

Impact of Erosion on Street Roads: A Case Study Of Sijuwade Area Akure Ondo State Nigeria

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Abstract

This research evaluates the impact of erosion and runoff on street roads. Reconnaissance survey was carried out to assist in the identification and accurate delimitation of the study area, out of which thirteen streets were selected. Factors responsible for erosion in the study area were observed to ranges from natural cause including topography, rainfall and soil nature. Human factor responsible for erosion in the area studied include land use pattern and waste disposal method, poor construction and maintenance activity. Effect of erosion on the studied area includes Rendering of road way non motorable through creation of gullies, Carving in (slope instability) on drains ditches that were not lined, Flooding of road ways during rain due to blockage of drains, Pollution of water bodies in the environment as a result of sediment deposition, Destruction of Pavement infrastructure i.e. pavement, culverts and drainages. It is therefore concludes that Erosion also have various effects on street roads not all factors assumed to be responsible for erosion form agricultural perspective is responsible for erosion on street roads. However, with good management practices, and paving of roads, the problems of erosion in built up area can be controlled.

Keywords: Reconnaissance Survey, Erosion, Runoff, Street Roads, and Road infrastructure

1.0 Introduction

Roads are built to facilitate the transport of people and goods, and to promote development (Robinson and Thagesen, 2004); however, menace of erosion on road has made some of it not to fulfill the purpose for which it was built. Runoff and soil erosion are among the major environmental threats around the world, they occur under very diverse conditions depending on interactions between land use, climate, soils and topography (Auzet, 2005). Erosion and in particular water erosion is an environmental problem in many parts of the world (Smith et al, 2003); water erosion is the removal of soil from earth's surface by running water (Schwab et al, 1992). It is the straight forward wearing away by the mechanical abrasion caused by suspended particle (Lister and Cook, 2006.). Soil water erosion is a major environment issue (Franco et al 2010), it can be a consequence of degradation of the soil structure, especially the functional attributes of soil pores to transmit and retain water, and to facilitate root growth (Lujan 2003). Runoff occurs only when the rate of precipitation exceeds the rate at which water infiltrates into the soil (Musa et al, 2010). However, Runoff and soil loss prediction has been widely used as a tool to guide conservation planning (Lujan, 2003). Erosion creates dangerous conditions on pathways and roadways, it can undercut and cause bank failure on pedestrian and vehicle routes, increasing risk of injury and death (Pineo and Barton 2009). When rain falls onto the earth surface, it moves according to the law of gravity, a portion of the precipitation seeps into the ground to replenish earth's ground water, but most of it flows downhill as runoff (Musa et al 2010). The transport of soil particles is by overland broad sheet flow enhanced by the flow turbulence caused by raindrop impact (Franco et al. 2010). The soil erodibility is the reciprocal of its resistance to erosion, representing its susceptibility to erosion at different rates, due to physical, chemical and mineralogical parameters (Franco et al, 2010). Moreover, Water transportation involves the kinetic energy which removes and transports the soil particles, and the resisting forces which retard erosion (Schwab et al. 1992). As watershed is urbanized, much of the vegetation is replaced by impervious surface, thus reducing the area where infiltration to ground water can occur (Musa et al 2010). Runoff is extremely important. It not only does serve rivers and streams, but also changes the landscape by an action of erosion (Musa et al, 2010). Flowing water has tremendous power, it can move boulders and carve out canyons (Aneke 1985). Water erosion needs to be controlled to maintain motor-able roads, crop productivity, sedimentation and stream pollution. Erosion problems are principally caused by human exploitation of natural resources and the removal of the protective cover of natural vegetation (Schwab et al. 1992). Runoff can be explained further as the part of precipitation on

uncontrolled surfaces, streams, rivers, drains, sewers or roads, which may further be classified according to the speed of appearance after rainfall or melting snow as direct or base runoff (Boardman et al. 1990). As more development and urbanization occur, more of the natural landscape is replaced by impervious surfaces such as roads, parking lots and buildings, hence reducing the rate of infiltration of water into the ground and thus accelerating runoff to ditches, streams or drainages (Musa et al, 2010). Erosion has been a menace in our society. It has been a problem in agricultural and engineering sector. It has been a problem affecting both highways and streets road with the problem of erosion on highways mostly reported and investigated. Erosion on streets road that provides accessibility to populace into their home has been a menace under discussed. However the incessant problem of gully on road, carving in on bridges and swelling of pavement foundation due to ingress of uncontrolled water and runoff into the pavement foundation, and crater thereby compounding road failure necessitated the need to investigate the causes, effect and ways of proffering solution to the problem of erosion on road ways. Hence, this research evaluates the impact of erosion and runoff on street roads.

1.1 Description of Study Area

The study area for this research is Sijuwade and its environs. Sijuwade is a low density residential area. It is located in Akure south Local Government Area of Ondo state. Akure is the administrative capital of Ondo State. Akure became the state capital of Ondo State in 1976. The town is located within $7^{\circ} 15'$ North of the Equator and Longitude $5^{\circ} 05'$ East of the Greenwich Meridian. Figures 1.0 show the location of Akure in Ondo state as well as Nigeria. In 2006, the provisional population for Akure was put at 353,211 (2006 census) out of which 175,494 are male and 177,716 are female. Generally, the people have almost the same life pattern. A large majority are civil servants and a consistently people of entrepreneurship (Owolabi, 2009).

The increased relative political influence of Akure as a State capital since 1976, when Ondo State was created has been partly responsible for its rapid development. This is because, the decentralization exercise, which accompanied the policy that led to the creation of the State led to the creation of jobs, which attracted many people. Improvements in transport facilities were given prominence in Akure shortly after 1976 when the city became the seat of Government. The major means of transportation in Akure is by road.

2.0 Methodology

2.1 Reconnaissance Survey of the Study Area

Reconnaissance survey of the study area which is Sijuwade in Akure South Local Government of Ondo state was carried out to assist in the identification and accurate delimitation of the study area. Essentially, the survey was done in order to collect proper information on the extent and nature of erosion occurrence on street roads. Also, residents were interviewed to ascertain the direct effect of soil erosion and management practices in the area. Figure 2.1 shows the Street Map of the study area. Extent of erosion damage in the case study area was examined through visual inspection. Street taken into consideration for this study are; Ifelodun street, Ilemobola street, Dele Johnson street, Old sijuwade street, Odoilula street, Ojulenla street, Dare Eke street, New Sijuwade street, New Ilula Area, Ala Quarters, Mercy Street, Yaba street. During the reconnaissance survey, the following features were examined namely Road type (paved or unpaved), Road infrastructures such as drain, culverts etc., Terrain (Flat or sloppy), Land use management. Pictures of the most affected areas were taken for thorough examination and the causes and the effect of erosion on the areas were then studied.

3.0 Results and Discussion

Erosion impact in the selected study area was found to vary from Minor to Severe and the main causes of erosion in these areas is water, these usually occur during the raining season. Figure 3.1 shows a typically affected erosion sites in one of the selected streets for observation. Table 3.1 shows the details of the street, topography, type of road, road infrastructure, and the impact of erosion. The level of impact of erosion on the street considered was determined by the ability of the streets to provide access to resident. Inability of the street to provide access to vehicle and residents were judge "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 street roads in these areas has not received attention as much as paved roads. Furthermore an integrated catchment drainage system was not present in all the study cases.

3.2 Evaluation of Factors Responsible for Erosion on Case Study Streets

Erosion which is a fundamental and complex natural process was observed to be strongly affected by human activities. The cause of erosion in these areas was view from natural perspectives and human perspectives.

3.2.1 Natural Causes of Erosion

Various factors were observed to be responsible for erosion problem on the case study streets. These factors include topography of the terrain, land use pattern, soil nature, rainfall, and poormaintenance practice of road infrastructure as well as absence of proper drainage. However the factor that controls the impact of erosion on unpaved roads differs from that of paved roads.

3.2.1.1 Rainfall

An important factor that controls the level of the impact of erosion on road is rainfall. It is an important factor that must be considered in assessing erosion. Without rainfall erosion cannot occur in the selected area.

3.2.1.2 Topography

Topography was observed to be one of the critical factors affecting erosion in the study area especially on Ifelodun, Ilemobola, Dele Johnson and Old Sijuwade Street. The topography of the area mentioned was observed to be sloppy and hence whenever rain fall movement of water is favoured toward the lower elevation which in turn discharged runoff with it impeding sediments into an adjacent stream that is not lined. This consequently causes the stream to over flow it banks unleashing flood to buildings that lies along its banks. Similar sloppy terrain was observed on all other site. On New Sijuwade street, Dare Eke street, OjuleNla, which is tarred (i.e.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 pothole on these roads. A situation where topography contributed to ability of runoff to erode the paved layer off the road consequently affecting the subgrade soil were seen at Ala quarter as shown on plate 1. In some cases at Yabastreet, Dele Johnson, Ifelodun and old Sijuwade street, the topography of the terrain has contributed to washing off of the soil that served as foundation for the drainages and culverts leaving them to fail during subsequent erosion.

3.2.1.3 Soil Condition

To an extent when rainfall water infiltrates into the existing soils that serve as the foundation for these unpaved street roads and when water input exceed the soil's capacity to absorb water runoff occur. Runoff when improperly channeled lead to erosion. On most of the unpaved roads studied there exist underlying impervious rock layers leading to formation of gully when the loose soil particles that overly these road has been remove. Such a scenario was observed on Yaba Street Idi-AgbaTitun as shown on plate 2.

Particularly, Erosion impact was found to be severe on Yaba Street at Idi AgbaTitun. Also, terrain where underlying impervious layers does not exist, craters were created making such road non motor able. A typical example of such was found at Ifelodun Streets as shown in Plate 3.

On some street road selected as case study there exist a loose sandy gravel soil, so when rain falls they are easily washed off. Soil condition was observed not to be a factor influencing erosion on paved roads

3.2.1.4 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 waterway. Also the way refuses 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 4.

3.2.1.5 Poor Maintenance Practices

Poor maintenance practices of exiting drainages in one of the important factor that was observed to leads to erosion. 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 ditches. However in the studied area, poor 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 New Sijuwade Street. In this case, uncontrolled run off 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 parts of the streets. Typical example of poor maintenance practice was also found on Ala quarter where a damaged drainage was not repaired as shown in plate 5 and 6.

3.2.1.6 Poor Construction Activity

Another factor that causes erosion on roadway including paved and unpaved road is poor construction activity. Road drainages are constructed without taken 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 New Sijuwade and Ifelodun Street.

Also improper construction of drainages and culvert 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 were observed to be constructed using double block wall. Alternate drying and shrinkage of these block wall by rain lead to drying shrinkage and whenever these occur they tend to give way to erosion thereby causing runoff to flow on road surfaces. Typical example can be seen on Plate 7, in this case a double block wall.

3.3 Effect of Erosion on the Study Case Environment

Effects of erosion on various case studied streets were observed to vary from severe to minor affecting homes streets and water bodies. However the following were observed to be the effects of erosion in environment of the study case area;

1. Rendering of road way non motarable through creation of gullies
2. Carving in (slope instability) on drains ditches that were not lined
3. Flooding of road ways 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

4.0 Conclusions and Recommendations

4.1 Conclusion

The effect of surface runoff and erosion on street roads in Sijuwade and its environs cannot be overemphasized as most residence find their roads non useable and their homes non accessible. Drivers encounter problems on the roads during the peak rainy season because of the increased number of potholes on the road created by surface runoff, road flooding and caving in of culverts and gullies. Therefore based on the survey carried out, it can be concluded that;

- Erosion also have various effects on street roads
- Not all factors assumed to be responsible for erosion form agricultural perspective is responsible for erosion on street roads
- The causes of erosion on street roads ranges from natural factors such as topography of the terrain, soil nature, rainfall and human factors such as land use, poor waste disposal methods, poor construction and maintenance activity

4.2 Recommendations

Based on the study carried out, it can be recommended that;

- Maintenance of proper road crown for good drainage
- Paving of unpaved surfaces. This is applicable to road surfaces where the topography is steep
- Ensuring that ditches are properly lined to prevent erosion
- Regular maintenance to keep ditches, drains and culverts clear
- Inspection of culverts on regular basis.
- Protecting inlets and outlet of culverts through the use of rip rap
- Installing diversions at all drain and culverts where runoff velocity can cause erosion

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Table 3.1: Description of the Topography, Impact of Erosion, Type of Road, Road Infrastructure Present on the Case Study

S/N	Roads		Road Infrastructure		Terrain			Erosion Effects			Remark	
	Street Name	Paved	Unpaved	Drain	Culvert	Flat	Sloppy	Steep	Gully	Rill		Crater
1	Ifelodun		X	X				X	X			Severe
2	Ilemobola		X	X			X					Major
3	Dele Johnson		X	X			X					Severe
4	Old Sijuwade		X				X		X			Severe
5	OdoIlula		X			X				X		Minor
6	OjuleNla	X				X					X	Minor
7	Dare Eke	X		X		X	X				X	Minor
8	New sijuwade	X		X	X		X				X	Major
9	Mercy Street		X				X			X		Major
11	Ala Quarters 1	X	X	X	X		X					Major
12	Ala Quarters 2		X	X	X		X		X		X	Major
13	Yaba		X	X	X		X		X			Severe

Note: “X” represents the presence of the factors examined on the case study streets

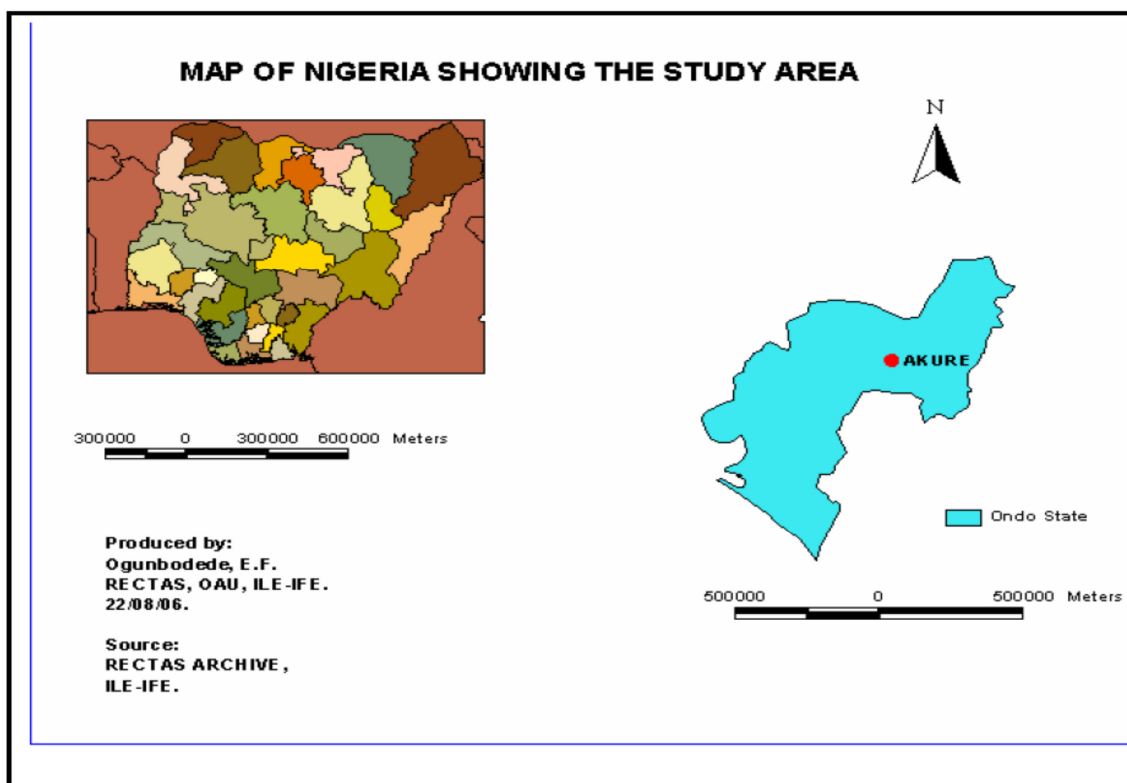


Figure 1.0: Map of Ondo State Showing the Study Area

Source: Rectas Archive, Ile Ife

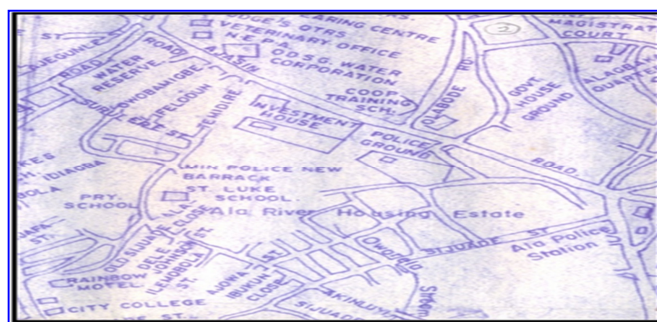


Figure 2.1: Map of the Study Area (Street Considered for Study)



Plate 2a: An Eroded Surface of a Paved Road and Gully Erosion at Yaba Streets



Plate 3: Erosion Problem at Ifelodun Street

Plate 4: A Typical Example of a Block Drain



Plate 5: An Improperly Maintained Drainage at Ala Quarters

Plate 6: A Caved in Section of Sijuwade Street



Plate 7: A Badly damaged Drain at Dele Johnson Street Due to Improper Construction