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An Evaluation of the Condition of Road Side Drainage Networks of Area Bz, Ahmadu Bello University, Zaria

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Abstract
Poor drainage system has in all means become a vital concern in any built environment. Flooding, stagnation of storm water and the deteriorating state of housing and other public facilities are all attributed to poor drainage systems. This research assessed the condition of road side drainage networks of Area BZ, Ahmadu Bello University, Zaria with a view of evaluating the adequacy and condition of the drainage network in the area. This was achieved by a detailed checklist. The research also adopted a well structured questionnaire, which sort for the resident's perception of the drainage condition as well as the environmental and infrastructural implication of poor drainage network in the area. The findings indicate that 75% of the drainage systems in the area are in a poor condition as a result of poor maintenance and negligence on the part of the Estate department. Also, the inadequacy of the drainage structure in the area was as a result of insufficiency in the capacity of the ditches and culverts to accommodate the runoff on events of rainfall. Consequently, the following were observed; erosion of road shoulders, formation of potholes, clogging of culverts with silt, flooding of road way, silting of ditches and distortion of environmental aesthetics. In conclusion, majority (75%) the drainage network in the area was rated poor. It is recommended that full implementation of proper maintenance policy, periodic evacuation of silted culvert and ditches and general rehabilitation of road surface.
Keywords: *Condition Survey, Roadside Drainage system,*

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I. INTRODUCTION

For staff residence on the campus, it is necessary to provide qualitative housing, which not only entails the building which houses the staff but also all ancillary services, environmental amenities and social infrastructure like; water, electricity, roads, drainage, sewage and waste treatment facilities personal safety and security among many others (Akinola, 1998). Furthermore Hanmer et al (2000), conclude that qualitative housing involves the provision of infrastructural services which could bring about sustainable growth and development through improved environmental conditions and improved livelihood. Similarly, Aduda (2002)

also reiterated that the provisions of adequate infrastructure are basic requirements for the socio-economic wellbeing of an area.

Infrastructure is one of the indispensable elements in the process of urbanization and emergence and continuity of an urban growth. It is considered as motor/engine for economic development (World Bank, 2006). This means infrastructures such as building, roads, water supply, electricity, urban storm water drainage etc, are pivotal to any nation's development.

Roads and drainages like the other infrastructures constitutes man's basic needs and it does have a profound impact on the health, wellbeing, social attitudes and the economic productivity of the individual (Gilbertson et al, 2010). Thus, the quality and state of infrastructures affects the well-being of the people, their productivity, and manner of living and decencies of their lives.

In university campuses, Provision of quality living and learning setting is crucial for staff and students in university. Buildings and roads are essential infrastructure to ensure safety, security and comfort to the campus users (Abbas and Arigbede, 2012).

According to Bedient et al (2008), a typical urban storm water system consists of streets constructed with curbs, gutters, inlets, and roadside ditches; underground storm sewers; and open outfall channels such as stream and rivers receiving runoff. Furthermore, Mays (2004) also stressed that these systems must be properly designed, built and maintained to properly collect water, avoid disruption of the roads transportation function, maintain safe travel conditions, and sustain infrastructure. This is because; poor design can direct water back onto the road or keep it from draining away and hence pose the above mentioned effects on the environment and people. Too much water remaining in the surface, base, and sub grade combined with traffic action will cause potholes, cracks and pavement failure.

As emphasized in Transparent Accountable Local Governance (2008), Provision for adequate drainage is of paramount importance in road design and cannot be overemphasized. This is because the engineering properties of the materials with which the road is constructed can be adversely affected by the presence of excess water or moisture within the roadway. These effects could be; road surface erosion, pot holes, cut or fills failures and weakened sub grade, all of which are attributed to inadequate or poorly designed drainage and are evident in the Area BZ.

When water is allowed to find its way into the road structure, it makes the pavement layers susceptible to the damaging effects of traffic as it reduces the strength of the pavement layers. Water can find its way into the road structure in one of two ways; either by storm water directly penetrating the surface or indirectly, by ground water infiltration. This is not to say that this is only effective on roads that are not properly constructed, for even on roads built with all the proper drainage elements, neglecting periodic maintenance is likely to result in flooding, washouts, and potholes. Walker et al (2000) were of the opinion that regular annual evaluation of drainage systems is an important part of maintaining and managing roadways. Hence to reduce water damage of road, build and maintain a good drainage system.

II. METHODOLOGY

This chapter will elucidate the research work design and methodology for the study. This research work was carried out via an extensive literature review of relevant text books, journals and conference proceedings and also internet materials were the source of data for the study. The field survey was by carefully studying the drainage network of the area under study which comprises of gutters and side ditches to the road network in the area by means of maps showing the area's layout. Also, relevant information were gathered by means of a structured questionnaire to be administered to the residents of the area under study, and a checklist to assess the condition of the drainage network structures as well as the interview with individuals.

Study Area

Area BZ is one of the eleven residential areas of the University lying north-east of the university main campus, precisely between latitude 7.63383 to latitude 7.64439 and longitude 11.15885 to longitude 11.14803. The area covers about 728934.00 sq. meters and is boarded with the university gymnasium and the agricultural practical field at the north, the Kubani River at the south, Area F at the east and the university academic area (main campus).

The area is naturally sloped in three directions towards three natural drainages bordering the area. These valleys are located west-wards; that is between the area under study (Area BZ), and Area F, southwards with the Kubani river valley lie and east-wards to where the Samaru river lake is situated, (find attached, Appendix III). All the above mentioned rivers are seasonal as they usually reach their maximum capacities at the peak of the rainy season usually in the months of June and July.

The area has 137 houses comprising of four (4) duplexes and one hundred and thirty – three (133) bungalows of varying specifications for staff of the university from different disciplines and each of these houses has attached at least a boy's quarters and arrayed along twelve (12) streets.

Data Collection Instrument

In addition to the literature review other data collection instruments such as a well-structured questionnaire, checklist, site inspection, which shall be accompanied with photographs and interview of the respondents was also adopted. The details of the sample size and the sampling method using the field survey are given below:

Questionnaire

The questionnaires were administered to residents of the area comprising of both academic and non-academic staff of the university and are of different academic backgrounds, that is, science, medicine, engineering and humanities.

With regards to the sampling size in the distribution of the questionnaire, the sampling size will be determined based on the formula below considering the fact that the targeted population is unknown. (IWSD, 2003 in Macdonald, 2006)

$$\mathbf{n= (z^2pq)/d^2}$$

Where;

n = the desired sample size

z = the ordinate on the Normal curve corresponding to α or the standard normal deviate, usually any of the following determined based on the 'margin error formula'

i. A 95% level of confidence has $\alpha = 0.05$ and critical value of $z_{\alpha/2} = 1.96$.

P = the proportion in the target population estimated to have particular characteristic (normal between the range of 0.1 - 0.5)

q = 1.0-p

d = degree of accuracy corresponding to the confidence level and Z selected.

A confidence level of 95% was adopted owing to the fact that the questionnaire is geared towards evaluating the perception of the respondents to overall effects of the drainage network in the area.

Consequently, the sample size is determined as thus,

z = 1.96, d = 0.05 where p = 0.9, q =0.1

Hence,

Sample size $n = [(1.96)^2 \times 0.9 \times 0.1]/ (0.05)^2 = 138.2$

Thus the study will administer 139 questionnaires.

The sampling technique adopted for the research was a random sampling owing to the fact that residents have their various opinion and perception of the drainage network in this area.

Checklist

A checklist was also prepared to collect all the relevant information about the drainage network in the area. Information regarding the general observation of the drainage structures installed in the area under study. Also, the checklist sought to enquire about the condition of other associated structure to the drainage; as regards the road surface, culvert and side ditches.

III. DATA ANALYSIS

The data collected for this study was subjected to various statistical analyses using the computer based software "Statistical Package of Social Sciences" (SPSS). The results of the analysis are presented in the forms of table for the purpose of easy comparison and clear expression of the findings. Relative importance indices (RII) was applied in the analysis to rate the severity of the condition of the drainage network by ranking some key indicator affecting the performance of the drainage network and it was calculated for each document according to their frequency of use as suggested for use by Memon et al, (2006) and Othman et al, (2005)

Relative Importance Index (RII) $= \frac{\sum fx}{\sum f} \times \frac{1}{k}$

Where,

$\sum fx$ = is the total weight given to each attributes by the respondents.

$\sum f$ = is the total number or respondents in the sample.

K = is the highest weight on the likert scale.

Results are classified into three categories as follows (Othman et al, 2005) when;

RII<0.60 -it indicates low frequency in use
0.60≤RII<0.80 -it indicates high frequency in use.
RII≥0.80 –it indicates very high frequency in use.
Also, the existing drainage systems in the selected area were rated based on the rating system developed by Walker et al. This rating system consists of four rating categories: excellent, good, fair, and poor. The ratings are based on the general condition, typical defects, and the recommended improvements as illustrated in Table 3.1. It is however worthy of note that the evaluation process performed in this work is based on visual inspection and on common sense and is intended for easy application in periodic assessment, evaluate, rate and improve the drainage conditions on the roads.

TABLE 3.1: RATING SYSTEM FOR ROADWAY DRAINAGE

Rating	Condition	Improvement
Excellent	Wide adequate ditches or like-new curb, gutter and storm sewer system. All culverts clean and sound.	No improvement Necessary
Good	Overall, pavement and shoulder have adequate crown, ditching or storm sewer on the majority of the section. May need localized cleaning of ditches, storm sewer and culverts, minor repairs to curbs, inlets and culverts. No drainage-related pavement damage	Minor or localized Repairs
Fair	Minimal crown on pavement. Some areas need shoulder slope improvement. Ditching improvement or cleaning needed on up to 50% of ditches. Pavement distress from localized flooding or ponding indicates improvements are needed in some storm sewer, inlets or ditching. Some culverts need cleaning or minor repairs	Several improvements necessary
Poor	No pavement crown, Shoulders create secondary ditch. Frequent ponding. Significant ditching improvements needed on more 50% of the roadway. Frequent localized flooding or erosion with pavement distress or failure. Significant improvement in storm sewer, curb or inlets and/or major culvert replacement or improvement needed.	Major improvement in drainage required

Source: Walker, et al (2000)

IV. DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 The Perception Survey

4.1.1 Questionnaires Survey Result and Analysis

During this research work, a total number of one hundred and thirty nine questionnaires were administered in the residential area to both staff and students residing there. The percentages of responses are presented in Table 4.1. Form the table it can be gathered that a total of one hundred and twenty-three questionnaires were received adequately filled giving a percentage response of 88.5%.

Table 4.1 Questionnaire administered

Questionnaires	**Frequency**	**Percentage of (%)**
Number returned	123	88.5
Numbers not returned	16	11.5
Total	**139**	**100.0**

Source: Field Survey, (2015)

4.1.2 Respondents' Profile

From the result of the analysis of the respondents opinion conducted, the profile of the respondents is as shown in Table 4.2. It is established that 73.2% of the respondents were staff of the university while 26.8% of them were students all residing in the area under study. It is can also be observed that a greater percentage of the respondents have resided in this area for over 10 years; (11 – 15 yrs; 29.3% and 16yrs and above; 45.5%), amounting to 74.8%.

On the question of educational qualification, the study revealed that 83.2% o the respondents had a minimum of bachelor's degree (this is made up of17.9% with doctorate and above;38.2% with masters and 17.1% with bachelor's degree), while 18.7% and 8.1% had Higher National Diploma (HND) and Ordinary National Diploma (OND) respectively. This result therefore implies that a greater percentage of the respondents have good educational background and rationale to conceptualize the research topic and hence give credible responses to the research questionnaire.

Table 4.2 Respondents' Profile

S/N	Variable		Option	Frequency (No)	Percentage (%)
1	Status:	a)	Staff	90	73.2
		b)	Student	33	26.8
		Total		123	100
2	Profession:	a)	Architecture	5	4.1
		b)	Building	4	3.3
		c)	Quantity Surveying	11	8.9
		d)	Engineering	24	19.5
		e)	Others	79	64.2
		Total		123	100
3	Educational qualification	a)	OND	10	8.1
		b)	HND	23	18.7
		c)	Bachelors Degree	21	17.1
		d)	Masters Degree	47	38.2
		e)	Doctorate and above	22	17.9
		Total		123	100
4	Residency duration	a)	0 - 5yrs	16	13
		b)	6-10yrs	15	12.2
		c)	11-15yrs	36	29.3
		d)	16yrs and above	56	45.5
		Total		123	100

Source: Field Survey, (2015)

4.1.3 Respondents' Perception to drainage structure

With respect to the perception of the respondents on the drainage structure, Table 4.3 presents the result of the analysis:

Table 4.3 Respondents' Perception of Drainage Structures

S/N	Variable		Option	Frequency (No)	Percentage (%)
1	Are there drainage structures in your premises	a)	Yes	123	100.0
		b)	No	0	0.0
		Total		**123**	**100.0**
2	Composition of the drainage network	a)	Curbs and inlet only	7	6.0
		b)	Gutter only	26	21.0
		c)	Side ditches	90	73.0
		Total		**123**	**100.0**
3	Material used for construction	a)	Concrete and earth	112	91.0
		b)	Steel	5	4.0
		c)	Timber	6	5.0
		Total		**123**	**100.0**
4	Respondents assessment of the drainage structure condition	a)	Good	4	3.3
		b)	Fair	46	37.4
		c)	Poor	73	59.3
		Total		**123**	**100.0**
5	Are the drainage structures of adequate capacity to evacuate storm water from the streets and road ways?	a)	Yes	31	25.2
		b)	No	92	74.8
		Total		**123**	**100.0**
6	Are there obstacles to the flow and conveyance of run off?	a)	Yes	97	78.9
		b)	No	26	21.1
		Total		**123**	**100.0**
7	What are the likely obstacles to the flow in the drainage system, if 'yes' above?	a)	Household waste	8	8.2
		b)	Plant materials	21	21.7
		c)	Eroded earth	68	70.1
		Total		**97**	**100.0**
8	Is the drainage network in the area well linked?	a)	Yes	78	63.4
		b)	No	45	36.6
		Total		**123**	**100.0**
9	What is the nature of the sides of the drainage in the area?	a)	Slopped	105	85.4
		b)	Vertically straight	18	14.6
		Total		**123**	**100.0**
10	Does the drainage system close up	a)	Yes	114	92.7

with time?	b)	No	9	7.3
	Total		**123**	**100.0**

Source: Field Survey, (2015)

As gathered from the research and presented in the Table 4.3, 100% of the respondent affirmed to the presence of drainage structure within the area and with regards to the composition of the drainage network, 73.0% identified the presence of side ditches; 21.0% recognize only gutters; while only 6.0% identified the presence of curbs and inlets. Thus, it can be inferred that most of the drainage do not have curbs and inlets. In inquiring about the materials used in the construction of the drainage structure, it is revealed that, 91.0% of the respondents identified concrete and earth as the construction materials for the drainages in the area. However, a negligible 4% and 5% identified steel and timber as the construction materials respectively. This analysis suggests that the drainage structures are mainly constructed of concrete and earth.

In assessing the drainage structure condition in the area, 59.3% of the respondents attested that the drainage structure are in poor condition, while 37.4% were of the opinion that the structures' condition is fair and a minute 3.3% suggested that the condition of the drainage structure is good. With regards to whether the structure are of adequate capacity to evacuate storm water from the streets and roadways, 74.8% of the respondents affirmed that the capacity of the structure was inadequate to evacuate storm water from roadway and street while 25.2% suggested otherwise. In response to obstacle in the conveyance of runoff, 66.7% agreed that there are obstacles to the flow of storm water in the drainage network around their premises, while 33.3% suggested that there were no obstacles to the flow of runoff in the network. However, of the 66.7% who opined to the fact that there are obstacles in the drainage network, 70.1% of the respondents identified eroded earth as the obstacle in the network, while 21.7% attested the presence of plant materials as obstacle to the flow of storm water in the drainage network and 8.2% identified household waste as the likely obstacle to the flow of storm water in the drainage system. Thus it can be inferred that the main obstacle to the flow in the drainage system in the area is eroded material. Also, as observed in the result of the analysis, majority of the respondents were of the opinion that the drainage network is well linked (63.4%), but however strongly averred that they close up with time; this made up 92.7% of the respondents in the area.

4.1.4 Adequacy of the Drainage Network in the Area

The questionnaire inquired the respondents' opinion with regards to the adequacy of the drainage network in the area of which, 92.7% of the respondents in the area considered the drainage network to be inadequate while 7.3% considered the network as being adequate as shown in the Table 4.4. This however reveals a minute fraction and hence it can be implied that the drainage network in the area is inadequate.

Table 4.4 Adequacy of the drainage network

Response	Frequency	Percentage of (%)
Yes	9	7.3
No	114	92.7
Total	**123**	**100.0**

Source: Field Survey, (2015)

4.1.5 Efficiency of the Drainage Network in the Area

The efficiency of the drainage system in the area of research was assessed with reference to some key indicators established from literatures. These indicators were ranked by respondents and the results of this ranking are as presented in Table 4.5 where it can be observed that the capacity of the side ditch in accommodating storm water runoff and also the capacity of the culvert to convey and allow the passage of runoff were ranked first and second with relative important indices (RII) of 0.77 and 0.76 respectively suggesting that these are the predominant efficiency parameter lacking in the area under study.

Table 4.5: Ranking Parameter Responsible for inefficiency of Drainage System in the area.

	WEIGHTNG/RESPONSE FREQUENCY									
EFFICIENCY PARAMETER	**1**	**2**	**3**	**4**	**5**	**(∑f)**	**∑fx**	**MEAN**	**RII**	**RANK**
Road constructed above original ground level to facilitate drainage/ structural integrity of road base materials	21	48	32	15	5	123	298	2.42	0.48	7th
Storm water flow from the road surface and directed to stable ditches, vegetative buffer of stable vegetated area	32	32	30	19	10	123	312	2.54	0.51	5th

Appropriate number of culverts installed and located to accommodate flow	09	14	41	33	26	123	422	3.43	0.69	3rd
Road shoulders are stabilized with vegetation or have a firmly packed gravel surface	41	27	38	17	-	123	277	2.25	0.45	9th
Stabilization of the ditches achieved by vegetation cover	32	27	35	19	10	123	336	2.73	0.55	4th
Capacity of the ditch in accommodating storm water runoff	-	16	27	42	38	123	471	3.83	0.77	1st
Capacity of culvert to convey and allow the passage of run off	-	28	12	38	45	123	469	3.81	0.76	2nd
Pavement shoulders adequately sloped to facilitate quick conveyance of runoff from pavement to side ditches	38	34	16	25	10	123	304	2.47	0.49	6th
Ditches are appropriately located and spaced turnouts that direct water into stable vegetated buffer areas	38	45	16	12	12	123	284	2.31	0.46	8th

Source: Field Survey, (2015)

Where: 1 –not efficient, 2 –fairly efficient, 3 – undeceive, 4-efficient, 5- highly efficient

Installation of appropriate number of culverts to accommodate the flow of storm water with RII= 0.69 followed in the third place and rounded up the most critical efficiency parameter lacking in the area. The other listed parameters will add little to the efficiency of the drainage in the area as the severity of their impact will be minimal as indicted by their low RII which falls below 0.6.

4.1.6 Causes of Poor Drainage Network

The questionnaire also sorts the respondents' opinion with regard to some key factors responsible for the poor performance of the drainage network in the area. The opinion and ranking of the respondent are presented in Table 4.6

Table 4.6: Ranking Factors causing poor Drainage in the Area
Source: Field Survey, (2015)

	WEIGHTNG/RESPONSE FREQUENCY									
CAUSE	**1**	**2**	**3**	**4**	**5**	**(∑f)**	**∑fx**	**MEAN**	**RII**	**RANK**
Disposal of solid waste into ditches/ channels	25	12	17	34	35	123	411	3.34	0.67	5th
Poor design	20	11	23	42	27	123	414	3.39	0.68	3rd
Absence of drain structure	38	43	18	24	-	123	274	2.23	0.45	8th
Poor monitoring and evaluation of site	37	42	28	16	-	123	269	2.19	0.44	9th
Improper and/or use of substandard construction materials	27	21	08	29	38	123	399	3.24	0.65	7th
Poor drainage path	21	16	18	39	29	123	408	3.32	0.66	6th
Poor maintenance culture	-	09	21	31	62	123	515	4.19	0.84	1st
Estate department negligence	10	11	32	28	42	123	450	3.66	0.73	2nd
Residents attitude	10	31	17	27	38	123	421	3.42	0.68	3rd

Where: 1 =strongly disagree, 2 = disagree, 3 =undeceived, 4= agree, 5=strongly agree

From Table 4.6, it can be observed that poor maintenance culture (RII=0.84) was ranked first as the chief cause of inadequacy of the drainage network, this followed closely by negligence on the part of the estate department (RII=0.73). Poor design and residents attitude were jointly ranked third (RII=0.68) and was closely followed by disposal of solid waste into ditches/ channels (RII= 0.67). Absence of drainage structures and poor monitoring and evaluation of site though constitute causes of inadequacy of the drainage network in the area are not intense due to their low relative importance index (RII), which are below 0.6.

4.1.7 Effects of Poor Drainage Network in the Area

The perceptions of the respondents as to evidence of poor drainage network in the area were assessed. Table 4.7 presents respondents response to the presence of the effects of poor drainage network with the area and it was

observed majority of the respondents (79.7%) attested to the fact that there are evidences of poor drainage networks in the area while, 20.3% were of contrary opinion that there were no signs of poor drainage in the area.

Table 4.7 Evidence of poor drainage network in the area

Response	Frequency	Percentage of (%)
Yes	98	79.7
No	25	20.3
Total	**123**	**100**

Source: Field Survey, (2015)

From Table 4.8, however, the effects of poor drainage network in the area were ranked as to the perception of the residence (respondents) and it was observed that all the under listed effect are prevalent in the area under study giving the fact that they all registered a Relative Importance Index (RII) above 0.6. However, erosion of the road shoulders was ranked first with RII of 0.84 this was followed closely with the silting of the road side ditches and flooding of the road way with RII's of 0.83 and 0.80 respectively. These RII values suggest that the effects are of high severity as described by very high frequency as the RII's were greater than the 0.8 value. Clogged culverts was ranked 4th with 0.79 RII close to the 0.8 RII and deterioration of the pavement was ranked after the erosion of the side ditches (6th and 5th) with RII's of 0.75 and 0.76 respectively. Deposition of debris in the premises of the residence was ranked 7th with RII of 0.67 and also dilapidation of buildings in the area was ranked last (8th) with RII of 0.66. From the mean distribution on the table, it can be established that in the general the respondents opined that the identified effects of poor drainage were all feasible options as the value of the mean is closer to the likert weighting of four (4) and also, the table gives a frequency break down on each of the options pertaining to the effects of the poor drainage in the area as chosen by the respondents.

Table 4.8: Ranking of the Effects of poor drainage

Source: Field Survey, (2015)

	WEIGHTNG/RESPONSE FREQUENCY									
EFFECTS	**1**	**2**	**3**	**4**	**5**	**(∑f)**	**∑fx**	**MEAN**	**RII**	**RANK**
Flooding of road way	-	19	11	45	48	123	491	3.99	0.80	3rd
Dilapidation of buildings in the premises	13	20	36	27	27	123	404	3.28	0.66	8th
Erosion of road shoulders	-	6	21	38	58	123	517	4.20	0.84	1st
Silting of road ditches	-	6	32	23	62	123	510	4.15	0.83	2nd
Clogged culverts	-	21	19	38	45	123	476	3.87	0.79	4th
Deposition of debris on premises	20	13	28	31	31	123	409	3.33	0.67	7th
Eroding of side ditches	-	08	39	38	38	123	475	3.86	0.76	5th
Deterioration of pavements	-	27	10	52	38	123	462	3.76	0.75	6th
Distortion of environmental aesthetic	20	16	24	31	32	123	408	3.31	0.66	8th

Where: 1 = strongly disagree, 2 = disagree, 3 = undeceived, 4= agree, 5= strongly agree

4.2 Result Of Field/Area Observation

A reconnaissance survey of the area was conducted and this entailed several field visits to the area and visually observing the operating conditions of the roadways' drainage structures. This process also involved the use of the area map (Appendix III) to help in the identification of the street layout and a camera with which photographs were taken to aid in the evaluation process. The visits were conducted during normal weather conditions as well as during and after the intense rains in the area, taking note of the performance of each of the components of the drainage structure identified during the walk through. From the survey, a total of twelve (12) streets were identified in Area BZ which comprised of both major and minor streets all of which have two side ditches and numerous culverts of which most are located off the street to link the driveway of the residents in the area. The names, types, approximate length in meters of the ditches and the number of culverts on each are presented in the Table 4.9;

Table 4.9: Identified streets and inventory of drainage structures in Area BZ

S/n	Street Name	Type	Aprox. Length (meters)	Culvert
1	Muhammadu Dikko	Major	451.43	9
2	Sardauna crescent	Major	916.6	27

3	Dowuona road	Major	405.7	2
4	R. Tukurwa	Minor	192.76	8
5	Usman Dalla	Major	748.23	14
6	Isa Kaita	Major	737.57	21
7	Tudun Muntsira	Minor	146.73	3
8	Biye	Major	630.64	11
9	Kudungi	Minor	178.75	4
10	Tudun Sarki	Minor	160.31	6
11	U. Magarabi	Minor	344. 06	9
12	Jama'a	Major	543.86	16

Source: Field survey, 2014

4.3 Checklist Survey

The result of the checklist carried out on the drainage system of the area after been rated in accordance to the rating system previously described for road way drainage developed by Walker et al (2000) is presented in Table 4.10. From the table it can be observed majority of the drainages are in a poor condition this made up 75% of the drainage in the area, while 16.7% of the drainage were observed to be fair with just 8.3% rated good. The percentages of the ratings are as presented in Fig 4.1.

Table 4.10 Drainage System Rating of Area BZ

S/n	Street Name	Type	Component	Rate
1	Muhammadu Dikko	Major	Side ditches, gutters and culverts	Fair
2	Sardauna crescent	Major	Stone lined side ditches, gutters and culverts	Good
3	Dowuona road	Major	Side ditches, gutters and culverts	Poor
4	R. Tukurwa	Minor	"	Poor
5	Usman Dalla	Major	"	Poor
6	Isa Kaita	Major	"	Fair
7	Tudun Muntsira	Minor	Side ditches and culverts	Poor
8	Biye	Major	None	Poor
9	Kudungi	Minor	Side ditches, gutters and culverts	Poor
10	Tudun Sarki	Minor	"	Poor
11	U. Magarabi	Minor	"	Poor
12	Jama'a	Major	"	Poor

Source: Field survey, 2014

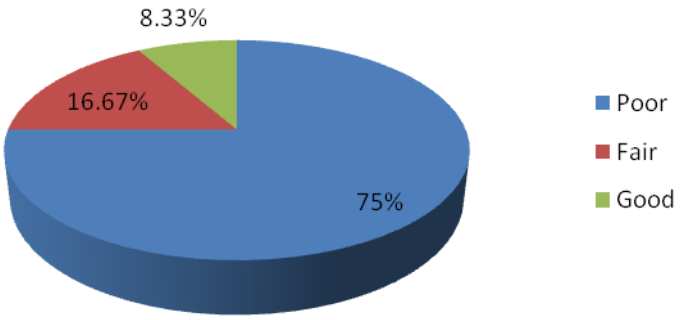

Fig 4.1: Pie Chart showing roadway drainage rating in Area BZ
Source: Field survey, 2014

4.4 DISCUSSION OF RESULTS

The discussion based on the results of the analysis of the respondents' opinion to the questionnaire administered and the checklist survey carried out for this study are as below;

4.4.1 Profile of Respondents

As presented in Table 4.2, 73.2% of the respondents acknowledged that they are staff of the university and 26.8% were students in the university and it was also established that a total of 74.8% of the respondents have attained over 10years of residency in the area under study with over 80% of the residents having a minimum of

a bachelor degree. Hence, they have a good knowledge of the drainage situation in the area with a firsthand experience of its effect and thus their responses are valid to the research topic.

4.4.2 Respondents' Perception of Drainage Structures

From the respondents perception of drainage structures presented in Table 4.3, it is gathered that there are drainage structures in the area as affirmed by 100% of the respondents and it was also revealed that these structures comprised of a system of side ditches and gutters of which 91.0% of the respondents attested that these structures were constructed mainly of concrete and earth.

In the overall assessment of the drainage structure's condition, majority of the respondents were of the opinion that the drainage structures were in poor condition as they lack the adequate capacity to accommodate the volume of storm water discharge during and after rains.

4.4.3 Adequacy of the drainage network.

The study also revealed that a striking majority of the respondents affirmed that the drainage network in the area is inadequate. This is reflected on Table 4.4 which shows that 92.7% of the respondents are of the opinion that the drainage system in area is inadequate to accommodate the storm water during and after rainfall.

4.4.4 Efficiency of the Drainage Network in the area.

The efficiency of a drainage network is the ease to which it can evacuate surface runoff from the road way and adjacent properties, convey and dispose unto a buffer zone of green area or stream. This therefore will require that the drainage have some properties/ characteristics and these were defined are the efficiency parameters.

Table 4.5 shows the respondents' ranking of nine (9) efficiency parameter of the drainage network in the area under study. This revealed that the capacity of the ditches and culvert in the accommodation of runoff were ranked first and second with Relative Importance Indices (RII) of 0.77 and 0.76 respectively, meaning that the capacity of the ditches and culverts are paramount to the efficiency of any drainage. This was strongly averred by the physical site investigation that showed shallow ditches and silted culverts hence adversely affecting the capacity of the ditches and culverts in occasion of heavy downpour that the region is prone to especially at peak periods.

The research also revealed that other efficiency parameters concerning the pavements and shoulders were not considered as having effect on the efficiency of the drainage network in the area. This owns to the fact that the roads in this area are of adequate elevation above the natural ground level and thus will naturally drain into the ditches if they are of ample capacity.

4.4.5 Causes of Poor Drainage Network in the area

In assessing the causes of the inadequacy of the drainage network, it was revealed on Table 4.6 that poor maintenance culture was ranked first as the chief causative factor of poor drainage in the area having a relative importance index of 0.84. This was closely followed by negligence on the part of the Estate Department relative importance indices (RII's) of 0.73 respectively. This therefore implies that there is no periodic monitoring and maintenance for these structures which ought to be on the part of the Estate Department. Lapses in the design of the drainage network and the attitudes of the resident were both rank third. This is evident in the omission of critical culvert crossings at street junctions and curves as we have at Usman Dalla and Isa Kaita intersection, the bend at Muhammadu Dikko and the intersections of Biye Street and Kudungi, Tudun Sarki, U. Magarabi and Jama'a streets. The attitude of the residence in the area especially as regard to waste disposal into ditched was also considered as one of the cause of the inadequacy of the drainage network in the area with a relative importance index of 0.67 as shown in Table 4.6.

4.2.5 Evidence of poor drainage network in the area.

The study established that about 80% of the respondent opined that there are evidences of poor drainage network in the area as presented in Table 4.7. Consequently, the effects of poor drainage was assessed and ranked by the respondents. The result of the research work as shown in Table 4.8 revealed that all the effects mentioned were observed in the area of which erosion of shoulders and silting of ditches were ranked first and second with RII's of 0.84 and 0.83 respectively. Erosion of shoulders were observe on most of the streets with the exception of Sardauna Crescent as most of the pavement shoulders on most street are performing the function of the road way as most motorist have adopted driving on the shoulders and inside ditches to avoid deteriorated road surface. It was also revealed that flooding of the road ways were highly felt as a result of the silting of the road side ditches and culverts. This is observed during the several visits to the area as evident in the plates attached. Other effects as revealed by the research were clogging of the culverts, erosion of the ditches, deterioration of the pavement which is dotted with pot holes and even to the buildings in the area as

poor drainage result in accumulation of water around the building wall result in the dampness and development of algae and cracking of walls as observed on most of the streets especially Jama'a street. These cracks are as a result of foundation failures resulting from differential settlement of foundation as a result poor drainage of building premises.

V. SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary of Research Findings

The following are the summaries of the findings:

i) The main components of the drainage system in Area BZ are side ditches, Gutters and Culverts

ii) All the ditches of the twelve streets in the area are lined with natural vegetation with the exception of Sardauna Crescent, which is stone lined

iii) 75% of the streets in the area have poor drainage system, 16.67% with fair drainage and 8.33% of the street were with good drainage system.

iv) The poor drainage in the area is as a result of the insufficient capacity of the ditches and culvert to accommodate the storm water runoff.

v) The inefficiency of the drainage network in the area is attributed to silting of the ditches and culvert. Which have resulted in the closing up of the ditches and culverts and in some cases, the culvert are completely buried and non functioning.

vi) Poor maintenance and negligence of the Estate Department are the chief contributors to the inadequacy of the drainage network in the area.

vii) The major problems of poor drainage in the area were erosion of road shoulders, clogging of culverts, flooding of road way, silting of ditches and distortion of environmental aesthetics.

5.2 Conclusion

Giving the fact that Area BZ is located in a University, provision of adequate structures for the staff should be geared towards improving their efficiency at their place of work and these structures include housing, ancillary services, environmental amenities and social infrastructure of which road and drainage are examples. The research sort to evaluate the adequacy and condition of the drainage network along road networks in Area BZ and the following conclusions were drawn;

a. The drainage network of Area BZ is made up of a system of open side ditches and culverts aligning the streets of the area. These streets were identified and are twelve (12) in number and are Sardauna Crescent, Dowuona road, Muhammadu Dikko, R. Tukurwa, Usman Dalla, Isa Kaita, Tudun Muntsira, Biye, Kudungi, Tudun Sarki, U. Magarbi, Jama'a Streets.

b. Of all the twelve streets, only the drainages of Sardauna crescent are lined with stones and the others were lined with natural verges.

c. The drainage network in the area was inadequate as indicated by the 92.7% of the respondent's opinion. Also, the result of the ranking of the efficiency parameter of the drainage network revealed that the drainage network in this area lack adequate capacity to accommodate storm water discharge in the area. This was affirmed by the result of drainage system rating from the checklist survey from which it was gathered that 75% of the drainages network was rated poor state, 16.7% were rated fair and 8.3% rated good.

d. Poor maintenance of the drainage network has resulted in the blockage of the flow channels by waste and eroded materials and on some low lying streets, structures such as culverts and gutter are complete buried.

e. The environmental and infrastructural implication of poor drainage in this area is revealed in the erosion of the road ways, road shoulders, and ditches. Also the severe cracks and algae growth on the walls of the buildings in the area and ponding of water are evident.

5.3 Recommendation

The following are recommended:

i) The capacity of the side ditches of the drainage system should be increased to enhance its adequacy in accommodating runoff. This can be achieved by evacuating deposited eroded material along ditches and especially at interceptions, bends and culvert inlets.

ii) A proper connectivity of the drainage structures should be ensured

iii) Provision of adequate culverts at channel junctions

iv) There is need to improve and upgrade the lining to the ditches from the existing natural grass lining to concrete or stone-wall lining as this will facilitate easy maintenance and prevention of sheet erosion of the ditches.

v) All dilapidated roads should be rehabilitated, with potholes and depressions repaired and a defined shoulder should be constructed which should linked to side ditches.

vi) The Estate Department of the University should pay more attention to the drainage network in the area by routine inspection and maintenance of the network and structures.

vii) Ditch dam should be constructed at intervals on the ditches to checkmate the erosion problems in the ditches especially on Donuona road, Usman Dalla and Jama'a Streets.

viii) Ditch turnouts should be incorporated into the drainage network to channel the runoff to a green buffer zone around the area. This should be constructed at muhammadu Dikko and Sarduana Crescent intersection, Tudun Muntsira Street, Isa Kaita Street and Jama'a Street and Usman Dalla intersections where peculation and ponding of runoff usually occur after rainfall.

ix) Silted ditches and culverts should be evacuated and carted away and used as fills off site.

x) Further researches on other drainage network improvement should be undertaken.

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