OSUN STATE UNIVERSITY

INAUGURAL LECTURE

SERIES

001

In Search of Climate Justice and Equity

Temi Emmanuel Ologunorisa B.Sc (Ibadan), M.Sc (Jos), PhD (Port Harcourt)
Professor of Climatology and Head
Department of Geography & Resource Management
College of Management and Social Sciences
Osun State University
Okuku Campus, Nigeria

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The Vice-Chancellor
Deputy Vice-Chancellor,
Registrar and other Principal Officers,
Provost, College of Management and Social Sciences,
Provosts of other Colleges,
Deans and Directors,
Members of Senate,
My Lords, Spiritual and Temporal,
Gentlemen of the Press,
My Colleagues in Academics,
Great UNIOSUN Students,
Our Distinguished Guests,
Ladies and Gentlemen.

Introduction

It was Isaac Newton, the great physicist, who once said "If I can see farther than my contemporaries, it is because I am standing on the shoulders of giants". Mr. Vice-Chancellor, Sir, permit me to give tribute to the personalities that God used to shape my career in the field of climatology. About 20 years ago, after my M.Sc. degree in Hydrology and Water Resources, I approached one of my lecturers, Professor Schoeneick, a Polish professor of Hydrology at the University of Jos for advice on what area I should pursue after being offered admission for Ph.D in Hydrology at the University of Lagos, and Ph.D in Climatology at the University of Port Harcourt. Professor Schoeneick then advised that climate was going to be a dominant issue in Nigeria and the world over, not only in the remaining part of the 20th Century, but also in the 21st Century. He therefore reasoned that since Nigeria has a lot of climate problems with fewer climatologists to proffer solution, that it was better to pursue a career in climatology.

This was how I found myself in Port Harcourt University in November 1991 under the supervision of the American trained Meteorologist, Dr. (Mrs) Oreoluwa Salau, and Professor Winston I. Bellgam, one of the leading environmental scientists on Niger Delta environmental

studies. To the glory of God, I completed the Ph.D degree which became not just the first Ph.D in Climatology to be awarded by the University of Port-Harcourt but also by any University in the East of the Niger. Today, by the grace of Almighty God, I stand before you as the first alumnus of the University of Port Harcourt to rise to the exalted rank of Professor of Climatology anywhere in the world. This inaugural lecture is also the first to be delivered in the history of this great University, and the 12th inaugural lecture to be delivered by a Professor of Climatology in any Nigerian University (Thambyahpillay, 1979; Oguntoyinbo, 1982; Ojo, S.O. 1987; Ayoade, 1995; Olaniran, 2002; Adefolalu, 2006; Ojo, O. A., 2007; Bello, 2008; Adebayo, W. 2010; Adebayo, A. 2010).

It is therefore a source of joy that shortly after being appointed as the first Professor in this University in October 2007, I am given this rare opportunity of being "inaugurated". The opportunity therefore affords me the opportunity of addressing the University community and policy makers on one of the hotly debated topical issues that will shape the environmental destiny of this world in the 21st Century. The topic of my lecture therefore, is "In search of climate justice and equity"

Before I move on to my topic, permit me to make one last observation. There are many rich traditions to inaugural lectures. These can be grouped into three major categories (Akinpelu, 1983). The first is that inaugural lectures are used to justify the appointment or promotion of the lecturers concerned to the exalted status of Professor. Such inaugural lectures sound like epilogues to their scholarly careers or like an actor's last piece before bowing out.

The word "inaugural" has a Latin origin which connotes a beginning and an initiation (rather than an end); and hence an inaugural lecture ought, among other things, to mark a fresh beginning of a profoundly deep and mature scholarship and productivity, rather than a termination of same. The second category is that inaugural lectures are used to solicit support for the disciplines or departments to which the lecturers belong; while the third category is that of lectures that are devoted to the systematic exposition of selected contemporary issues on which the expertise and the discipline of the lecturers can shed some light. This is the tradition of the British inaugural lectures. It is this British inaugural tradition that I would like to adopt in this lecture.

Conceptual Clarifications

We will need to define three key terms central to our discussion. They are "Climate", "Justice" and "Equity". The term "climate" can be defined as a synthesis or an amalgam of weather . In other words, it is the mean expectation of weather at a given period over a location or area. It can also be regarded as the statistical abstraction of actual weather experienced in an area over a long period of time. This is why man sees climate as the average weather condition. This notion of climate is not strictly correct. This is because climate includes not only the average weather conditions but also the study of weather extremes and deviations from those average condition and the probability of occurrence or re-occurrence of a particular weather event (Ayoade, 2004). The changeability of weather is a common phenomenon; this is because weather variations occur frequently, often on a timescale of a few hours. Climate variations are not a common occurrence because they occur much less frequently on a timescale of several years or hundreds of years. Climate is a variable phenomenon with variations occurring on varying time scales. And that is why various terms are used to describe variations or fluctuations in climate and these are valid with reference to some appropriate time scales at which the variations or fluctuations are considered.

The terms "climate variability", "climate variations" and "climatic fluctuations" are used to express the inherent variability of climate. Climate is not fixed or static but rather dynamic and changing. Climate trends occur only when fluctuations or variations in climate follow a trend over a period of time. The fluctuation may also be cyclical in nature to give rise to climatic cycles. Over a long period of time, climate fluctuations may be such that a shift in type of climate over a given area occurs, we then say there is a change or climatic change (Ayoade, 2003).

What is justice in a geographical context? As commonly used in geography, justice refers to equity in the spatial distribution of the benefits and burden of society. It is also referred to as territorial justice or spatial justice (Okafor, 2007). According to Knox and Marston (2004), spatial justice refers to "the fairness in the distribution of a society's burden and benefits, taking into account spatial variations in people's needs and in their contribution to the production of wealth …"

Equity refers to fairness. Equity is an ideal that shapes our view of what is right or just. It is predicated on the notion of common good and, at times, calls on some to sacrifice for the sake of others. But the problem is how do we decide what is fair? Within the context of climate change, there are five dimensions of equity. First, equity boils down to an allocation of responsibility. When our interests are harmed, the question of who to blame is usually among the first to arise. In the realm of the environment, the polluter pays principle illustrates this. It requires the party responsible for the harm to bear the costs of repairing it. Secondly, equity is also based on the idea that all humans have equal rights or entitlements to certain goods or benefits. Thirdly, equity relates to the capacity to act. The idea that the most able should contribute the most to the provision of a public good is well established, in most national politics and in the international system. An equitable approach to climate would thus demand more from those most equipped to respond. Fourthly, equity is based on the idea that the strong and well endowed should help the weak and less endowed at least in meeting their most basic needs. Thus, a fair climate change agreement would if possible help, and certainly not undermine, the efforts of the poorest communities to meet the basic needs of their people. Fifthly, in assessing whether an outcome is equitable, parties will invariably compare the effort they are being asked to make and that required of other parties. The five dimensions of equity just described above have focused on equity between people living now. But climate change will restrict the choices of generations to come. Then the question is how can we ensure that our approach to it is also fair to them? Future generations have no responsibility for the problem that is handed to them. They are therefore entitled to a fair share of carbon space.

Climate Justice and Equity

When the United Nations Framework Convention for Climate Change was formulated and then signed and ratified in 1992 by most countries of the world, the principle of common but differentiated responsibilities was acknowledged. The concept of climate justice is based on the above principle. This principle recognises that historically:

- Industrialised nations have emitted far more greenhouse gas emissions than developing nations;

- Rich countries therefore face the biggest responsibilities and burden for action to address climate change.
- Rich countries therefore must support developing nations adapt to avoid the polluting (easier and cheaper) path to development – through financing and technology transfer. This is what constitutes the notion of climate justice and equity in this paper. The principle also recognises that:
    - The largest share of historical and current global emissions of greenhouse gases has originated in developed countries;
    - Per capita emissions in developing countries are still relatively low;
    - The share of global emission originating in developing countries will grow to meet their social and development needs.
    - Rich nations are known as Annex I countries have historically emitted more than the rest of the world combined, even though China, India and others have been growing recently. This is why the "Common but differentiated responsibilities principle was recognised".

It is therefore unfair to expect the third world to make emission reductions to the same level as rich nations, especially considering their development and consumption which is more of basic needs while rich nations have moved on to luxury consumption and associated lifestyle.

Under the Convention, the rich were to help provide means for the developing world to transit to cleaner technologies while developing. The above, and other principles in the convention, formed what some described as the social justice and equity part of climate change issues. Unfortunately, these have been largely ignored in the discussions which are usually dominated by the rich nations, and oil producing countries, who talk more about economic effectiveness.

Climate justice as a concept therefore represents the confluence of different streams of concern with fairness and ethical relations as they relate to people's use of the world's finite carbon resources. A concern for climate justice is built on the fact that the world's poorest, and those least responsible for the human cause of climate change, are the most vulnerable and exposed to its effects. Climate justice advocates insist that equitable climate change strategies should not displace responsibility for carbon emissions upon those least responsible for them.

Climate through the Ages

Although the earth is estimated to be over 4 billion years old, the study of past climate, which is called paleoclimatology, extends only to 500 to 600 million years before present. Table I summarizes the variations in global climate from the pre-Cambrian era to the present. Not much about past climate could be studied during this era. This is because pre-Cambrian rocks hardly contain an evidence of past climate. Instrumental observations of weather began less than 200 years with the invention of the thermometer in 1593 by Galileo and the Mercury barometer in 1643 by Torricelli (Oguntoyinbo, 1982). Our knowledge of past climate dating to pre-instrumental period is therefore based on the imprints of the climate in those periods on the landscape, soil, vegetation and later on, human activities.

Table I: Summary of Paleoclimatic History of the Earth

Era	Period	Age by radio-activity in Million years	Climate
Pre-Cambrian		560	Glacial
Palcozoic	Cambrian	510	Gold, becoming warm
	Ordovician	400	Moderate to warm
	Silurian	340	Warm
	Devonian	310-340	Moderate, becoming warm
	Carboniferous	260-300	Warm at first becoming moderate
	Permian	210-240	Glacial at first becoming moderate
Mesozoic	Triassic	190	Warm and equable
	Jurassic	155	Warm and equable
	Cretaceous	110	Moderate
	Eocene		Moderate becoming warm
	Oligocene	60	Moderate to warm
	Miocene	30	Moderate
	Pliocene	13	Cool
Quaternary	Pleistocene	1	Sequence of glacial and interglacial periods
	Holocene		Present inter-glacial 12,000 to 10,000 years before present and reached climatic optimum about 5,000 years before present mild climatic 800 – 1000 A.D. Little Ice Age 15 – 1700 A.D. Worldwide warming of about 0.60C from 1880's to 1940's. Relative cooling with several trend reversals since then. Warming since 1980's.

Source: (Modified after Brooks, 1949).

The details of these indications of past climates as given by Ayoade (2004) include:

A. Biological Indicators

i. Pollens

ii. Fossils

iii. Tree rings

B. Lithogenetic Indicators

i. Varves

ii. Salt deposits or evaporates

iii. Laterites

C. Morphological Indicators

i. Relic Landforms – old beaches and sand dunes, glacial landforms such as moraines and eskers.

ii. River terraces.

D. Archaeological/Documentary Indicators

i. Artefacts

ii. Cave draining

iii. Evidence of large scale migration

iv. Abandonment of settlements

v. Records of famines

The summary of variations of global climate given in Table I is based on various studies of Paeloclimates in various parts of the world using a variety of indicators of past climate. These studies show that the global climate has oscillated between cold (glacial) and warm (non-glacial) phases since the Pre-Cambrian era. The oscillation according to Ayoade (2003), has been on varying time scales with the larger time-scale ones affecting larger areas of the globe than the smaller time-scale oscillations. Apart from the major ice ages during Pre-~Cambrian 560 million

years ago, there are also the Permian ice age, which occurred 210-240 million years ago, and the Pleistocene ice age, which occurred less than a million year ago. Significant ice ages have occurred every 100,000 years with termination period of 10,000 years. Minor ones have occurred over 20 – 30,000 years (Ayoade, ibid). The last period of extensive glaciations occurred between 22,000 and 14,000 years ago. The period from 7,000 to 5,000 years ago was warmer than the present time. The last 5000 years have been characterized by declining temperatures with very cold intervals some 28,000 and 350 years ago. The latter cold interval between 1550 and 1850 AD has been referred to as the little ice-age. During this period, vineyards disappeared from England and European glaciers grew. It is generally believed that we are at present passing through an interglacial period. Since the advent of instrumental records, data have indicated a warming trend in the Northern Hemisphere from the 1880's to the 1940's and a warming trend in the early 1950s in the Southern Hemisphere. The warming trend in the Northern hemisphere terminated in the 1940s when cooling set in but this cooling has been reversed particularly since the 1970's. The Intergovernmental Panel on Climate Change (IPCC) 2007 report as shown in Fig. I, II and III further confirms the reality of the present global warming.

Evidence of Climatic Change

Episodes of climatic anomaly are both of historical and contemporary interest. Some of the episodes were highlighted by Olaniran (2002). The first one dates back to the biblical time of Noah (about 4000 years ago) when it rained for 40 days and 40 nights with the resulting flood waters reaching 6m level and lasting 150 days. According to biblical account, only Noah, his household and representatives of animals/birds collected by him, survived the prolonged and widespread flooding (Genesis, Chapter 7, Verses 4-20). Oguntoyinbo (1982) also cited the widespread famine of 1887 in Southwestern Nigeria which was called "iyan s'odi dogbun" meaning "a famine which turned the moat into an impassable trench" as well as a similar famine in the same area from 1903-4 which was labelled "Iyan K'ehin S'ara" meaning "a famine which caused man to turn his back on his relations". Ekiti land according to Olaniran (2002) had experienced "Iyan f'owo re mi" which means "famine in which life is saved by cash or cash survival famine".

In recent times, we had the Ogunpa flood disaster in Ibadan known in local parlance as "omi y'ale, agbara ya sobu" meaning that both residential and commercial area are invaded by floodwaters. Perhaps, the worst flood in the history of the city occurred on 31st August, 1980 with property damage at current rate at about N1.5 billion (See Akintola, 1992).

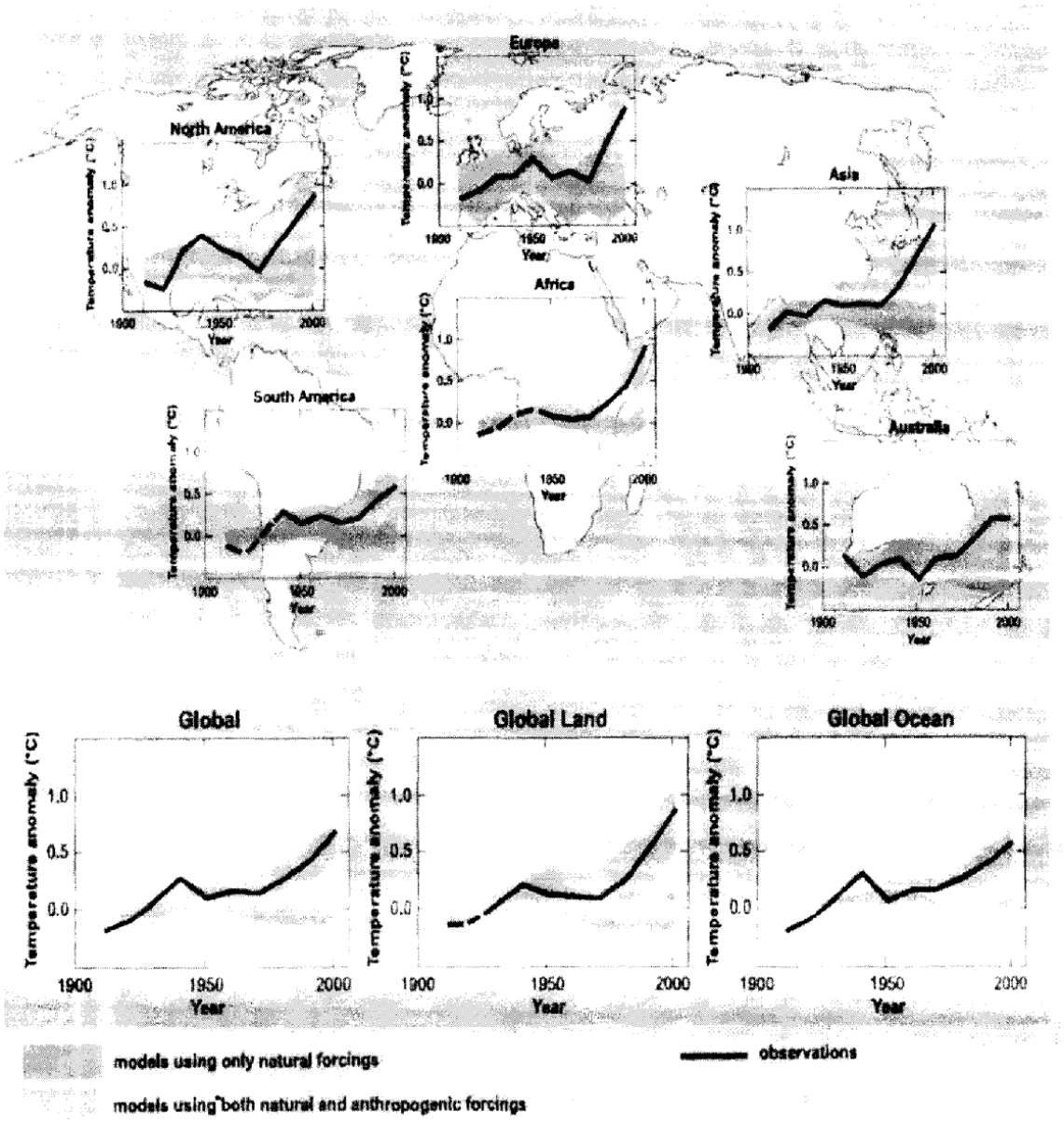

Fig. 1: GLOBAL AND CONTINENTAL TEMPERATURE CHANGE

Source: IPCC, 2007 WorkingGroup 1 Report

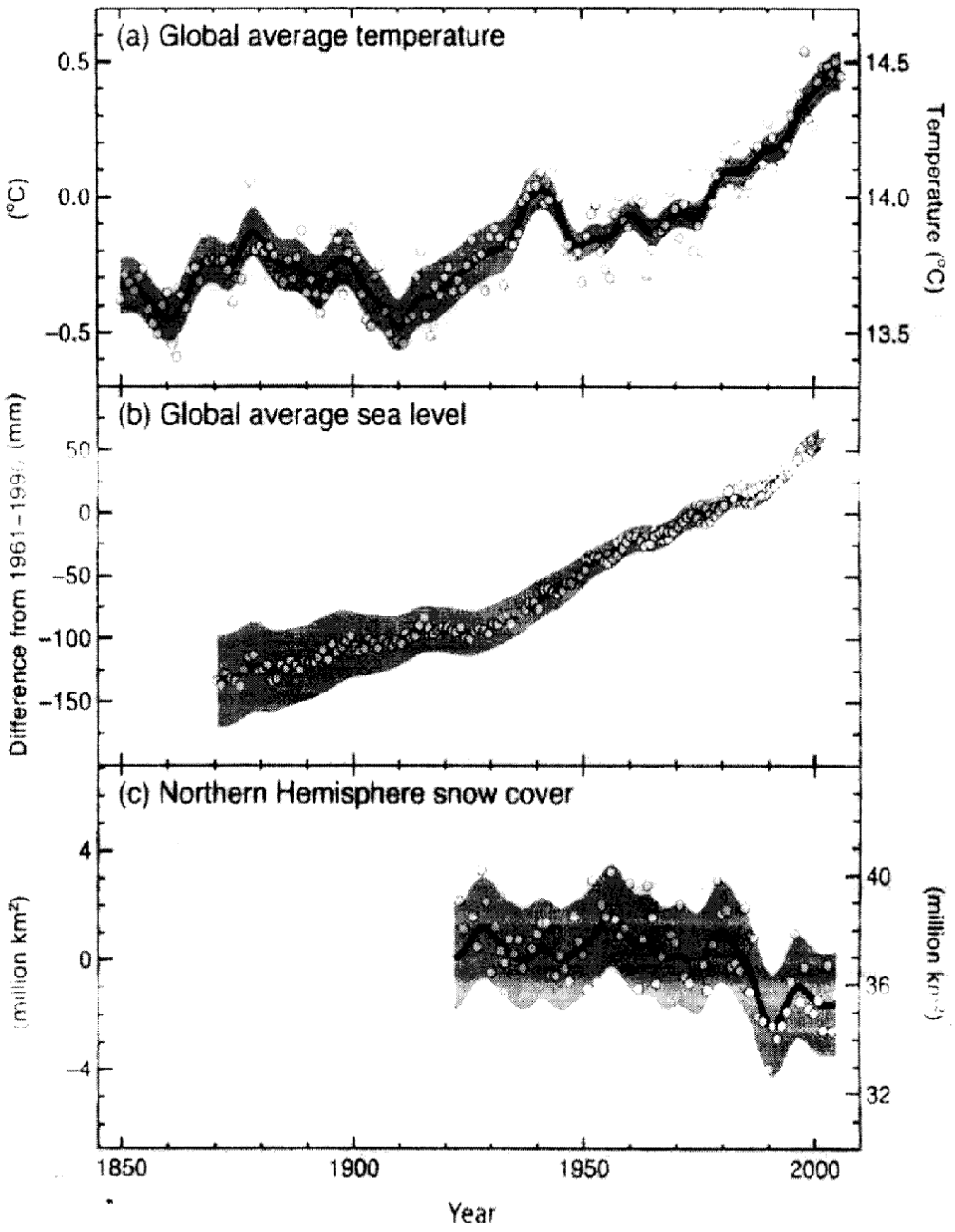

Fig. II: Changes in Temperature, Sea Level and Northern Hemisphere Snow Cover

Source: IPCC, 2007 WorkingGroup I Report

CHANGES IN GREENHOUSE GASES FROM ICE CORE AND MODERN DATA

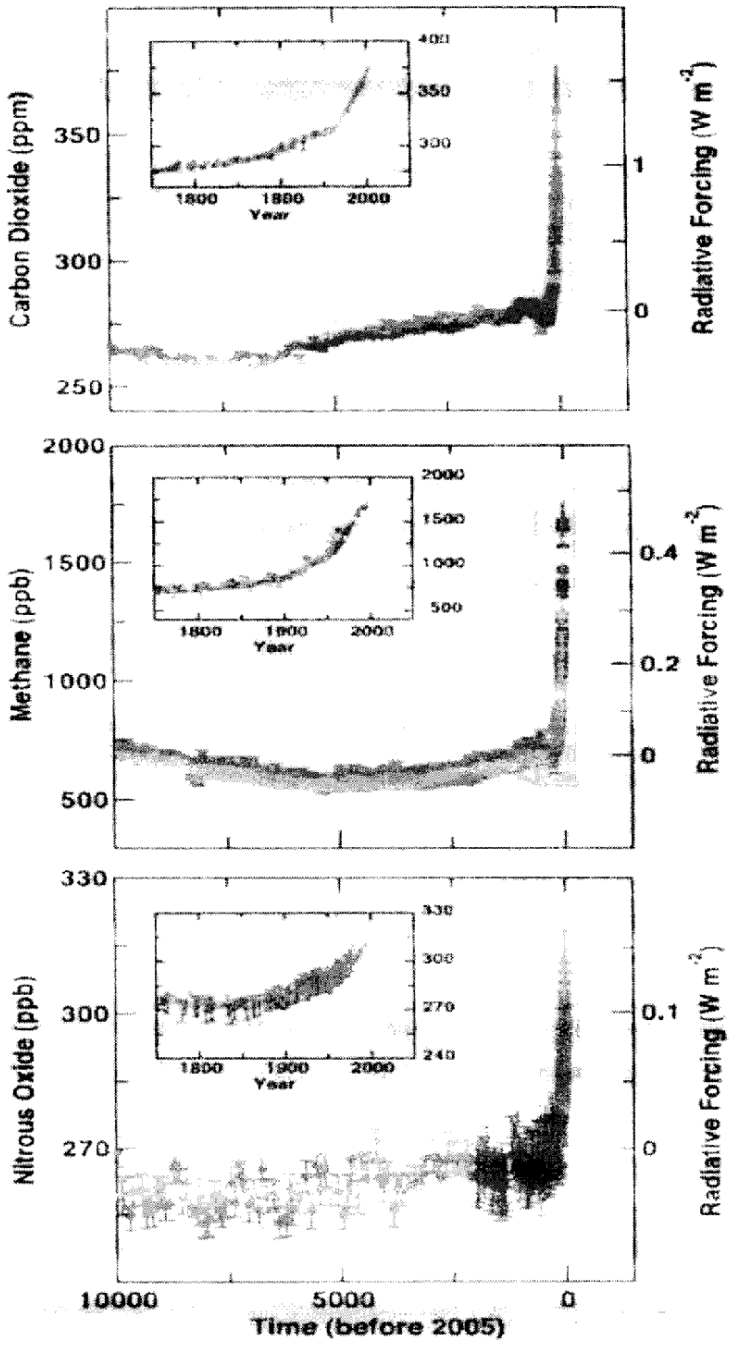

Fig. III: CHANGES IN GREENHOUSE GASES FROM ICE CORE AND MODERN DATA

Source: IPCC, 2007 WorkingGroup 1 Report

TABLE 2: Some Episodes of Rainfall Anomaly in History

S/N	Date	Area Affected	Mode of Occurrence	Remarks	Source
1.	About 400 years ago	Biblical world of that time	40 days and 40 nights of continuous rainfall. The flood waters reached 6m level and lasted 150 days	Only Noah, his household and representatives of animals/birds collected by him survived the widespread flooding	Genesis Chap.7: 4-20
2.	About 3,000 years ago	Egypt	7 years of abundant rainfall followed by seven years of severe drought	During the 7 years of abundance, the land produced plentifully. In the case of the 7 years of widespread famine, there was lack of food over the land.	Genesis Chap. 41: 47-56
3.	Between 974 and 852 B.C.	Samaria	3 years without rainfall	There was widespread shortage of food.	I Kings, Chap 18:1
4.	1887	SW Nigeria	Widespread famine	Iyan S'odi dogbun' (A famine which turned moat into an impassable trench)	Oguntoyinbo (1982) citing historical events reported by Ajayi
5.	1903-4	SW Nigeria	Widespread famine	Iyan K'ehin Sa'ra (a famine which caused man to turn his back on his relations.	Oguntoyinbo (1982) citing historical events reported by Ajayi
6.	1910-4	Hausa Land	Widespread famine	Kakalaba famine	Thambyahillay, 1979
7.	1918	SW Nigeria	Widespread famine	'Iyan lapelape (Lapelape drought during which people trekked from Igboho to Ibadan (150 Km by shortest route to buy food items).	Oguntoyinbo (1982) citing historical events reported by Ajayi
8.	1927	Hausa land Nigeria	Widespread famine caused by drought	Called Yan Buhu	Thambyahillay, 1979.
9.	1942	Hausa Land Nigeria	Widespread famine caused by drought	Called Yar Gusau	-do-
10.	1941-44	Ekiti Land, Nigeria	Widespread drought	Called Iyan f'owo re mi i.e. famine in which life is saved with cash	Adefolalu (personal communication)
11.	1945-6	SW Nigeria	Widespread famine	'Iyan Abbatial'	Oguntoyinbo (1982) citing historical events reported by

					Ajayi
12.	Oct. 19, 1976	Ilorin, Nigeria	One week of heavy rainfall from 14-19 October	24 houses submerged by water and 50 others evacuated.	Olaniran (1983).
13.	Aug. 30, 1979	Ilorin, Nigeria	Caused by two prolonged heavy rainfalls on 27th and 29th in the month of August which was characterised by moisture surplus.	One house and two cars were submerged while many houses built on banks of river ASAP were temporarily abandoned	-do-
14.	Aug. 31 1980	Ibadan, Nigeria	Floods are called 'omiyale, agbara ya sobu' in local parlance. This particular event was caused by prolonged and high intensity rainfall 273 mm in magnitude, the highest daily rainfall ever received in a century	300 lives were lost while property damage was estimated at N1.5 million (about 1.5 billion now).	Akintola (1992)

Source: Olaniran, 2002

Climate Change Debate

Three different positions can be distinguished. First, there are the climate change sceptics who claim the case that present day processes of global warming are produced by human activity is not proven. Fluctuations in climate, they point out, produced by natural causes, have been constant features of world history. The current situation, they assert, is not different. Other sceptics accept that climate change is happening and that it is humanly induced, but argue that the threat it poses has been exaggerated. For them, other world problems such as poverty, AIDS or the possible spread of nuclear weapons are both more worrying and present more pressing dangers than climate change. The sceptics have dwindled significantly in numbers in recent years as the science of climate change has progressed, but they still get a significant hearing (Giddens, 2008).

Second, there is a mainstream view about climate change. The IPCC has had an enormous influence over world thinking on climate change in so far as there is a consensus about its extent and dangers; it has played a large part in building it. Those who are sceptical about

climate change see the IPCC as the enemy of free and proper scientific thinking. The battle between the sceptics and the body of scientific opinion continues, with each tending to rubbish the other's argument.

Third, there is a further divergence of opinion between the mainstream and authors and researchers who think climate change poses event greater and more urgent threats than is ordinarily acknowledged. These are the "radicals". They argue that there are threshold effects in climate change, as the naturally-induced climatic fluctuations we know about from the past reveal. Abrupt changes in climate have happened in previous ages, even within as short a period as 10 years. The radicals hold that the same could be true of humanly induced climate change today. Some radicals believe it is already too late to avoid dangerous climate change. They argue that it is better to concentrate most of our energies preparing to adapt to it and cope as best we can. Others think we can still hold back the more devastating effects but to do so we must start taking far reaching action in the here-and-now.

Climate System

In order to understand why climate varies, we need to understand the mechanisms that give rise to climate. Climate depends on the nature of the general circulation of the global climatic system. The global climatic system consists of five physical components: the atmosphere (air), the hydrosphere (water), the biosphere (living organisms), the lithosphere (land) and the cyosphere (ice and snow) interacting with one another under the influence of solar energy. It is observed that the climatic state of a place at any given period is determined by three crucial factors; these are:

(i) The amount of solar energy received by the climatic system, which depends on the solar output, the extent of radiation losses in space before the earth's atmosphere, the distance of the earth from the sun and the angle of tilt of the earth's axis of rotation.

(ii) The way this energy is distributed and absorbed over the earth's surface, which depends on the earth's atmospheric composition, its topography, extent of ice and snow cover and the distribution of continents and oceans.

(iii)The nature of the interaction processes between the components making up the global climatic system.

The Role of Man in Climate Change

All the theories of climatic change attempt to account for variations in the amount of solar energy received by the earth and the spatial and temporal distribution of this energy over time. In the last few decades, research findings have indicated that man can influence climate through various activities. The causes of climatic variation ascribed to human activities are:

(i) Increase in the CO_2 content of the atmosphere as a result of bush burning, and burning of fossil fuels such as coal, gas, oil;

(ii) Artificial generation of heat as a result of human activities especially in urban areas;

(iii) Interference with the ozone layer by pollution deriving from human activities;

(iv) Alteration in the earth's albedo as a result of deforestation, land clearing for cultivation or construction and animal grazing.

The most important pollutants as far as climate modification is concerned are CO_2, fluorocarbons, sulphur compounds and dust (aerosols).

Major Greenhouse Gases and Their Contributions to Global Warming

The major greenhouse gases produced by human activities are CO2, methane, nitrous oxides and chlorofluorocarbons (CFCS). Emissions of greenhouse gases ranked by country are shown in Table 3.

Table 3: Greenhouse Gasses Ranked by Country in 1987

Country	Greenhouse Index Rank	CO2	CH4	CFCs	Total	Total%
United States	1	540,000	130,000	350,000	1,020,000	17.6
USSR	2	450,000	60,000	180,000	690,000	12.0
Brazil	3	560,000	28,000	16,000	600,000	10.5
China	4	260,000	90,000	32,000	380,000	6.6
India	5	130,000	98,000	700	230,000	3.9
Japan	6	110,000	12,000	100,000	220,000	3.9
Germany, Fed. Rep.	7	79,000	8,000	75,000	160,000	2.8
United Kingdom	8	69,000	14,000	71,000	150,000	2.7
Indonesia	9	110,000	19,000	9,500	140,000	2.4
France	10	41,000	13,000	69,000	120,000	2.1
Italy	11	45,000	5,800	71,000	120,000	2.1
Canada	12	48,000	33,000	36,000	120,000	2.1
Mexico	13	49,000	20,000	9100	78000	1.4
Nyanmar	14	68,000	9,000	0	77,000	1.3
Ireland	15	56,000	6,400	13,000	76,000	1.3
Spain	16	21,000	42,000	48,000	73,000	1.3
Columbia	17	60,000	4,100	52,000	69,000	1.2
Thailand	18	48,000	16,000	3,500	67,000	1.2
Australia	19	28,000	14,000	21,000	63,000	1.1
German Dem. Rep.	20	39,000	2,100	20,000	61,000	1.1
Nigeria	21	32,000	3,100	18,000	53,000	0.9
South Africa	22	34,000	7,800	5,800	48,000	0.8
Cote d'Ivoire	23	44,000	550	2,000	47,000	0.8
Netherlands	24	16,000	8,800	18,000	43,000	0.7
Saudi Arabia	25	20,000	15,000	6,600	42,000	0.7
Philippines	26	34,000	6,700	0	41,000	0.7
Las Perples Dam. Dep.	27	37,000	1,000	0	38,000	0.7
Vietnam	28	28,000	10,000	0	38,000	0.7
Czechoslovakia	29	29,000	2,200	2,700	34,000	0.6
Iran	30	17,000	6,400	9,000	32,000	0.6
Argentina	31	13,000	12,000	5,500	31,000	0.5

Korea Rep.	32	21,000	2,900	5,400	29,000	0.5
Turkey	33	16,000	3,600	9,200	29,000	0.5
Romania	34	25,000	3,100	0	28,000	0.5
Venezuela	35	19,000	4,700	3,200	27,000	0.5
Yugoslavia	36	15,000	2,800	8,200	26,000	0.4
Malaysia	37	22,000	1,400	8,500	26,000	0.4
Belgium	38	12,000	1,200	12,000	25,000	0.4
Algeria	39	8,400	12,000	4,100	25,000	0.4
Peru	40	22,000	870	0	23,000	0.4
Bangladesh	41	2,300	20,000	0	22,000	0.4
Ecuador	42	19,000	570	1,700	21,000	0.4
Greece	43	7,000	1,100	12,000	20,000	0.4
Korea Dem. Rep.	44	18,000	2,300	0	20,000	0.4
Portugal	45	3,700	1,000	13,000	18,000	0.3
Egypt	46	9,000	3,100	5,100	17,000	0.3
Bulgaria	47	15,000	660	1,600	17,000	0.3
Austria	48	6,500	960	9,100	17,000	0.3
Zaire	49	16,000	990	0	17,000	0.3
Cameroon	50	16,000	580	0	17,000	0.3
Total (rounded)		3,390,000	720,000	1,280,000	5,390,000	

Source: (Commoner, 1991)

Table 4: Major Greenhouse Gases and their Contributions

Co_2	55%
Chlorofluorocarbons (CFCs)	24%
Methane	15%
Nitrous Oxide	6%

Chlorofluorocarbons also contribute to the depletion of ozone in the stratosphere. Over 80% of global warming is due to Co_2 and CFCs (See Table 4). Carbon dioxide is produced mainly by activities involving the burning of fossil fuels like coal and oil. Hence, vehicular emissions and emissions from industrial establishments and thermal power stations are the major man-made sources of Co_2 found the atmosphere.

Table 5: Greenhouse Gas Emission by Country in 2007

Country	Change in greenhouse gas emissions (1992 – 2007)	2007 Per-Capita CO2 Emissions (Metric Tonnes Per Person)	Share of 2007 Worldwide CO2 Emissions
World Total	39.22%	4.52	100.0%
China	154.42%	4.75	21.01%
USA	18.41%	19.94	20.08%
Russian	-17.41%	11.83	5.59%
India	110.99%	1.25	4.68%
Japan	17.13%	9.91	4.22%
Germany	21.62%	10.13	2.79%
Canada	75.34%	17.91	1.97%
UK	-2.62%	9.28	1.89%
South Korea	75.34%	10.69	1.72%
Iran	108.83%	7.5	1.64%
Italy	10.9%	7.92	1.54%
Australia	67.8%	21.99	1.53%
Mexico	44.48%	4.17	1.51%
South Africa	40.11%	9.35	1.51%
Saudi Arabia	84.29%	15.73	1.45%
France	5.84%	6.36	1.35%
Brazil	67.22%	2.05	1.33%
Spain	50.8%	9.47	1.28%
Ukraine	-33.8%	7.65	1.18%
Indonesia	76.38%	1.36	1.06%
Taiwan	133.01%	13.47	1.03%

Poland	-8.71%	7.83	1.01%
Turkey	99.86%	3.71	0.93%
Netherlands	22.69%	15.78	0.87%
Thailand	145.82%	3.81	0.83%
Kazakhstan	-18.26%	14.16	0.72%
Venezuela	53.65%	6.6	0.57%
UAE	67.49%	38.46	0.57%
Argentina	50.91%	4.14	0.55%
Egypt	70.34%	2.11	0.53%
Malaysia	116.3%	6.35	0.53%
Singapore	126.35%	33.86	0.52%
Belgium	15.59%	13.87	0.48%
Pakistan	97.02%	0.82	0.46%
Uzbekistan	27.52%	4.52	0.41%
Greece	35.02%	10.07	0.36%
Nigeria	9.97%	0.72	0.35%
Romania	-20.83%	4.63	0.34%
Algeria	22.99%	3.03	0.34%
Remaining Countries	31.29%	1.68	9.24%

(Source: United Nations, 2007)

Table 5 shows the reduction in the human made emissions of greenhouse gases required to stabilise atmospheric concentration. The emission of greenhouse gasses in Nigeria is shown in Table 6. Table 7 shows emission of greenhouse by sector in Nigeria and Table 8 shows the emission of greenhouse gas emission by state. Methane (CH4) is the main component of natural gas. It can be seen over marshy area where organic matter is decomposing. Hence, methane is often referred to as marsh gas. Natural sources of Methane include wetlands, termites and the oceans. Anthropogenic sources of Methane include coal mining activities, natural gas and petroleum industry, rice paddies, animal wastes, domestic sewage treatment plants, landfills and biomass burning.

The current levels of methane in the atmosphere are about 1.72 ppm compared to the pre-industrial levels (1750 to 1800 AD) of about 0.8 ppm. The levels are increasing at a rate of 0.9% per annum. It should be stated that although CH_4 levels are low compare to those of Co_2, methane is three times as effective as Co_2 as a greenhouse gas. Methane's residence time in the atmosphere is relatively short. It is approximately 12 years.

Nitrous Oxide (N_2O) is produced naturally by process of nitrification in oceans and soils. The major anthropogenic sources of nitrous oxide are chemical industries, denitrification of fertilizers used.

Table 6: Stabilization of Atmosphere Concentrations: Reduction in Human Made Emissions of Greenhouse Gases Required to Stabilize Concentrations at Present Levels

Greenhouse Gases	**Reduction Required**
Carbon Dioxide	>60%
Methane	15-20%
Nitrous Oxide	70-80%
CFC-11	70-75%
CFC-12	75-85%
11CFC – 22	40-50%
Source: IPCC 1990	

Table 7: Emission of Greenhouse Gases in Nigeria, 1988

S/N	**Sources**	**Emissions in Gigagrams**		
		Co_2	CH_4	N_20
1.	Fossil Fuel combustion	35672.224	5.036	0.915
2.	Industrial Process	1874.167	0.000	0.000
3.	Oil and gas systems	34625.893	115.936	0.84
4.	Biomass burning	0.000	0.28	0.84
5.	Land-use changes	0.000	48.414	4.834
6.	Savannah burning	0.000	69.711	0.932
7.	Agricultural wastes	0.000	47.238	1.555
8.	Rice Production	0.000	19.110	0.000
9.	Ruminants	0.000	364.800	0.000
10.	Non-ruminants	0.000	39.210	0.000
11.	Animal wastes	0.000	83.603	0.000
12.	Municipal solid wastes	0.000	187.251	0.032

13.	Agricultural solids	0.000	0.000	0.000
14.	Natural	1038.958	66.225	0.000
15.	Coal Mining	0.000	0.480	0.000

Source: (Adapted from Magbagbeola, 1999)

Table 8: Emissions of Greenhouse Gases by Sector, 1988

S/N	Sources	Emissions in Gigagrams		
		Co_2	CH_4	N_20
1.	Households	3991.77	154.35	2.56
2.	Agricultural/Forestry	0.30	672.09	2.56
3.	Service	45.73	0.01	000
4.	Industry	10689.43	33.24	0.37
5.	Transportation	14558.81	4.09	02.0
6.	Energy Conversion	34635.36	116.36	0.38
7.	Primary Energy Conversion	34635.36	116.36	0.38
8.	Natural Resources	1038.96	66.23	0.000

Source: (Adapted from Magbagbeola, 1999)

Table 9: Greenhouse Gas Emissions by State, 1988

S/N	Sources	Emissions in Gigagrams				
		Co_2	**CH_4**	**N_20**	**Total Emissions**	**% of Nigeria's Total Emissions**
1.	Abia	9.13	4.17	0.01	13.31	0.2
2.	Akwa Ibom	5733.60	23.30	0.33	5766.23	10.16
3.	Anambra (1988)	1277.04	53.36	0.38	1330.68	2.34
4.	Bauchi-Gombe	856.72	60.53	0.39	4284.13	7.55
5.	Edo-Delta	4282.89	0.71	0.53	4284.13	1.62
6.	Benue (1988)	473.07	25.87	0.30	499.24	0.88
7.	Bornu-Yobe	609.22	126.40	0.81	736.43	1.30
8.	Cross River	599.08	18.18	0.22	618.13	1.09
9.	Adamawa-Taraba	456.08	78.96	0.35	535.40	0.94
10.	Imo (1988)	3275.17	23.96	0.42	3299.55	5.81
11.	Kaduna	1367.07	35.45	0.29	1402.81	2.47
12.	Katsina	133.96	24.41	0.28	158.65	0.28

13.	Kano-Jigawa	1226.13	38.29	0.66	1265.08	2.23
14.	Kwara (1988)	931.04	57.77	0.21	989.02	1.74
15.	Lagos	8271.68	24.66	0.56	8296.93	14.62
16.	Niger (1988)	444.71	57.87	0.21	502.70	0.98
17.	Ogun	1296.90	14.15	0.22	1311.27	2.31
18.	Ondo-Ekiti	635.22	26.48	0.32	662.02	1.07
19.	Oyo-Ogun	1848.37	40.18	0.52	1889.07	3.33
20.	Plateau-Nassarawa	964.47	46.09	0.25	1010.81	1.78
21.	Rivers-Bayelsa	20457.7	83.28	0.59	20.541.57	36.18
22.	Sokoto-Kebbi-Zamfara	634.21	95.00	0.72	729.93	1.29
	Sum of States	**55,786.11**	**971.98**	**10.51**	**56,786.60**	**100.00**

Source: (Adapted from Magbagbeola, 1999)

Impact of Climate Change

Variations in climate will no doubt have planning implications. Appropriate long term planning must be put in place to enable man live successfully within the limit of his variable climatic resources. Ayoade (2004) illustrated this scenario with a few examples. He argued that if there is cooling on a large scale, decreased agricultural length of the growing season would result. Similarly, there would be increased space heating and consequently greater demands in power generation activities. New strains of crops and animals may need to be developed to withstand the harsher climatic conditions. Cooling will also affect precipitation adversely particularly in the tropics since the monsoons tend to fail when there is cooling. Prolonged and intense cooling may lead to fall in the level of rainfall because moisture withdrawn from the sea is not returned but locked up as ice on the land. Polar port cities may become hinterland cities as the sea retreats. On the other hand, global warming may result in coastlands. The growing season in temperate region will increase with possible increase in agricultural yields because of relatively short growing season. In the tropics, warming may not be beneficial as this would mean higher rates of evapotranspiration with attendant problems of meeting crop water demands especially in the savanna areas. Warming may however encourage more convectional storm giving rainfall while the destructive capacity of tropical storms may also increase as well as their frequency.

From the foregoing, it can be deduced that climatic variations can influence human affairs in several ways including the survival of man and his socio-economic structures. There is need for man to be keenly interested in the problems of climatic variations especially their causes and mechanisms. More so as some human activities have the potential of influencing global

climate. An increase in global mean temperature of 0.2 to 0.5^{o}C per decade or an earth warming of 2^{0}C to 5^{0}C is accompanied by a sea level rise of 3 to 10 cm per decade before the end of the next century is predicted. Although the extent of the impacts of the global environmental change on individual country is still subject to speculation, there is a consensus that the effects on some areas may be catastrophic.

Table 10 shows the projected climate change for five world's regions. The table shows that rainfall decrease would be experienced in the Sahel, Southern Europe and Austrlia; while Central and North America, South Asia, West Africa and parts of Australia would have increased rainfall. For example, in 1990, the Inter-governmental Panel on Climate Change's (IPCC) assessment of impacts identified some regions "at risk" from climate change, based on a current assessment of "vulnerable" regions (mostly dry lands) and preliminary climate model projections of regional reductions in soil moisture. As can be seen from Table 11, Magreb, West Africa, Horn of Africa and Sothern Africa are among the areas identified as regions "at risk" from climate change. The immediate impact of global warming is likely to result in further fluctuations in rainfall patterns. It is predicted that global warming will make dry areas drier and wet areas better. The expected sea level rise may also spell danger to many countries such as Nigeria, Mozambique, Kenya, Gambia and Egypt. Thus, global environmental change is another factor that may well add to the deteriorating food production problem in Africa.

Table 10: Projected Climate Change for Five of the World's Regions

Regions	Temperature Increase	Rainfall Change
Sahel (10-2^{o}0N.20-50^{o}E)	Warmer by 1-30^{o}C	Decrease by 6-10%
S/Europe (35-50^{o}N, 10^{o}N-45^{o})E)	Warmer by 22^{o}C	Decrease by 5-10%
C/N/America (35-50^{o}N, 85^{o}-105^{o}N)	Warmer by 2-3^{o}C (Summer)	Slight increase 2% (Winter)
Southern Asia (5-30^{o}N) (70-105^{o}N)	Warmer by 2-3^{o}C (Summer)	0-15% increase (Winter)
Australia (12-45^{o}S) (110-115^{o}E)	Warmer by 1-2^{o}C Year round)	5-10% decrease (Summer)
West Africa (4-10^{o}N) (17^{o}N – 15^{o}E)	Warmer by 1-3^{o}C (Year round)	0-15% increase (summer)

Source: Metro-France, National Meteorological Research Centre (Based on IPCC Working Group 1, 1990 Report) in Fall (1977). Smith, 1994).

Table 11: Region "at Risk" from Climatic Change

Continent	Specific Region
Africa	Maghreb, West Africa, Horn of Africa Southern Africa
Asia	Western Arabia
North and Central America	Mexico and Central America
South America	Parts of Eastern Brazil

Source: IPCC Working Group 2, 1990 (Cited in Kates and Chen 1993)

The number of African countries currently affected by drought is estimated to be thirty six. While twenty one of these countries are located in the Sudan-Sahelian region, ten are located in the Kalahari Desert area, and more importantly is that nineteen of these countries belong to the category of the least developed countries in the world.

Table 12: Physical Effects and Natural System Projection to 21st Century in the Niger Delta

S/N		Currently no ASLR	ASIR I 0.3 M	ASIR II (1.0M)

1.	Erosion (in 1 year)	10 -15	16 – 19	20 -25
2.	Erosion Area lost (Km^2)	26 – 45	55 – 120	130 330
3.	Inundation and erosion (Km^2)	3,000	7,000	15,000
4.	% of total area lost due to inundation and erosion (%)	15	35	75
5.	Natural system responses (i) agriculture (7.940 Km^2) (Km^2)	794	2,779	5,955
6.	Number of villages impacted (no)	50	200	350
7.	Number of people displaced (no)	150,000	1-2m	2-3m

Note: **ASIR = accelerated sea-level rise**

Source: **Awosika et al (1994)**

Table 13: Land Loss Projection to 21st Century along the Coast of Senegal

Sea-Level Rise (m)	Erosion	Inundation	Total
0.2	11 – 18	338	349 – 349
0.5	28 – 44	1.919	1,947 – 1,963
1.0	55 – 86	5,987	6,092 – 6,073
2.0	105 – 157	6,389	6,494 – 6,546

Source: Niang et al (1992)

It is estimated that towards the end of the 21st century, projected sea-level rise will affect low-lying coastal areas with large populations (see Table 12). Mangroves and coastal reefs are projected to be further degraded, with additional consequences for fisheries and tourism. Also, excessive rainfall with high flow risk in coastal areas. The land loss projection to 21st Century along the coast of Senegal is shown in Table 13.

Projected Impact of Climate Change in Africa

The IPCC 2007 predicted that by 2020, between 75 million and 250 million people are projected to be exposed to increased water stress due to climate change. If coupled with increased demands, this will adversely affect livelihoods and exacerbate water-related problems.

- The area suitable for agriculture, the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas, are expected to decrease. This would further adversely affect food security and exacerbate malnutrition in the Continent.
- In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020.
- Local food supplies are projected to be negatively affected by decreasing fisheries resources in large lakes due to rising water temperatures, which may be exacerbated by continued over-fishing.
- Towards the end of the 21st Century, projected sea-level rise will affect low-lying coastal areas with large population. The cost of adaptation could amount to at least 2-10% Gross Domestic Product (GDP).
- Mangroves and coral reefs are projected to be further degraded, with additional consequences for fisheries and tourism.

Health

- Projected climate change-related exposures are likely to affect the health status of millions of people, particularly those with low adaptative capacity, through:
    - Increases in malnutrition and consequent disorders, with implications for child growth and development;
    - Increases in malnutrition and consequent disorders, with implications for child growth and development;
    - Increased deaths, disease and injury due to heat waves floods, storms, fires, and droughts;
    - The increased frequency of Cardio-respiratory diseases due to higher concentrations of ground level ozone related to climate change; and
    - The altered spatial distribution of some infection disease vectors

Coastal Systems and Low lying Areas

- Coasts are projected to be exposed to increasing risks including coastal erosion, due to climate change and sea-level rise. The effect will be exacerbated by increasing human-induced pressures on coastal areas.
- Increase frequency of coral bleaching events and widespread mortality.
- Coastal wetlands including salt marshes and mangroves are projected to be negatively affected by sea-level rise especially when they are constrained on their landward side, or starved of sediments.
- Many million more people are projected to be flooded every year due to sea-level rise by the 2080s.
- The numbers affected will be largest in the Mega-Deltas of Asia and Africa while small islands are especially vulnerable.

Ecosystems

- The resistance of many ecosystems is likely to be exceeded thus century by an unprecedented combination of climate change associated disturbance (e.g. flooding, drought, wildfire, insects, ocean acidification) and other global change drivers (e.g. land use change, pollution, over-exploration of resources).
- Approximately 20-30% of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5-2.5^{o}C.
- The progressive acidification of oceans due to increasing atmospheric carbon dioxide is expected to have negative impacts on marine shell forming organisms (e.g. corals) and their dependent species.

Security Challenges

Climate change will lead to pressure on food and livelihood. This would lead to populist and/or military coups in a number of countries. This will produce continuing instability in Africa, in particular. Between 1980 and 2001, there were 95 attempted coups in Africa, 33 per cent of them successful (Brown, Hamill and Mcleman, 2007). Popular discontent over livelihood security was a contributing cause of many of these. It may even lead to a succession of new wars – for example, a June 2007 report by the United Nations Environment Programme (UNEP) suggested that the conflict in Darfur has in part been driven by climate change and environmental degradation. Over the past 40 years, rainfall in the region has fallen by 30 per cent and the Sahara has advanced by more than a mile every year. The resulting tension between farmers and herders over disappearing pasture and declining water-holes underpins the genesis of the Darfur conflict. It also threatens to reignite the half-century-long war between North and South Sudan, currently suspended by a fragile 2005 peace accord. The Southern Nuba tribe, for example, have warned that they could "restart" the war if Arab nomads displaced South by the drought continue to cut down "their" trees for fodder to feed their camels. (Brown, Hamill and Mcleman, 2007).

Who is most Vulnerable?

Although climate change is a global problem, studies have shown that some countries have a greater degree of vulnerability to the impact of climate change than others (IPCC 2007).

- Countries within the tropics are likely to experience more incidences of tropical storms caused by climate change.
- Also, countries with significant lengths of coastline will be more threatened by sea-level rises induced by climate change.
- Countries with poorly developed infrastructure, insufficient public health systems, and/or low levels of emergency preparedness will experience more negative impacts of climate change.
- Countries whose economies and livelihood have a greater sensitivity to climate-related events such as rainfall, wind, (etc.) will be more affected.

Vulnerability Assessment of Nigeria to Climate Change

It has been observed that global climate change will have a strong impact on Nigeria – particularly in areas of agriculture, land use, energy, biodiversity, health and water resources.

Nigeria and all the countries in sub-Saharan Africa, are highly vulnerable to the impacts of climate change (see IPCC Report, 2007).

NEST (2006) noted that Nigeria specifically ought to be concerned by climate change because:

(i) of the country's high vulnerability due to its long (800km) coastline that is prone to sea-level rise and the risk of fierce storm).

(ii) Almost 2/3 of Nigeria's land cover is prone to drought and desertification.

(iii) Its water resources are under threat which will affect energy sources (Kainji and Shiroro).

(iv) Rain-fed agriculture and fishing activities from which 2/3 of the Nigerian population depend primarily on for food are under serious threat.

(v) Nigeria has a very high population pressure – 140 million people surviving on the physical environment through various activities within an area of 923,000 square kilometres.

(vi) Nigeria lacks the financial capacity and technological know-how to combat the postulated negative impacts of climate change.

(vii) Nigeria does not yet have a fully established institutional and legal framework, nor systematic approaches and policies targeted at combating, mitigating and adapting to the impacts of climatic change.

Studies have also shown that a sea-level rise of just 0.2m as a result of climate change could flood over 3,400km2 of the country's coast land. Nigeria may lose close to 9 billion as a result of such a disaster while at least 80% of the inhabitants of the Niger Delta will be displaced.

Also, more than 2/3 of Nigeria is prone to desertification. Climate change is predicted to worsen the incidence of drought and desertification and millions of people will be turned into refuges because of disaster. States such as Borno, Sokoto, Jigawa, Zamfara, Kebbi, Yobe, Kaduna, Kano, Bauchi, Adamawa, Niger and others are at risk.

Over 80% of farmers who engaged in agriculture which is rain-fed will be affected. Our agricultural production system will be adversely affected by the variability in timing and amount of rainfall, frequent outbreaks of crop pests and diseases and heat stress. Food shortages will increase and many farmers could lose their sources of livelihood due to climate change.

From the above, it is clear that Nigeria's long term development priority of vision 2020, poverty reduction, the Millennium Development Goals and Seven Point Agenda will be severely constrained if sufficient attention is not paid to the current and future impact of climate change in Nigeria.

Contributions to the Understanding of Climatic Events and Climatic Change Induced Hazards in Nigeria

At this juncture, Mr. Vice-Chancellor, I propose to give a resume of our contributions to the understanding of climate change induced hazards in Nigeria. I have worked and published extensively in the area of climatic and meteorological hazards, their analyses and prediction. My pioneering work in Nigeria (with T.T.T. Tamuno of the Niger Delta Universiry, Amassoma, Bayelsa State, Nigeria) in the area of Sandstorms in the Sudano-Sahelian region of Nigeria provide a building block for the control and monitoring of desertification in Nigeria. Four articles which conveyed my contributions in this regard were published in the Journal of Meteorology, U.K. and the International Journal of Theoretical and Applied Climatology, Fed. Rep. Germany (see Ologunorisa and Tamuno, 2002, 2003 and 2003; Ologunorisa and Babatolu, 2004).

I have also worked in the area of tropical rainstorms and flooding. Data provided from my analysis of tropical rainstorms in Ibadan, Ondo and Port-Harcourt constitute the database necessary for engineering control of floods in the area mentioned (see Akintola and Ologunorisa, 1999; Ologunorisa, 1999, 2001, 2002).

My Doctoral thesis entitled "An assessment of flood risk in the Niger Delta, Nigeria" has proved very successful from the standpoint of flood hydroclimatology in changing policy direction in the management of flood hazard in the Niger Delta region of Nigeria. This has

been demonstrated not only in terms of the number of papers that have been published in reputable international scientific journals (such as the Environmentalist, The Netherlands; and the International Journal of Environmental Studies, U.K.) but more in terms of the detailed analysis of rainfall characteristics influencing flooding in the region. It has also helped in providing a methodological framework for the assessment of flood vulnerability zones applicable not only in the Niger Delta but also in the Wetlands of the world (see Ologunorisa, 2004; Ologunorisa and Adeyemo 2005; Ologunorisa, 2006). I have equally done a pioneering work in Nigeria in the area of flood damage assessment (see Ologunorisa and Ali, 2006). My analysis of rainfall periodicity using the contemporary analytical tool of spectral analysis has helped to resolve the crisis of defining rainfall cycles in the Niger Delta region, and this is a necessary ingredient for the understanding and management of floods and drought phenomena in the region (see Ologunorisa and Adejuwon, 2003).

The problems of acid rain pollution, gas flaring and its environmental implications in the Niger Delta, and the effects of fog and Harmattan dust haze on aviation have also been studied. My findings from these studies have formed the basis of environmental planning and pollution control in the Niger Delta region of Nigeria (see Ologunorisa, 1995, 1999, 2000, 2001). My current research work is on the analysis of extreme events in climatology, most especially, the analysis of extreme rainfall events and their implications for flood frequency. I am also working on the problem of drought prediction in Nigeria and climate change impact assessment on water resources and agriculture in the sudano-sahelian region. These foregoing efforts as contributions to knowledge are rather dynamic and continuing process, and thus, are enduring challenges in the profession.

Sandstorm/Dust storms

The study of the spatial, seasonal and diurnal variations of sandstorms in Nigeria has also been well documented. In view of the menace of sandstorms as a meteorological hazard that affect aviation operations and road transport (See Ologunorisa and Tamuno, 2001; Ologunorisa and Tamuno, 2003). The results of the analysis show that stations with high frequencies of sandstorms which are mainly in the north have low co-efficient of variation while the middle belt and the south with frequencies have very high co-efficient of

variations. There is high frequency between 1300 and 2100 hours with peak at 1800 hours. The study concludes that the main source region of sandstorms in Nigeria is Sahara desert, and that the major factors determining the spatial and seasonal variations of sandstorms over Nigeria, apart from Inter-Tropical Convergence Zone (ITCZ) are the distance inland from the coast, the distance inland from the coast, the distance away from the desert margins, relief, disturbance lines and anthropogenic factors.

Rainstorms and Thunderstorms

The importance of thunderstorms in terms of their significant contribution to flooding episodes and soil erosion process due to their high intensity and torrential characteristics have been well highlighted (see Ologunorisa, 2004; Ologunorisa and Chinago, 2004). The studies have also shown that thunderstorm activity for the country is on the increase.

Harmattan Dust Haze

Attempts have also been made to study the diurnal and seasonal variations of harmattan dust haze and its risk limit to airline operation (See Ologunorisa, 1999), as well as the seasonal incidence of Sahara dust over Nigeria.

Ologunorisa and Keobunah (2006) examined the seasonal incidence, recession, duration and diurnal variations of Sahara dust haze in northern Nigeria. It was observed that the incidence of dust haze over northern Nigeria during the period of study started in October, with a peak occurrence in January. The recession period starts from February and ends in the month of April. Stations which are closely located to the source region (that is at the northern fringe) experienced very high incidence of dust haze more than those at the Southern part of the study area. Also, the duration of dust haze varies from 8 to 19 weeks, and finally, in terms of diurnal variations, two major peaks can be recognised, these are 0000 hours (GMT) having the highest and 0500 hours (GMT) the lowest.

Dust storms are low level clouds of moving sand and dust initiated by strong winds as a result of insatiability in the atmosphere which reduces visibility to less than a kilometer

(Ologunorisa and Tamuno, 2003). Little or no attempts have been made in literature to monitor dust storms events through the analysis of meteorological data in the Sahelian zone of Nigeria. Ologunorisa and Babatolu (2004) examine the understanding of the geography of dust storms, monitoring of desertification and other associated environmental consequences in Nigeria. Data from three meteorological stations in the Sahelian zone of Nigeria were analysed to examine the relationship between annual rainfall variability and annual dust storm production.

Results reveal that dust storms production follows changes in rainfall pattern. Results of the correlation analysis between annual rainfall and dust storm frequencies are discussed with statistical significance (See Table 14). Analysis of data from Sokoto, Kano and Maiduguri reveal that dust storm production follows changes in rainfall pattern. The dustiest year correspond with drought years in the region while the wettest years with the exception of 1988 have the lowest dust storm production in the study area. Despite this observation, the results of the correlation analysis between annual rainfall and annual dust storms frequencies show a very low positive correlation coefficient of 18 percent for Sokoto and 23 per cent for Kano which are statistically significant at 0.05 probability level while Maiduguri showed a zero correlation and with a validity and reliability estimate of 95 percent.

Table 14 : Result of Correlation Analysis of Annual Rainfall and Annual Sandstorm in the Sahelian Zone of Nigeria

Status	γ	γ^2	Cal. T.Value	Table Value	Result
Kano	0.48440	0.234	0.0165	0.05	Significant
Maiduguri	0.001	0	0.9940	0.05	Not Significant
Sokoto	0.41260	0.170	0.016	0.05	Significant

(Source: Ologunorisa and Babatolu, 2004)

Rainfall Trend and Periodicity

Ologunorisa and Adejuwon (2003) did analysis of annual rainfall trends and periodicity in the Niger Delta, Nigeria. Annual rainfall data between 1931 – 1997 for 12 regional weather stations were used for the research. However, few stations have a complete series of rainfall records; these include Yenagoa which has 37 years, Ahoada, Onne and Uyo with 25 years, 21 years and 17 years records respectively. Due to data limitation, only stations with data covering 1931 – 1997 were used for rainfall periodicity. The rainfall trends for all the stations were analysed using the Pearson Product Moment Correlation Coefficient and Simple Linear Regression Analysis, while Spectral analysis (a modification of Fourier series) was used for determining rainfall periodicity. The results of the analysis showed that the rainfall correlation coefficients for the twelve stations provide positive correlation except Port Harcourt and Calabar which have negative correlation. The result of the spectral analysis showed that there are significant cyclical patterns in rainfall of the Niger Delta. The study concludes that the significant periodicity detected in the rainfall series range from 3 to 7 years. The implications of rainfall characteristics (See Table 15) in the Niger Delta region for flooding have been well documented (See Ologunorisa and Adejuwon, 2010).

Extreme Rainfall and Flooding

The relationship between extreme rainfall and urban flooding in major Nigerian cities such as Port-Harcourt, Warri and Makurdi and Kaduna have been studies in recent years (See Ologunorisa, 2001; Ologunorisa and Diagi, 2005; Ologunorisa and Tor, 2006; Ologunorisa and Solomon, 2010). The major conclusion is that extreme rainfall events are associated with high flood frequencies, and the seasonality of flooding occurs between May and October.

Table 15: Summary of Rainfall Statistics for Selected Stations in the Niger Delta

S/N	Station	Mean Annual Rainfall (MM)	Mean Monthly Nov-Feb Dry Season	Percentage (%) of Mean Rainfall in Nov-Feb	Mean Monthly Rainfall (Mar – Oct) Wet Season	Percentage (%) of Mean Rainfall (Mar – Oct.)
1.	Benin	2087.1	145.8	7.05	1939.9	92.95
2.	Sapele	2391.5	167.5	7.03	2223.4	92.97
3.	Warri	2907.8	228.7	8.18	2578.0	91.82
4.	Forcados	3469.3	267.2	8.90	3159.1	91.10
5.	Yenagoa	31190.8	305.9	9.57	2885.5	90.43
6.	Ahoada	2370.1	187.1	6.90	2206.4	93.43
7.	Port Harcourt	2370.5	237.9	9.77	2138.9	90.23
8.	Degema	2355.1	257.9	10.93	2097.9	89.07
9.	Onne	2438.4	222.4	8.74	2225.3	91.26
10.	Opobo	3816.8	370.4	9.44	3456.4	90.56
11.	Calabar	2903.8	304.1	10.75	2591.5	89.25
12.	Uyo	2124.2	142.1	5.48	2007.7	94.52

Source: Ologunorisa and Adejuwon, 2010

Flood Predictions and Risk Assessment

Ologunorisa (2004) developed a methodology for the assessment of flood vulnerability zones applicable not only to the Niger Delta but to any wetlands in the world. The study deals with an assessment of flood vulnerability zones in the Niger Delta region by using hydrological techniques based on some measurable physical characteristics of flooding and vulnerability factors. On the basis of these factors, 18 settlements randomly selected across the three ecological zones in the region were assessed. Three flood risk zones emerged from the analysis. These are severe flood risk zones, moderate flood risk zones and low flood risk zones. Strategies of flood mitigation in the Niger Delta and many Nigerian cities have been well documented (See Ologunorisa and Tor, 2007 and Ologunorisa, 2009).

Flood Risk Model

The risk situation is quite complex to define. In fact, we assume that we can analyze on the basis of two independent factors, one based on the socio-economic perception of risk, and the other depending on the hydrologic and hydraulic knowledge of the hydrological regime (See Fig. 4).

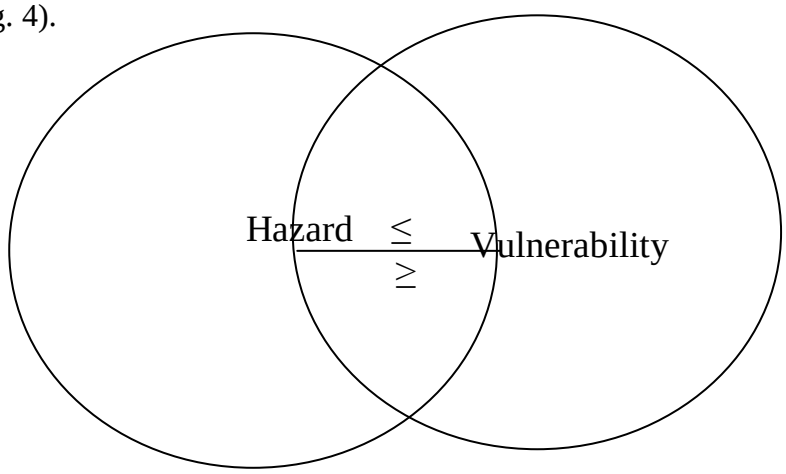

Figure 4: Risk Conceptualization

(Source: Ologunorisa, 2001, 2004)

The first factor is called vulnerability and represents the sensitivity of land use to the flood phenomenon. Consequently, it depends only on the type of land use and the social perception of risk.

The second factor is called hazard, and depends only on the flow regime of the river, independent of the land use of the flood plain. That is to say that the same flow will flood the same area with the same physical parameters whatever the land use.

According to these two basic factors, a real flood risk level requires a certain level of vulnerability. A situation of risk is due to the incompatibility between hazard and vulnerability levels on the same plot. This decomposition of risk into two components is a first simplification or conceptualization of a complex reality, which should allow a better comprehension and analysis of the problem.

Prediction of Risk

The risk of flooding of a particular area depends on hazard factors and vulnerability factors. A method to assess the risk form a natural disaster is given by the risk index, as follows:

$$\text{Risk Index (RI)} = \text{HFXVF} \quad (1)$$

where HF = Hazard factors; the hazard factors are defined as the elements that cause the risk and, in this case, the physical characteristics of flooding such as flood depth, frequency, duration, damage and velocity; while the vulnerability factors are defined as the land use and social-economic variables or socio-economic perception of risk. And this includes: types of land use, proximity to hazard source, length of time flood was experienced, adequacy of flood alleviation measures, and extent of property damage. The hazard factors are calculated using Equation (2).

$$HF = f(h_1 \times h_2 \times h_3 \times h_4 \times h_5 \times \ldots\ldots\ldots\ldots\ldots\ldots H_n) \quad (2)$$

Where HF = hazard factors, e.g. depth of flooding, while the vulnerability factors are calculated using (3)

$$VF = f(V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \ldots\ldots\ldots\ldots\ldots\ldots V_n) \quad (3)$$

Where V_1 = proximity to hazard zone; finally, the flood risk index is calculated by Equation (1). In this method, the higher the value of the risk index, the higher the degree of risk.

Flood Vulnerability Assessment in the Niger Delta

The flood risk map of the study area was carried out based on the flood risk assessment of some environmental parameters in 18 settlements used in this study. The flood vulnerability assessment was achieved in two stages. The first step involves the identification of the most important environmental parameters (that is hazard and vulnerability indices) influencing flood risk.

Nine indices were utilized for measuring levels of flood risk in the study area, as shown in Table I. Their selection is based on the reasoning that they are capable of truly measuring flood risk. They are believed to be capable of doing this because previous studies have shown that they have a strong positive bearing on flood generating and vulnerability components of flood hazards (12). Also, the parameters selected are easy to measure and quantify. Finally, it is also believed that they will clearly bring out internal variations within the study area.

Table 16 : Environmental Parameters Selected for Defining Flood Vulnerability Zone in the Niger Delta

1. Depth of Flooding (meters)
2. Duration of flood (Hours/Weeks)
3. Perceived frequency of flood occurrence
4. Perceived extent of damage arising from floods (in percentage)
5. Percentage deviation of seasonal rainfall (mm) from the mean
6. Elevation of settlement above sea level (m)
7. Proximity to hazard source, e.g. to source of a river (in m)
8. Land use or dominant economic activity
9. Adequacy of flood alleviation measures

Table 17: Graduated Scales for Scoring the Selected Parameters used in Defining Flood Risk or Vulnerability

S/N	Parameters	Range of Values	Scores
1.	Depth of Flooding (m)	<1.0 metres 1-2.0 m >2.0 m	1 2 3
2.	Duration of floods (hours/weeks)	<12 hours 12-24 hours >24 hours	1 2 3
3.	Perceived frequency of flood occurrence	Once in 5 years of more Once in 3 years Once in a year	1 2 3
4.	Extent of damage (in percentage)	<25 per cent 25-50 per cent >50 per cent	1 2 3
5.	Percentage deviation of seasonal rainfall (mm) from the normal average	<25 per cent 26-60 per cent >50 per cent	1 2 3
6.	Relief in meters above sea level	>15 meters 5-15 meters <5 meters	1 2 3
7.	Proximity to hazards (in metres)	<5 meters >200 meters 100 – 200 meters	1 2 3
8.	Perceived adequacy of flood control measure (in percentage)	<100 meters >50 per cent 25-50 per cent	1 2 3

9.	Dominant land use or economic activity	Agricultural Residential (planned and unplanned) Industrial/Commercial	1 2 3

(Source: Ologunorisa, 2001, 2004)

The second stage involves the quantitative rating and assessment of the environmental parameters (hazard and vulnerability factors) in the selected settlements for flood risk mapping based on the rating scales devised in this study.

The scales for scoring the environmental parameters in this study are shown in table 17. In devising the scales for scoring the nine environmental parameters, emphasis was placed on the range of values obtained during fieldwork using questionnaires, topographical maps and rainfall data in the study area. The rating procedure adopted was based on Clark's principle (13). This entails multiplying the scores of the parameters selected in this study in each settlement, to give the settlement's flood risk index for land use planning. By multiplying the scores, the flood risk in each settlement will be limited to the least favourable parameter influencing flooding (that is, the law of minimum). This is preferred to the additive method of computing indices, which assumed that the different parameters add together without interference. In this method, the higher the value of the risk index, the higher the degree of flood vulnerability.

Based on the rating scales in Table 17, three flood risks were obtained and shown in Table 18, while Table 19 shows the computation on the flood risk indices for the data collection in the selected settlements used in this study. The flood risk classes obtained in Table 19 were used to divide Niger Delta region (that is the Rivers and Bayelsa States) into flood vulnerability zones for land use planning.

The resulting flood risk map consisting of three zones is shown in Figure 5. The first zone consists of areas of severe or high flood risk, and these include Sagbama, Yenagoa, Ekeremor, Ogbia, Ogba/Egbema/Ndoni, Ahoada, Gokana and Khana areas.

The second zone is made up of areas of moderate flood risk. These include Port Harcourt, Obio/Akpor, Ikwere areas; finally, the third zone including areas of low flood risk such as Etche, Emohua, Oyibo, Tai/Eleme area, and all the salt water areas under tidal influence, such as Bonny, Opobo, Degema and Southern Ijaw.

It should be stated that the coastal areas of the Niger Delta do not experience severe flooding because they are under tidal influence. Tidal floods have a short duration, and are less severe and therefore of low risk.

TABLE 18: Flood Risk Class for Land Use Planning

Flood risk indices	**Flood risk class**	**Remark**
<100	I	Low Flood Risk
100-600	II	Moderate Flood Risk
>600	III	High Flood Risk

TABLE I9: Computation of Flood Risk Indices for Land Use Planning

S/No	Settlements	Depth of Flooding (m)	Duration hours/weeks	Perceived frequency of flood occurrence	Extent of flood damage	% deviation of seasonal rainfall from the mean	Relief or elevation	Proximity to hazard source	Adequacy of alleviation measures	Dominant economic activity	Flood risk index	Flood risk class
1	Port Harcourt	2	1	3	2	3	1	3	3	3	972	II
2	Etche	1	1	1	1	2	1	1	1	2	04	I
3	Ahoada	3	3	2	3	3	3	3	3	2	3888	III
4	Ndoni	3	3	3	3	2	1	3	3	1	1368	III
5	Bori	3	3	3	2	3	2	3	3	2	3648	III
6	Isiokpo	2	2	1	2	2	1	2	2	2	64	I
7	Abua	3	3	3	3	3	3	3	3	2	12922	III
8	Akinima	3	3	3	3	2	1	3	3	3	2916	III
9	Yenagoa	3	2	3	3	3	2	2	2	1	1944	III
10	Sagbama	3	3	3	3	3	2	2	2	3	7752	III
11	Kaima	3	3	3	3	3	3	3	3	3	12922	III
12	Emohua	1	1	3	1	3	3	1	1	1	27	I
13	Ekeremor	3	3	3	3	3	3	3	3	2	12922	III
14	Oporoma	3	3	3	3	3	3	3	3	2	12922	III

15	Ogbia	3	3	3	3	3	3	3	3	2	12922	III
16	Brass	1	1	1	1	3	3	2	1	2	36	I
17	Opobo	1	1	2	1	3	3	2	1	2	72	I
18	Degema	1	1	1	1	3	3	2	2	1	36	I

(Source: Ologunorisa, 2001, 2004)

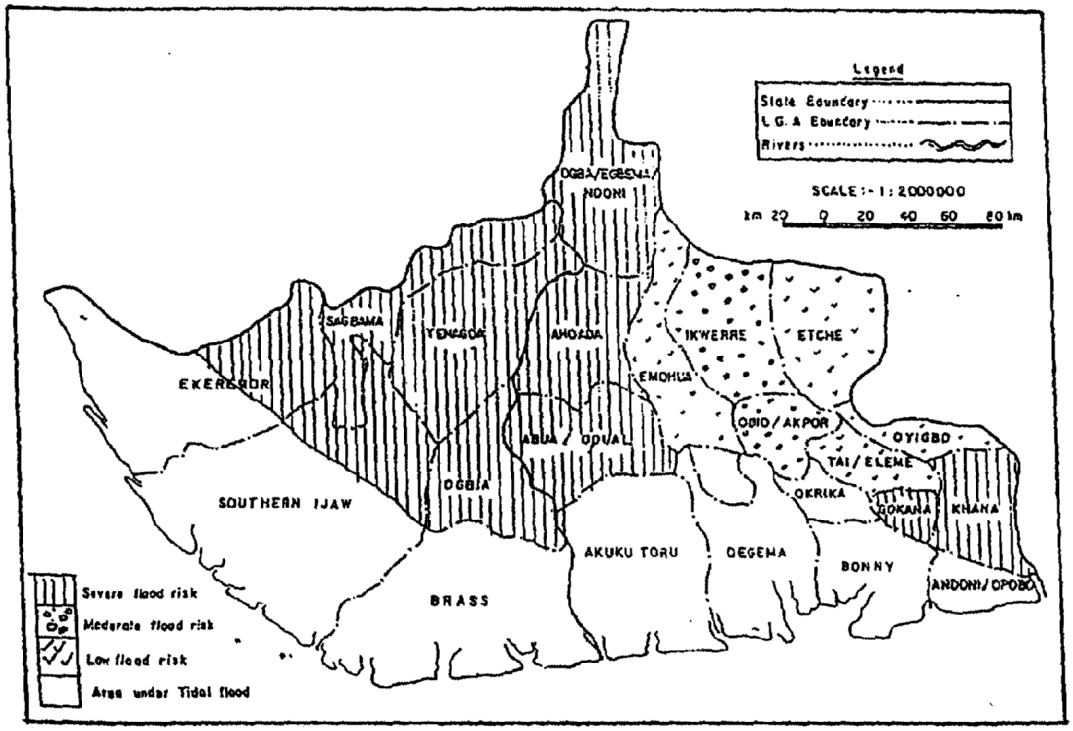

Figure 5: Spatial Variations in the Level of Flood Risk in Niger Delta.

Source: (Ologunorisa, 2001, 2004)

Flood Perception, Damage Assessment and Management Strategies

Ologunorisa and Adeyemo (2005) analysed public perception of flood hazard in the Niger Delta, Nigeria. The study had the aim of understanding how flood plain dwellers regard the risk of flooding. About 500 questionnaires were administered to landowners in the selected settlements in the study area using systematic random sampling. The results of analysis show, among other things, that the population regards most important the causes of floods as heavy, prolonged rainfall and river overflow. Nevertheless, they have little knowledge of the frequency of severe floods, and flood alleviation schemes. Most flood victims do not get compensation or relief during flood disasters, and the reason why they remain in the study area is influenced by their occupation, especially fishing, subsistence agriculture, and the presence of crude oil in the region which has attracted many migrants who cannot afford the high cost of accommodation and are therefore forced to live in vulnerable areas of the floodplain. Finally, the study concludes that flood control in the region needs the cooperation of government community efforts and enlightenment programmes through environmental education and mass media. The analysis of flood stage damage curve relationships for commercial and residential landuse in the Benue valley was documented by Ologunorisa and Ali (2005, and 2009).

Gas Flaring

Ologunorisa (2001) reviewed the effects of gas flaring on the Niger Delta environment. The Niger Delta region of Nigeria has suffered all forms of pollution and degradation arising from oil and natural gas exploitation. These include a decrease in agricultural yield, depression in flowing and fruiting in okro and palm trees, deformities in children, liver damage and skin problems, increasing concentrations of airborne pollutants, acidification of soils and rainwater, corrosion of metal roofs and significant increases in concentrations of sulphates, nitrates and dissolved solids, with associated socio-economic problems.
In spite of decree 99, which bans unauthorized flaring, over 75% of the gas produced is still being flared (See Ologunorisa, 1996, 1998).

Response Strategies to Climate Change

Response strategies to climate change will be determined by several factors including the magnitude, rate and regional patterns of climate change as well as the degree of vulnerability to climate change. Although climate change is ultimately a global issue, the impacts of climate change will vary from one region of the world to another and even within a given country.

There are basically two types of response strategies to climate change.

1. We have strategies aimed at controlling or preventing climate change. These are known as mitigation measures.
2. We have strategies which aimed at adapting to or accommodating the impacts of climate change. These are known as adaptation measures.

Most of the natural causes of climate change are outside the influence or control of man. Man can only deal with the man-made causes of climate change; the most important of this man-made alteration of the chemistry of the atmosphere through the emission of greenhouse gases by various human activities. Mitigation measures are therefore actions taken by man to prevent or

retard the increase of greenhouse gases concentration in the atmosphere. This may be achieved by limiting current and future emissions from man-made sources of greenhouse gases concentration and by enhancing the potential sinks of greenhouse gases. Two climate change policies will be discussed. These are: Montreal Protocol and Kyoto Protocol.

Montreal Protocol

In view of the harmful effects of CFCs on the protection of ozone layer, the Montreal protocol on substances that deplete the ozone layer was negotiated in 1987 to drastically limit and eventually stop the production and use of CFCs. Under the protocol, developed countries are to freeze the production and use of CFCs, 11, 12, 113, 114 and 115 at their 1986 levels from the year 1990, a reduction to 80% of their 1986 levels from the year 1993 with a further reduction of 50% of their 1986 levels from 1998.

However, developing countries with per capita use of CFCs that is below 0.3kg are allowed to increase their per capita use up to this level and can delay compliance with the control measures by 10 years (IPCC, 1990). If the terms of the protocol are faithfully implemented, atmospheric concentrations of CFCs will still be about 30 to 40% of the current levels for at least 100 years because of the long atmospheric lifetimes of CFCs.

Kyoto Protocol

The Kyoto protocol was established in Kyoto, Japan on 11th December, 1997 under the United Nations Framework Convention on Climate Change (UNFCC). The objective of the UNFCC is to achieve the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The war on carbon emissions appears to have been less successful so far because countries like the USA have reservations on the Kyoto Protocol.

Mr. Vice-Chancellor, Sir, the next section of this lecture will examine the contentious issues in the Kyoto Protocol.

Contentious Issues in the Kyoto Protocol

Under the Kyoto Protocol, whilst developing countries are not obliged to accept any emission reduction or stabilization targets, the industrialized world collectively agreed to a cut of first 5.2 per cent below 1990 levels by 2012, with the European Union agreeing to a reduction of 8 per cent, the USA 7 per cent, Japan and Canada 6 per cent and Australia winning an increase of 8 per cent. This principle of differential burden sharing between the developed and developing countries adopted in the Kyoto Protocol has generated at least two polarized visions of political reality. One is the 'Northern view" while the other is the "Southern view" Kronick (1999) observes that the "Northern view" required two things in the protection of climate.

The first was a means of ensuring the eventual participation of the developing world in greenhouse gas emission reduction. The second was the development or refinement of the mechanisms that would begin the slow incremental reduction of those gases without causing financial hardship to those developed countries making the cuts. In the United States, the most significant act of congressional subversion of the Kyoto Protocol is the Brd Hagel Resolution, passed by a unanimous vote of 95 in June 1997. It effectively prevents the ratification of the Kyoto Protocol by stipulating that any United Nations Protocol on climate change that failed to mandate "new scheduled commitments to limit or reduce greenhouse gas emissions for developing countries within the same compliance period" and which would "result in serious harm to the economy of the United State of America" would be unacceptable. Even now, President Barrack Obama of United States of America has not changed this vexed position.

The "Southern view" believes that the current state of the negotiations continues to deny the developing world their right to benefit equally from the protection of what is a common resource belonging to the entire global population: the atmosphere. Also, interest groups in the South are willing to participate in such deals to boost their expectations for increased development. In this connection, there are many in the South who feel that any participation in the process (Protocol) by developing countries who bear no historical responsibility for the damage to climate is to mortgage the prosperity of future generations. Leaving these two views un-harmonized is definitely an impediment to realizing the goal of the Kyoto Protocol.

Another central source of concern with the Kyoto Protocol revolves around the issues of "sinks" — those natural processes that absorb more carbon than they give out. In other words,

the concept of "carbon sinks" is based on the natural capacity of forests to absorb carbon dioxide and temporarily store the carbon in trees, organic matter and soils. The Kyoto Protocol allows countries to count such carbon absorption by forests, and perhaps later by agricultural soils and other carbon sinks, as offsets against CO_2 emissions.

Under the agreement, each industrialized country's total net emissions will be calculated by subtracting the amount of carbon absorbed by forestry and land- use change from each country's gross emissions. Countries will thus be able to claim credit for any increase they make to their carbon sinks. In other words, a country that plants trees to absorb carbon dioxide can emit that much more CO2 from burning fossil fuels.

This approach according to Kronick (1999) is extremely politically convenient. This is because forest cover is increasing in most industrialized countries, including forestry. This, by implication, will produce a lower emission figure. One other problem now is that there is not yet enough data on natural carbon sinks. The science simply does not exist to be able to predict exactly how much carbon is being absorbed by a country sinks and how long the carbon moving into industrialized country forests will actually stay there (Kronick, 1999). Another contentious political issue in the Kyoto Protocol is the inclusion of "three flexible mechanisms" in the Kyoto Protocol to "help" governments of industrialized countries to achieve their obligation through carbon trading and emission reduction activities abroad rather than domestically. These three flexible mechanisms are Emission Trading, Joint Implementation and Clean Development Mechanism. The Emission Trading ('ET) System will allow industrialized countries to buy and sell emission credits; Countries that keep emissions below their agreed targets will be able to sell the excess emission credit to countries that find it more difficult or more expensive to meet their own targets. One of the main concerns is that Kyoto targets of some countries are so low that they can be met with minimal effort. These countries could sell large quantities of emission credits (known as "Hot Air"). The rules of this trading are not very clear because there are many unresolved issues in the trade.

For instance, what percentage of a country's reductions may be achieved by trading? Which greenhouse gases can be traded? What body regulates and verifies the trading regime? The Joint Implementation (JI) Mechanism will allow industrialized countries to gain credits for financial emission reduction projects in other industrialized countries. The reporting rules, monitoring guidelines and the extent to which credits can be gained from carbon sinks have not

yet been decided. The Clean Development Mechanism (CDM) will allow industrialized countries to gain credits for financing emission reduction projects in developing countries without emission targets. These mechanisms, this paper argues, could be better described as means of robbing Peter to pay Paul.

One of the controversial issues is whether or not credits can be gained from carbon sink project, as the text of the Protocol is ambiguous on the issue. Whereas this possibility is explicitly mentioned for Joint Implementation projects, it is neither explicitly mentioned nor excluded from the CDM text. It should be stated that the inclusion of carbon sinks in the flexible mechanisms has generated a lot of debates. Those in favour of their inclusion argue that, at long last, environmental services that forests provide will be paid for. They also believe that including "carbon sinks" in the flexible mechanisms will provide funding for forest conservation projects and pointed out the potential benefits of forest-related projects for local people. The potential negative effects on forests, biodiversity or local people of such carbon sinks projects should be addressed by the development of clear guidelines and standards (Fern, 2000).

Alternative Views on the Protocol

Those who oppose the inclusion of carbon sinks argue that tying up lands in the South for decades to come so that the North can continue emitting greenhouse gases amounts to a new form of colonialism — Co2 colonialism. They believe that including carbon sinks will stifle the switch to already existing renewable energy technologies. They point out that intergovernmental discussions have not produced guidelines that would both safeguard forest biodiversity and Forest people's rights (see Fern 2000). The chances of agreeing on them in an international agreement that focuses on climate change thus appear slim.

Furthermore, it has also been argued that projects that safeguard forest biodiversity and respects Forest Peoples' right will in most cases not be the same projects that deliver carbon credits. It is therefore, very unlikely that governments will reach consensus on sound criteria and, at the same time, maintain investor's interest in carbon sink projects that promise to deliver sizeable quantities of carbon credits.

In addition to this, the process of global negotiation of the protocol is very complex. In spite of a deepening knowledge of the increasing damage to the climate system, action to reduce emissions of greenhouse gases is not accelerating. The opposite is actually true in both developed and developing countries where emissions are currently increasing. For instance, it took greenhouse gas concentrations around 150 years to increase in the atmosphere by approximately 30 per cent largely as a result of the burning of fossil fuels. The bulk of that increase has taken place in the last 60 years. Kronick (1999) observes that it would take nearly another 30 years of negotiation to reduce emissions of greenhouse gases by around 5 per cent whereas concentrations will still continue to rise, and this is where the problem lies.

Another truth is that the political process to protect climate is becoming increasingly arcane. There is a group in the industrialized North (principally North America) who believes that it doesn't matter if climate change is real, this group argues that it is simply "too expensive" to reduce emissions. This group is committed to maintaining the global industrial and economic status quo.

One major issue is whether economic sanctions or some other forms of penalties will be allowed against countries that fail to fulfil their obligations. The central issue of concern is what to do on United States' refusal to ratify the Protocol and even post Kyoto Protocol after 2012. There are two schools of thought as regards this. First, there is the view that the Protocol will be meaningless without United States' ratification, and this school of thought argues for compromises to be made in order to make the Protocol acceptable to the US. This is because the United States is the greatest emitter of greenhouse gases in the world, although it has now been overtaken by China.

The second school of thought feels that the compromises demanded by the US undermined the whole purpose and effectiveness of the Protocol. They believe that the Protocol can be ratified and entered into force without the US. The US will then be under pressure to join later. It should be stated that the refusal of US to ratify the Protocol is based on three grounds. First, there must be meaningful participation of developing countries in emission cuts: second, the need to grant the US unlimited use of flexibility mechanisms; and third, the right to count the "sink" capacity of US forest.

Politically, the most difficult equity question (that is equal emission rights) to resolve is how to decide what quantity of greenhouse gases each country will be allowed to produce in the

long term, especially after 2012 when the second round of negotiation of emission cuts would commence. In order to resolve this, the idea of equal rights or "per capita rights" has been proposed. This involves working out how much total emission of greenhouse gases the globe can sustainably support and dividing that by the number of people in the world to find the quantity each person can be allowed to emit. These per capita rights would then be .used for setting national allocations. Opposing this idea, some industrialized countries argued for per capita or national entitlements to be based on historic and current levels of emission.

The most pressing inequity issue for developing country stakeholders has to bear human impact burdens disproportionate with causal responsibilities, and their view that this issue has hitherto largely been ignored. A look at recent academic equity literature lends support to this view. It indicates that while "equity" is often put on the agenda by developing country experts, the scope of the agenda itself — namely emission mitigation has been firmly set by industrialized world (Giddens, 2008).

One of the root causes of this divide is a fundamental difference in the perception of climate change itself. In the industrialized North there is a widely held "ecological view" of the problem. Climate change is perceived as a prob1em of polluting the environment, of degrading the eco-system. As such, its essence is seen to be that of a wrongful act against "Nature". The chief victim from this perspective is Nature; mankind's role is primarily that of culprit.

The reality in the South is quite different. Climate change has primarily come to be seen as a human welfare problem. The harm is against humans, it is largely other — inflicted, and it is not life-style, but life — threatening. In short, the chief victim of climate change is not 'Nature', but people and the paramount inequity is one between human victims and human culprits.

The political process of the Kyoto Protocol is flawed in that as long as progress of climate protection is dependent upon the consensus of governments who have wildly divergent interest, the chances for success are slim. Kronick (1999) wonders why a member of Organization of Oil Exporting Countries (OPEC), whose GDP and prosperity are derived almost exclusively from the sale of fossil fuels, or the United States of America with less than 5 than per cent of global population, but who is responsible for around 25 per cent of global greenhouse gas emission converge on an outcome similar to that of a low-lying Island State facing inundation by rising sea levels. This paper observes that unless all the issues raised here are addressed, the emission of greenhouse gases by developed countries will still continue unchecked.

Post Kyoto Protocol and the Significance of Copenhagen Conference

The essence of Copenhagen is to assess progress in the Kyoto Protocol and to plan for future. It was also meant to design an agenda for the world to take up in fighting climate change after 2012.

Following preparatory talks in Bonn, Bangkok and Barcelona, the 2009 conference was held in December 2009 in Copenhagen. The overall goal for the COP 15of the United Nations Climate Change Conference in Denmark was to establish an ambitious global climate agreement for the period from 2012 when the first commitment period under the Kyoto Protocol expires. It was expected that the Copenhagen Conference would adopt a treaty to succeed Kyoto Protocol. The conference did achieve a binding agreement for the post Kyoto Period. A 13-paragraph called "Copenhagen Accord" was agreed by most of the parties but without any legal commitments.

The Copenhagen Accord recognizes the scientific case for keeping temperature rises below 2^0C, but does not contain commitments for reduced emissions that would be necessary to achieve that aim. One part of the agreement pledges US $30billion to the developing world over the next three years, rising to US $100 billion per year by 2020, to help poor countries adapt to climate change. Also earlier proposals that would have aimed to limit temperature rises to 1.5°C and CO2 emissions by 80 per cent by 2050 were dropped. Finally, an agreement was also reached that would set up deal to reduce deforestation in return for cash from developed countries.

What were the issues Negotiated between Developing Countries and Negotiation Blocks?

The international efforts to date have resulted in a series of negotiations among nations from developed and developing countries. This has resulted in the formation of different negotiation groups with varied interests. The main United Nations Framework Convention on Climate Change (UNFCCC) negotiation groups are:

(i) Central Asia, Caucasus, Albania and Moldova (CACAM);

(ii) Environmental Integrity Group (EIQ);

(iii) European Union (EU);

(iv) Group of 77 and China;

(v) Negotiating Groups

(vi) Organization of Petroleum Exporting Countries (OPEC) Members and,

(vii) The Umbrella Group.

In general, all the groups can be categorized into developed and developing countries. There are variations and differences among the countries and groups of countries, even though there are also areas of common (See Table 20) concerns. Key areas for dialogues among parties include:

(1) Funding of adaptation activities in developing countries. Finance has been identified as a key issue for the discussion on a post-2012 climate change agreement. Estimating the exact costs of adapting under various scenarios, as well as the ability of countries to self-finance faces a number of challenges such as:

(i) Differences in adaptive capacity

(ii) Adaptation measures may not be solely for the purpose of adapting to climate change

(iii) Uncertainties associated with methodologies, and

(iv) Existence of adaptation deficit, which is the gap between the adaptation that is possible without additional policy or projects and the level that is needed to avoid adverse effects of climate change (Burton et al 2006).

The following sources of funding are presently available for developing countries and Africa in particular.

(i) **Special Climate Change Fund (SCCF)** — to finance projects related to adaptation, technology transfer and capacity building, energy, transport, industry, agriculture, forestry, waste management and economic diversification.

(ii) **Least Developed Countries Fund (LDCF)** — to assist a work programme for least developed countries for the preparation and implementation of National Adaptation Programme of Action (NAPAs).

(iii) **Adaptation Fund** — to support concrete adaptation project and programmes in developing countries that are parties to the Kyoto Protocol. It is financed from 2% share of proceeds from the Clean Development Mechanism (CDM) and other

voluntary sources. The Adaptation Fund which became operational in 2007 is managed by an "Adaptation Fund Board". The Board has (a) government representation following United Nations regional distribution and a majority of developing countries; and (b) is elected and directly accountable to the supreme body of the Kyoto Protocol, the Conference of the Parties serving as a meeting of the parties to the Kyoto Protocol (CMP).

(iv) **Strategic Priority on Adaptation** — contains about US$450 million from the Global Environment Facility's trust funds to support pilot adaptation activities.

In addition to the above, Red and Hug (2007) observed that a number of bilateral funding agencies in developed countries such as Canada, Germany, the Netherlands, Japan, the United Kingdom and the United States have allocated funding for adaptation activities, including research and pilot projects up to the tune of US$1 10 million for over 50 adaptation projects in 29 countries as at 2007.

Despite the above global efforts to fund climate change programme, there are still some concerns by developing countries about:

(i) The relatively small amount of funds currently available to address adaptation under the convention.

(ii) Complexity in the design of the funds and problems of implementation of the guidelines has curtailed the accessibility of many developing nations to the funds.

(iii) The imperative for the flow of additional fund to cope with adaptation needs and the adjustments needed to combat climate change.

(2) Enhancing technical training for integrated climate change impact, vulnerability and adaptation assessment. This is because of the fact most developing countries have weak networks of climate change data and information as well as limited capacity to undertake scientific assessment of climate change. There is therefore the need to facilitate informed decisions in practical adaptation actions and measures in developing countries.

(3) Promoting the transfer of adaptation technologies from developed countries to developing countries. It has been recognized that transferring existing technology and promoting technological innovation are key to the future of climate adaptation especially the role of the Experts Group on Technology Transfer (EGTT).

(4) Establishing adaptation pilot projects in developing countries.

(5) Supporting systematic observation and monitoring networks and early warning systems in developing countries. This will allow for the collection, management, exchange, access to and use of observational data needed to enable developing and accurate vulnerability assessment, building long term forecasting capacity for effective planning and development of sound adaptation policies.

(6) Sustainable development issue. It is a well-recognized fact that adaptation is not a stand-alone issue, as climate change is a development issue. It has relationship with poverty reduction and general socio-economic wellbeing of the people.

(7) The feasibility of using climate "insurance" as an adaptation mechanism. The idea that insurance can spread the risk of potential climate change impacts through public-private risk transfer mechanisms, weather- derivatives, catastrophe bonds and micro-insurance (Satthage, et al, 2006). The implication for developing countries with nascent insurance industries, however, needs to be better understood.

African Position in Copenhagen

It may be necessary it this juncture to ask what was African position at Copenhagen? Africa put forward a single position. They demanded that Africa be compensated for suffering the effects of climate change for which it has not been responsible. It called on the industrialized nations to make greater efforts to support Adaptation fund which would finance the measures and technologies necessary for Africa to adapt to climate change.

It should be mentioned that though the above represents African position, South Africa position was a bit different. South Africa being a major polluter adopted waits and see attitude. South Africa supported Africa's position hut unlike the rest of the continent, is a large perpetrator of greenhouse emission. And that is why it cannot claim to be a victim in the process of climate change negotiation.

For progress to be made towards the ratification of Post Kyoto Accord, the developing countries should be ready to make some concessions on the flexible mechanisms in the Protocol. This is because without flexibility mechanisms, it would be difficult, if not impossible, for the developed world, especially the United States to meet her commitments. This is particularly so since the economy of the United States is heavily geared towards fossil fuel.

In addition, the developing countries might have to commit themselves to future reductions; and the European Union (EU) would have to drop their proposal to limit the use of flexibility mechanisms. The developed countries should see the need to assist the developing countries to adapt to climate change through proper financing and technology transfer as a moral and priority issues that should be pursued.

Table 20: Overview of Developed and Developing Country Position and Views on Adaptation

Group	Positions
Common concerns	• The need for a methodological shift from climate change impact studies to increased understanding of how to make adaptation happen; • How to examine adaptation needs and identify priorities. • The relative roles of adaptation and mitigation actions • The lack of clarity on the relationship between climate change adaptation measures and the mainstream of development, particularly in relation to financial assistance. • What institutions and funding mechanisms are used for delivery at international and national level.
Developed Countries	• The need to meet obligations and provide financial assistance to cover costs of impacts caused by historically accumulated greenhouse gas stocks is generally accepted. • Issues relating to potential climate change impacts have been raised during discussions on support for in country studies and on engaging developing countries more directly on mitigation. • The financial mechanism should deliver effectively for their taxpayers. • Overseas Development Assistance (ODA) should integrate climate

	change into its activities. • There should be no proliferation of new funds under the Convention • There should be minimum conditions for accessing funding.
Developing Countries	• Equity and justice issues about damage of climate change to vulnerable countries due to emission from "rich" developed countries are a primary concern. • Developed countries must deliver on their obligations under the Convention on finance, technology and capacity building. • Funding for adaptation should cover the additional costs of climate change and existing ODA commitments should not be diverted (also, no new conditionalities should be added to ODA). • Governance of financial mechanisms should be transparent, include an equitable and balanced representation by all Parties, and operate under the authority of the CMP. It should provide "direct access" to funding and ensure that recipient countries are involved during all stages "Predictable" sources of funding are needed, not just more funding. • Support should be provided through the UNFCCC instruments rather than through fragmented efforts outside these instruments. • New institutional arrangements should be created, such as an adaptation committee or an expert body like the one covering technology transfer (EGTT) within the Convention.

Source: (UNDP, 2008)

Was Copenhagen a Success?

Although a 13-paragraph called "Copenhagen Accord" was agreed by most of the parties not without any legal commitments, a number of factors came into play to mar the success of Copenhagen Climate Change Conference. Nations of the world could not agree on a number of issues. First, some countries or groups of countries want to set greater targets, and make them apply to more countries. Secondly, some small island states feel that the targets that may be set

are insufficient to protect them. Thirdly, other countries like China and India are arguing that quantifiable targets are inappropriate as a way forward.

In addition to this, some oil-rich countries are arguing that they should receive huge compensation to reduce their production. Finally, poorer countries are arguing that the richer ones need to finance measures they need to take to deal with climate change, since they did not cause the problem. This paper believes that for any meaningful progress to be made in the implementation of the Protocol, the developed world must be ready to shift their present position and make further commitments to emission cuts, and they should be ready to offer assistance to vulnerable countries in developing world. Emerging economies such as Brazil, Russia, India and China should be ready to make emission cut. After all recent studies have shown that China is now leading USA as the leading emitters of greenhouse gases in the world (See Table 5).

The recently held climate conference in Cancun, Mexico offers little progress toward resolving splits over Kyoto. It promised to set up a Green Climate Fund to help channel $100 billion inn climate aid a year from 2020, along with new systems to protect topical forests and share cleaner technologies.

Conclusion: Nigeria's Response to Climate Change Adaptation

Nigeria was one of the 154 countries that initiated the Convention in Rio in 1992, and it became a party as soon as the Convention came into force. Nigeria was party to the ratified Convention on the 29th August 1994 and has also signed the Kyoto protocol. By 27th November, 1994, Nigeria became committed when the Convention entered into full force. As a signatory to UNFCCC under the Non-Annex I parties, some of Nigeria's obligation

includes the following:

- To produce four key National Communications (the l and only National Communication was produced by Nigeria in November 2003);
- To produce four in-depth review summaries. (none has been produced);
- To produce a demonstrable progress report (yet to be produced);
- To produce the National Adaptation Programmme of Action (yet to be produced);
- To produce a Global Climate Observing System (GCOS) Report (yet to be produced)

A review of some key policy documents shown in Table 21 shows that there is no clear policy on climate change, and only indirect references are made to this important issue (Oladipo, 2009).

Table 21: Summary of references to climate change in national environmental policies in Nigeria

S/N	Policy	Reference to Climate Change	Remarks
1.	National Policy on Environment (1999 revised)	No direct mention. References only to climate change impacts (e.g. flood, erosion, drought and desertification in Chapter 5).	As this policy was reviewed in 1999 (5 years after Nigeria was party to the UNFCC, it should have included a specific section on climate.
2.	Nigeria's National Agenda 21 (1999)	No specific reference to climate change	Chapter 2 indirectly dealt with some adaptation or mitigation issues while addressing ways to address the challenges of environmental problems in the country (e.g. afforestation, erosion control, combating desertification and mitigating the effects of drought, disaster preparedness and management and flood management.
3.	National Drought and Desertification Policy 2007	Climate Change was treated in Chapter 5	The short chapter covered the major issues related to Climate Change in the context of drought and desertification. It made a few policy statements and provided strategies for implementation.

4.	National Drought Preparedness Plan	No specific mention of climate change	Indirectly addresses some adaptation issues for drought mitigation.
5.	National Forest Policy (2006)	No direct mention of climate change.	Some climate change adaptation or mitigation measures (e.g. tree planting for carbon credits, drought and desertification amelioration) were discussed without specifically saying so.
6.	National Food Control Policy (2005)	No specific attention was paid to the issue of climate change.	The introductory section of the policy document made reference to climatically-induced hazards that constitute major ecological disasters, which are constraints to sustainable land and water management in Nigeria.
7.	National Policy on Food and Nutrition	No direct mention of climate change	Crop harvesting and food processing was highlighted as adaptation technologies.
8.	National Food Security Program	Both direct and indirect reference to climate change and climate change adaptation	Mention of desertification, uncontrolled grazing/livestock migration as threats to food production. Suggestion for the use of Jatrapha for biofuel production (cleaner energy) and for combating desertification.
9.	Agricultural Policy (2001)	No direct mention of climate change	The recommended use of appropriate technologies and farm practices for food production.
10.	National Policy on Population for Sustainable Development (2004)	A good mention of climate change almost directly.	Section 4.3 draws the relationship between population, development and environment. The document makes suggestions for adaptation for a healthy relationship.

(Source: Oladipo, 2009)

Despite the absence of an approved national policy on climate change, Nigeria has, nevertheless taken the challenge of climate change seriously. The First National Communication was produced November, 2003. A stakeholders' initiation workshop on the second National Communication (SNC) took place in December2006.

Nigeria created a Special Climate Change Unit (SCCU) within the Federal Ministry of Environment with the Secretariat in Abuja, Nigeria. The Unit was created to implement the Convention and the protocol activities. There is also a Presidential Implementation Committee on the Clean Development Mechanism (CDM) in the Presidency. The Department of Meteorology in the Ministry of Civil Aviation was upgraded to a full-fledged Nigerian Meteorological Agency (NIMET) in 2003 to enhance climate data and climate monitoring systems (Oladipo, 2009).

From the foregoing, Nigeria is yet to have a very clear policy on climate change adaptation. The country is yet to prepare a National Adaptation Programmes of Action (NAPA), which would have been to easily identify urgent priorities and needs that would enhance adaptive capacity to climate change and variability. There is also the absence of a National Climate Change Policy or Strategy that should have presented Nigeria's current and future efforts to address climate change vulnerability and adaptation, as well as the country's competency-building efforts and participation in international climate change discussions and negotiations. At the national level in Nigeria, specific funding of climate change is still very limited to supporting the Special Climate Change Unit of the Federal Ministry of Environment, with no specific budget for specific initiatives that could strengthen the country's preparedness for climate change adaptation.

Another concern is the limited human and institutional capacity to deal with climate change uncertainty and model impacts. Institutional and professional competences are yet to be fully built to be able to develop and implement appropriate preparedness actions for climate change adaptation. There are very few experts in the country. There is urgent need for a National Centre/Institute on Climate Change. There is poor understanding of adaptation and inadequate data for evidence-based analysis. Adaptation challenge is not well understood and scientific knowledge about needs and solutions remains weak. The situation according to

Oladipo, (2009), is compounded by inadequate climate data. Extensive data gaps exist in Nigeria with respect to assessing impacts and adaptation strategies. Key data gaps include (i) climatic data and trends, (ii) baseline natural resource and socio-economic conditions, (iii) location and importance of assets, and (iv) accurate data on extreme events such as drought, flooding and coastal flooding, and socio-economic data at local and regional levels.

There is limited practical guidance on adaptation, which could support national adaptation processes to protect and enhance human well-being in the face of climate change. There is problem of poor integration of climate change adaptation into the national development planning and process. There is also a general conflict between climate change and competing development agendas such as poverty reduction, education and health for all and accelerated economic growth.

Other problems are low level of awareness of the dimension of contemporary environmental problems particularly climate change and the urgency to address them; there is need for climate change education and curriculum to increase awareness; limited political will and generally poor environmental governance; limited or lack of involvement of the large proportion of the population that depend on natural resources for livelihoods; and aversion to change and reluctance to adopt new strategies and poor infrastructural development.

In conclusion, the following conditions outlined by Ashton and Wang (2003) constitute what we can call a set of minimum attributes by which an equitable agreement can be recognised. The first equity condition is the participation of the United States. The U.S. is the world's most prolific emitter and, among the major economies, the largest per capita emitter, and with a veto power. Progress towards the overall climate stabilisation goal would be harder if the economy that accounts for some 25 per cent of global emissions takes on no climate commitment even if others are willing to play their part. It may also put a restriction in what other industrialised countries would be able to do. They would be under pressure from sectoral interests not to cede further competitive advantage to the U.S.

The second equity condition is continued leadership by industrialised countries. In addition to United States participation, industrialised countries must as a group continue to lead the effort, as the Framework Convention obliges them to do. Collectively, industrialised countries account for some 85 per cent of historic and 65 per cent of current emissions. These developed countries have higher per capita emissions, greater capacity to act, and are less

vulnerable to the consequences of climate change. They will need to accept deeper cut in emissions. Equity consideration in the distribution of burden suggests that those with higher per capita emission will be expected to do more than those with lower carbon economies.

The third equity condition is that some developing countries constrain emission. This is the most sensitive and complex condition. Developing countries have consistently argued that it would be unfair to impose constraints at this stage on their economies. They believe that this would unreasonably restrict their ability to address their more urgent priorities, and particularly to fight poverty. They fear that the obligation to limit emissions would make it harder for them to deliver sustainable livelihoods, housing, education, health, and other essential public goods. These are legitimate concerns. No climate regime should undermine the ability of parties to meet the basic need of their people.

The fourth equity condition is that developing countries will need more help in dealing with climate impacts. They need financial support, capacity building to deal with climate impacts, necessary technologies, and governance systems that can support this. The fifth equity condition relates to other kinds of help. The North will still need to do more in other areas to help the South. This can be regarded as an investment in the capacity of developing countries to participate in the climate process. A key area will be the development of affordable clean energy and transport options.

Aside from the five equity conditions above Mr. Vice-Chancellor Sir, any multilateral agreement without the active participation of major emitters in developing world (especially China, India, Brazil, Russia, Mexico, South Korea and Indonesia) would be meaningless. It is also observed that economics and political agendas always make it difficult to produce a treaty that all nations can agree to easily. The wealthier and more powerful nations are naturally able to exert more political clout and influence. The United States, for example, has pushed for carbon trading in emission to enable it maintains its dominance.

There is also the controversial question of the legal status of any agreement on climate change from the need to secure a political consensus on a range of mitigation and adaptation strategies. International coherence and coordination will also need to be sought with regard to measuring parties' mitigation efforts through internationally agreed monitoring, reporting and verification system. The Copenhagen negotiation has shown measurement and verification to be

a highly sensitive political subject, which will require a great deal of trust-building, persuasion and reciprocal action among the major powers.

The lack of political will among major emitters is a major problem to Kyoto protocol which should be urgently addressed. Major emitters lack the necessary domestic support or have yet to create policies as a basis for measuring international commitment.

The Post Kyoto climate treaty may have to re-design its regime structure in terms of emission targets, the ability of countries to withdraw from the agreement and a weak compliance mechanism. The present design is faulty as it reduces the incentive of Annex I (developed) countries to invest in mitigation efforts and undermine the willingness of non-Annex I (developing) countries to join the agreement at some future.

Finally, developing countries, most especially in Africa, must brace up to the reality of climate change. They must invest heavily on adaptation measures to protect their citizens from climate related hazards. They should integrate climate change into their developmental agenda, build institutions, invest in capacity building and formulate and implement all the necessary climate and environmental policies that will ensure sustainable development. I foresee a brighter future only if Africa can also fight against poverty, bad and weak governance, political marginalization and absence of basic infrastructure. The core challenge at the local level is to develop the framework and capacity to:

(i) assess the vulnerability of sectors and sections to different scenarios of climate change impact,

(ii) develop, assess and implement mitigation and adaptation options, and

(iii) strengthen the negotiating ability in climate change transactions.

If the developed countries cannot provide the required fund, technology and capacity building necessary for adaptation, Africa will have no option than to follow the unsustainable path the developed countries took to development. The developed world should realise that climate change is an ill wind that will blow no one any good. Afterall, recent IPCC report (2007) has shown that the rich will also cry.

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The Author

Professor Temi E. Ologunorisa was born on the 20th October, 1966 to Pa Gabriel Adelabu Ologunorisa and Madam Grace Bamidele Ologunorisa. He had his Primary School Education at United Primary School, Akungba-Akoko (1971-1977). He subsequently attended African Church Grammar School, Oka-Akoko and Oroke High School, AkungbaAkoko, Ondo State, Nigeria (1977 — 1982). Professor Ologunorisa had his B.Sc(Hons) Degree in Geography (with minor in Geology and Botany) from the Faculty of Science, University of Ibadan, Nigeria in 1988; M.Sc in hydrology and water resources from the Faculty of Environmental Science, University of Jos in 1991; and a Ph.D in Climatology from the University of Port Harcourt, Nigeria in 2002.

He started his teaching career with his appointment as an Assistant Lecturer in Geography in May 1991 at the Rivers State College of Education, Port Harcourt and after seven years in the College of Education system, he joined the services of the University of Port Harcourt as a Lecturer in February 1998. Through dint of hard work, he had a meteoric rise to the rank of Professor of Climatology at the Osun State University, Osogbo, Nigeria in October 2007. By this appointment, he became the first Professor to be appointed by the Osun State University.

His research interests cover broadly climatic hazards and vulnerability studies; flood hydro-climatology, air pollution meteorology, climate change impact assessment and climate change policy. He has been a consultant on many environmental projects to Mobil Oil Producing Unlimited (now Exxon Mobil); Agip Oil, Federal Ministry of Mines and Power, Environment, the British Council and the Lagos State Government. Professor Ologunorisa has published widely as he has over 100 publications to his credit made up of 50 articles in national and international journals; l2chapters in books, 3 books, 2 monographs, 10 edited books; 20 published conference proceedings and 6 technical reports. Perhaps the quality of his contribution to knowledge can be better appreciated when one considers the major outlets for his publications which include some of the top 10 journals of geography, environment and meteorology/climatology in the world. These include: The International Journal of Environmental Studies (UK); The Environmentalist (The Netherlands). The International Journal of Theoretical and Applied Climatology (Germany), International Journal of Climatology (U.K.);

Progress in Physical Geography (USA), The International Journal of Meteorology (U.K.); The International Journal of Sustainable Development and World Ecology (U.K); Journal of Sustainable Development (Canada); Journal of Modeling and Simulation Techniques in Enterprises (France), among others.

He is a recipient of many honours, awards, and academic distinctions. He was awarded the membership of the American Association for the Advancement of Science (AAAS) by special invitation in 2003. He won the international nomination to serve in the International Editorial Advisory Board Member of the International Journal of Meteorology, U.K in 2005. (The second person in Africa to serve in the Board). He was a plenary lecturer at the International Association of Hydrological Science Conference held at Exeter College, Oxford University, U.K in January 2007. He was a Visiting Professor to the Department of Geosciences, University of Missouri, Kansas City, USA in summer 2008; Visiting Professor to the Graduate School of Science and Engineering, Tokyo Metropolitan University, Miniami-Osawa, Tokyo, Japan in summer 2009. He was appointed an Honorary Visiting Professor, School of Geography, Population and Environmental Management, Flinders University of South Australia, Adelaide, Australia in 2009. He was a Visiting Professor to the School of Geography and Earth Sciences, McMaster University, Hamilton, Ontario, Canada in summer 2010. He was also a Guest Professor at the Institute of Water, Environment and Health, United Nations University, Hamilton, Ontario, Canada in 2010. He is a Fellow of the European Drought Research Centre, U.K.

Professor Ologunorisa is currently sitting on the editorial board of over 10 international journals. These include: CATENA published by Elsevier; International Journal of Biometeorology, published by Springer, The Netherlands; Natural Hazards published by Springer; JAMBA published by North-West University, Portchefstron, South Africa; Journal of Applied Geography published by Elsevier among others.

He was the Editor-in-Chief of the Journal of the Nigerian Meteorological Society (2008-2010) and also the Associate Editor of the Journal of the Association of Nigerian Geographers (2004-2005); Editor for Climatology, Centre for Distance Learning, University of Abuja; Editor, Nigerian Journal of Tropical Geography among other. He is a member of several learned societies such as International Association of Hydrological Sciences,U.K; Royal Meteorological Society U.K; American Geophysical Union; Annals of the Association of American Geographers

(AAAG); Tornados and Storm Research Organization (TORRO) UK; Nigerian Meteorological Society; Association of Nigerian Geographers; Environment and Behaviour Association of Nigeria, and Waste Management Society of Nigeria. Professor Ologunorisa has supervised over 20 M.Sc dissertations and currently supervising 2 Ph.D students. He has served as external examiner for M.Sc and Ph.D Degrees in Geography and Environmental Management and Meteorology in many Nigerian Universities including University of Agriculture, Abeokuta (2006-Present); Lagos State University (2007-2009), University of Abuja (2005-Present) among others.

He is actively involved in various administrative duties at the Osun State University in addition to teaching and research. He is a member of numerous statutory and adhoc committees and held many positions of responsibility at the University including Foundation Head, Department of Geography and Resource Management (2007-Present); Foundation Director, Centre for Climate Change and Environmental Research (2008- Present); Foundation member of Senate (2007 – Present); Member, Business Committee of Senate (2007-2009); Member, Appointment and Promotion Committee (Academics) (2007 — Present); Member Research and Publication Committee (2009 — Present); Acting Provost, College of Management and Social Sciences (2009) among others. He is happily married to Folukemi (nee Ale) and blessed with children.