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Determination of Physico-Chemical Parameters and Water Quality Index (Wqi) of Kilange Stream (Water) of Adamawa State, Nigeria.

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ABSTRACT

The present study was carried out to determine various Physico-chemical parameters and water quality indexto examine the quality of water for public consumption, recreation and other purposes.This study deals with the influence of environmental factors as well as domestic activities in the water quality in the study area.
Keywords:Water quality index; Physico-chemical; Fresh water; Kilange Stream.

INTRODUCTION

Water is an essential component of the environment and it sustains life on the earth. All organisms depend on water for their survival [1,2,3,4] the quality of drinking water is essential for life. Contaminants such as bacteria, viruses, heavy metals, nitratesand salt have polluted water supplies as a result of inadequate treatment and disposal of waste fromhumans, livestock, industrial discharges, domestic discharge and extensive use of limited water resources [5,6,7,8]. There are a number of reported cases of typhoid, diarrhea and other water borne diseases arising from the consumption of contaminated water. Different works have been reported by many researchers on water quality assessment. Today, contaminated water kills more people than cancer, AIDS, wars, terrorism or accidents [9,10,11,12]. Physico-chemical properties of the water gets varied season wise and in addition, anthropogenic activities such as agriculture, urbanization, domestic sewage, etc in the catchment area resultin the deteriorationof water quality [13]. Temperature, turbidity, nutrients, hardness, alkalinity and dissolved oxygen are some of the important factors that play a vital role for the growth of living organisms in the water body. Water quality indicates the relation of all hydrological properties including physical, chemical and biological properties of the water body. Hence, water quality assessment involves analysis of Physico-chemical, biological and microbiological parameters that reflects the biotic and abiotic status of ecosystem. Water quality index (WQI) provides a nominal number that represent overall water quality at a certain location and time, based on several water quality parameters. The objective of water quality index is to turn complex water quality data into detailedinformation useful for public. WQI indicatesthe water quality in terms of index number andoffers a useful presentation of overall quality of water for public or for any intended use as well as in the pollution abatement programmers and in water quality management [14, 15]. The present study deals with the assessment of Physico-chemical characteristics of water and on the basis of these variousparameters, water quality index is determined which revealed in the Kilange stream in Adamawa State, Nigeria.

MATERIALS AND METHODS

Plastic bottles for the collection of water, polyethylene bags (white Santana leather bags)) for soil and sediments collection, black polyethylene bags for collection of vegetables crops samples, Hoe, Stainless steel knife, Spoon, Ruler, Sediment Sampler, Digestion flasks, Pyrex beakers and conical flask, measuring cylinder, pen , masking tape, makers, Mortar and pestle, sieve.

Equipment's (Apparatus and instruments)

The major Equipment's used are: Atomic Absorption Spectrophotometer (model AA0904M046), X-ray Fluorescence Spectrophotometer (EDXF Minipal 4030 with a computer interphase), Metler Analytical balance, pH meter, Thermometer, Conductivity meter, Dissolved Oxygen meter, and heating mantle.

Study area

The Kilange Stream catchment covers an area of 4955 km^2encompassing parts of Fufore,Song, Gombi, and Hong, Local Government Areas of Adamawa state, Nigeria. It is located between latitudes 9° 23´ 26'' N to 10° 19´ 00'' N and longitudes 12° 15´ 00' E to 13° 17´ 25'' as shown in Figure 1 below.This research work were carried out in some selected farmlands of villages along river Kilange in four (4) local government areas of Adamawa state.

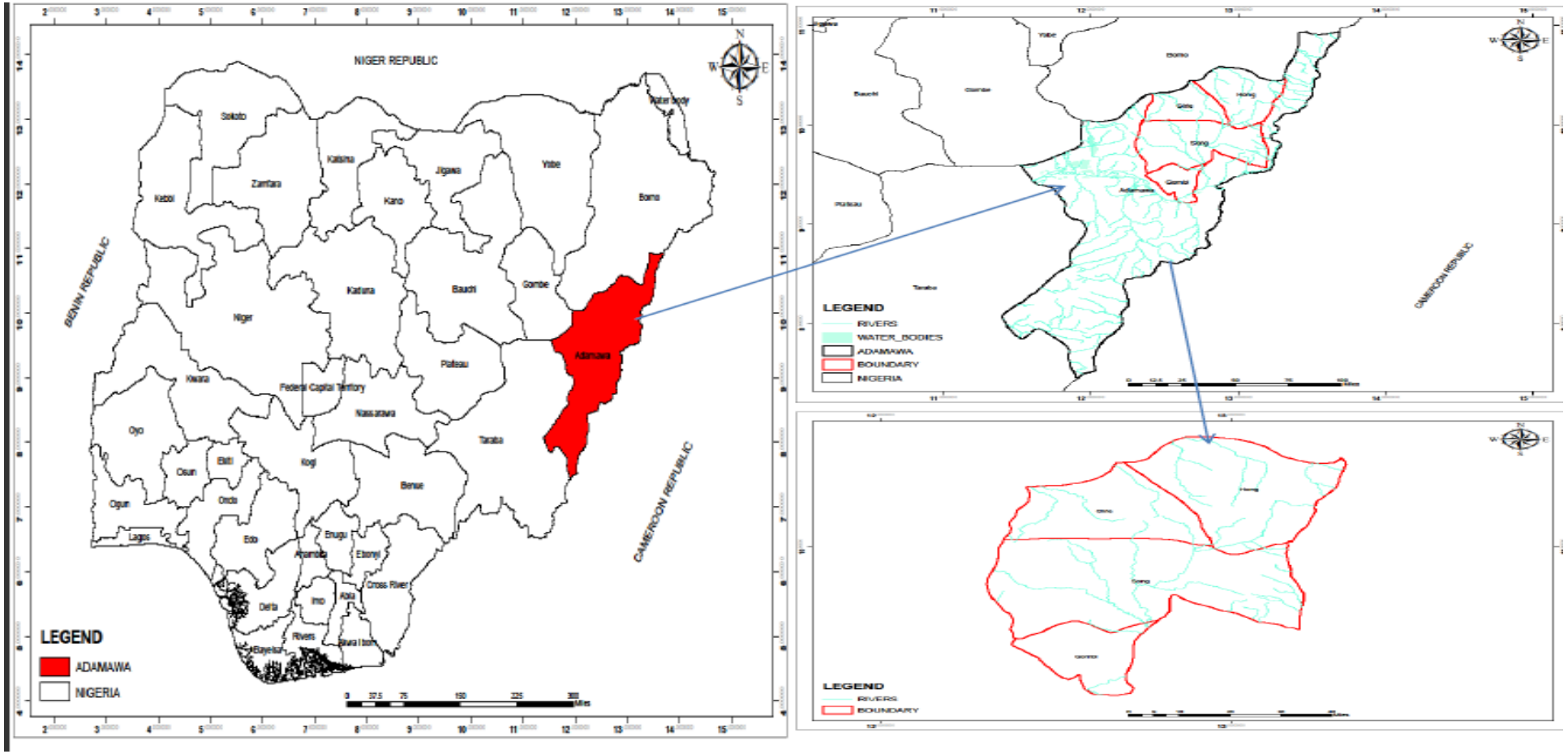
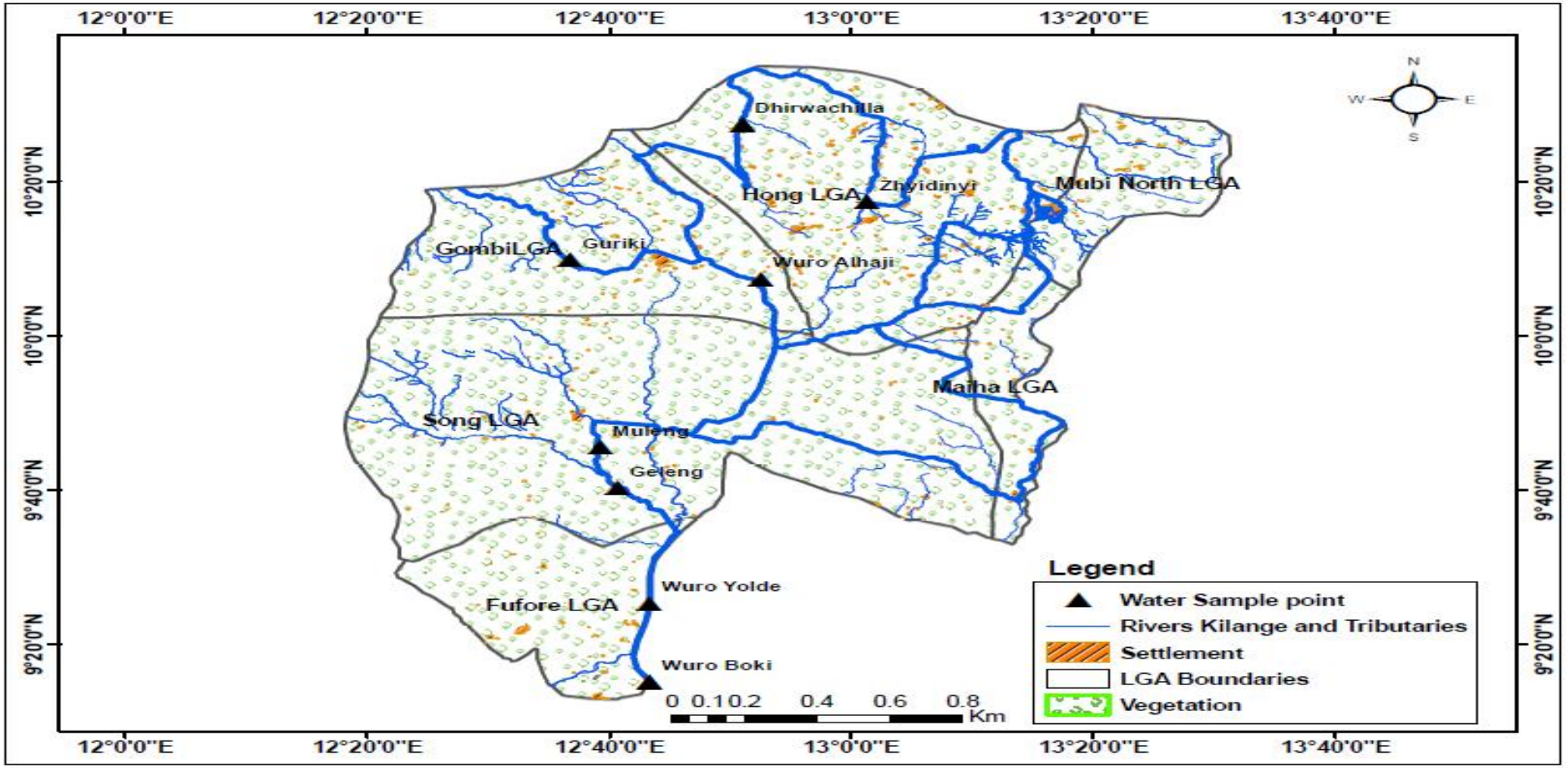


Figure 1: Map of the study area showing sample location



Map of Sampling Area

Sampling and Sample preparation

Samples collection, treatment and preservation

The Sampling and preservation of samples were carried out as prescribed by APHA method [7]. In the field, soil, sediment, water, and some vegetable samples were collected fromeight different locations along Kilange stream in Adamawa state (Wuro-bokki, Wuro-yolde,Geleng, Muleng, Guriki,WuroAlhaji,Zhyidinyi,and Dhirwachilla)sampling plots as shown in Figure 1below, Between (January and March 2020), for Dry season in each plot, and from (July and September 2020) for Wet Season in each plot.

Physico-Chemical Analysis

Water samples collected were analyzed by both classical and automated instrumental methods prescribed by standard methods for the analysis of water and United State Environmental protection Agency. A digital Jeanway 3505 pH meter was calibrated with standard solutions (pH 4 and 10.0). The water surface temperature was determined by lowering the probe to about 1cm below the water surface for about five (5) minutes until it stabilized and the temperature was recorded immediately. Conductivity, Total Dissolved Solids, and Turbidity were measured by a HACH Conductivity meter. The results obtained for various tests carried out on the physicochemical properties of the water samples and their comparison with the World Health Organization (WHO) standard specified for drinking and wastewater [8].

METHODS

Eight different sites were selected for the collection of water samples (Figures 1 and 2). The samples were collected in sterilized polythene bottles of one litter capacity. Monitoring was performed Between (January and March 2020), for Dry season in each plotand from (July and September 2020) for Wet Season in each plot. For unstable parameters such as temperature, electrical conductivity (EC), pH, and dissolved oxygen (DO) were measured at the sampling site. Samples were brought to the Chevron Biotechnology laboratory, Modibbo Adama University, yola, for analysis of other physico-chemical parameters like sodium, total alkalinity, calcium, magnesium, and biochemical oxygen demand (BOD). The parameters were compared according to the standard methods described by [12]. The weighted arithmetic index method was used for the calculation of water quality index (WQI) of the water body. Further, quality rating or sub index (qn)was calculated by the following expression.

$$q_{n = 100[Vn - V10] / [Sn - V10]}$$

Where: qn=Quality rating for the *nth* water quality parameter,

Vn=Estimated value of the *nth* water quality parameters of collected sample,

Sn=Standard permissible value of the *nth* water quality parameter,

V10=Ideal value of the *nth* water quality parameter in pure water.

(i.e. 0 for all other parameters except the parameter pH and Dissolved oxygen (7 and 14.6 mg/L respectively.) (Let there be *n* water quality parameters and quality rating or sub index (*qn*) corresponding to *nth* parameter is a number reflecting the relative of this parameter in polluted water with respect to its standard permissible value.) Unit weight was calculated by a value inversely proportional to the recommended standard value Sn of the correspondingparamete

WQI=

Where: Wn=Unit weight for nth water quality parameter,

Sn=Standard permissible value of the nth water quality parameter,

K=Constant for proportionality.

The overall WQI was calculated by aggregating the quality rating with the unit weight linearly.

$WQI = \Sigma q_n W_n / \Sigma Wn$

Where:

qn = Quality rating for the *nth* water quality parameter,

Wn=Unit weight for *nth* water quality parameter.

Water Quality Index Level	Water Quality Status
0-25	Excellent water quality
26-50	Good water quality
51-75	Poor water quality
76-100	Very poor water quality
>100	Unsuitable for drinking

RESULTS AND DISCUSSION

The Physico-chemical parameters such as pH, electric conductivity, dissolved Oxygen, total dissolve solid, calcium, magnesium,biological oxygen demand, and total hardness of water were analyzed for the water samples collected from the Kilange stream. These parameters were taken at the eight points of the Kilange stream season wise (dry and wet). All parameters with the mean value of the data with standard error were calculated as shown in the Table 1 below.

Electrical conductivity

Water capability to transmit electric current is known as electrical conductivity and serves as tool to assess the purity of water Ramu *et.al,*2006. This ability depends on the presence of ions, their total concentration, mobility, valence, relative concentrations and temperature of measurement.The electrical conductivity ranged from 167 to 401 (µS/cm). The highest electrical conductivity was reported during wet season 401 (µS/cm) due to the addition of domestic wastage into the stream, and lowest during wet season 167 (µS/cm) because of water dilution by rainy waterGolter MEM [8].

Total dissolved solids

Solids refersto the suspended and dissolved matter in water. They are very useful parameters describing the chemical constituents of the water and can be considered as edaphically relation that contributes to productivity within the water body. Golter MEM [11]. The total dissolved solidsin the sampled water ranged from the 110 to 291 mg/L. The highest TDS reported during wet season was 291 mg/L and lowest TDS reported during dry season was 110 mg/L due to the addition of organic matter and solid waste into the Stream.

pH

pH is defined as the intensity of the acidic or basic character of a solution at a given temperature. pH is the negative logarithm of hydrogen ion concentration (pH=-log [H+]). The pH in water samples was range of 6.49to 7.63. The pH of water is important for the biotic communities as most of the plant and animal species can survive in narrow range of pH from slightly acidic to slightly alkaline condition Golter MEM (2002) In studythe maximum pH reported during wet season was due to the burning of bush in clearing of farms land along thestream which bring washing into the river (stream,)by the rain water, and minimum was during dry season was due to thewater levels, concentration of nutrients in the water as reported byGolter MEM [8].

Calcium

Calcium is most abundant ions in fresh water and is important in shell construction, bone building and plant precipitation of lime. The analysis of calcium revealed a ranged between1.3 to 17.28 mg/L. The highest amount of calcium recorded in water samples during wet season was 17.28mg/L due to the addition of sewage waste along with rain water and responsible for the increase in amount of calcium as reported by Verma P.U *et.al.,* 2010 The lowest amount of calcium in water was recorded during dry season due to calcium absorbed by the large number of organisms for shell construction, bone building and plant precipitation of lime as reveal by the study conducted Golter MEM [8].

Magnesium

Magnesium is often associated with calcium in all kinds of waters, but its concentration remains generally lower than the calcium. Magnesium is essential for chlorophyll growth and acts as a limiting factor for the growth of phytoplankton Solanki H.A(2012). The amount of magnesium recorded in the water ranged between0.81to 6.45 mg/L. The highest amount of magnesium in the water samples was recorded during dry season 6.45 mg/L as it is associated with calcium in all water types and during dry season,calcium was also higher in dry season.The lowest value was recorded during wet season due to themagnesium essentiality for chlorophyll bearing plant for photosynthesis, which is related to study conducted by [11].

Dissolved oxygen

The higher value of dissolved oxygen indicates good aquatic life. The amount of dissolved oxygen of Kilange stream water samples ranged between 0.25 to 6.18 mg/L. The highest amount recorded during wet season was 6.18 mg/ due to the turbulence of water facilitating the diffusion of atmospheric oxygen and the increased solubility of oxygen at lower temperature. The lowest dissolved recorded during dry season was 0.25 mg/L due to the high temperature and addition of sewage and other waste which can be responsible for low value of dissolved oxygen as reported by [10].

Water Quality Index

The water quality index (WQI) of Kilange was established from various Physico-chemical parameters in two seasons (Dry and Wet) from January –March 2020 and Jul -September 2020. The values of various Physico-chemical parameters for calculation of water quality index are presented in Table 2. Season wise WQIcalculations are presented in the Tables 2-16. The WQI obtained for the water body in sameseasons of study period dryseason from muleng, geleng wuro-alhaji, and Dirwachilla are 79.20, 90.45, 99.95, and 101.10 respectively, which indicate that water is not suitable for drinkingdue to high pollution level during dry season when compared to the wuro- bokki ,wuro yolde, geleng which indicate that water is suitable for drinking and other recreational activities of the same seasons. While water from wuro-bokki, wuro-yolde, and geleng are 13.93, 14.51 and 20.37 are good and suitable for drinking and other recreational activitiesduring wet season compare to muleng,Guriki, wuro- Alhaji, and Dirwachilla water sampling sites with high pollution levels of 62.70,72.13.71.20.79.32 and 101.6 respectively during same wet season, due to some values exceeding

the permissible limits as prescribed by WHO standards. Those areas with water high WQI and high pollution level is not used for public consumption due to high WQI and high pollution level. Water purification system must be installed to purify the water body as other alternatives, for domestic usage is recommended by the WHO and NAFDAC. The purification requires civic body initiative to clean up.

CONCLUSION

Some of the samples have total dissolved solids, pH, andTemperature valuesexceeding the permissible limits as prescribed by WHO standards. We noticed parameters such as electrical conductivity, chloride, nitrate and biological oxygen demand values are within permissible limits. Some competed WQI indicates that the some sampling site their water quality is poor and not totally safe for human consumption due to presence of high level of pollutants. The water is not used for public consumption and recreation due to lack of water purification. This study showed that the water quality of some sampling point along Kilange Stream remain as it is than it will destroyed the ecosystem of the stream. The government body such as NAFDAC, WHO and other civic organization should take the action against releasing of domestic waste directly into the stream or installed a water purification system.

Table 1: Physico-Chemical Parameters of Water along Kilange stream

Site	Seasons	Temp (°c)	pH	Conductivity (µS/cm)	DO (mg/L)	TDS (mg/L)	Turbidity (NTU)	Ca (mg/L)	Mg (mg/L)
WBW	Dry	29±0.03	7.63±0.02	216±0.06	1.7±0.010	141±0.08	3.99±0.07	11.52±0.09	5.06±0.04
	Wet	30±0.07	7±0.09	256±0.08	2.31±0.06	155±0.02	4.66±0.011	3.87±0.03	2.09±0.04
WYW	Dry	28±0.01	6.9±0.02	236±0.03	0.25±0.02	291±0.06	7±0.07	5.72±0.011	6.45±0.06
	Wet	28.5±0.05	7.01±0.06	278±0.02	1.71±0.03	229±0.07	9.25±0.04	10.92±0.05	4.03±0.03
GEW	Dry	29.1±0.07	6.49±0.09	353±0.08	1.47±0.09	150±0.010	7.18±0.07	1.62±0.01	2.23±0.011
	Wet	30±0.06	7.03±0.011	361±0.07	1.32±0.08	129±0.04	8.69±0.06	2.78±0.02	4.09±0.07
MW	Dry	28.2±0.07	6.53±0.01	231±0.04	2.41±0.011	287±0.010	5.69±0.02	2.06±0.06	6.23±0.08
	Wet	28.5±0.05	6.9±0.01	304±0.02	3.42±0.03	218±0.05	6.12±0.06	5.45±0.07	4.69±0.08
GW	Dry	27.1±0.06	6.51±0.08	271±0.04	3.01±0.011	161±0.09	3.85±0.06	3.71±0.08	2.6±0.04
	Wet	27.9±0.07	6.75±0.06	291±0.03	3.71±0.03	215±0.010	3.9±0.07	8.57±0.03	3.98±0.09

Table 1 Continuation

Site	Seasons	Temp (°c)	Ph	Conductivity (µS/cm)	DO (mg/L)	TDS (mg/L)	Turbidity (NTU)	Ca (mg/L)	Mg (mg/L)
WAW	Dry	30±0.08	6.95±0.08	286±0.06	4.76±0.01	110±0.011	9.36±0.08	17.28±0.06	6.07±0.09
	Wet	28±0.09	6.89±0.07	317±0.07	3.78±0.02	127±0.01	10.45±0.09	1.12±0.08	2.95±0.07
ZW	Dry	28.5±0.011	7.33±0.06	401±0.07	5.13±0.03	235±0.09	6±0.010	1.3±0.06	1.26±0.04
	Wet	28.4±0.010	7.01±0.05	386±0.08	6.18±0.01	236±0.08	6.55±0.011	17.28±0.07	1.31±0.05
DW	Dry	29.7±0.09	6.51±0.04	167±0.06	1.35±0.04	192±0.010	3.79±0.02	3.22±0.08	1.63±0.08
	Wet	28.8±0.02	6.89±0.04	198±0.08	1.97±0.05	155±0.02	4.77±0.03	1.93±0.08	0.81±0.09
Range		27.1-30.0	6.51-7.63	167-401	0.25-6.18	110-291	3.79-10.45	1.12-17.28	1.26-6.45
Per. Value: WHO (2008)		30	6.5-8.9	8-10000	0-5	1000	5	0-75	0-150
P-value		P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P>0.05

Mean ± Standard Deviation within a column are not significantly different at P > 0.05 according to Duncan Multiple Range Test
BDL = Below Detection Limit

Table 2: Calculation of WQI of water samples in the dry season at Wuro –bokki sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	29.0	25	0	0.040	116.00	4.6400
2	pH	7.63	8.5	7	0.1180	42.00	4.9392
3	Conductivity (µ/scm)	216	1000	0	0.0010	21.60	0.0216
4	TDS (mg/L)	141	500	0	0.0020	28.200	0.056
5	Dissolved Oxygen (mg/L)	1.7	5	14.6	0.200	2.588	0.518
6	Calcium (mg/L)	11.52	75	0	0.0133	15.360	0.2043
7	Magnesium(mg/L)	5.06	30	0	0.0340	16.876	0.5617
	Water Quality indecx				ΣWn= 0.4072	ΣQn= 242.615	ΣWnQn= 10.941
	WQI= ΣWnQn/ΣWn= 26.87						

Table 3: Calculation of WQI of water samples in the wet season at Wuro –Bokki sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	30	25	0	0.040	120.000	4.800
2	pH	7	8.5	7	0.1180	0.00	0.00
3	Conductivity (µ/scm)	256	1000	0	0.0010	25.60	0.026
4	TDS (mg/L)	155	500	0	0.0020	15.500	0.031
5	Dissolved Oxygen (mg/L)	2.31	5	14.6	0.200	2.532	0.5064
6	Calcium (mg/L)	3.87	75	0	0.0133	5.160	0.073
7	Magnesium(mg/L)	2.09	30	0	0.0340	6.967	0.237
	Water Quality Index WQI= ΣWnQn/ΣWn= 13.932				ΣWn= 0.4072	ΣQn= 181.159	ΣWnQn= 5.6734

Table 4: Calculation of WQI of water samples in the dry season at Wuro –Yolde sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	28	25	0	0.040	1120.00	4.48
2	pH	6.9	8.5	7	0.1180	6.667	0.7867
3	Conductivity (µ/scm)	236	1000	0	0.0010	21.60	0.022
4	TDS (mg/L)	291	500	0	0.0020	28.200	0.057
5	Dissolved Oxygen (mg/L)	0.25	5	14.6	0.200	2.872	0.5744
6	Calcium (mg/L)	5.72	75	0	0.0133	7.627	0.107
7	Magnesium(mg/L)	6.45	30	0	0.0340	21.500	0.731
	Water Quality Index WQI= ΣWnQn/ΣWn= 15.43				ΣWn= 0.4072	ΣQn= 293.799	ΣWnQn= 6.2811

Table 5: Calculation of WQI of water samples in the Wet season at Wuro –Yolde sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	28.5	25	0	0.040	114.00	4.560
2	pH	7.01	8.5	7	0.1180	0.6667	0.0786
3	Conductivity (µ/scm)	278	1000	0	0.0010	27.80	0.028
4	TDS (mg/L)	155	500	0	0.0020	31.00	0.062
5	Dissolved Oxygen (mg/L)	1.71	5	14.6	0.200	2.587	0.5174
6	Calcium (mg/L)	10.92	75	0	0.0133	14.560	0.2043
7	Magnesium(mg /L)	4.03	30	0	0.0340	13.433	0.457
	Water Quality Index						
	WQI=				ΣWn= 0.4072	ΣQn= 203.447	ΣWnQn= 5.907
	ΣWnQn/ΣWn= 14.506						

Table 6: Calculation of WQI of water samples in the dry season at Geleng sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	29.1	25	0	0.040	116.400	4.656
2	pH	6.49	8.5	7	0.1180	34.00	4.012
3	Conductivity (µ/scm)	353	1000	0	0.0010	35.300	0.0352
4	TDS (mg/L)	150	500	0	0.0020	30.00	0.060
5	Dissolved Oxygen (mg/L)	1.47	5	14.6	0.200	2.634	0.5268
6	Calcium (mg/L)	1.62	75	0	0.0133	2.160	0.03024
7	Magnesium(mg /L)	2.23	30	0	0.0340	7.433	0.2527
	Water Quality Index						
	WQI=				ΣWn= 0.4072	ΣQn= 293.927	ΣWnQn= 9.573
	ΣWnQn/ΣWn= 23.51						

Table 7: Calculation of WQI of water samples in the wet season at Geleng sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	30	25	0	0.040	120	4.80
2	pH	7.03	8.5	7	0.1180	20	2.36
3	Conductivity (µ/scm)	361	1000	0	0.0010	36.1	0.034
4	TDS (mg/L)	129	500	0	0.0020	25.8	0.0516
5	Dissolved Oxygen (mg/L)	1.32	5	14.6	0.200	2.6630	0.5326
6	Calcium (mg/L)	2.78	75	0	0.0133	3.707	0.0519
7	Magnesium(mg /L)	4.09	30	0	0.0340	13.633	0.4635
	Water Quality Index						
	WQI=				ΣWn= 0.4072	ΣQn= 221.903	ΣWnQn= 8.2936
	ΣWnQn/ΣWn= 20.37						

Table: 8 Calculation of WQI of water samples in the dry season at Muleng sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	29.2	25	0	0.040	1.168	0.4672
2	pH	6.53	8.5	7	0.1180	48.45	5.70
3	Conductivity (µ/scm)	231	1000	0	0.0010	0.231	0.000231
4	TDS (mg/L)	2.87	500	0	0.0020	57.4	0.1148
5	Dissolved Oxygen (mg/L)	2.41	5	14.6	0.200	126.90	25.40
6	Calcium (mg/L)	5.45	75	0	0.0133	7.2666	0.0966
7	Magnesium(mg /L)	4.69	30	0	0.0340	15.633	0.5201
	Water Quality Index						
	WQI=				ΣWn= 0.4072	ΣQn= 42028	ΣWnQn= 32.30
	ΣWnQn/ΣWn= 79.3						

Table 9: Calculation of WQI of water samples in the wet season at Muleng sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	28.5	25	0	0.040	1140	4.56
2	pH	6.9	8.5	7	0.1180	0.667	0.7839
3	Conductivity (µ/scm)	304	1000	0	0.0010	30.4	0.0304
4	TDS (mg/L)	218	500	0	0.0020	43.6	0.0872
5	Dissolved Oxygen (mg/L)	3.42	5	14.6	0.200	116.458	23.29
6	Calcium (mg/L)	5.45	75	0	0.0133	7.267	0.0966
7	Magnesium(mg /L)	4.69	30	0	0.0340	15.633	0.5201
	Water Quality Index						
	WQI=				ΣWn= 0.4072	ΣQn= 217.807	ΣWnQn= 29.371
	ΣWnQn/ΣWn= 72.13						

Table 10: Calculation of WQI of water samples in the dry season at Guriki sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	27.1	25	0	0.040	108.4	4.336
2	pH	6.50	8.5	7	0.1180	100	11.80
3	Conductivity (µ/scm)	271	1000	0	0.0010	27.10	0.0271
4	TDS (mg/L)	161	500	0	0.0020	16.10	0.0322
5	Dissolved Oxygen (mg/L)	3.01	5	14.6	0.200	120.73	24.15
6	Calcium (mg/L)	3.71	75	0	0.0133	4.947	0.0659
7	Magnesium(mg /L)	2.60	30	0	0.0340	8.667	0.2947
	Water Quality Index						
	WQI=				ΣWn= 0.4072	ΣQn= 385.944	ΣWnQn= 40.71
	ΣWnQn/ΣWn= 99.97						

Table 11: Calculation of WQI of water samples in the wet season at Guriki sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	27.9	25	0	0.040	111.6	4.464
2	pH	6.75	8.5	7	0.1180	14.286	1.68
3	Conductivity (µ/scm)	291	1000	0	0.0010	29.1	0.0291
4	TDS (mg/L)	215	500	0	0.0020	43.0	0.08.6
5	Dissolved Oxygen (mg/L)	3.71	5	14.6	0.200	113.38	22.68
6	Calcium (mg/L)	8.57	75	0	0.0133	11.43	0.1523
7	Magnesium(mg /L)	3.98	30	0	0.0340	13.67	0.418
	Water Quality Index						
	WQI=				ΣWn= 0.4072	ΣQn= 336.06	ΣWnQn= 25.126
	ΣWnQn/ΣWn= 61.70						

Table 12: Calculation of WQI of water samples in the dry season at wuro- alhaji sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	30	25	0	0.040	120.0	0.048
2	pH	6.95	8.5	7	0.1180	103.33	12.193
3	Conductivity (µ/scm)	286	1000	0	0.0010	28.6	0.0003
4	TDS (mg/L)	110	500	0	0.0020	22.00	0.044
5	Dissolved Oxygen (mg/L)	4.76	5	14.6	0.200	102.5	20.5
6	Calcium (mg/L)	17,28	75	0	0.0133	23.04	3.07
7	Magnesium(mg /L)	6.07	30	0	0.0340	20.233	0.6879
	Water Quality Index						
	WQI=				ΣWn= 0.4072	ΣQn= 419.70	ΣWnQn= 36.83
	ΣWnQn/ΣWn= 90.45						

Table 13: Calculation of WQI of water samples in the wet season at wuro- alhaji sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	28	25	0	0.040	112	4.48
2	pH	6.89	8.5	7	0.1180	14.286	1.6857
3	Conductivity (µ/scm)	317	1000	0	0.0010	31.7	0.0317
4	TDS (mg/L)	127	500	0	0.0020	25.4	0.0508
5	Dissolved Oxygen (mg/L)	3.78	5	14.6	0.200	112.71	22.5417
6	Calcium (mg/L)	1.12	75	0	0.0133	1.4933	0.1991
7	Magnesium(mg /L)	2.95	30	0	0.0340	0.0983	0.00327
	Water Quality Index						
	WQI=				ΣWn= 0.4072	ΣQn= 297.69	ΣWnQn= 28.99
	ΣWnQn/ΣWn= 71.2						

Table 14: Calculation of WQI of water samples in the dry season at Zhyidinyi sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	28.5	25	0	0.040	114.00	4.56
2	pH	7.33	8.5	7	0.1180	78.00	9.207
3	Conductivity (µ/scm)	401	1000	0	0.0010	40.10	0.0401
4	TDS (mg/L)	235	500	0	0.0020	47.00	0.094
5	Dissolved Oxygen (mg/L)	5.13	5	14.6	0.200	7.802	1.560
6	Calcium (mg/L)	1.3	75	0	0.0133	1.733	0.231
7	Magnesium(mg/L)	1.26	30	0	0.0340	4.20	0.1428
	Water Quality Index WQI= ΣWnQn/ΣWn= 39.11				ΣWn= 0.4072	ΣQn= 292.84	ΣWnQn= 15.926

Table 15: Calculation of WQI of water samples in the wet season at Zhyidinyi sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	28.4	25	0	0.040	113.60	4.544
2	pH	7.01	8.5	7	0.1180	99.33	11.7213
3	Conductivity (µ/scm)	386	1000	0	0.0010	38.6	0.0385
4	TDS (mg/L)	236	500	0	0.0020	47.2	0.094
5	Dissolved Oxygen (mg/L)	6.18	5	14.6	0.200	87.701	17.542
6	Calcium (mg/L)	17.28	75	0	0.0133	23.04	3.064
7	Magnesium(mg /L)	1.31	30	0	0.0340	4.366	4.367
	Water Quality Index						
	WQI=				ΣWn= 0.4072	ΣQn= 413.84	ΣWnQn= 41.37
	ΣWnQn/ΣWn= 101.6						

Table 16: Calculation of WQI of water samples in the dry season at Dirwachillah sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	29.7	25	0	0.040	29.7	1.218
2	pH	6.51	8.5	7	0.1180	100	11.80
3	Conductivity (µ/scm)	167	1000	0	0.0010	16.7	0.0167
4	TDS (mg/L)	192	500	0	0.0020	38.4	0.0768
5	Dissolved Oxygen (mg/L)	1.35	5	14.6	0.200	138.02	27.60
6	Calcium (mg/L)	1.93	75	0	0.0133	2.573	0.343
7	Magnesium(mg/L)	0.81	30	0	0.0340	2.70	0.0918
	Water Quality Index						
	WQIΣWnQn/ΣWn=101.				ΣWn= 0.4072	ΣQn= 328.093	ΣWnQn= 41.15

Table 17: Calculation of WQI of water samples in the wet season at Dirwachillah sampling point in Kilange stream.

S/No	Parameter	Observed value (Vn)	Standard value (sn)	Ideal value (Vi)	Unit weight (wn)	Quality rating (Qn)	WnQn
1	Temperature ^{O}C	28.8	25	0	0.040	115.2	4.608
2	pH	6.89	8.5	7	0.1180	7.333	0.8653
3	Conductivity (µ/scm)	198	1000	0	0.0010	19.8	0.0198
4	TDS (mg/L)	155	500	0	0.0020	31.0	0.062
5	Dissolved Oxygen (mg/L)	1.97	5	14.6	0.200	131.563	26.31
6	Calcium (mg/L)	1.93	75	0	0.0133	2.573	0.343
7	Magnesium(mg/L)	0.81	30	0	0.0340	2.667	0.0907
	Water Quality Index						
	WQI=				ΣWn= 0.4072	ΣQn= 310.13	ΣWnQn= 32.29
	ΣWnQn/ΣWn= 79.30						

Table 18: Seasonal variation of water quality index of Kilange stream Adamawa state during dry season and wet season.

S/NO.	Sampling point	Water Quality Index (WIQ)	dry season
1	WBW	26.87	
2	WYW	15.43	
3	GEW	23.51	
4	MW	79.2	
5	GW	99.95	
6	WAW	90.45	
7	ZW	39.11	
8	DW	101.1	
S/NO.	Sampling point	Water Quality Index (WIQ)	Wet season
1	WBW	13.93	
2	WYW	14.51	
3	GEW	20.37	
4	MW	72.13	
5	GW	61.70	
6	WAW	71.20	
7	ZW	101.6	
8	DW	79.32	

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