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Radiative Forcing: Miscreant, Climate Change and Adaptive Measures in Nigeria

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Abstract: *Climate change has been a topic of great current concern around the world. Radiative forcing of earth's atmosphere is increasing at unprecedented rate due to increase of greenhouse gases - CO_2, CH_4 and N_2O. This paper discusses the deliberate human attempts in modifying the climate through emission of particulates, which affect public health and ecosystem; burning of fossil fuel, which has direct impact on CO_2 concentration; and emission of trace species that alter the radiative properties of the atmosphere directly. Decadal meteorological data from the Nigerian Meteorological Agency (NIMET) for Ijebu, Maiduguri, Calabar, Enugu, Iseyin and Ikom spanning from 1971-2013 has been analyzed. Signatures of climate change such as rain variability, changes in land use, and an intense heat wave has been discussed. Increase of rainfall is as a result of anthropogenic impact and adaptive measures have been discussed.*

Keywords: *Climate effect, forcing, rainfall, Adaptive measures*

I. Introduction

Global climate change over centuries has reinforced the recognition that climatic conditions are non-stationary and human activities have major impacts on the climate system.

The driving mechanism of climate change is the climate forcing, which is caused by anthropogenic vegetation (Roger et al., 2003). Human effects on vegetation cover a wide history, and burning of vegetation has been traced equally. The green house gases (GHG_S) which include carbon (IV) oxide (CO_2), methane (CH_4), and nitrous oxides (N_2O) are the main cause of global warming (Arhens, 2001). Consequently, the periodic appearance of natural phenomena, such as volcanic eruptions, also contributes in the climate variance through the ejection of large quantities of particles into the atmosphere that reflect the sun's radiation. Hence, volcanoes play an interesting role in the destruction of ozone. Volcanoes release bromine and chlorine when they erupt and those chemicals could have a disastrous effect on the ozone layer in the upper atmosphere. For instance, hydrogen chloride a common volcanic gas efficiently destroys ozone. Significant ozone loss was observed in the stratosphere after the devastating 1991 eruption of Mt. Pinatubo, Philippines which produced a plume that rose to 34 km well into the stratosphere. At least 20 commercial jet aircraft were involved in incidents related to volcanic ash from the June 1991 eruptions. Sixteen in-flight encounters occurred between June 12 and 18; at least two encounters involved loss of engine power. In addition to the numerous in-flight encounters, about two dozen airplanes on the ground in the Philippines were also damaged by Pinatubo ash (Potts, 1993)

Changes in the Earth's climate occur from changes in the Sun's energy, albedo variations and changes in the composition of the atmosphere; green house effect affects countries' economy, induces food scarcity. Increase in temperature and changes in rainfall patterns affect agricultural production (Wiebelt et al., 2011). The terrestrial biosphere influences the incoming radiation, and outgoing re-radiation, through human transformation of the land-cover, especially deforestation and agriculture affects the atmospheric composition because of the great amount of carbon dioxide. So buffering carbon dioxide cycle in our dear atmosphere and causing warming. Climate change has produced unsteady weather patterns, eroded coastlines, spread pests and waterborne diseases (Belinda and Asfaw 2011). Measures are needed to integrate the processes of urbanization and industrialization so as to reduce poverty, arrest and manage anthropogenic activities that causes climate change

II. Climate Change Screenplay In Nigeria

2.1 Rainfall cycle

Rainfall is one of the climatic factors that indicate climate variation (Ayoade, 2004), and is important for economic growth. The belt of convectional rain follows the overhead sun and shifts north and south across the country (Iloeje 1981). It is also experienced nearly all the year round along the coast which is near the Equator. Chineke et al., (2010) discussed variations in seasonal distribution, caused by maritime mass. The tropical air mass, which originates from the southern high-pressure belt, crosses the equator and picks moisture from the Atlantic, which enters Nigeria from the south. This influences the country in July. The tropical continental air mass which picks up little or no moisture enters the country from the north in the month of October. In this study, monthly rainfall trend was analyzed using data spanning a period of 42years (1971-2013) which was obtained from the Nigerian Meteorological Agency (NIMET). Six locations in the southeastern Nigeria were considered. The data were divided into decades, and subsequently using statistical tools for the analysis.

2.2 Changes in Land Use

Desertification is induced by gradual and prolonged loss of vegetation cover over extensive land areas in a country, leading to reduction in soil moisture that curtails biodiversity and productivity (Belinda, 2011). Changes in temperature causing vegetation shifts and conservation challenges most especially on arid zone. As plant try to adjust to the changing climate by moving towards area that is cool and animals that depend on them will be forced to move.

Carbon dioxide (CO**2)** is actually trace part of the atmosphere, but one of the most important GHGs (Crowley, 2000). It is released naturally into the atmosphere through eruption, animal respiration and human activities such as deforestation and the burning of fossil fuels for energy (Andrews, 2010). CO2 spends a long time in the atmosphere increasing its impact. Since the industrial revolution, anthropogenic impact has increased atmospheric CO2 concentration by 30% (IPCC, 2007).

Methane (CH_4**)** the second most important GHG, is produced naturally and through human activities. The most notable sources of Methane come through the decomposition of organic matter in landfills and agriculture (Salby 1996). Another large source is the digestion of ruminants. Methane is a stronger GHG than CO2 because it can absorb more heat, however is much less abundant in the atmosphere.

Nitrous oxide (NO_2) is a powerful GHG. It is produced in the agricultural sector, specifically used as organic fertilizers. It is also produced when burning fossil fuels (John and Alan 2006).

2.3 Intense heat waves

The mean temperature of the planet is the most appropriate and stable climatic parameter that can be under see in relation to the climate conditions and changes. The atmosphere is continually bombarded by solar photons at infra-red and ultra-violet wavelengths (Andrews 2010). Alternate current consumption appliance, clouds and Earth's surface emit and absorb infra-red photons, leading to more heat transfer between one region and another, lost of heat to space; due to emission of atmospheric molecules that absorb more heat.

III. Data And Methodology Of Research

Decadal rainfall data for the average period of 1971-2013 for six locations in Nigeria, obtained from NIMET presents the rainfall data in mm per day. And the averages were taken using Microsoft Excel.

Table 1: Average rainfall trend of Ikom lat 5.97^{o}N, long 8.72^{o}E & Maiduguri lat 11.85^{o}N, long 13.08^{o}E

IKOM	**1972-1981**	**1982-1991**	**1992-2001**	**2002-2011**	**2012-2013**
JAN	0.30	0.27	0.24	0.59	0.26
FEB	1.95	1.74	0.44	1.56	2.39
MAR	3.88	3.71	3.27	1.99	1.50
APR	6.35	5.30	5.33	6.24	7.17
MAY	7.36	7.89	7.21	8.74	10.45
JUN	9.99	9.95	11.46	11.25	16.64
JUL	9.77	10.05	10.40	9.63	8.45
AUG	10.50	12.56	10.39	10.18	10.49
SEP	12.69	10.79	12.67	10.70	10.90
OCT	12.20	7.87	11.15	10.23	11.56
NOV	1.55	1.13	1.46	1.68	2.85
DEC	0.16	0.38	0.28	0.25	1.01
MAIDUGURI	**1971-1980**	**1981-1990**	**1991-2000**	**2001-2010**	**2011-2013**
JAN	0	0	0	0	0
FEB	0	0	0	0	0
MAR	0	0.025	0.013	0	0
APR	0.264	0.186	0.189	0.146	0.0844
MAY	1.137	0.689	1.113	1.033	1.109
JUN	2.706	1.673	2.179	3.76	2.533
JUL	4.901	3.422	5.888	5.384	6.019
AUG	5.899	4.376	6.04	6.967	7.741
SEP	3.556	2.321	3.469	4.236	3.877
OCT	0.416	0.161	0.5	0.737	0.4
NOV	0	0	0	0	0
DEC	0	0.008	0	0.012	0

Table 2: Average rainfall trend of Ijebu 6.82 ^{o}N, long 3.92^{o}E & Iseyi lat 7.97^{o}N, long 3.60^{o}E

IJEBU	**1980-1989**	**1990-1999**	**2000-2010**	**2011-2013**
JAN	0.287	0.315	0.469	0.466
FEB	0.841	1.001	1.545	2.202
MAR	2.562	3.212	3.053	1.047
APR	3.188	5.478	3.959	3.8
MAY	6.727	4.289	6.109	6.491
JUN	7.942	8.211	10.921	7.278
JUL	6.497	9.98	7.897	12.149
AUG	5.275	4.203	4.388	2.348
SEP	7.27	7.185	10.278	8.285
OCT	5.338	7.163	7.036	7.001
NOV	0.878	1.584	1.709	2.435
DEC	0.18	0.702	0.316	0.482
ISEYIN	**1982-1991**	**1992-2001**	**2002-2011**	**2011-2013**
JAN	0.573	0.357	0.175	0.43
FEB	0.524	0.485	0.502	0.7526
MAR	2.039	2.111	2.049	0.824
APR	3.93	3.311	3.31	4.706
MAY	5.198	5.2	4.585	5.532
JUN	5.198	5.485	6.252	4.306
JUL	4.814	4.333	5.084	2.958
AUG	4.879	4.15	5.122	2.348
SEP	6.433	6.563	7.49	5.631
OCT	4.081	5.397	6.407	5.583
NOV	0.414	0.434	0.82	1.598
DEC	0.315	0.07	0.087	0.12

Table 3: Average rainfall trend of Calabar lat 4.97^{o}N, long 8.35^{o}E & Enugu lat 6.50^{o}N, long 7.00^{o}E

CALABAR	**1971-1980**	**1981-1990**	**1991-2000**	**2001-2010**	**2011-2013**
JAN	0.77	0.58	1.12	1.13	1.86
FEB	2.32	0.85	0.86	2.13	7.16
MAR	3.91	4.64	6.01	5.94	4.24
APR	6.8	6.46	7.94	7.78	6.34
MAY	7.85	10.53	7.4	11.17	13.4
JUN	12.83	14	13.01	12.09	13.85
JUL	13.53	14.64	15.49	14.61	18.86
AUG	13.85	9.64	14.32	14.98	18.6
SEP	14.56	12.69	13.96	11.34	14.45
OCT	10.78	9.36	11.56	7.26	13.66
NOV	5.78	4.37	4.8	5.15	7.41
DEC	0.92	1.02	0.87	0.59	1.77
ENUGU	**1971-1980**	**1981-1990**	**1991-2000**	**2001-2010**	**2011-2013**
JAN	0.24	0.18	0.27	0.3	0.79
FEB	1.08	0.3	0.32	0.43	0.94
MAR	2.17	1.66	1.88	1.07	1.77
APR	4.08	3.83	5.93	5.17	3.9
MAY	7.43	6.63	8.22	8.8	8.13
JUN	8.93	7.04	9.33	9.1	8.88
JUL	6.8	8.68	8.82	8.71	7.8
AUG	7.67	8.72	8.89	6.72	9.72
SEP	11.59	8.93	8.69	10.21	13.93
OCT	7.64	5.84	7.09	7.56	5.64
NOV	0.71	0.34	0.72	1.14	0.84
DEC	0.21	0.32	0.05	0.83	1.04

IV. Results Of Analysis And Discussion

Presented are results of analyzed rainfall data from 1972-2013 at the six locations in Nigeria indicated in Tables 1, 2 & 3. It is noted from Figs. 1 – 6 that the tropical rainfall peaks around April to September all through the years and stations under study. This confirms the two major seasons obtainable in Nigeria: wet and dry seasons which span from April through September and October through March respectively. With the exception of Iseyin, other stations experienced average maximum amount of rainfall in the year 2012 through 2013.

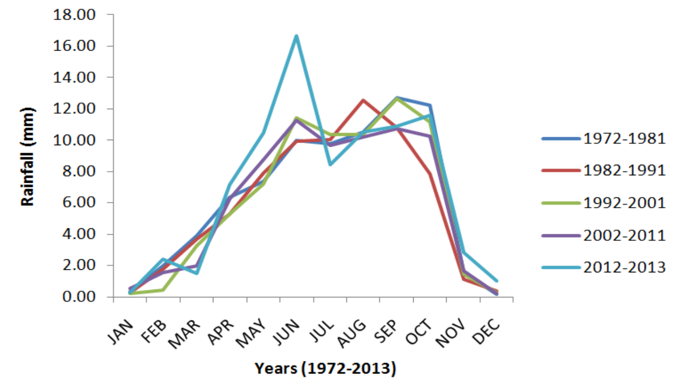

Fig. 1:Rainfall variation in Ikom

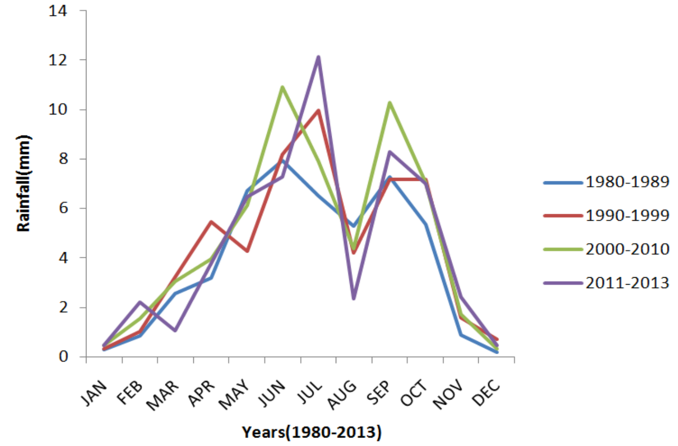

Fig. 2: Rainfall variation in Ijebu

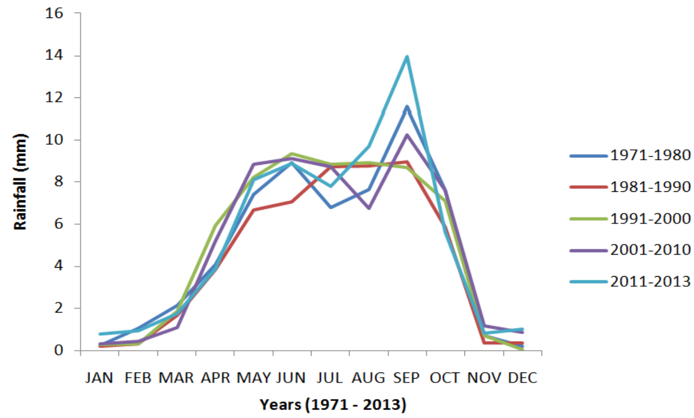

Fig. 3: Rainfall variation in Enugu

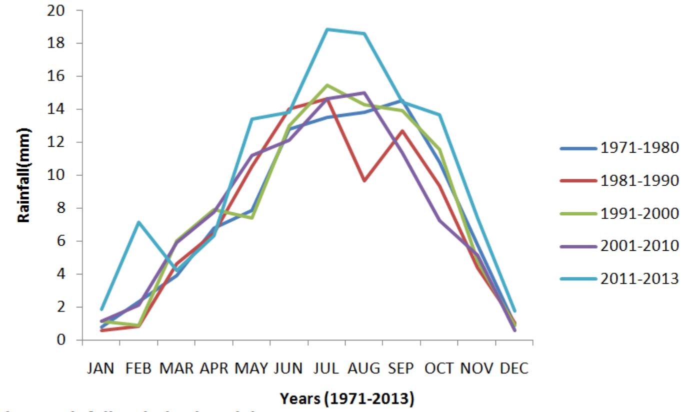

Fig. 4: Rainfall variation in Calabar

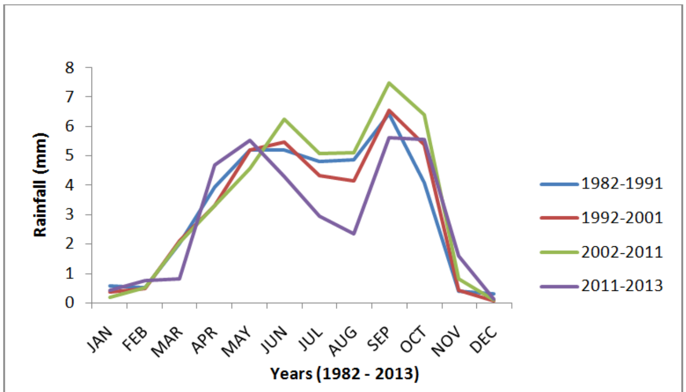

Fig. 5: Rainfall variation in Iseyin

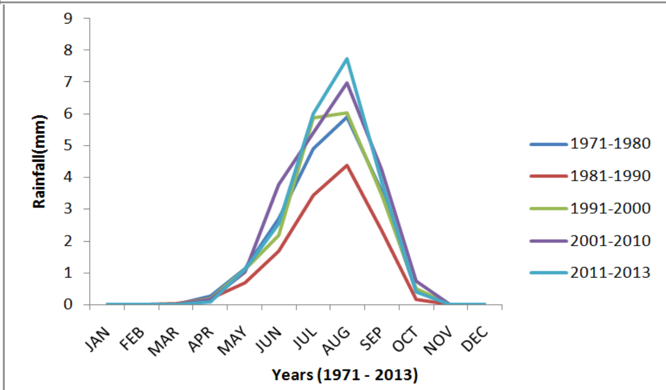

Fig. 6: Rainfall variation in Maiduguri

V. Adaptive Measures

Any factor that causes a sustained change to the amount of incoming energy or that of outgoing energy can lead to climate change. Climate forcers push the climate towards a new long term, warmer or cooler depending on the cause of change (Green 1999).

This is due to natural causes like volcanic activity, solar output, earth's orbit around the sun, human activities of fossil fuel burning, land conversion to forestry and agriculture.

Some steps should be adhered to ensure remedy

- Reduce energy use by adopting energy saving habits. At least, make it a habit to turn off the lights as you leave a room. It is also encouraged to replace standard bulbs with energy efficient compact fluorescent bulbs.
- Switch off your computer and unplug electronics when they are not in use.
- Change the way you think about transportation, walk whenever possible to reduce carbon footprint.
- Conserve water by fixing drips and leaks. Install low flow shower heads and toilets, and turn off water when brushing teeth or shaving.

VI. Conclusions

During the twentieth century, human land-use variation appears to play potential significant role in the large-Scale radiative forcing of climate. Bauer et al. (2003) used a climate modeling to examine the biophysical forcing from deforestation, including increased surface albedo as well as reductions in evapotranspiration and surface roughness.

Daniel (2005) discussed the photon and atmosphere interaction, as a result of molecule emission in considering the policy options for dealing with greenhouse gases. It is necessary to have a simple way of describing the relative abilities of emitting greenhouse gases to affect radiative forcing and hence climate.

A useful approach could be to express any estimates relative to the trace gas of primary concern, namely carbon dioxide. The analyses of the past trends and future projections of the changes in concentrations of greenhouse gases indicate that the radiative forcing from these gases may increase.

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