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MEASUREMENT OF GULLY EROSION ON FARM ROAD USING PROFILE REDUCED LEVEL METHOD IN *ILE-APA*, ILORIN-WEST, KWARA STATE, NIGERIA

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ABSTRACT

Farm roads are essential for the conveyance of farm inputs to the farm and evacuation of harvested crops from the farm. Many rural farm roads, including such roads as Ile-Apa road in Ilorin-East Local Government area of Kwara State, are devasted by erosion thereby hampering trafficability, even by pedestrians, and therefore need urgent attention. Measurement of the extent of the gullies on this road by traditional methods and models may not be adequate due to their nature and time requirement. The Profile Reduced Level method was used to measure the gully on the Ile-Apa farm road as it produced immediate results. Results obtained from the measurement showed that the gully had an average depth of 0.58 ± 0.35 m, which varied from -0.97 m to 0.03 m, and a mean width 2.45 ± 1.05 m. These parameters indicated that trafficability of the road may be impossible owing the varying and undulation of the gully bottom, but may allow for pedestrian passage, though with much discomfort. This may lead to increased hunger and poverty thereby aggravating food insecurity. An urgent stabilisation of the road is therefore recommended.

Keywords: Soil erosion, Farm roads, Gully, Profile reduced levels, Trafficability

INTRODUCTION

Gully is a type of erosion with relatively steep sides, and through which water may flow during, or immediately after rainfall. Bruce (2016) defines it as a channel so wide that is impossible to cross by vehicular wheels or obliterated farm implements. These types of channels cannot be recovered through conventional tillage practices, and pose great hinderances to agricultural production. Dragovic & Vulevic (2020) explained that erosion is the degradation of soil through the process of displacement of topsoil from the surface of the earth by water, wind or tillage. Fagbohun et al (2016) defines erosion as the process of detachment and transportation of soil particles by forces of erosion. These forces may include water, wind, ice and anthropogenic activities. This idea is supported by Wischeier & Smith (1978) and Orakwe (2021), who added topology as a factor contributing to erosion. Erosion process may be more visibly pronounced on steep lands where soil materials are easily rolled downwards, aided by gravitational forces.

The problem of soil erosion is a major worldwide phenomenon. Ogunlela (1996) agreed that erosion is a common problem in many parts of the world, and added that erosion by water is of greater concern that erosion by wind. This is further corroborated by Mahmud et al (2018), cited by Izge et al (2023), who reported that approximately 80% of worldwide land degradation is attributed to soil erosion. FAO & UN (2015) reported that annual global soil loss due to erosion is 20 – 30 billion tons. Pin et al (2020) saw erosion as world's greatest scientific problem. This is a menace that calls for urgent attention (Ekpo et al, 2022).

Nigeria is not exempt for the problems of erosion. Bruce (2016), citing Enabor & Sagua (1988), estimated the annual soil loss to gully erosion to be 30 million tons, affecting both rural and urban communities. The Federal Government of Nigeria (FGN, 1997) as cited by Mbajirogu (2008) reported that more than 90% of total land in Nigeria is under rill and gully erosion, and added that there are over 2000 active gullies across the country. Mbajirogu (2008) included Kwara State of Nigeria among states affected by this menace. Mbajirogu (2008) further stated that the effects of gully erosion included reduction in productivity, impoverishment of people and threat to infrastructure. Infrastructures threatened includes roads. As stated by Pin et al (2020), cited by Mohammed et al (2021), soil erosion has the effect degradation of land, reduction in water quality and destruction of roads. *Ile-Apa* roads in Ilorin, Kwara state, Nigeria is one of such roads. Tanam (2023) concluded that with soil cohesion of 1.4 N/cm^2 angle of internal friction of 34.8^o and a void ratio of 1.21, *Ile-Apa* road lacked sufficient strength to support heavy loads when wet.

Several methods exist for the measurement erosion. Ogunlela (1996) stated that the study of erosion could be by experimentation or modelling. The most common tool is the use of USLE. This method does not measure soil loss from a single storm (Ogunlela, 1996). Ogunlela (1996) further explained that the USLE lumps together rill and interrill erosion together, and does not account for deposition within the watershed. Obtaining and accurate erosion measurement must then be by experimentation. Most erosion measurement experiments are time consuming. Using the profile reduced level methods, especially in gullies, provides immediate result. The aim of this work therefore, was to use the profile reduced level method to measure the extent of the gully on *Ile-Apa* road in Ilorin.

MATERIALS AND METHODS

Study Area

Ilorin is the capital city of Kwara state of Nigeria with *Ile-Apa* located between latitude 8º26′6″ North and longitude 40º40′52″ East. Located in the Savannah region, Ilorin has an annual rainfall of 990.3 mm to 1310 mm (Olubanjo, 2019). The road under study is one running from behind the University of Ilorin to *Ile-Apa*, a farming community behind the university.

Reduced Level Measurement

Materials used were Ranging poles, Level, Tripod, Staff, Pegs, and vi. Tape. A length of 500 m was measured along the road in the region of the gully. A profiled baseline was established with the aid of ranging poles. The baseline was marked and pegged at intervals of 20 m to establish the profile. From each mark, 3 offsets were measured and denoted a, c, b, forming a grid of 75 points as shown in Figure 2.1. Points a and b were located at the edges of the gully while point c was at the bottom of the gully. As necessary, foresights, inter-sights and backsights were taken, with as many change points as needed. Analysis of the data to produce the reduced levels was performed using the Height of Instrument method with a Temporary Bench Mark (TBM) of 50 m. A check for accuracy of the analysis was equally performed by ensuring that the difference between the sum of the backsights and foresights is equal to the difference between the first and last reduced levels.

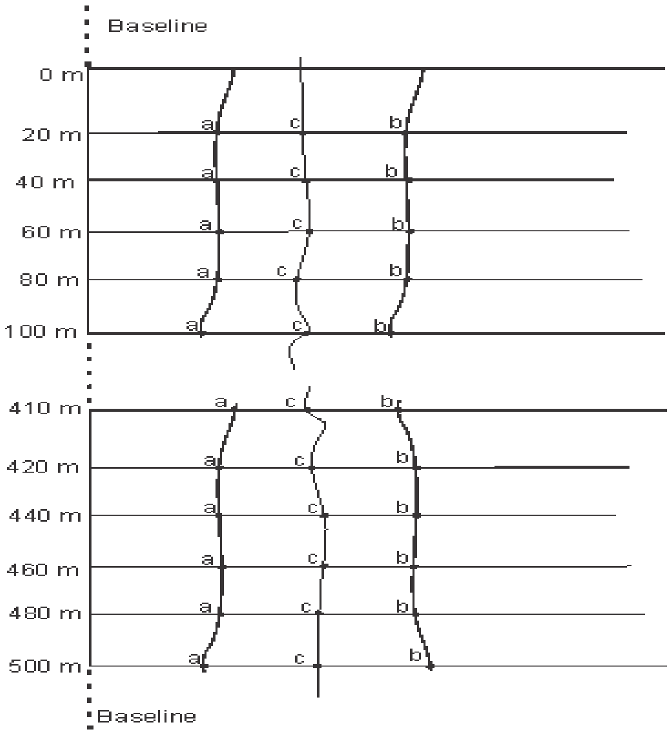

Figure 1: Layout of Erosin Grid Showing Node for Measurement of Elevation

RESULTS AND DISCUSSION

Table 1 shows the reduced levels on each of the offsets from each chainage of the baseline. Column a represents the reduced levels on the left side of the gully, column c is reduced level at the bottom of the gully, while column b shows the reduced levels on the right side of the gully. For each chainage, the depth of the gully at that point is shown by the column labeled "Depth".

Table 1: Reduced Levels Along the Sides and Bottom of the Gully Site

Chainage	a	C	b	Depth
20	50.10	49.63	49.78	-0.31
40	48.64	48.30	48.64	-0.34
60	47.24	46.91	47.24	-0.33
80	45.94	45.11	45.79	-0.75
100	45.83	44.13	44.35	-0.97
120	43.24	42.27	43.02	-0.86
140	42.16	41.63	42.03	-0.47
160	40.48	40.40	40.63	-0.15
180	39.80	39.81	39.75	0.03
200	38.67	37.33	38.61	-1.31
220	37.06	36.88	37.16	-0.23
240	35.89	35.32	35.73	-0.49
260	34.85	34.51	34.81	-0.32
280	33.64	32.82	33.52	-0.76
300	32.45	31.95	32.54	-0.54
320	31.25	30.90	31.20	-0.32
340	30.63	29.36	30.65	-1.28
360	29.22	28.22	29.27	-1.02
380	31.13	30.32	30.95	-0.72
400	29.75	29.25	29.57	-0.41
420	28.18	27.28	28.38	-1.00

Chainage	a	C	b	Depth
440	26.77	26.04	26.83	-0.76
460	25.22	25.10	25.36	-0.19
480	23.95	23.28	23.88	-0.64
500	22.43	21.77	21.75	-0.32

a – reduced level along left side of gully
c – reduced level along bottom of gully
b – reduced level along right side of gully

The mean depth at each chainage revealed that the points were below road benchmark surface, except at chainage 180 m, where the depth was 3 cm above benchmark. The bottom of the gully can clearly be seen to be rough, with much undulation, with a mean depth of 0.58±0.35 m below the road benchmark. This makes trafficability most difficult, as agreed by Ituen (2009), Zoz & Grsso (2003) and Abubakar et al (2022). Ituen (2009) also added that such roads are impassable, even by cyclists. Although the road may be passable by pedestrians, it poses immense discomfort, even with their low haulage capacities. The longitudinal profile of the bottom of the gully is presented in Figure 2.

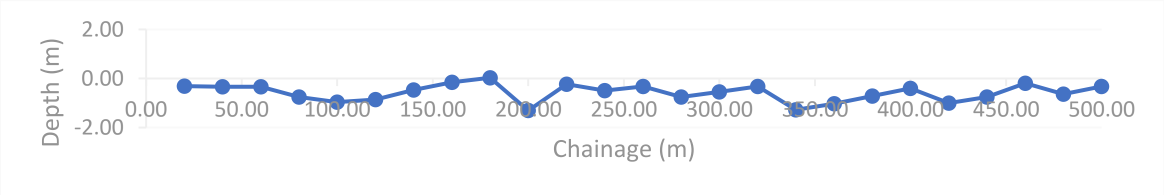

Figure 2: Longitudinal Profile of Bottom of Gully on Ile-Apa farm Road

The roughness of this profile is an indication that even pedestrians would have great discomfort trafficating the road. Figure 3 is the longitudinal profiles of reduced levels along lines a, b, and c of Figure 1.

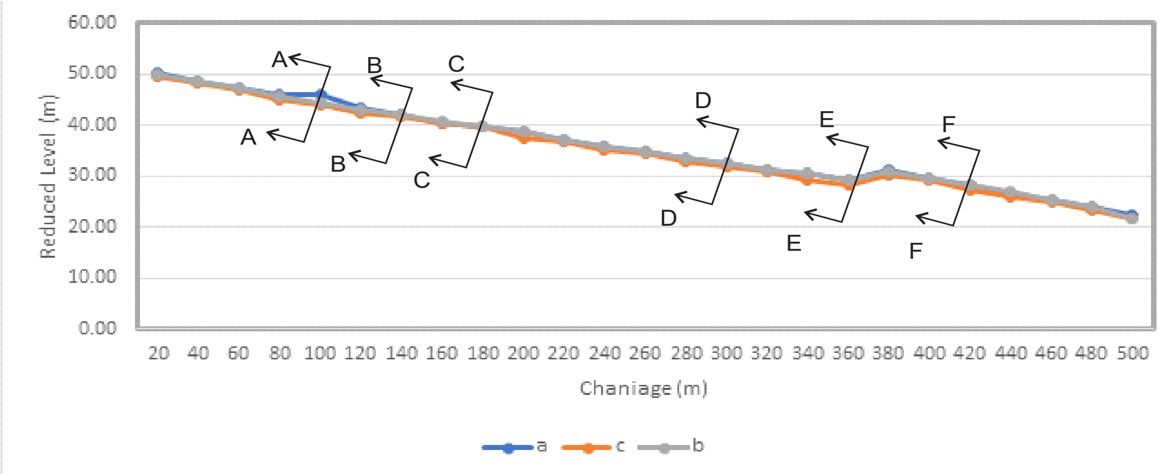

Figure 3: Longitudinal Profiles Showing Reduced Levels of along lines a, b, and c

Sections A-A, B-B, C-C, D-D, E-E and F-F reveals the width of the gully at chainage 100 m, 140 m, 180 m, 280 m, 360 m, and 420 m respectively. These are shown in Figures 4 to 9. The width of the gully at these sections were found to be 3.75 m, 1.0 m, 2.60 m, 1.85 m, 3.70 m and 1.5 m respectively, having a mean of 2.45 ± 1.05 m, while the depths at these sections were -0.97 m, -0.47 m, 0.03 m, -0.54 m, -1.02 m and -1.00 m respectively. The shape of each curve shows what the gully looks like at each of the sections taken.

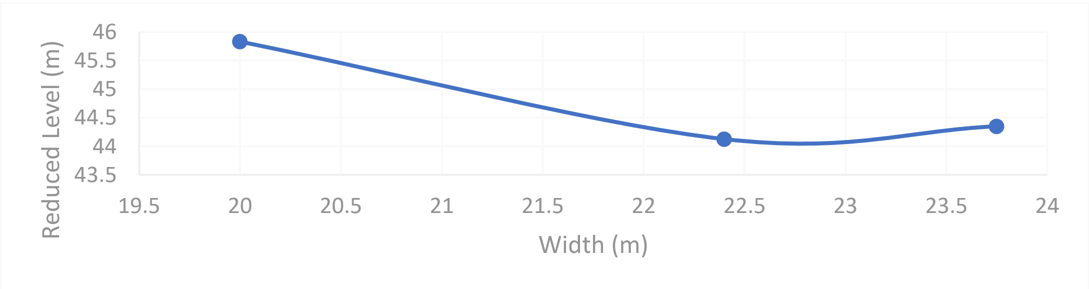

Figure 4: Gully Cross-Section showing Width at Section A-A

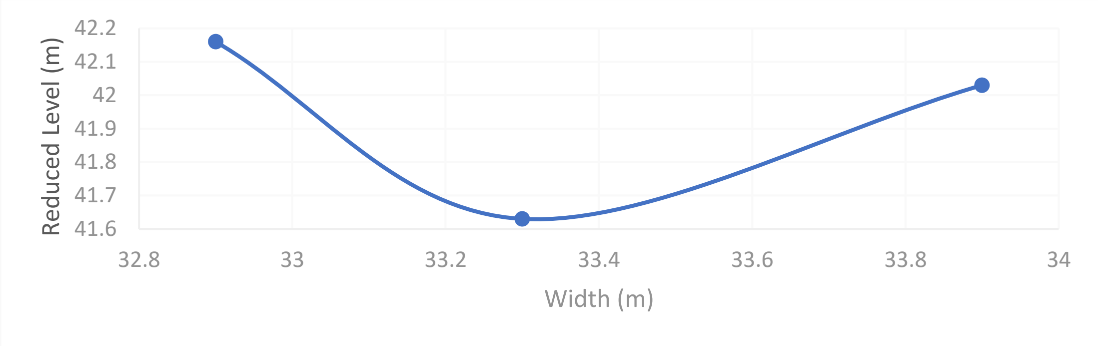

Figure 5: Gully Cross-Section showing Width at Section B-B

While all sections of the gully show a deep depression, at chainage 180 m (Figure 6) it shows a slight elevation. The undulating nature of the bottom of the gully makes trafficability difficult, if not impossible.

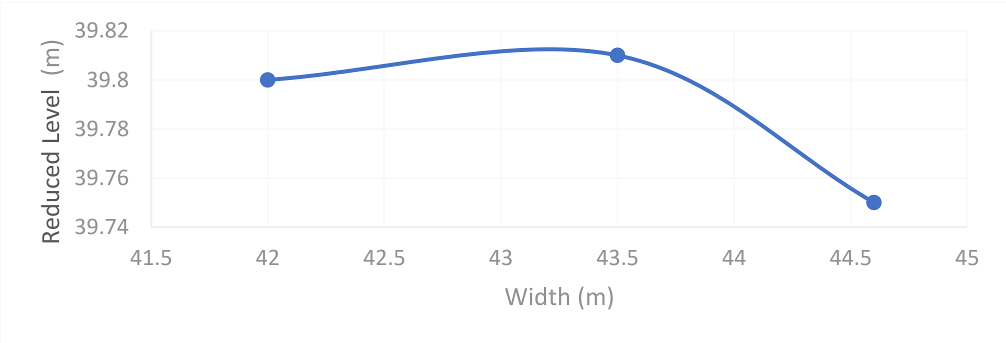

Figure 6: Gully Cross-Section showing Width at Section C-C

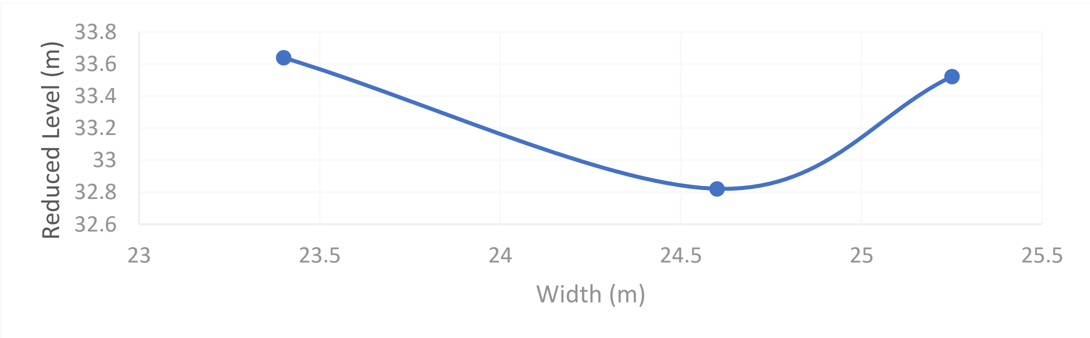

Figure 7: Gully Cross-Section showing Width at Section D-D

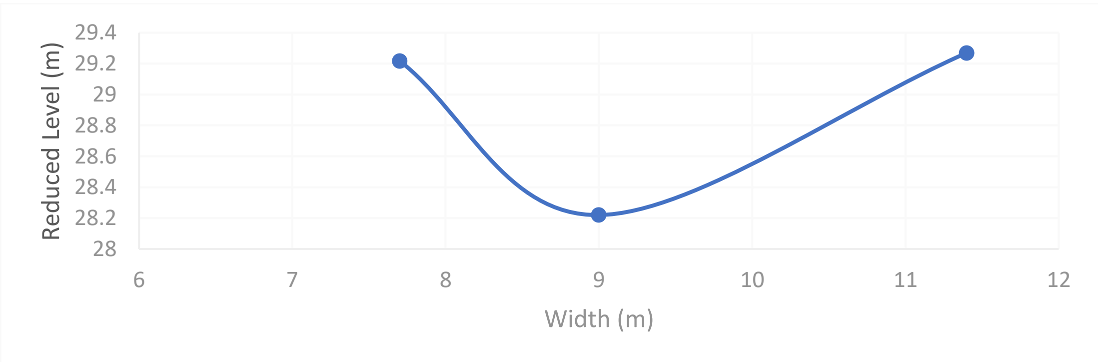

Figure 8: Gully Cross-Section showing Width at Section E-E

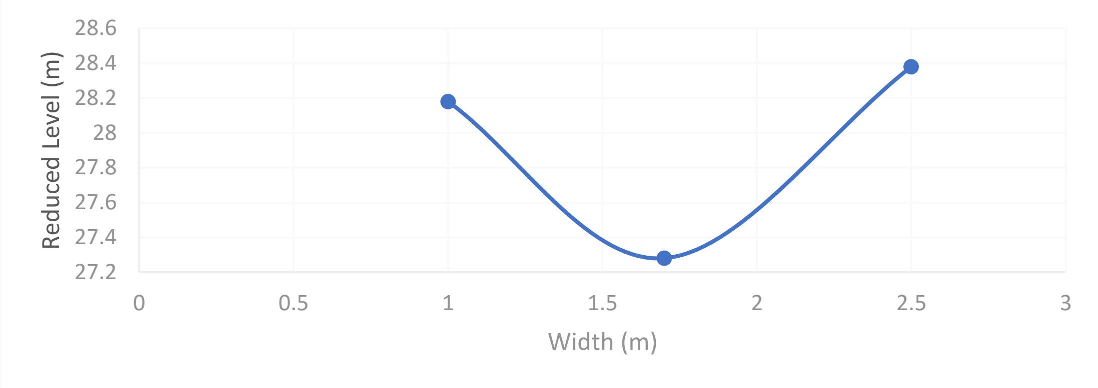

Figure 9: Gully Cross-Section showing Width at Section F-F

The widening and narrowing of the sides of the gully, as well as the undulating nature makes it impossible for a farm vehicle or machine attempting to travel through the gully bottom to do so. This is because most farm machines are wider the width of the gully. The implication is that moving farm inputs to the farm and evacuation of produce to markets may be difficult. This agrees with the submission of Ping *et al* (2020 in their study of the effects of road erosion on trafficability. Almouctar *et al* (2021) agreed with Tanam (2023) that such roads lack sufficient capacity to support tractive devices especially those of farm nature. The problem is further compounded by the nature of the soil in the region which Kitandis and Bras (1999), cited by Fasinmirin and Olorunfemi (2013) reported makes the road even more susceptible to water erosion due to high moisture. These conditions have impact on the wellbeing of the inhabitants of *Ile-Apa* as they pose a threat to their lives and increase in food insecurity, leading to greater impoverishment of the people of this community (Mbajirogu, 2008) in particular, and Nigeria as a whole. This may ultimately cause a drop in the revenue of Nigeria leading a dwindling GDP. A timely intervention in the stabilisation of this road may greatly mitigate the negative impact on the live and economy of the people as well as that the nation.

CONCLUSION

Measurement of the extent of gully erosion on *Ile-Apa* farm road in Ilorin reveals that the average depth of the bottom of the gully was 0.58±0.35 m, varying from -0.97 m to 0.03 m. The mean width was found to be 2.45 ± 1.05 m. The high standard deviation of these parameters indicates that the road may not be trafficable, except by pedestrians whose haulage capacity is considered extremely low, and hence, may lead to increased hunger and poverty. It is therefore recommended that this road be given urgent stabilisation.

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