MITIGATION STRATEGIES ON THE IMPACT OF CLIMATE CHANGE ON WATER RESOURCES MANAGEMENT IN NIGERIA; A CASE STUDY OF OGUNPA RIVER.

STEPHEN ABEDNEGO.O[1] IGBINEGBU ALHASSAN[2]
Department Of Civil Engineering Technology. Auchi Polytechnic.
Corresponding Author email: tsikenu200@yahoo.com

ABSTRACT
Nigeria as a country is blessed with several resources which include: favourable weather, rich natural resources, human resources and enormous water resources. Globally, Water is widely regarded as the most essential natural resources yet freshwater systems are directly threatened by human activities which is further termed as the anthropogenic causes of climate change. Moreover, the water resources sector of Nigeria demands proper and adequate management of water in terms of quality and quantity. However, climate change is indeed a major regional and global challenge which is currently posing a serious threat to the water resources sector of the nation and the world at large. However, this global problem can be mitigated by putting precautionary measures in place. Considering the case study, River Ogunpa is one of the major rivers located in Ibadan, Nigeria. The watershed hydrology has changed considerably due to increased anthropogenic activities which often serves as one of the principal actors of climate change. The watershed is 6,680ha with 49 stream junctions. Rainfall data of 26 years (1984 – 2009) were collected in addition to some other meteorological data such as Relative humidity, sunshine hours, temperatures (1990-2009) etc.Besides, the river Ogunpa flow record (1990 – 1994) was collected and analyzed. The result of the data analysis using least square method and rank correlation formula generated the simulation equation thus: $Y = 0.63 + 0.002x$ for determining flow or discharge from the available rainfall data. The flow- rainfall correlation was satisfactory as shown by the correlation coefficient of 0.84 from a collective sample of flow records and rainfall data (1990 – 1994).

KEYWORDS: *Water Resources Management, Climate Change, Ogunpa River, Impact, Ni*geria,

1.0 INTRODUCTION

Water is a very important resource; it is essential and indispensable for man's existence and development in all ramifications. The use of water by man, plants and animals is universal and the need for water is inexorable. There is no doubt "Water is life" It is all-encompassing with respect to its usefulness from one generation to the other. Every living thing requires water for survival and sustenance. Water is used for human consumption, industrial purposes, irrigation, power production, navigation, recreation and waste disposal, as well as for the maintenance of healthy aquatic ecosystems. Geographically, about 75% which is three-quarters of the earth is made up of water (W.G

Stone 1975). Besides, the map of the world also reveals that a larger percentage of the earth is surrounded by water bodies.

Obviously, the largest component of the earth surface is water which is referred to as the "hydrosphere".This show that the copious water resources must not be wasted but Properly managed to satisfy the economic growth and development of the nation and the society at large. Moreover, Water resource management is the activity or process which involves the planning, developing, distributing and managing the optimum use of water resources. Ideally, water resource management planning seeks to allocate water on an equitable basis to satisfy all uses and demands.

1.1 WHAT IS CLIMATE CHANGE?

Climate change refers to a deviation from the normal weather conditions of an area over time, whether due to natural conditions or as a result of human activities which results in degradation of an environment (Nwosu, 2012). Climate change is the variation in the statistical distribution of the average weather conditions over a prolong period of time (Ikehi & Zimoghen, 2014). Climate change is a major problem which affects the major component of the environment (earth surface) which is water. Climate change according to the intergovernmental panel on climate change (IPCC) refers to a change in climate over time, whether due to natural variability or as a result of human activity. Moreover, the intergovernmental panel on climate change (IPCC) (2007) also defines climate change as a change in the state of climate that can be identified by using statistical tests by changes in the mean and/or the variability of its properties that persists for an extended period usually in decades or longer period.

However, the framework convention on climate change (FCCC) refers to climate change as a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere that is in addition to natural climate variability observed over comparable time periods. It encompasses all forms of climate inconsistencies i.e. any differences from long term statistics of the meteorological elements calculated for different periods but relating to the same area. World Meteorological Organization (1992).

1.2 THE WATER RESOURCES OF NIGERIA.

Nigeria is located approximately between latitude 4° and 14° North of the Equator, and between longitudes 2° 2' and 14° 30' East of the Greenwich meridian. It is bordered to the north by the Republics of Niger and Chad, to the south by the Atlantic Ocean, to the east by the Republic of Cameroon and to the west by the Republic of Benin.

Nigeria has two major rivers, the Niger, after which the country is named, and the Benue. The water resources sector is an integration of these two major rivers and other rivers in Nigeria. Table 1 reveals the volume and the percentage of the water on the earth surface.

Table 1: Water on the Earth.(Adopted from Leopard 1974)

Location	Water volume ($km^3 \times 10^4$)	Percentage(%) of total water
SURFACE WATER		
Fresh water lakes Saline Lakes and inland seas Average in stream channels	12.50 10.41 0.13	0.009 0.008 0.0001
SUBSURFACE WATER		
Water in unsaturated aerated zone. Groundwater within depth of 0.8km Groundwater deep lying	6.66 416.40 416.40	0.005 0.31 0,31
OTHER WATER LOCATIONS		
Icecaps and glaciers Atmosphere(at sea level) World Oceans	2914.80 1.30 132000.00	2.15 0,001 97.20
Total(Rounded)	135778.60	100.00

2.0 THE THEORETICAL FRAMEWORK

Climate is relatively constant when compared with weather especially high altitude weather. However, climate may not be constant from one decade to another. The evidence of the earth's climate in the past suggests that climate exhibits its varying scales of temporal variation. Hare (1983, 1985) distinguishes between climatic noise, climatic variability and climatic change. Climatic noise refers to short term weather changes; climatic variability represents variation within a given averaging period. The evidence of climatic change can be divided into global and regional changes. A number of scholars: Grove (1958); Oliver (1973 and 1981) have produced evidences to show that the climate of the earth has undergone considerable climatic changes. Climatic changes involve some cycles which are related to changes in the global carbon cycle (Mannion, 1992). Lamb (1984) observed that 19^{th} century surface temperature rose by about 0.8^0C in the northern hemisphere. This period came to an end in the 20^{th} century; Perry (1984) and was followed by a short decrease in temperature clearly evident in the 1960's. The Sahel has turned into Sahara and in Mauritania, the desert has advanced 200km southward since 1960. Rainfall in the country in the year 1983 was only twenty-three (23) percent of the mean annual rainfall between the year 1941-1970. Some places like Nouadhibour in Mauritania had no rainfall at all in 1982 and 1983.

Desertification and desert encroachments are common phenomena which are major ecological problems throughout West Africa and in Nigeria; especially in : Sokoto, Katstina, Kano, Bauchi and Borno States.

However, climate change can affect multiple features of water resources such as quantity and quality, high- and low-flow extremes, timing of events, water temperature, etc.

2.1 THE IMPACT OF CLIMATE CHANGE ON WATER RESOURCES.

It is important to make a distinction between the processes of climate change and the impacts on

water suppliers resulting from these changes. Although global warming is fairly straightforward, the impacts on water suppliers may involve many additional cause and effect relationships. According to the department of climate change, Federal Ministry of Environment, a warming climate in Nigeria will have impacts on water quantity across the country.

Global climate change may lead to change directly in morbidity and mortality through global warming and through UV-B radiation increase. Global climate change is likely to affect the ecosystem and alter the human hazards such as parasites and chemical pollutants and also affect human health by producing changes in air quality and water quality; IPCC(1990)

This global warming has been strongly linked to changes in the global hydrological cycle such as: increases of atmospheric water vapour resulting in changes of precipitation patterns, intensity, and extremes; reduced snow cover and the widespread melting of ice; and changes in soil moisture and runoff. These impacts on water quantity and quality due to climate change are very much likely to affect the functions and operations of existing water infrastructures including hydropower, structural flood defenses, drainage, and irrigation systems, as well as water management practices (IPCC, 2008).The impacts of climate change can be divided into three major classes: direct impact, indirect impact, and compound impact.

2.1.1 DIRECT IMPACTS

Direct impacts are defined as resulting from the effects of Climate Change on water utility functions and operations. The following evidences of direct impacts of climate change include:

- More rain, more rain-on-snow, and earlier spring snowmelt
- Altered recharge of groundwater aquifers
- Earlier runoff into surface waters
- Increased water temperature
- Increased water demand
- Increase in the concentration of green house gases(GHG) due to uncontrolled emission.
- Ozone layer depletion, Shrinking ice sheets, Rise in Sea levels, ocean acidification etc.

3.0 MATERIALS AND METHOD

Ogunpa River is a typical example of surface water system which also contributes to the water resources sector of Ibadan and Nigeria at large. It is one of the four main rivers in Ibadan city. The Ogunpa River as shown on the location map in figure 1 may be described as one of the major rivers which originated as a very small river and later spread with respect to time and space due to urbanization and increased anthropogenic activities. Ogunpa river have a watershed of 6,680 hectares served by Forty-nine stream junctions. It was observed that up to eighty- five percent (85%) of the river's catchment is fully developed. The overall length of the river is 21Km with an average slope of 5.80m/Km.Rivers Kudeti, Gege and Labelabe are major tributaries of Ogunpa. (Source- from a seminar presentation on "FLOOD DISASTER IN THE CITY OF IBADAN, NIGERIA "delivered by Engr.A.Tokun and Engr.M.O Adesina-principal partners from Osot Associates). From history, Ibadan had witnessed floods due to the impact of climate change which came up periodically causing great losses to lives and properties. Previous Flood records in Ibadan reflect the following order of severity by years thus:

(i) 17th June, 1955 (Disastrous),
(ii) 17th August, 1960 (Mild).
(iii) 28th August, 1963(Disastrous),
(iv) 5th August, 1973 (Disastrous).
(v) 20th April, 1978 (Disastrous),

(vi) 31st August, 1980(Most Disastrous),
(vii) 31st August ,2011(Disastrous).

This information on the previous flood record and its severity is a pointer to the need for proper mitigation strategies against the impacts of climate change which is most times largely unfavourable to the water resources sector of the nation's economy.

Fig 1: The Location Map Showing Ogunpa River

Actually, the methods used to evaluate the impact of climate change on a typical surface water (Ogunpa River) was broadly categorized into two namely:

Collection of Data
Analysis of Data

3.1 COLLECTION OF DATA

The collection of data consists of meteorological data of twenty-six (26) years record of rainfall (1984 -2009), temperature data record of about twenty (20) years (1990-2009) and relative humidity and evaporation data of ten years record (1999 -2009) were collected from the

Nigerian Meteorological Agency, old airport Samonda, Ibadan with flow records for Ogunpa (1990-1994) at the Molete gauging station which is one of locations for Ogun-Osun River Basin Development.

However, the data made available for this paper are the rainfall and mean temperature parameters.

3.2 ANALYSIS OF DATA

The data collected were analyzed both qualitatively and quantitatively using a computer package such as Excel. Manual calculations via statistical formulas were used to calculate and obtain the satisfactory coefficient of correlation (R) which was computed as 0.8 using the rank correlation formula as shown in equation 1.2 while the quantitative method via Excel packages was used to calculate the mean, standard deviations, variance and skewness. During the analysis, the consumptive use (U) or evapotranspiration were computed using the Blanney Criddle formula of potential evapotranspiration (PET) thus:

$$U=\sum Kp\left(\frac{4.6t.+81.3}{100}\right) \quad \ldots\ldots\ldots \text{ Equation 1}$$

$$U=\sum Kf$$

$$\text{Where } f=P\left(\frac{4.6t+81.3}{100}\right) \quad \ldots\ldots\ldots \text{ Equation 1.1}$$

P - Monthly percentage of sunshine hours

t - Is the mean monthly temperature derived from table 2

K-Monthly consumptive use coefficient which is normally determined from experimental data.

$$R=\frac{\sum(\Delta X*\Delta Y)}{(\sum(\Delta X)^2*\sum(\Delta Y)^2)^{0.5}} \quad \ldots\ldots\ldots \text{ Equation 1.2}$$

Where R - Correlation Coefficient

However, an average K factor of 0.67 was used in computing for evapotranspiration (ET). Besides, the net or the effective rainfall was also determined by taking a difference between rainfall and potential evapotranspiration. The net rainfall was computed by taking the difference between rainfall and potential evapotranspiration. Besides,the simulated flow-rainfall equation was derived thus:

$$Y=0.63+0.002x \quad \ldots\ldots\ldots\ldots \text{ Equation 1.3}$$

Where: y = flow in (m^3/s and x = Rainfall in (mm)

The computed values of a and b ; 0.63 and 0.002 respectively were generated from the least square method of linear regression as shown in equations 1.4 and 1.5 respectively.

$$\sum Y = na+b\sum X \quad \ldots\ldots\ldots\ldots\ldots \text{Equation 1.4}$$

$$\sum XY=a\sum X+b\sum X^2 \quad \ldots\ldots\ldots \text{ Equation 1.5}$$

4.0 RESULTS AND DISCUSSION.

The interpretation of the results obtained based on the method of analysis requires a clear understanding of the hydrological indices such as rainfall, temperature evaporation and runoff. By analysis, the rainfall data which spanned between the climatic period (1984 -2009) were transformed into flow in million cubic meter (MCM) with the aid of the simulated flow-rainfall equation thus: y = 0.63 + 0.002x. The standard deviations and the means of the data as shown in the tables 2 and 3 were computed via quantitative analysis to establish the occurrence and the reality of climate change in Nigeria especially as it affects the water resources sector of the nation.In table 2, the mean temperature from 1990 to 2009 was computed as 27.2^0C. By considering the value of the mean annual temperature (1990-2009) which is 27.2^0C, a comparison was made with the mean temperature of the climatic period between (1901-1938). According to Odjugo et al (2010), the mean temperature of the climatic period was found to be 26.04^0C. Moreover, the difference in the mean temperatures of the climatic periods of 137years (1901 -1938) and 19 years (1990 - 2009) by computation is 1.16^0C. The global temperature for the past 100 years is found to be 0.74^0C. By comparison, this implies an acute rise of 0.32^0C above the 0.1^0C rise in the average

global temperature. The increase in the global temperature is an indication of the occurrence of climate change in Nigeria and beyond. Besides, figure 2 which is a graphical representation of table 2 also confirms or justifies the evidence of climate change because there was palpably a sharp drop in the mean temperature of the year 2000.The value of the mean temperature for the year 2000 was 24.7^{O}C which is deviation from the normal range of mean temperatures for other years as show on table 2.

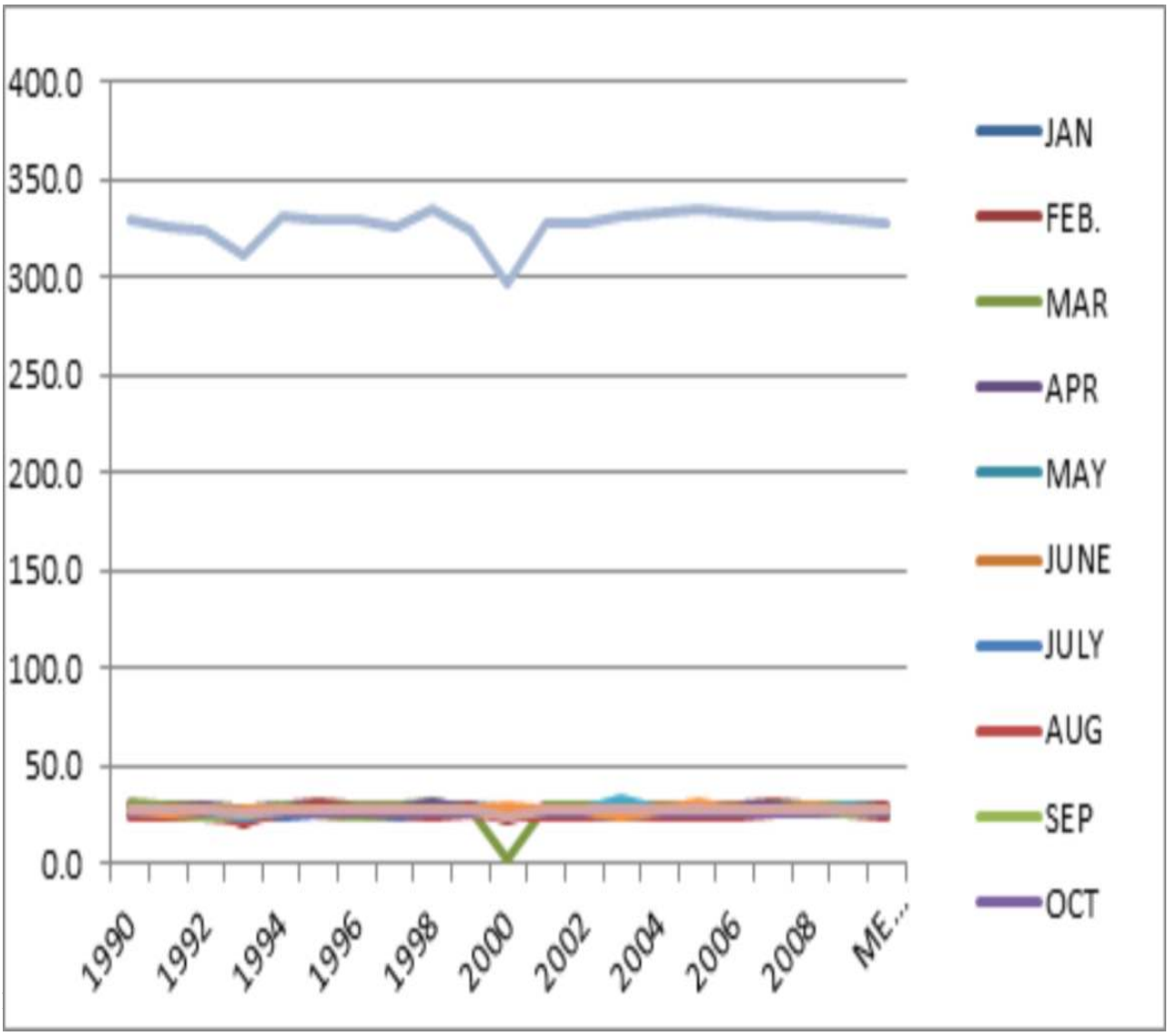
Besides, the mean annual rainfall value for the years between (1901-1938) was 1571 mm while the mean annual rainfall values of the climatic period between the years (1984-2009) as shown in table 3 was estimated to be 1352.2mm. By comparison between these two different climatic periods (1901 -1938) and (1984 -2009), a drastic decrease of 218.8 mm was observed. Hence, the decreasing rainfall and increasing temperatures are basic features to establish global warming and climate change. Obviously, the decrease in the mean annual rainfall and the increase in the mean annual temperatures will definitely results into a decrease in the flow trend of any river in Nigeria e.g Ogunpa river and the world at large. Moreover, the minimum annual rainfall for the years under consideration occurred in the year (1986) with a total rainfall amount of 974mm, while the maximum or the highest rainfall occurred in the year (1999) with a total rainfall amount of 1834.2mm as shown in table 3,thus; the mean annual rainfall and standard deviation are 112.3mm and 18.9. It was also observed that the annual rainfall in the last ten years (1999-2009) was greater than the annual rainfall in the first ten years (1984-1994) This observation is a proof that climate change is evident. Besides, further implications of this recent increase in the amount of annual rainfall is the occurrence of high surface runoff. This also implies that increase in rainfall will sustain the water level in the river and reservoirs, bringing about the reduction in evaporation and infiltration losses.

The summary about the impacts of climate change is that river changes in stream flow is a function of changes in precipitation and potential evapotranspiration

Table 2: Mean Temperature (1990-2009)

YEAR	JAN	FEB.	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV.	DEC.	TOTAL	AVE
1990	28.3	29.1	30.8	28.2	27.5	27.1	25.2	24.9	25.7	26.5	28.4	27.8	329.5	27.5
1991	28.2	29.5	29.5	28.1	27.5	27.0	25.9	25.0	25.1	25.8	27.8	26.9	326.3	27.2
1992	26.5	29.6	29.9	28.8	27.5	26.0	25.0	24.3	25.0	26.5	27.0	27.5	324.0	27.0
1993	27.4	19.9	28.5	28.7	27.9	26.6	25.4	22.1	26.0	26.7	24.5	27.3	311.0	25.9
1994	27.6	29.5	29.9	28.9	27.4	26.5	24.9	25.5	29.3	26.5	27.8	27.1	330.9	27.6
1995	27.8	30.6	28.4	28.7	27.9	26.7	25.5	25.8	26.2	26.5	27.5	28.2	329.8	27.5
1996	28.7	29.4	28.9	28.1	27.2	26.9	26.9	24.9	25.0	25.8	28.0	28.5	328.3	27.4
1997	28.2	29.0	28.9	27.7	27.0	26.3	24.9	25.1	26.6	26.7	27.9	28.0	326.3	27.2
1998	27.9	30.3	31.4	30.7	28.1	26.8	25.6	24.7	25.5	26.8	28.6	27.6	334.0	27.8
1999	28.8	28.8	28.5	28.1	27.4	26.3	25.4	25.2	25.2	25.8	27.3	27.8	324.6	27.1
2000	28.1	22.1	3.0	28.5	27.9	26.5	25.1	24.4	25.7	27.0	28.5	29.9	296.7	24.7
2001	28.0	29.3	29.5	27.9	27.5	26.3	25.5	24.2	25.3	26.7	28.7	28.5	327.4	27.3
2002	27.6	29.8	29.8	28.1	27.6	26.5	25.6	24.9	25.5	26.3	28.3	28.0	328.0	27.3
2003	28.0	29.6	30.1	28.1	28.0	26.1	25.0	25.1	26.0	27.0	33.4	23.7	330.1	27.5
2004	27.9	29.1	29.9	28.4	27.4	30.4	25.3	24.7	25.9	26.5	28.1	28.7	332.3	27.7
2005	27.7	30.1	29.4	29.3	27.8	26.2	25.2	24.5	26.1	26.8	28.6	32.1	333.8	27.8
2006	28.7	30.3	28.8	29.3	27.0	28.8	26.0	25.0	25.4	26.6	27.9	28.1	331.9	27.7
2007	27.6	30.9	30.4	29.0	27.8	26.5	25.5	25.5	25.8	26.3	27.9	27.7	330.9	27.6
2008	28.4	29.4	29.5	27.9	27.5	26.7	27.1	25.2	26.0	26.5	27.8	29.2	331.2	27.6
2009	27.1	29.2	29.2	28.2	27.5	26.6	25.8	25.3	26.0	27.2	28.8	28.5	329.4	27.5
MEAN	27.9	28.8	28.2	28.5	27.6	26.8	25.5	24.8	25.9	26.5	28.1	28.1	326.8	27.2
STD	0.5571	2.739	5.9859	0.6892	0.308	1.02	0.5906	0.7611	0.9167	0.3864	1.5435	1.5341	8.6356	1.4
VAR	0.3104	7.502	35.831	0.475	0.0948	1.0404	0.3488	0.5792	0.8403	0.1493	2.3825	2.3535	74.573	4.3
SKEW	-0.645	-2.754	-4.345	1.7213	-0.155	2.7964	1.5473	-2.467	2.9278	-0.594	1.5191	-0.179	-2.723	-0.1

SOURCE: Meteorological Department, Old Airport, Samonda, Ibadan.


400.0
350.0
300.0
250.0
200.0
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1990
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ME...
JAN
FEB.
MAR
APR
MAY
JUNE
JULY
AUG
SEP
OCT

Table 3: Rainfall data in mm (1984-2009)

YEAR	JAN	FEB.	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV.	DEC.	TOTAL	AVE
1984	0.0	5.2	132.8	100.8	273.1	191.2	131.5	283.7	206.8	137.8	18.5	4.4	1485.8	123.8
1985	0.6	15.0	53.8	135.4	175.7	215.6	338.8	166.5	302.6	198.6	51.4	0.0	1654.0	137.8
1986	20.6	41.5	80.8	64.4	113.7	253.5	141.7	28.0	27.6	197.5	5.1	0.0	974.4	81.2
1987	5.3	12.1	38.1	52.0	116.9	229.7	122.5	256.4	272.6	184.9	102.5	20.0	1413.0	117.8
1988	0.0	22.2	45.9	122.8	143.9	237.8	177.4	113.9	209.6	140.4	0.0	0.0	1213.9	101.2
1989	9.5	25.3	9.9	170.3	156.5	80.1	189.7	73.1	190.8	123.4	12.2	65.6	1106.4	92.2
1990	3.4	15.1	14.1	212.0	156.2	92.6	281.3	94.1	204.8	144.6	4.0	45.4	1267.6	105.6
1991	0.0	40.3	5.3	108.2	177.2	205.0	327.2	103.7	149.5	116.2	11.2	31.9	1275.7	106.3
1992	0.0	0.0	24.7	104.4	107.3	195.4	206.4	62.3	228.0	198.0	1.6	0.0	1128.1	94.0
1993	0.0	68.0	150.7	48.0	136.9	196.4	59.5	141.9	224.3	168.6	44.2	22.0	1260.5	105.0
1994	0.8	20.2	43.8	64.7	260.5	98.4	139.3	47.4	282.3	159.7	23.0	0.0	1140.1	95.0
1995	0.0	0.9	135.7	182.4	251.9	165.1	270.1	295.8	208.8	139.4	23.0	0.0	1673.1	139.4
1996	0.0	80.1	108.8	130.3	182.5	170.8	180.5	240.4	180.8	108.2	0.0	0.0	1382.4	115.2
1997	6.3	0.0	99.2	268.5	158.9	96.1	63.8	111.8	113.6	160.0	33.4	23.7	1135.3	94.6
1998	0.0	9.1	20.5	73.3	116.0	167.3	102.7	52.7	288.8	151.8	19.2	14.8	1016.2	84.7
1999	0.0	79.2	82.8	167.7	157.0	305.8	333.7	124.4	157.3	354.7	71.5	0.0	1834.1	152.8
2000	30.1	0.0	95.7	126.1	80.6	116.0	220.7	232.4	236.2	215.9	0.0	0.0	1353.7	112.8
2001	0.0	8.4	121.6	142.2	231.2	114.9	257.8	53.2	285.6	72.3	2.1	1.1	1290.4	107.5
2002	0.0	0.0	70.6	171.1	108.7	300.9	302.4	131.5	162.5	212.9	0.0	0.0	1460.6	121.7
2003	25.2	81.6	3.6	184.1	191.3	315.4	227.8	40.9	232.7	215.2	51.7	0.0	1569.5	130.8
2004	13.2	78.7	32.5	92.0	232.0	183.9	181.2	161.2	156.2	196.3	0.3	0.0	1327.5	110.6
2005	0.0	33.1	101.9	118.2	114.7	225.2	182.9	64.0	234.1	135.9	4.0	12.2	1226.2	102.2
2006	19.1	1.6	109.1	79.0	197.3	164.5	65.2	128.1	312.5	166.0	17.0	0.0	1259.4	105.0
2007	0.0	0.5	36.2	39.5	303.8	173.7	188.3	98.1	231.7	254.0	6.5	8.3	1340.6	111.7
2008	0.0	1.5	132.2	158.9	113.2	373.4	238.2	263.3	253.0	193.4	0.0	18.7	1745.8	145.5
2009	1.0	1.2	80.4	203.7	129.3	217.4	205.6	98.0	385.5	250.5	49.1	0.0	1621.7	135.1
MEAN	5.2	24.6	70.4	127.7	168.7	195.6	197.5	133.3	220.7	176.8	21.2	10.3	1352.2	112.7
STD.	8.9	29.1	45.7	57.1	59.1	74.1	81.7	80.9	71.6	56.5	26.2	16.6	607.5	50.6
VAR.	79.0	845.7	2087.4	3265.4	3495.4	5497.1	6669.5	6542.3	5120.7	3196.4	686.2	274.8	37759.8	3146.6
SKEW	1.7	1.1	0.1	0.5	0.7	0.5	0.1	0.8	-0.3	1.1	1.6	2.0	9.8	0.8

SOURCE: Meteorological Department,Old Airport,Samonda,Ibadan.

4.1 MITIGATION STRATEGIES TO THE IMPACT OF CLIMATE CHANGE

Climate changes, whether they occur on a global or regional scale, may be accompanied by adverse consequences. While some of these changes are spontaneous, lasting for short periods with disastrous effects, others linger for years with pronounced negative Consequences. The hydrologic aspect of these changes could be in the extremes-either as too much water causing flooding or too little water resulting in drought. Many water utilities have begun to respond to climate change through "adaptation" measures to modify plans and operations to minimize impacts. These adaptations efforts fall into two broad categories. The first consists of vulnerability analyses that are intended to identify the most near term priorities in places where impacts could be felt the soonest. The second is long-term planning, or more formally, Integrated Resource Planning (IRP) that adopts the broadest possible strategic view of how a

utility can be planned to cope with such systemic changes over the longer term. In addition, the adoption of measures that will help to mitigate the onset of the impact of climate change should be put in place. Ogunpa River, which is taken as a sample representative to attest to the impact of climate change on rivers in Nigeria, was popular with the "flood disaster" of the year 1980 which was described as the most disastrous in the history of flood disasters that had ever taken place in Ibadan. The flood disaster resulted to the loss of lives and properties worth of mammoth sum of money. The occurrence of the "flood disaster" which was the harbinger of the impact of climate change was triggered by the unethical anthropogenic activities of the people at that time. Another flood disaster in the year 2011 also occurred resulting into loss of lives and properties. The Flood disasters are the emblem of the impact of climate change as it affects Ogunpa River, other rivers in Nigeria and the environment at large. Hence, the mitigation strategies should include: the discouragement and prevention of these unethical anthropogenic activities(domestic and industrial in nature) by the Federal environmental Protection agency(FEPA),the compliance with water laws which should be enforced by the various River Basin development authority and other safety measures that will help to quell the challenges posed to the environment by Climate change. In the case of Ogunpa River, Channelization project was done to actually combat and attenuate the problem of flooding due to climate change at that time. This should be done where necessary with proper maintenance. Another mitigation strategy also includes the reduction of the volume of energy consumption that contributes to the production of Greenhouse gases (GHGs). According to climate change facts gathered from National Climate Assessment (2014), mitigating the damage of global warming is a moral responsibility requiring global cooperation. Hence, it is imperative to respond to the clarion call to discourage every activity and operations that promote the negative impact of climate change in our society at large.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 CONCLUSION

The paper shows that climate change is really evident in Nigeria as well as the regional and global levels. This paper also reveals the impacts of climate change on the water resources sector with a focus on the Ogunpa River as a representative sample of surface water in Nigeria. Although, there are some uncertainties about the climate scenarios at local levels, yet the problem of climate and its impacts is real. The whole essence of the paper suggests the need to restructure and also fortify the water resources management of Nigeria against the present and the future impacts of climate change. From the data collected and analysed,it may be established that the climate change at any locations,countries,and regions have numerous impacts on the flow regime of a river and other surface water bodies. Climate change has started impacting and will continue to affect global temperatures, water resources, ecosystems, agriculture and health among others. There is high confidence that neither adaptation nor mitigation alone can avoid or prevent all the impacts of climate change. However, they can complement each other and together can significantly reduce the risk of climate change. Many impacts can be reduced, delayed or avoided by mitigation, so key sectors mitigation technologies need to be developed up to an acceptable standard. These key sectors include: energy supply, transportation,

buildings, industries, agriculture and forestry and waste; (IPCC, 2007).

4.2 RECOMMENDATIONS

Based on the findings of this paper, I hereby recommend mitigation measures or strategies against the impact of climate change on the water resources management of Nigeria thus:

The collaboration of the Ministry of Environment and the Ministry of Water Resources as this will help to unfold current strategies needed to mitigate the impact of climate change on water resources sector in Nigeria as well as step up integrated water resources management.

Reliable, current and sufficient data should be made available as this help to understand the regional and global trend of the impact of climate change on the environment as well as prevent untold occurrence of extreme events due to Climate change.

The Government at all levels should be more sensitive to the challenges that may likely be posed to the water resources sector in Nigeria due to climate change by providing adequate fundings to the relevant agencies.

Training of staff in the water resources sector(Ministries and Institutions of Higher learning) in order to strengthen research and development for new technologies.

There should be regular and adequate public lectures with enlightenment programmes via media (Local and National) informing the citizens of Nigeria on the causes and the impacts of climate change and how to reduce the anthropogenic activities that are responsible for it.

The re-establishment and revitalization of a regulatory body in charge of the impact of climate change within the ministries of Environment and water Resources.

Constant Research on climate change, its impacts on the environmental components and mitigation strategies should be funded and highly encouraged.

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