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ASSESSMENT OF URBAN STORM RUNOFF WATER QUALITY IN LUGBE, ABUJA MUNICIPAL AREA COUNCIL, FCT, NIGERIA

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ABSTRACT

This study assessed urban storm runoff water quality of areas in different landuses in Lugbe a suburban community within the Abuja Municipal Area Council, FCT. Seven different landuses were selected and classified; twelve rainfall events were monitored between July and November 2015. Four storm runoff water samples were collected for each sampling day: three were for Physico-chemical parameters, heavy metals and microbiological parameters while the fourth sample was for sediment analysis. Standard laboratory and field procedures were used in collecting and analyzing the storm runoff water. Results of storm runoff water quality show significant differences in the storm runoff water quality amongst the landuses. The unplanned residential, high way and commercial landuse had the highest values for heavy metals while the least is recorded in the planned residential. The physico-chemical parameters were generally low except for the total suspended sediment and turbidity that were high. The unplanned residential had the highest TSS of 4183mg/l and a turbidity of 670.41FTU while the least values were recorded in the planned residential and high way. The results of the microbial parameters for all land uses on average basis were above SON and WHO Permissible limits of 0 cfu/100ml.. We can therefore conclude that landuse type affects storm runoff water quality. Consequently, pollution is eminent and this portents health challenges to communities downstream. There is a need for proper waste management, improved drainage with good connectivity and public enlightenment on the health risks in order to achieve a suitable public health.

Keywords: Storm runoff water, Landuse, Water quality

INTRODUCTION

Across the globe, human populations are becoming increasingly urban. Notably, the United Nations has also recently projected that nearly all global population growth from 2017 to 2030 will be by cities, about 1.1 billion new urbanites over the next 10 years (Cohen 2015). It is predicted that by 2050 about 64% of the developing world and 86% of the developed world will be urbanized (*International Herald Tribune 2008 and UN DESA, 2018)*. Water is essential to life; its distribution and availability are closely associated with the development of human society. The demand for water doubles every 20 years which is more than twice the rate of the world's population growth, with new water sources becoming scarcer and cost of treatment and remediation of existing sources becoming more expensive (McCully, 2006; Clothier *et al*, 2008).

Urban and suburban developments result in the replacement or covering of porous, vegetated areas with impervious surfaces such as concrete and asphalt capturing and redirecting precipitation. Storm runoff water could be used as a source of water for the teeming growing population. The type and magnitude of pollutants absorbed by runoff depends upon the surface(s) over which urban runoff travels. As the built environment continues to grow, unregulated nonpoint pollutants from increased human activity and large-scale development severely stress urban streams and

lakes resulting in their currently impaired or degraded state (Zickovich and Mays 2018).
Several researchers have shown that there are strong relationships between the land use of a particular site and the runoff volume and characteristics (Chen *et.al,* 2008). Increasing levels of impervious surfaces associated with urbanization result in higher volume of runoff with higher peak discharge, shorter travel time, and more severe pollutant loadings. Urban storm runoff has been known to have potentially adverse effects on the water quality of receiving waters. Makepeace *et al* (1995) have reported elevated concentrations of various chemical constituents in urban storm runoff. Stanley *et al.*, (1994); Frederick, (2003); Gregory *et al*, (2004); and Boogaad *et al*, (2014) and Yang *et al (*2019) in separate studies of urban storm runoff water quality of urban landuse (residential, commercial, highway, industrial) in Dallas, Eastern Baton range Parish Louisiana, South Florida, Netherlands and in Shenzhen, China respectively observed high level of pollutants in the storm runoff water which were above permissible limits in such areas. Such urban areas in the developed world are comparatively neater, better planned, organized and managed than those in the developing world, where sanitation practices are typically poor with wastes commonly disposed indiscriminately on urban surfaces. Storm water quality monitoring in Nigeria has been quite limited and sporadic, leading to calls for greater development of national urban stormwater quality data bases.

The bulk of the few studies conducted on urban storm runoff quality in developing world such as Nigeria are based on water samples collected from boreholes, wells, streams, and rivers that collect water from urban drains instead of the urban surfaces. Izofuo and Bariwena (2008), Yaro and Umar (2009); Onwughara *et al.*, (2011); Okunlola *et al.*, (2015) collected water from the streams and rivers in Yenogua, Katsina, Nigerian waters and Lugbe respectively. These results show that most of the physico-chemical parameters of the water were within safe limits except for some few metals. Similarly, Adekunle *et al*, (2012) and Adedeji & Olayinka (2013) in Abeokuta and Lagos reported values that were within safe limits. This study therefore seeks to assess water quality from storm event runoff in Lugbe urban area of Abuja FCT in order to ascertain the level of pollution generated on the urban surface.

MATERIALS AND METHODS

Study Area

Lugbe is located in the Kabusa ward within the Abuja Municipal Area Council (AMAC) on the eastern wing of the Federal Capital Territory (FCT). It is situated between latitudes $08^0 55'$N to $09^0 00'$N of the Equator and longitudes $07^0 19'$E to $07^0 26'$E of the Greenwich Meridian. Lugbe is characterized with tropical wet and dry climate just like the other parts of the FCT. The mean annual rainfall total ranges from 1,145mm to 1,631.7mm with day time temperatures during the raining season ranging between 28^0C and 30^0C and night time temperature hovering around 22^0C to 23^0C. In the dry season, day time temperatures can soar as high as 35.1^0C. The study area is underlain by crystalline rocks comprising of older granite and Migmatite-gneiss of the pre-Cambrian Basement complex rocks (Balogun 2001) and falls within the Gwagwa plains which are undulating plains, dotted with inselbergs and rock outcrops.
The major rivers draining the FCT are Gurara and river Usuma with their tributaries. (Balogun 2001). Pakayi stream which is the main river within the study area and empties its water into the Kabusa River which is a tributary of river Usuma. Most of the rivers flow seasonally although not completely dry as puddles of water were observed, some still flowing while others were stagnant during the dry season. Soils of Lugbe can be classified as luvisols, however hydromorphic soils can be found along river and stream courses (Balogun, 2001). The FCT falls within the Guinea forest- Savanna mosaic zone of the West African sub-region. Patches of rain forest can be found in the Gwagwa plains, especially in the gullied areas to the south and the rugged southeastern parts of the plain. The population of the Federal Capital Territory according to 2006 National Population Census of the Federal Republic of Nigeria Official gazette (2007 No. 24 Volume 94) was 1,405,201, while the female population was 740,489 and the male 664,712. The dominant ethnic group is Gwari, according to Mundi (2000).

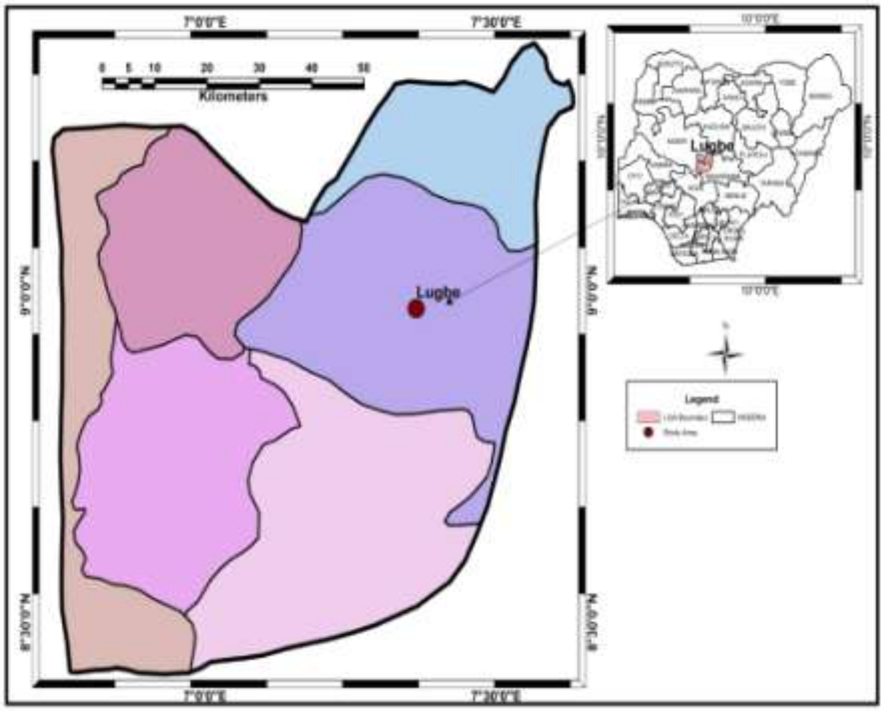

Figure 1: Location of Lugbe within AMAC in the FCT.
Source: Department of Geography, University of Abuja, 2019.

Data Collection

Data of storm runoff water, the total land area in square meters contributing urban storm runoff to each sampling point was measured using a Global Positioning System (GPS). Storm water quality parameters tested include physical, chemical, metals, nutrients and biological properties using standard laboratory and field procedures. Seven (7) sampling sites were selected for monitoring, the selection was based on the land use type of the study area.

Experimental Design

The sites were classified as: predominantly residential unplanned (A); Mixed land use medium density (B); Mixed land use high density (C); predominantly residential planned (D); predominantly commercial (E); the high way (F) and commercial (G). The sampling points were selected at the main drains that collect water from each site. This is to ensure that as much as possible all the runoff from the site is captured from such drains Secondly, only storm events of one raining season were studied and the storm water samples used for the laboratory analysis were those collected from rain events that occurred during the daytime where visibility was obvious. Description of sample sites and sampling Points are presented in Table 1. Grab samples were collected in accordance with the storm water sampling guidelines proposed by Timpe *et al.* (1996). A total of three samples were collected at each site; one for the metals and nutrients, another for biological parameters and the last one for the suspended sediment concentration (SSC). This gives a total of twenty-one samples collected at each sampling day. Approved analytical techniques (FDEP, 1992; APHA, 1998) were used in sample collection, field and laboratory analysis. After collection, the water samples were carried to the National Advanced Laboratories, National Science and Technology Complex, Sheda and the Department of Chemistry, University of Abuja for further analysis.

Suspended sediment samples were collected at each sampling point using the USDH 48 sediment sampler designed by the United States Federal Inter-Agency Sedimentation project after rainfall events. The depth-integrated technique was adopted to take sediment-water mixture vertically from the water surface to the base of the drain. The sampler with a simple open nozzle was lowered close to the base of the drain and raised to the surface at a constant to collect storm water sample.

Some of the Physiochemical Parameters (Total Dissolved Solids TDS, P^H, Electrical conductivity EC, Temperature) were determined on site using the Hanna HI98130 meter while Total Suspended Sediment TSS (Gravimetric method); Dissolved oxygen DO (NWAY9500 DO_2 meter); Biochemical Oxygen Demand BOD (Oxygen Reduction method/Titration) and Turbidy were determined in the laboratory. All the heavy metals were determined in the lab using the AAS Thermo Scientific iCE 3000. Multiple Tube Fermentation Method was used to estimate the microbial properties.

Data Analysis

ANOVA was also used to check for the significance in the levels of pollution at the different sampling points.

Table 1 Description of sample Point Locations Lugbe, Abuja Municipal Area Council

S/N	Major Land use Type	Site Description	Area (m^2)	Geographic Co-ordinates
1.	Predominantly Residential, unplanned (PRU)	This point is located around Solid Rock International School by Police Signboard, the houses are poorly built and not spaced with few drains large communal waste dumpsite, poor water and sanitation activities.	67,580	N 08^0 58′22.9″ E007^0 21′45.1″
2.	Mixed Landuse: Med Density (MMD)	Along 1st Avenue, close to link bridge between AMAC layout and FHA Estate by MTN office outlet FHA. A few roads within this sampling site are paved with drainage channels that are grossly inadequate to convey storm water flows while the majority of the roads are unpaved and without drainages.	212,525	N 08^0 58′50.8″ E007^0 21′46.1″
3.	Mixed Landuse: High Density (MHG)	By 1052 Resort. Some of the houses have been converted to shops, schools, churches, restaurants, recreational centres and clinics. Some of the roads are tarred while some are not.	221,683	N 08^0 59′09.3″ E007^0 21′13.9″
4.	Predominantly Residential planned (PRP)	By Road 1 (S) Crescent by Mountain Top Academy within New FHA (Phase II) well planned area predominantly residential and the houses are well spaced. The roads are tarred with a fairly good drainage system and fairly connected which makes easy flow of storm runoff.	252,481	N 08^0 59′52.1″ E007^0 21′01.8″
5.	Predominantly commercial, (PC)	4th Avenue Junction with 1st Avenue around the interchange bridge at the entrance into FHA, It is a well-planned area predominantly commercial with well-planned and paved landscape. It has lots of shops (Eateries, clothing, Car spare parts, household equipment, provision)	37,408	N 08^0 59′01.0″ E007^0 22′30.7″
6.	High Way (HW)	By the Pedestrian Bridge (Water Board) along the Umaru Musa Yarad'ua Express Way. The surfaces are tarred and runoff flow within the well-structured network of drains that empty one into another chamber	25,711	N $08^0$58.621 E$007^0$22.33
7.	Commercial (C)	At the Lugbe Ultra-Modern Market	67,844	N$08^0$58.361 E $007^0$21.744

RESULTS

The mean values of the results of the storm runoff water analyses from the different land uses are presented in Tables 2, Table 3 and Table 4.

Heavy Metals

All the mean values for iron as shown in Table 2 in the study area were above the maximum required value of 0.3 mg/L. The highest concentrations of 7.644 mg/L was recorded in the commercial landuse, followed by the unplanned resisdential area and the mixed landuse.. The least values were obtained from the planned residential area and the highway. Similar to iron, the concetration of Cadmium was above the permissible limits of 0.003mg/l. Variations in concentration were reflected thus:Unplanned residential > mixed landuse: high density > mixed landuse: low density > high way > planned residential > commercial > pre commercial . The commercial landuses had the least mean concentrations of 0.0168mg/l and 0.0162mg/l respectively (Table 2). Mean concentrations of chromium amongst the different landuses were also above the SON limit of 0.05mg/l. The predorminantly commercial landuse had the highest concentration of 0.2677mg/L, slightly higher than the highway with a mean concentration of 0.2518 mg/L . The mixed landuses recorded the least values for 0.1877 mg/L and 0.1847 mg/L respectively (Table 2). All the landuses had copper concentration within the acceptable limits of 1.0 mg/l except for the highway which had concentration of 1.255mg/l (Table 2). The unplanned residential and mixed land use had the least copper concentrations of 0.1079 mg/l and 0.1051 mg/l. The concentration of lead in Table 2 shows that the commercial landuse had the highest concentration of 0.393 mg/l closely followed by the planned residential with a concentration of 0.0385mg/l and the predominantly commercial 0.0359 mg/l. The mixed landuse and the residential landuse had concentrations of 0.031mg/l and 0.0256 mg/l respectively while the least concentrations were recorded from the high way and mixed landuse. All landuses had concentrations that were above the permissible limit of 0.01 mg/l except the mixed landuse with a concentrtation of 0.0079 mg/l. Manganese concentrations were above the permissible limits for five landuses (Table 2). The predominantly commercial and highway had the least concentation of 0.1375 mg/l and 0.0997 mg/l respectively which fall within the permissible limit of 0.20mg/l. Nickel was found to be in concentrations higher than the permissible limits of 0.02 mg/l for the landuses. The unplanned residential had the highest concentration of 0.6028 mg/l , secondly the planned residential, the mixed landuse and the predominantly commercial landuse. High way had the least concentration of 0.0357mg/l closely followed by the market and the mixed landuse with concentrations of 0.0403 mg/l and 0.0556 mg/l respectively. The zinc concentration from the landuses were all below the permissible limit of 3.0 mg/l (Table 2). The high way had the highest concentration of 0.3102 mg/l; commercial 0.2099 mg/L; unplanned residential 0.1597 mg/L; mixed landuse 0.1140 mg/L; mixed landuse 0.0940 mg/L; predominantly commercial 0.0936 mg/L and planned residential 0.0874 mg/L.

Microbial Parameters

The laboratory result of the microbial parameters for all land uses on average basis was above SON and WHO Permissible limits of 0 cfu/100ml (Table 3). The least concentrations bacteriologically were recorded in the high way and the commercial landuses while the highest were recorded in the residential and mixed landuses.For the Fecal coliform the high way had the least concentration of 349.86 (cfu/100ml), closely followed by the commercial landuse and the predominantly commercial landuse. The mixed landuses had the highest concentrations of 507.28(cfu/100ml) and 473.08(cfu/100ml) respectively while the planned residenrial and unplanned residential had concentrations of 476.00 (cfu/100ml) and 462.19 (cfu/100ml) respectively. Variation in E coli concentration and total coliform reflected a similar trend with the Fecal colifrom..Staphylococcus concentration was the least of the microbial properties, variations in concentrations were completely different with the others parameters. The highway had the highest concentration of 359.58 (cfu/100ml); predominantly commercial, 266.83(cfu/100ml) and the commercial landuse had concentration of 250.22 (cfu/100ml). The mixed landuses had the least with concentrations of 161.06 (cfu/100ml) and 212.31(cfu/100ml) while the unplanned reidential had the least concentration of 160.11 (cfu/100ml).

Physico-Chemical Parameters

The physico-chemical properties of the water samples from the different landuses are presented in the Table 4. Both the BOD and % DO_2 were above the WHO and SON permissible limit. There were little variations amongst the landuses.The pH ranges between 8.10 and 8.50 showing that the storm water runoff is slightly alkaline despite the fact that it falls within the SON and WHO the safe limits. On considering Temperature ,little variation exist in the temperature values amongt the landuses. Temperature ranged between 24.96^0C and 25.68^0C. TDS concentrations samples are within the WHO limits of 500mg/l. The unplanned residential landuse has the highest concentration of TDS of 0.1758 mg/l closely followed by the mixed landuse (high density) with a mean concentration of 0.1308 mg/l. The high way had the least concentration of 0.0442 mg/l. The mean conductivity values not significantly different amongst the stations and all fall within the WHO maximum permissible limits of 1000µs/cm. The low concentration of TDS has directly affected the conductivity implying that fewer ions are within the storm water runoff. The SSC for all the study sites were high above the permissible limits of WHO and SON. The highest SSC was recorded in the unplanned residential landuse with the concentration of 4183.33 mg/l .Consequently to the high sediment concentration, the turbidity is high and above the permissible limit of 5 FTU for all the landuses. Similar trend was obseved in turbidity as the sediment concentration. The unplanned residential landuse was the most turbid with a value of 670.41 FTUwhile the planned residential landuse is least turbid. The Unplanned residential had the highest values for all the physico-chemical parameters investigated. Closely followed are the mixed landuses, the commercial landuse while the least were recorded in the planned residential, predominantly commercial and highway respectively.

Table 2 Mean Values for Heavy Metals in Lugbe, Abuja Municipal Area Council

Parameter	Land Use Type							Overall	
	PRU	MHD	MLD	PRP	HW	PC	C	Mean	STD.
Fe (mg/L)	6.1948	5.5388	4.0257	1.1091	1.8796	1.4668	7.6440	3.9798	2.38
Cd (mg/L)	0.1320	0.0228	0.0247	0.0180	0.0162	0.0219	0.0168	0.0361	0.04
Cr (mg/L)	0.2125	0.1877	0.1847	0.2517	0.2677	0.2518	0.2413	0.2282	0.03
Cu (mg/L)	0.1079	0.1051	0.1336	0.1198	0.1444	1.2515	0.1778	0.2914	0.39
Pb (mg/L)	0.0256	0.0079	0.0321	0.0385	0.0359	0.0251	0.0393	0.0292	0.01
Mn (mg/L)	1.3615	0.6651	0.5452	0.2208	0.1375	0.0997	0.9450	0.5678	0.43
Ni (mg/L)	0.6028	0.1004	0.0556	0.1059	0.0724	0.0357	0.0403	0.1447	0.19
Zn (mg/L)	0.1597	0.1140	0.0940	0.0874	0.0936	0.3102	0.2099	0.1527	0.08

Key: *PRU – Predominantly Residential Unplanned ; MHD - Mixed landuse High Density, MLD – Mixed Landuse Low Density ; C – Commercial ; PRP – Predominantly Residential Planned; HW – High Way; PC – Predominantly Commercial*

Table 3 Mean Values for the Microbial Parameters in Lugbe, Abuja Municipal Area Council

Parameter	Land Use Type							Overall	
	PRU	MHD	MLD	PRP	HW	PC	C	Mean	STD.
Faecal Coliform (cfu/100ml)	462.19	473.08	507.28	476.00	459.17	349.86	391.28	445.55	50.79
E coli (cfu/100ml)	662.92	804.64	690.97	657.03	617.89	452.31	475.19	622.99	114.25
Staphylococcus (cfu/100ml)	160.11	212.31	161.06	250.94	266.83	359.58	250.22	237.29	63.89
Total coliform (cfu/100ml)	739.92	732.58	730.47	699.68	542.39	542.31	469.42	636.68	105.83

Key: *PRU – Predominantly Residential Unplanned ; MHD - Mixed landuse High Density, MLD – Mixed Landuse Low Density ; C – Commercial ; PRP – Predominantly Residential Planned; HW – High Way; PC – Predominantly Commercial*

Table 4 Mean Values for Physico-chemical Properties in Lugbe, Abuja Municipal Area Council

Parameter	Land Use Type							Overall	
	PRU	MHD	MLD	PRP	HW	PC	C	Mean	STD.
%DO_2	60.62	59.25	62.81	64.40	62.50	63.61	62.90	62.30	1.64
BOD (mg/l)	9.14	7.75	7.89	8.32	8.45	8.58	8.29	8.35	0.42
Turbidity FTU	670.41	658.33	662.30	577.21	231.33	210.81	271.45	468.83	202.72
P^H	8.34	8.41	8.35	8.10	8.53	8.28	8.54	8.36	0.14
TDS mg/L	0.1758	0.0967	0.1308	0.0600	0.0658	0.0442	0.0742	0.09	0.04
Temperature ^oC	25.09	25.26	25.22	25.39	25.43	25.68	24.96	25.29	0.22
EC μsm^{-1}	0.3358	0.1942	0.2592	0.0850	0.1308	0.0692	0.1767	0.18	0.09
TSS (mg/L)	4183.33	1216.67	783.33	327.92	293.33	601.25	1583.33	1284.17	1259.96

Key: *PRU – Predominantly Residential Unplanned ; MHD - Mixed landuse High Density, MLD – Mixed Landuse Low Density; C – Commercial ; PRP – Predominantly Residential Planned; HW – High Way; PC – Predominantly Commercial*

DISCUSSION

Heavy Metals

The results of the heavy metals were generally high and above the acceptable limits and therefore pose a great threat to the suitablity of the water for human consumption. The results obtained in this study were however contrary to the results obtained by Izofuo and Barwei (2001), Adekunle *et al.*, (2012), Kaczala *et al.*, (2012) with the exception of Fe, Adedeji and Olayinka (2013), Odoh and Dauda (2013), Boogaad *et al.*, (2014) and Okunlola *et al.*, (2015), respectively who showed that most of the heavy metals were within permissible safe limits except for Cu and Pb that were above the permissible limit as reported by Okunlola *et al.*, (2015). The probable reason for this variation may be due to the fact most of the storm runoff water samples were collected from the rivers, wells and creeks not from the urban surface with the exception of Odoh and Dauda (2013) who collected water samples from roof tops. Hence the possibility of dillution cannot be overlooked or underestimated.Contrary to the studies carried out within Nigeria, Wondie (2009) reported higher concentration in heavy metals from storm runoff in Ethopia. Similarly, Gregory *et al* (2004); and Qianquan *et al* (2012) also reported higher concentrations of heavy metals in South Florida, Changqing and the Netherland respectively. In these studies storm runoff water were collected from different landuses on the urban surfaces and not from streams or rivers. Generally these high values can be attributed to the presence of watse dumps within these sites and the presence of a mechanic workshop because iron occurs in waste effluents on land and corroding metal. The least values were obtained from the planned residential area and the highway. This is indicative of pollution and predisposes the communities downstream to toxicity from these metals as the storm water feeds nearby streams which are sources of portable water for communities down stream of the study area.

Microbial Parameters

The microbial quality is the most important water quality parameter of the urban runoff, in determining the potential for causing widespread diseases, and far outweighs the risk from chemical contaminations .This is a clear evidence of domestic wastewater contamination in all monitoring sites. Frederick (2003) reported higher concentration the ranged between 1,100 (cfu/100ml) and 100,000 (cfu/100ml) in commercial landuse and 3,400 (cfu/100ml) and 10,600 (cfu/100ml) in residential landuse in East Baton Rouge parish, Louisiana. Similarly, Okunlola *et al* (2015) reported high concentration in Total Coli and E. coli within Lugbe surface water and ground water. In the same pattern, Wondie (2009) in Ethopia reported that counts of total coliform were considerably high and attributed it to untreated domestic wastewater from most hotels which are discharged in to the storm draining ditch. Average values for all the microbial parameters exceeds the acceptable limits , this is indicative of bacteria contamination.The could be attributed to poor disposal of waste water which are largely untreated and the presence of dump sites within the study area with treats of negative impacts on the communities downstream.

Physico chemical Parameters

Although the pH ranges between 8.10 and 8.50 showing that the storm water runoff is slightly alkaline despite the fact that it falls within the SON and WHO the safe limits; it could have possibly contributed to the the high microbial growth which has grossly polluted the storm water runoff. Adedeji and Olayinka (2013) reported a higher pH value of 9.07 for urban storm runoff while Okunlola *et al* (2015) reported lower pH values of 5.94 for surface water and 6.27 for ground water in Lugbe.The presence of unpaved roads within the study catchment may also be one of the causes for high value of suspended solids. Storm runoff that sweeps most of the main roads and walkways, erodes the road surfaces and the generated sediments constitute part of the load. Construction of new houses and conversion of lands from one use to another also contributes to the quantity and quality of suspended sediment generated. More importantly the poor refuse disposal methods where waste are indiscrimately disposed on the urban surface, poorly constructed drainages have also contributed to the high sediment generated . Subsequent runoff generated from the rain will loose the surface materials and carry them along. High concentrations in turbidity and suspended sediments were similarly recorded in Ethopia by Wondie, (2009) while on the contrary, Kaczala *et al* (2012) and Boogaad *et al.*, (2014) reported lower sediment concentration of 278.8 mg/l and 17 mg/l respectively. Consequently to the high sediment concentration, the turbidity is high and above the permissible limit of 5 FTU for all the landuses. Such high level of turbidity is known to reduce the aesthetic quality of the water and could be harmful to fish and other aquatic organisms. On the contrary, Okunlola *et al* 2015 reported lower values of 10.92FTU and 21.45FTU for surface and groundwater respectively while Yaro and Umar (2009) reported a turbidity of 37.11FTU in storm runoff in Ginzo river.

CONCLUSION

It can be concluded that the storm runoff water quality within the study area is poor and below acceptable standards for human consumption. It therefore portents danger and risk to living organisms both plants and animals within the urban environment and more importantly a threat to the communities that live at the downstream of the rivers where the collected storm runoff eventually end up. Consequently, there is need for regular comprehensive water quality monitoring and evaluation programs to determine the real, significant water quality-use impairments that are occurring in within the Pakaiyi stream (especially the downstream waters) and once the water quality problems have been defined and the sources of the responsible pollutants identified, then a reliable evaluation can be made of the management practices that can be implemented to control the pollution of urban streams. There is a need for improved drainage, sewage network that can help in proper disposal waste.

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