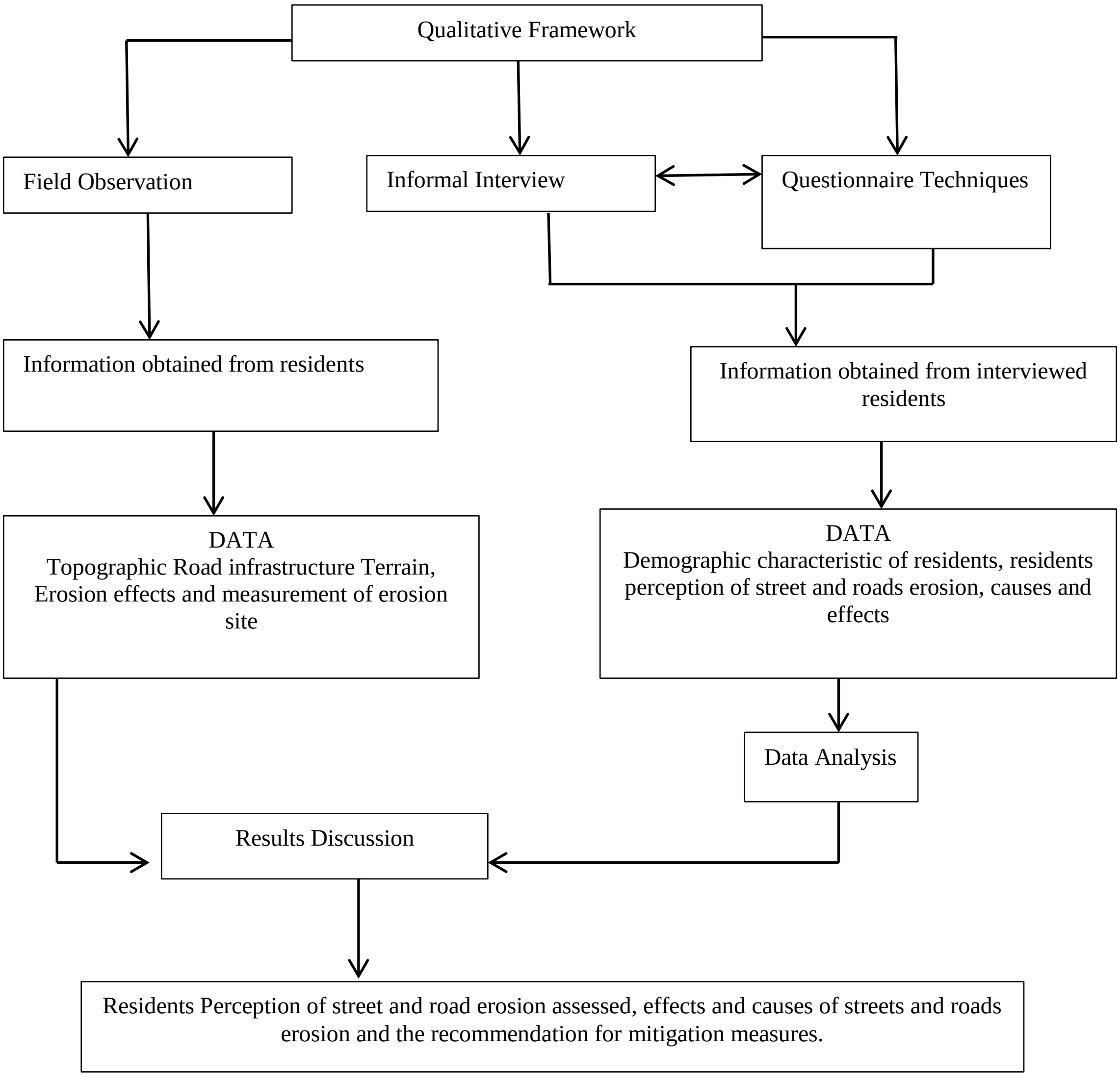

Figure 2: A flow chart of research design (a qualitative approach using a case study design).

The figure 2 shows a qualitative approach used for this study. The approach was based on the information collected from the residents in the study area. The information on the study area was collected through field observation and erosion site measurement. Information from the residents was gathered by interviewing the residents about their demographic characteristics, their perception about street and roads erosion, causes, effects as well as responses to streets and roads erosion.

Two types of data are required for this study-primary and secondary data. The primary data was sourced from the physical measurement of the erosion site in order to ascertain the severity of the erosion. Secondly, structured questionnaires and interview schedule was administered to a sample of respondents. The random sample technique was employed in the selection of respondent interview. The secondary source includes Taraba ministry of environment and urban development, Taraba road construction and maintenance agency (TARCMA) as well Taraba Bureau for land and survey.

Reconnaissance survey of the study area which is Jalingo metropolis (state capital) of Taraba State was carried out to assist in the identification and accurate delimitation of the study area (June, 21st, 2021). The survey was done in order to collect proper information on the causes and effects of erosion occurrence on street and roads. Furthermore, resident was interviewed to ascertain the direct effect of soil erosion and management practices in the area, showing of the street maps. Extent of the erosion damage in the study area were examined through visual inspection. Streets that were taken into consideration for this study were selected streets in all the Ten (10) wards of Jalingo LGA. During the reconnaissance survey, the following features were examined namely; Road infrastructures such as, drain, culverts, Terrain (flat or sloppy), and land use management, pictures of the most affected areas were taken for thorough examination and the causes and the effect of erosion on the study were then studied.

The data was obtained as soon as raining season commences June 21st 2021. A multi stage sampling techniques were used in selection of respondent. The first stage involved the identification of existing wards in the study area in the month of May 2021, namely, Barade ward, Turaki "A" ward, Turaki "B" ward, Sintali "A" ward, Sintali "B', ward, Sarkin dawaki ward, Konna ward, Kachalla sambe ward, Yelwa ward, and Majindadi ward

The secondary stage involved selection of the specific street/roads within the existing wards mentioned, named, Magami (Barade ward), Mayo-Gowi area (Sintali "B" ward), Sabon-gari area (Kachalla Sambe ward), Jekada-fari area (Sintali A ward), Galadima area (Sarkin Dawaki Ward), Roadblock/Mile Six area (Kona ward), Nukai/Kofai area, Mallam Joda/NTA area, Agwan Kasa/Abuja phase II area and Lassandi/Nasarawo.

Field observation is an importation technique of collecting primary data. In this regard, in order to achieve the objective concerning the first phase of data collection for this study, the researcher went around the ten (10) wards of the study area. This is to gain an understanding of the study area, with respect to the purpose of the study.

During the tour, the researcher observed that most of the road infrastructure such as drain, culverts, Terrain (flat and sloppy) were affected as a result of erosion. The knowledge of these was used to refining the scope of the study problem, identifying major information gap, and guiding the sampling process.

The primary objective was to gain an understanding of the prevailing streets and roads erosion problem in the study area as far as resident's perception of erosion on streets and roads as well as causes and effects are concerned. In this regard, reconnaissance survey of the study area which is Jalingo metropolis, the State Capital of Taraba State capital was carried out to assist in the identification and accurate delamination of the area. Accordingly, data collection was divided into two pleases.

i. The first phase involved the collection of general information about the study area through structured questionnaire and informal interview. During the observation, the following features were examined namely; Road infrastructures such as drain, culverts, Terrain (Flat or soppy), and Land use management, pictures of the most affected area were taken for thorough examination, and the causes and the effects of erosion on the study area were then studied. More so, measurement of eroded streets and roads were carried in the selected roads cut across all the ten (10) wards of the metropolis. Measurement tape was employed and the format records showed the following:

i. Date of the measurement, ii.Location of the streets and road, iii.Length (m2), iv.Width (m2), v.Depth (mr) and vi.Terrain

ii. The second phase covered the data collection from the sample of residents. This phase was achieved by conducting interviews using structured questionnaire. This component was conducted to understand residents' perception (knowledge) about erosion on streets and roads and its causes and effect.

An interview is one of the most important tools for gathering primary data through interviewing people who knew about the problem under study. It is an important tool for gathering information in much detail to better understand people's perception and awareness. In this regard, in order to achieve the objective concerning the first phase of data collection for this study, information was obtained through informal interviews in three successive sessions. Firstly, before the questionnaire administration, and secondly, during the questionnaire administration from some randomly selected residents. The interview focused on the residents' knowledge and perception as well as causes and effect of erosion on streets and roads. Additionally, data was collected through a formal administration of 120 copies of questionnaires to twelve (12) respondents each from the ten (10) wards. Respondent's demographic status (gender, age education, and marital status), perception (knowledge) about erosion on streets and roads, knowledge on the causes of erosion on street and roads, the effects of erosion, and ways to mitigate the erosion menace in Jalingo were the information sought through the questionnaires. Descriptive statistics and partly quantitative analysis to interpret and present the data.

Variable	No of Respondents	Category	No of Respondents
Age	120	20-29	12
		30-39	20
		40-49	40
		50 above	48
Gender	120	Male	100
		Female	20
Marital status	120	Married	99
		Single	21
		Divorced	Nil
		Widow/Widower	Nil
Occupation	120	Trading	40
		Civil Servant	48
		Artisan	10
		Farming	22
		Others	Nil

Source: Fieldwork, 2021

Table 1 presents the result for the demographic variables of Jalingo. The attributes presented and discussed are the age, gender, marital status, etc of the respondents. From the table 1, none of the respondents was under the age of 20 as 12 respondents were between 20-29 years. In the 30-39 age brackets, there are 20 respondents and 40 of the respondents are between 40-49 years old while 48 respondents are 50 years and above. This shows more matured adults took part in the study and most likely will impact positively on the result of the study. Furthermore, Table 1 equally shows that more males than females participated in the study as 100 of the respondents are male while 20 are female. This could be a result of the subject matter of erosion which males who owns and repairs the cars in most cases are prone to complain about more than their wives or female in general. Similarly, Table 1 shows that in terms of the marital status of the respondents, none of the married respondents is either a widow/widower or divorced. The result shows that 99 respondents are married and 21 are single. This shows that most of the respondents still have their marriage very intact and happy. On the occupation of the respondents, 40 respondents are traders, 48 respondents are civil servants, while artisans are about 10 respondents and 22 of the respondents are farmers. The implication of the result is that more civil servants took part in the study as they had the largest number of 48 respondents. This is because they suffer the effects of the erosion of roads and streets more and less socio-economically empowered to repair their vehicles or other effects of erosions.

Perception on the Effects Erosion on the Road and Streets in Jalingo

Result from the interview and field observation revealed that some major parts of selected study areas were not motor-able. However, some vehicles do maneuver their ways out in some of these roads which causes delays and loss of man-hour in the morning for those going to the office and their business premises as well as those taking their children to school. Some tricycle riders used skills and care before crossing the eroded surface of the roads. These affect the free vehicular movement of goods and service. The socio-economic activities of those areas have been crippled because of inaccessibility of vehicles. Example, e.g places like Sabon-gari, Ungwan Yangdan, Angwan-Kasa, Abuja phase II, and Lassandi. These places are heavily affected by erosion.

The residents from these affected communities had no choice than to trek a little distance before getting bike (tricycle). The worst parts of these areas are Gulum (Kona Road), Mayo-Dassa, Mile Six, and behind stadium.

More so, some residents disclosed that some of them couldn't park their cars in eroded surfaces of the roads. They, therefore, opted to park their cars in their neighbor houses that were not affected by these erosion menaces.

Obviously, effects of erosion on various studied street and roads were observed to vary severe to minor affecting homes streets, and water bodies. However, the following were observed to be the effects of erosion in an environment of the study case area:

1. Rendering of streets and roads ways nonmotorable through creation of gullies
2. Carving in (slope instability) on drains ditches that were not lined
3. Flooding of roadways during rain due to blockage of drains
4. Pollution of water bodies in the environment as a result of sediment deposition
5. Destruction of pavement infrastructure i.e pavement culverts and drainages
6. Loss of properties and land through washing away of building foundation base.
7. Unearthing the underground water pipes and telecommunication cables. Constant movement of vehicles are causing damages to those infrastructural facilities.

Erosion in the selected study area was found to vary from minor to severe and the main causes of erosion in these areas is water from rainfall usually occur during the raining season Plate1 shows a typically affected erosion site in Galadima. Furthermore, Table 2 shows the details of the street, topography, and the impact of erosion.

The level of impact of erosion on the street and roads considered was determined by the ability of the streets to provide access to residents. Inability of the street to provide access to Vehicles and residents were judged "severe", Partial accessibility termed "major" and relative low erosion impact termed "Minor".

Unpaved roads are familiar sight on streets. Almost all of these roads are used for daily transportation by residents except for those in a total state of disrepair. Erosion is perhaps the most challenging problem in all the area considered for study. However, management of unpaved streets and roads in these areas has not received attention as much as paved roads.

Plate 1. An affected erosion site in the Sabon-Gari. area of Jalingo

Table 2. Description of topography, impact of erosion and road infrastructure in Jalingo

		Road Infrastructure		Terrain			Erosion Effects			
SN	**Street Name**	**Culvert**	**Drain**	**Flat**	**Sloppy**	**Steep (up & down)**	**Gully**	**Rill**	**Crater**	**Remark**
1	Sabon-Layi	X	X		X					Major
2	Galadima	X	X	X						Minor
3	Sabon-Gari		X	X			X	X	X	Severe
4	NTA	X	X		X				X	Severe
5	Mayo-Gwoi		X		X					Major
6	Nassarawo				X		X		x	Severe
7	Abuja Phase I		X	X			X			Severe
8	Abuja Phase II			X					X	Severe
9	Angwan-Kasa				X				X	Severe
10	Dorowa			X			X			Minor
11	Lasandi				X			X	X	Severe
12	Mile Six					X				Major
13	ATC Kofai					X	X	X		Severe
14	Nyabon-Kaka					X			x	Severe
15	Nyamusala		X		X					Minor
16	CBN					X	X	X		Severe
17	Magami	X			X					Minor
18	Jakada-Fari	X	X							Major
19	Mayodassa				X		X		X	Severe
20	Nukkai				X			X		Minor
21	Mallam Joda				X					Major
22	Angwan Sarki	X	X							Minor
23	Angwan Yandan	X	X	X						Minor

Author Research Work (2021)

Note: The symbol "X" represents the nature of road/street infrastructure, the nature of the topography, and the type of erosion.

Table 2 shows the street and the nature of the road/street condition and the rate of erosion as well as level of devastation. From table 2, the areas with severe erosion effects are Sabon-Gari, NTA, Nassarawo, Abuja Phase I, Abuja Phase II, Angwan-Kasa, Lasandi, ATC Kofai, Nyabon-Kaka, CBN, and Mayodassa. In the category of major erosion effect on road and streets are Sabon-Layi, Mayo-Gwoi, Mile Six, Jakada-fari, and Mallam Joda while Galadina, Nyamusala, Dorowa Magami, Nukkai, Angwan Sarki, and Angwan Yandan. From the result presented, 48% of the locations had severe erosion effects, 22% of the location had major erosion effects and 30% of the location had minor erosion effects on their street and roads. This shows more areas have severe effects.

Table 3. Depth, Length, and Width of Erosion on Streets and Roads in Jalingo

S/N	**Date**	**Location**	**Erosion**	**Erosion**	**Erosion**	**Terrain**

			Length (m^2)	Width (m^2)	Depth (m^2)	
1.	12/06/2021	Sabon-Gari	146m	4.3m	1.1m	Sloppy
2.	12/06/2021	Galadima	164m	4m	1m	Sloppy
3.	12/06/2021	Sabon-Layi	154m	4.3m	1.3m	Sloppy
4.	12/06/2021	NTA	1204m	4m	07m	Sloppy
5.	12/06/2021	Mayo-Gwoi	174m	2m	05m	Sloppy
6.	15/6/2021	Kasuwan Yelwa	208m	2m	08m	Sloppy
7.	15/6/2021	Nassarawo	236m	3m	1.1	Sloppy
8.	15/6/2021	Abuja Phase I	146m	3m	09m	Steep/sloppy
9.	15/6/2021	Phase II	163m	3m	07m	Steep/sloppy
10.	15/6/2021	Angwan Kassa	316m	4.5m	1.3m	Sloppy
11.	20/6/2021	Mallam Joda	218m	3.5m	0.6m	Sloppy
12.	20/6/2021	Dorowa	133m	4.8m	0.8m	Sloppy
13.	20/6/2021	Lasandi	317m	4.2	1m	Steep/Sloppy
14.	20/6/2021	Mile Six	144m	2.6m	08m	Flat/Steep
15.	24/6/2021	ATC (Kofai)	123m	3.1m	09m	Sloppy
16.	24/6/2021	Angwan Korofi	116m	2.8m	07m	Sloppy
17.	24/6/2021	Nyabun Kaka	222m	3.4m	06m	Flat/Steep
18.	26/6/2021	New CBN Area	219m	2.6m	1.2m	Flat/Steep
19.	26/6/2021	Nyamu Salla	139m	2.1m	0.8m	Flat/Steep
20.	26/6/2021	Magami	112m	3.4m	0.6m	Flat/Steep
21.	1/7/2021	Jekada fari	204m	2.1m	0.7m	sloppy
22.	1/7/2021	Primary Board	206m	1.8m	05m	sloppy
23.	1/7/2021	Angwan Sarki	309m	1.7m	04m	Flat/step
24.	6/7/2021	Angwan Yelwa	404m	2.1m	05m	sloppy
25.	6/7/2021	Angwan Yangdang	607m	2m	0.3m	sloppy
26.	6/7/2021	Nyabun Kaka	305m	2.1m	04m	sloppy
27.	10/7/2021	Dinyavo	401m	2.3m	05m	Flat/step
28.	10/7/2021	Angwan Kasuwa	200.6m	3m	0.8m	Sloppy
29.	10/7/2021	Shavo	209m	3.2m	0.6m	Flat/step
30.	15/7/2021	Nakkai	409m	3.6m	0.9m	Sloppy
31	15/7/2021	CBN	306m	2.9m	0.6m	sloppy

Source: Author Research Work (2021)

Table 3 shows the depth length and width of erosion sites on the streets and roads in Jalingo. Generally, from Table 3, the terrain majorly slopping with few steep and flat surfaces in Jalingo. This may have been contributing to the erosive power of the overland flow during rainfall in rainy season. The highest erosion length was recorded in NTA with 1204m in a sloppy terrain while the least erosion was recorded in Magami on a flat terrain at 122m. The width of the erosion sites ranges from 1.7m in Angwan Sarki on a flat/steep slope to 4.8m in Dorowa on a sloppy terrain.

Findings from the interview showed that most of the respondents were aware that erosion occur as a result of rainfall which is natural and indiscriminate dumping of refuse/wastes on a drainage systems which is man-made.

Some of the respondents interviewed portrayed that the community is not making any bye effort to mitigate the menace of the erosion, rather they all folded their hands waiting for government to take action.

On the other hand, the respondents revealed that the community uses to sand fill the eroded surface of the roads twice or thrice in a year, depending on the magnitude and the velocity of the rain for that year instead of waiting for government.

Causes of Streets and Roads Erosion in Jalingo

Erosion which is a fundamental and complex natural process was observed to be strongly affected by human activities. The causes of erosion in these areas were viewed from natural and human perspective. The natural causes include topography of the terrain; soil nature and rainfall. However, the factors that control the impact of erosion on unpaved roads differs from that of paved roads.

Rainfall: An important factor that controls the level of the impact of erosion on streets and roads is rainfall. It is an important factor that must be considered in assessing erosion. Without rainfall, erosion cannot occur in Jalingo.

Topography:

Topography was observed to be of the critical factors affecting erosion in the study area, especially on NTA area, Sabon-layi, Mayo-gwoi, Nassarawo, Angwan Kasa, ATC Kofai, Nyabon Kaka, CBN area, Mayo-Dasa, Nukkai, Mallam Joda, and Angwan Sarki. The Topography of the areas mentioned were observed to be sloppy and hence whenever rainfall, movement of water is favoured toward the lower elevation which in turn discharged run off with it impeding sediment stream that is not lined. This consequently causes the stream to overflow it bank unleashing flood to buildings that lies along its bank. Similar sloppy terrain was observed on all others sites. In Sabon-layi Anguwan Sarki and behind Jalingo main market which is roughly surface dress (i.e partially tarred or paved), the effect of topography on ability of the road to be eroded was insignificant. However, it contributed to storage of runoff into craters which aid in the development of potholes on these roads. In same-cases at Sabon-gari, Jekada-Fari, Sabon-layi, Abuja Phase I and II, the topography of the terrain has contributed to washing off of the soil that served as foundation for the drainages and culverts learning them to fail during subsequent erosion.

Soil Condition: To an extent when rainfall water infiltrates into the existing soils that serve as the foundation for these unpaved streets and roads and when water input exceed the soil's capacity to absorbed water runoff occur. Runoff when improperly channeled lead to erosion. On most of the unpaved roads in the study areas, there exist underlying impervious rock layers leading to formation of gully when the loose soil particles that overly these roads has been removed. Such a scenario was observed on Galadima street as shown in plate 3. Particularly. Erosion impact was found to be severe on Sabon-layi and NTA areas. Also, terrain where underlying imperious layers does not exist, craters were created making such road nonmotorable. A typical example of such was found at Lasandi and angwan Kasa as shown in plate. On some streets and roads selected as case study, there exist loose sandy gravel soils, so when rain falls they are easily wash off. Soil condition was observed not to be a factor influencing erosion on paved streets and roads.

Human Causes of Erosion.

Land use Pattern and waste Disposal Method:

Land use pattern in the areas studied were observed to be terrible. Some of the buildings were observed to be constructed on waterways. Again, the way refugees were dumped in the existing drainage limited the way in which drainage performs, and when drainages which are expected to be conveying runoff from the road surfaces are obstructed it causes erosion. This often aids in the development of gully on roadway and sometimes flooding which affect both homes and pavement infrastructures as capture in plate 2 (Appendix).

Poor Maintenance Practices: A poor maintenance practice of existing drainages is one of the important factor that was observed to lead to erosion in the study area. Drainage system is known for carrying surface runoff and loosens soil particles. When these particles are carried by runoff, they settle out in the drainage or where there is obstruction in the drainage system thus diminishing the carrying capacities of the maintenance of existing drainage infrastructure (i.,e Drains and Culverts) causes obstruction in the flow of runoff which in turn causes roadway flooding.

Typical example of this can be found on Sabon-layi and Angwan Sarki areas. In this case, uncontrolled runoff and incessant disposal of wastes into the drainage channel often causes flooding when rainfall, and this has also lead to carving in of the cross culvert that provide access to other part of the streets. Typical example of poor maintenance practice was also found in Angwan Yandan and Dorowa where a damaged drainage was not repaired as shown in one of the plate.

Poor Construction Activities

Another factor that causes erosion on roadway including paved and unpaved road is poor construction activities. Road drainages are constructed without taking anticipated runoff into consideration and this often leads to the design of drains that cannot hold and channel runoff into the nearby stream. Similarly, culvert inlets are designed improperly. All these lead to runoff overflowing onto roads thereby causing erosion and flood. Street, where such were found, are Sabon-Layi and NTA area.

Further, improper construction of drainages and culverts were also found to cause road erosion. Drain that was supposed to be constructed using concrete retaining wall at one side and block wall on the other side were observed to be constructed using double block wall.

Alternate during and shrinkage of these block wall by rain lead to dying shrinkage and whenever these occur they tend to give way to erosion thereby causing runoff to flow on road surfaces.

Summary and Conclusion

This research work was embarked to ascertain the impact of erosion on streets and roads in Jalingo metropolis. As more development and urbanization occur in the study area, erosion has been a menace on streets and roads, thereby causing damages to many infrastructural facilities such as roads, electricity poles, and houses as well as free movement of people and vehicles.

To achieve the objectives of the research work, reconnaissance survey of the study areas was carried out to assist in the identification and accurate delimitation of the study areas. The survey was done in other to collect proper information on the causes and effect of erosion occurrence on street and roads. Extent of the erosion damage in the study area was examined through visual inspection. Streets that were taken into consideration for this study was selected street in all the ten (10) words of the Jalingo local Government area. During the reconnaissance survey, the following features were examined namely; roads infrastructures such as drain, culverts, terrain (flat or sloppy), land use management, pictures of the most affected areas were taking from thorough examination.

The result proved that erosion which is the fundamental and complex natural process was observed to be strongly affected by human activities. The causes of erosion in these areas were viewed from natural perspective and human perspective. The natural causes of erosion are rainfall, topography, soil condition while the human causes of erosion include: land use pattern and waste disposal method, poor maintenance of practices, and poor construction activities.

The following were observed to be the effects of erosion in the study area: rendering of streets and roads ways non-motorable through creation of gullies, carving in (slope instability) on drains ditches that were not lined, unearthing the underground water pipes and telecommunication cables, loss of properties and land through washing away of building foundation base, etc.

Conclusion

The effects of surface runoff and erosion on street and roads in Jalingo metropolis cannot be over-emphasized as most residence find their roads none useable and home none accessible. Drivers encounter problems on the roads during the peak of rainy season because of the increased number of potholes on the roads created by surface runoff, road flooding, and carving in of culverts and gullies. Therefore, based on the survey carried out, it can be concluded that erosion also have various effects on streets and roads and, the causes of erosion on streets and roads ranges from natural factors such as topography of the terrain, soil nature, poor waste disposal methods, poor construction and maintenance activities

Recommendations

Based on the study results, the recommendations are maintenance of proper road crown for good drainage, paving of unpaved surfaces. This is applicable to the road surfaces where the topography is steep, ensuring that ditches are properly lined to prevent erosion, regular maintenance to keep ditches, drains, and culvert clean, inspection of culverts on regular basis, protecting inlets and outlets of culverts through the use of rip rap and, installing diversions at all drain and culverts where runoff velocity can cause erosion.

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