

Research Paper

A Study of the Relationship of Global Warming on Temperature, Wind Speed, Relative Humidity and Rainfall Variations in Gombe State, Nigeria

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A study on the effects of global warming in Gombe State was conducted. Daily Wind speed, Temperatures, Rainfall and Relative Humidity for a period of six years, (2007-2012) was obtained from Meteorological Centre, Gombe Area Office. The data was analyzed using Pearson Product Moment Correlation coefficient. The results indicated that there is a strong relationship between rainfall and relative humidity, whereas there are weak correlations amongst rainfall and temperature, rainfall and wind velocity, relative humidity and temperature, relative humidity and wind

velocity. The strong correlation between rainfall and temperature resulted to the excessive rainfall (flooding) witnessed during the period under review. Recommendations are made which include advising farmers to plant crops that are friendly to the emerging seasonal changes across the state; and planting of trees as a means of reducing desertification.

Key words: Desertification, precipitation, resources, energy, crops and rainfall.

INTRODUCTION

Global warming is the increase in the average measured temperature of the earth's near-surface air and oceans since the mid-20th century, and its projected continuation (Wikipedia, 2012). Increasing global temperature is expected to cause sea levels to raise, an increase in the intensity of extreme weather events, and significant changes to the amount and pattern of precipitation, likely including an expanse of the subtropical desert regions, (Sinton, 1995). Other expected effects of global warming include changes in agricultural yields, modifications of trade routes, glacier retreat, mass species extinctions and increases in the ranges of disease vectors (Botkin and Keller, 1997).

Energy development is the ongoing effort to provide sufficient primary energy sources and secondary energy forms to fulfill civilization's needs. It involves both installation of established technologies and research and development to create new energy-related technologies. Major considerations in energy planning include resource depletion, supply production peaks, security of supply, cost, impact on air pollution and water pollution, and whether or not the source is renewable (Wikipedia, 2011).

Technologically advanced societies have become increasingly dependent on external energy sources for transportation, the production of many manufactured

goods, and the delivery of energy services. This energy allows people who can afford the cost to live under otherwise unfavorable climatic conditions through the use of heating, ventilation, and/or air conditioning. Level of use of external energy sources differs across societies, as do the climate, convenience, levels of obesity, traffic congestion, and pollution, production, and greenhouse gas emissions of each society.

Increased levels of human comfort generally induce increased dependence on external energy sources, although the application of energy efficiency and conservation approaches allows a certain degree of mitigation of the dependence. Wise energy use therefore embodies the idea of balancing human comfort with reasonable energy consumption levels by researching and implementing effective and sustainable energy harvesting and utilization measures, (Langa and Ododo, 2011). Greenhouse effect is basically the rise in temperature that the Earth experiences when certain gases from the atmosphere trap energy from the sun. The environment includes the surroundings in which a plant or an animal lives. There is continuous interaction between organisms and their environment. The above translates into what is known as global warming. In Gombe State for instance, it has experience climatic changes ranging from poor agricultural yields, early stoppage of rains, lack of dew, desert encroachment and flooding. In the year 2012, Nigeria was worse heat by flooding in almost all the states if the federation Gombe State inclusive (Thisday, 15th August, 2012). Gombe State witness flooding in Nafada, Kwadon, Kwami, Gombe town, etc in 2012.

The aim of the paper is to study the effects of global warming in relation to weather parameters in Gombe State and to advice farmers on how to mitigate these adverse weather conditions.

Climate change denial

Some people might try to tell you: "Global warming is natural" or "The Earth is actually cooling" or "There's nothing we can do anyway"...

Here is the truth:

- (i) It is true that Earth's climate has always changed, and temperatures risen and fallen over thousands of years. But it is happening now at a far faster rate than ever before, which does not give the world's species (including ourselves) much time to react or adapt.
- (ii) It is true that Earth was in a cooling cycle, slowly heading for another ice age in a few thousand years— but the who can stop this?
- (iii) The burning of fossil fuels has upset that cycle, vastly increasing the greenhouse gases in the atmosphere.
- (iv) The good news is, if we accept that, we are a major

cause of climate change, we can choose to do something about it. But we have to do it soon (www.goodlife.com.ng/reviews_page.php?reviews=read&id=504).

Global warming does not mean we'll all have warmer weather in future. As the planet heats, climate patterns change, with more extreme and unpredicted weather across the world – some places will be hotter, some colder. Some wetter, others drier. We know the planet has warmed by an average of nearly 1°C in the past century. This might not sound much, but small rises can create big problems for people and wildlife.

A rise of just 2°C means that there will be severe storms and floods in some countries, droughts in many more, seas become more acidic, coral and krill die, food chains are destroyed, and finally no Arctic ice in summer – not just bad news for polar bears, it also means global climate warms faster (polar ice deflects sunlight) (www.wwf.org.uk/ClimateChange).

Human activity over the past 150 years, especially by the world's industrialised nations have unwittingly upset the delicate balance of the carbon cycle by burning huge amounts of fossil fuels (concentrated carbon, like coal, oil, gas), as well as breeding vast numbers of methane-producing livestock, and cutting down the forests that naturally absorb CO₂ from the air. The extra carbon in the atmosphere has been raising global temperatures (www.wwf.org.uk/ClimateChange). Man's ability to manipulate the environment has today resulted in several serious problems.

The most serious of these problems, is the environmental pollution. The atmosphere, the hydrosphere and to some extent the lithosphere are the parts of the earth from which all the members of the biosphere obtain their essential requirements. Since, living organisms are in constant interaction with these constituents, any slight change in the composition of the atmosphere, or the hydrosphere or the lithosphere, will have marked influence on the biosphere.

Environmental pollution can be defined as an undesirable change in the physical, chemical and biological characteristics of the environment. Such changes are caused by substances that are introduced into the environment, by human activities (Botkin and Keller, 1997). If such substances have a recognisable adverse effect on the living organisms, they are described as pollutants. Otherwise, they are described as contaminants.

Carbon dioxide (CO₂) is a natural gas, essential for all life on earth. It's absorbed by plants as they grow, and emitted by all life forms when they die (or are burnt as fuel). Other than water vapour, it's the most common 'greenhouse gas'.

Greenhouse gases (GHG) including carbon gases like CO₂ and methane, are vital in the Earth's atmosphere in certain quantities because they help trap and retain some of the sun's heat (the 'greenhouse effect').

This makes life as we know it possible on Earth – without it the world would be mostly frozen. But too much is dangerous. Environmental ethics refers to the responsibility of man to protect and conserve nature. In other words it is "life in harmony with nature". Primitive man exploited nature moderately (Botkin and Keller, 1997). But drastic increase in population forced man to over exploit nature. This led to degradation of environment and imbalance of nature (Langa and Ododo, 2011). Pollution may be defined as an undesirable change in the physical, chemical or biological aspects of environment which makes it harmful for humans, for other living organisms and for cultural assets. It may also be defined as an addition or excessive addition of undesirable materials to the physical environment (water, air and land), making it less fit or unfit for life (Botkin and Keller, 1997).

Basic cause and effect of global warming

Almost 100 % of the observed temperature increase over the last 50 years has been due to the increase in the atmosphere of greenhouse gas concentrations like water vapour, carbon dioxide (CO₂), methane and ozone. Greenhouse gases are those gases that contribute to the greenhouse effect. The largest contributing source of greenhouse gas is the burning of fossil fuels leading to the emission of carbon dioxide. When sunlight reaches Earth's surface some is absorbed and warms the earth and most of the rest is radiated back to the atmosphere at a longer wavelength than the sun light. Some of these longer wavelengths are absorbed by greenhouse gases in the atmosphere before they are lost to space. The absorption of this long wave radiant energy warms the atmosphere. These greenhouse gases act like a mirror and reflect back to the Earth some of the heat energy which would otherwise be lost to space. The reflecting back of heat energy by the atmosphere is called the "greenhouse effect". The major natural greenhouse gases are water vapor, which causes about 36-70% of the greenhouse effect on Earth (not including clouds); carbon dioxide CO₂, which causes 9-26%; methane, which causes 4-9%, and ozone, which causes 3-7 %. It is not possible to state that a certain gas causes a certain percentage of the greenhouse effect, because the influences of the various gases are not additive. Other greenhouse gases include, but are not limited to, nitrous oxide, sulfur hexafluoride, hydro fluorocarbons, per fluorocarbons and chlorofluorocarbons (www.goodlife.com.ng/reviews_page.php?reviews=read&id=504). Greenhouse gases in the atmosphere act like a mirror and reflect back to the Earth a part of the heat radiation, which would otherwise be lost to space. The higher the concentration of green house gases like carbon dioxide in the atmosphere, the more heat energy is being reflected back to the Earth. The emission of

carbon dioxide into the environment mainly from burning of fossil fuels (oil, gas, petrol, kerosene, etc.) has been increased dramatically over the past 50 years. The increase of greenhouse gas concentration (mainly carbon dioxide) led to a substantial warming of the earth and the sea, called global warming. In other words: The increase in the man-made emission of greenhouse gases is the cause for global warming. There are two major effects of global warming:

- i. Increase of temperature on the earth by about 3° to 5° C (5.4° to 9° Fahrenheit) by the year 2100.
- ii. Rise of sea levels by at least 25 meters (82 feet) by the year 2100 (FAO, 1999).

Increasing global temperatures are causing a broad range of changes. Sea levels are rising due to thermal expansion of the ocean, in addition to melting of land ice. Amounts and patterns of precipitation are changing. The total annual power of hurricanes has already increased markedly since 1975 because their average intensity and average duration have increased (in addition, there has been a high correlation of hurricane power with tropical sea-surface temperature).

Changes in temperature and precipitation patterns increase the frequency, duration, and intensity of other extreme weather events, such as floods, droughts, heat waves, and tornadoes. Other effects of global warming include higher or lower agricultural yields, further glacial retreat, reduced summer stream flows, species extinctions. As a further effect of global warming, diseases like malaria are returning into areas where they have been extinguished earlier (Gebelein, 1997). So what we need to do now is to take a positive step to do whatever we can do to keep the earth green.

Global warming

Gases like carbon di oxide, methane, water vapour are called green house gases. The increase in the concentration of these gases in the atmosphere allows radiations of short wave length to escape into space. Solar radiations of long wave length are reflected back to the earth. The consequent increase in the global mean temperature due to green house gases is called global warming, (Wekipedia, 2012). This has led to rise in sea level, has an effect on distribution of species and also brings about drastic changes in weather and climate. In Nigeria, the year 2011 and indeed 2012 witness so much flooding in about 26 states of Nigeria resulting into loss of lives and property. It has so caused the Federal Government Billions of naira to bring relief to the displaced people (Vanguard, 2014).

Gombe State is one of the frontline states bedeviled by desert encroachment and deforestation because of over dependence on fuel wood as a source of energy (Langa

and Ododo, 2011). Forests in the state have disappeared giving rise desert encroachment especially in the northern part of the state. This trend if left unchecked will affect the agricultural products, which will in turn affect the annual income of our teeming farmers and will translate into an economic backwardness in the state.

The efficient use of energy resources available in Nigeria and indeed Gombe State has not been effective. Also, the use of fossil fuels and its consequent effects on our fragile environment have increased the level of concerns shown by environmental scientists in the globe on the need to protect the environment from degradation (Garg and Prakash, 1998). The recent flooding in the country left no one in doubt that we need more awareness on realities of the effects of global warming which is what this paper seeks to achieve.

MATERIALS AND METHODS

Area of study

This research work was carried out in Gombe State. Gombe State is located at the centre of the North-East subregion of Nigeria. The data was specifically collected in Gombe metropolis (GSADP Office) and at Dadin Kowa (Upper Benue River Basin Authority Station). Gombe State, which was created on October 1, 1996, is located in the northeast geo-political zone of Nigeria. It is bounded in the north by Yobe State, in the south by Taraba and Adamawa States, in the east by Borno State and in the west by Bauchi State. It has a population of about 2.1 million people (NPC, 2006) and occupies a total landmass of 20,265 km², State Economic Empowerment and Development Strategy (SEEDS, 2006).

Methodology

A five year daily data of rainfall, temperature, relative humidity and wind speed were collected from Meteorological Centre, Gombe. Thereafter, the averages of these data were computed from which correlations were computed.

Correlation was used in determining the strength of relationship that exist among rainfall, temperature, relative humidity and wind speed for a period of five years (2007-2012). A statistical tool known as Pearson Product Moment Correlation coefficient was used and the results were presented in the tables below.

RESULTS AND DISCUSSION

The results of the correlations are as presented on (Tables 1 to 6). The correlation between rainfall and relative humidity indicated a strong and positive

correlation that shows that the hypothesis is rejected at 1 % level of significance since the least value at which the hypothesis will be rejected is 0.00 and the value of correlation is 0.875. The correlation between rainfall and temperature and that rainfall and wind speed revealed negative and weak relationship; therefore the hypotheses were accepted at 1% level of significance since the least values at which the hypotheses will be rejected were 0.231 and 0.981 respectively.

The hypothesis that there is no significant relationship between rainfall and relative humidity is rejected at 1 % level of significance since the least value at which the hypothesis will be rejected is 0.000 and the value of Correlation is 0.879 and concluded that there is significance relationship between rainfall and relative humidity. On the other hand, the correlation between rainfall and temperature is negative and weak since the least value at which the hypothesis will be rejected is 0.656 and the value of correlation is -0.144.

The correlation between rainfall and relative humidity indicated a strong and positive correlation that shows that the hypothesis is rejected at 1% level of significance since the least value at which the hypothesis will be rejected is 0.000 and the value of correlation is 0.904. The correlation between rainfall and temperature revealed negative and weak relationship, therefore the hypotheses is accepted at 1% level of significance since the least value at which the hypothesis will be rejected is 0.332.

The hypothesis that there is no significant relationship between rainfall and relative humidity was rejected at 1 % level of significance since the least value at which the hypothesis will be rejected is 0.000 and the value of correlation is 0.916 and concluded that there is significance relationship between rainfall and relative humidity. On the other hand, the correlation between rainfall and temperature is negative and weak since the least value at which the hypothesis will be rejected is 0.112 and the value of correlation is -0.483. However, the correlation between rainfall and wind velocity is negative and weak since the value at which the hypothesis will be rejected is 0.222.

The hypothesis that there is no significant relationship between rainfall and relative humidity was rejected at 1 % level of significance since the least value at which the hypothesis will be rejected is 0.000 and the value of correlation is 0.855 and concluded that there is significance relationship between rainfall and relative humidity. On the other hand, the correlation between rainfall and temperature is negative and weak since the least value at which the hypothesis will be rejected is 0.324 and the value of correlation is -0.312. However, the relationship between rainfall and wind velocity is negative and weak correlation since the least value at which the hypothesis will be rejected is 0.921 and the value of the correlation is -0.032.

The correlation between rainfall and relative humidity

Table 1. 2007 Correlations.

Parameter		Rainfall	Relative Hu.	Temp.	Wind Vel.
Rainfall	Pearson Correlation	1	0.875**	-0.374	-0.008
	Sig. (2-tailed)	2	0.000	0.231	0.981
	N	12	12	12	12
Relative Hu.	Pearson Correlation	0.875**	1	-.103	0.008
	Sig. (2-tailed)	0.000	2	.751	0.981
	N	12	12	12	12
Temperature	Pearson Correlation	-0.374	-0.103	1	0.222
	Sig. (2-tailed)	0.231	0.751	2	0.489
	N	12	12	12	12
Wind Vel.	Pearson Correlation	-0.008	0.008	0.222	1
	Sig. (2-tailed)	0.981	0.981	0.489	2
	N	12	12	12	12

**Correlation is significant at the 0.01 level (2-tailed).

Table 2. 2008 Correlations.

Parameter		Rainfall	Relative Hu	Temp.
Rainfall	Pearson Correlation	1	0.879**	-0.144
	Sig. (2-tailed)	2	0.000	0.656
	N	12	12	12
Relative Hu	Pearson Correlation	0.879**	1	-0.046
	Sig. (2-tailed)	0.000	2	0.887
	N	12	12	12
Temperature	Pearson Correlation	-0.144	-0.046	1
	Sig. (2-tailed)	0.656	0.887	2
	N	12	12	12

** Correlation is significant at the 0.01 level (2-tailed).

Table 3. 2009 Correlations.

Parameter		Rainfall	Relative Hu	Temp.
Rainfall	Pearson Correlation	1	0.904**	-0.307
	Sig. (2-tailed)	2	0.000	0.332
	N	12	12	12
Relative Hu.	Pearson Correlation	0.904**	1	-0.222
	Sig. (2-tailed)	0.000	2	0.488
	N	12	12	12
Temperature	Pearson Correlation	-0.307	-0.222	1
	Sig. (2-tailed)	0.332	0.488	2
	N	12	12	12

**Correlation is significant at the 0.01 level (2-tailed).

indicated a strong and positive correlation that shows that the hypothesis is rejected at 1% level of significance since the least value at which the hypothesis will be rejected is 0.003 and the value of correlation is 0.784. The correlation between rainfall and temperature

revealed negative and weak relationship, therefore the hypothesis is accepted at 1% level of significance since the least values at which the hypothesis will be rejected were 0.298 and the value of correlation is -0.328. However, the correlation between rainfall and wind velocity

Table 4. 2010 Correlations.

Parameter		Rainfall	Relative Hu.	Temp.	Wind Vel.
Rainfall	Pearson Correlation	1	0.916**	-0.483	-0.381
	Sig. (2-tailed)	2	0.000	0.112	0.222
	N	12	12	12	12
Relative Hu.	Pearson Correlation	0.916**	1	-0.353	-0.419
	Sig. (2-tailed)	0.000	2	0.261	0.175
	N	12	12	12	12
Temperature	Pearson Correlation	-0.483	-0.353	1	0.523
	Sig. (2-tailed)	0.112	0.261	2	0.081
	N	12	12	12	12
Wind Vel.	Pearson Correlation	-0.381	-0.419	0.523	1
	Sig. (2-tailed)	0.222	0.175	0.081	2
	N	12	12	12	12

**Correlation is significant at the 0.01 level (2-tailed).

Table 5. 2011 Correlations.

Parameter		Rainfall	Relative Hu.	Temp.	Wind Vel.
Rainfall	Pearson Correlation	1	0.855**	-0.312	-0.032
	Sig. (2-tailed)	2	0.000	0.324	0.921
	N	12	12	12	12
Relative Hu.	Pearson Correlation	0.855**	1	-0.179	0.018
	Sig. (2-tailed)	0.000	2	0.577	0.957
	N	12	12	12	12
Temperature	Pearson Correlation	-0.312	-0.179	1	0.510
	Sig. (2-tailed)	0.324	0.577	2	0.090
	N	12	12	12	12
Wind Vel.	Pearson Correlation	-0.032	0.018	0.510	1
	Sig. (2-tailed)	0.921	0.957	0.090	2
	N	12	12	12	12

**Correlation is significant at the 0.01 level (2-tailed).

Table 6. 2012 Correlations.

parameter		Rainfall	Relative Hu.	Temp.	Wind Vel.
Rainfall	Pearson Correlation	1	0.784**	-0.328	0.135
	Sig. (2-tailed)	2	0.003	0.298	0.675
	N	12	12	12	12
Relative Hu.	Pearson Correlation	0.784**	1	-0.075	0.074
	Sig. (2-tailed)	0.003	2	.817	0.820
	N	12	12	12	12
Temperature	Pearson Correlation	-0.328	-0.075	1	0.626*
	Sig. (2-tailed)	0.298	0.817	2	0.029
	N	12	12	12	12
Wind Vel.	Pearson Correlation	0.135	0.074	0.626*	1
	Sig. (2-tailed)	0.675	0.820	0.029	2
	N	12	12	12	12

*Correlation is significant at the 0.05 level (2-tailed).

is positive and weak since the value at which the hypothesis will be rejected is 0.675 and the value of correlation is 0.135.

Steps to reduce global warming

- i. Reduction in emission of green house gases by reduced usage of fossil fuels.
- ii. Increase the vegetation so that carbon di oxide is effectively used for photosynthesis.
- iii. Develop renewable sources of energy like solar energy, wind energy, etc. Ozone is a colourless gas, found in the upper atmosphere (stratosphere) and is highly beneficial. Ozone absorbs the UV radiation from the sun, thereby protecting life on our planet. Ozone layer in the stratosphere is thinning due to the emission of pollutants like aerosol, chloro fluoro carbon (CFC) into the atmosphere. Holes caused in the Ozone layer allow the harmful UV radiation to reach the earth surface. This causes skin cancer, affects the immune system, etc.

Conclusion

It was observed that there is a strong relationship between rainfall and relative humidity, whereas there are weak correlations amongst rainfall and temperature, rainfall and wind velocity, relative humidity and temperature, relative humidity and wind velocity. The strong correlation between rainfall and temperature resulted to the excessive rainfall (flooding) witnessed during the period under review. However, the weak correlations amongst rainfall and temperature, rainfall and wind velocity, relative humidity and temperature, relative humidity and wind velocity resulted into poor condensation that gave rise to drought and poor yield of crops like cowpea, guinea corn, etc.

Recommendations

- (a) Trees should be grown in all available places. The trees use carbon dioxide and release oxygen. This purifies the air for man and animals to breathe. Certain plants (*Phaseolus vulgaris*, *Coleus blumeri*, *Ficus variegata*) can fix carbon monoxide, and some plants (*Pinus*, *Juniperus*, *Quercus*, *Pyrus*, *Vitis*) can metabolise nitrogen oxides. Plantation of such species should be encouraged to depollute the air.
- (b) Good quality fuel (low-sulphur or sulphur-free and lead-free fuel) should be used in motor vehicles. The exhaust gases from motor vehicles may be cleaned by use of a catalyst. These steps can reduce SO₂ pollution.
- (c) Advice farmers to plant crops that are friendly to the emerging seasonal changes across the state; and

- (d) Advice farmers to plant crops that are friendly to the emerging seasonal changes across the state.
- (e) To forecast volume of possible rainfall in future a time series modelling techniques should be employed.

Authors` declaration

We declare that this study is an original research by our research team and we agree to publish it in the Journal.

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