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Climate Change and Sustainable Growth and Development in Lagos Metropolis, Nigeria

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Abstract

Ozone depletion and the ravaging effect on climate, lives and physical environment are global. The objectives of this paper are to describe atmospheric chemistry leading to ozone depletion, global warming and unravel the consequences of global warming in Lagos Metropolis with a view to making suggestions for sustainable growth and development. Recent literatures were contacted. News paper cuttings were read. Reports and communiqués of conferences, workshops, seminars and committees were read and used. Radio and television documentaries and programmes were listened to and used. Empirical observations were made on weather elements, plants and animals and others. Data on weather elements were derived from Federal Meteorological Station, Oshodi. Members of the public were interviewed and they provided information on recent changes in weather phenomena, acid rain, inclement warmth, vegetation and others. Compositions of the air differ significantly from the WHO permissible standards. Cloud cover is unusually thicker; early rains are cloudy and more acidic. Runoffs have increased, and aquatic ecosystems are gradually getting depleted and giving way to terrestrial type of ecosystem. There are threat to lives and property. There may be need for additional research to further establish the findings. But for sustainable development, every stake holder must rise against the adversities of global warming and harness its advantages.

Keywords: *Inclement warmth, acid rain, sustainable development, Lagos Metropolis.*

1. Background to the study

There had not been serious attention given to the depleting ozone layer, global warming and climate change until about four decades ago when it became obvious that anthropogenic damage to the earth's stratospheric ozone layer will lead to an increase in solar ultraviolet (UV) radiation reaching the earth's surface, with a consequent adverse impact, (Brain, 2004). According to him, more recently, there has been an increased awareness of the interactions between ozone depletion and climate change, which could also impact on human exposure to terrestrial UV. "The most serious effect of UV exposure to human skin is the potential rise in incidence of skin cancers". He went further to explain that risk estimates of this disease associated with ozone depletion suggest that an additional peak incidence of 5,000 cases of cancer per year in the United Kingdom would occur around the mid-part of this century. At the global level, among the major challenges of combating the menace is finance. But the next global meeting on climate change came up in Cancum, Mexico in December 2010 "where issues of financing saw significant progress," (Kortenhorst, 2010).

Shaheen (1992: 95) asserts that although ozone is a serious pollutant at ground levels around the atmosphere, in the upper atmosphere (around 25-44 kms) the ozone layer in the stratosphere protects the earth and the people living on it by blocking ultraviolet radiation (UV) coming from the sun. According to him, it has been estimated by the American Environmental Protection Agency (AEPA) that each 1%

decline in worldwide average of ozone will cause an increase in skin cancer by nearly 5%. It is the chlorofluorocarbon (CFCs) produced by humans that reach the upper atmosphere, where they cause destruction of the ozone; by doing so, they allow the harmful ultraviolet rays to reach the earth's atmosphere. In the upper atmosphere, the ultraviolet light breaks off a chlorine atom from chlorocarbon molecule, and then the chlorine attack the ozone molecule, causing its break up. By then, an ordinary oxygen molecule attaches itself to the chlorine to give chlorine monoxide. Subsequently, free oxygen atoms breaks up the chlorine monoxide and free the chlorine again to start its process of destruction by attacking another ozone molecule and the cycle goes on.

The importance and the gravity of the situation, led to an international conference sponsored by the United Nation Environmental Programme that was held in Montreal, Canada; and recently the Copenhagen Climate Change Conference. It was since the Montreal conference that 24 nations signed a milestone accord which promised to cut the production and use of ozone-destroying chemicals by 50% around the year 1999. The chairman to the conference declared: "There has never been an agreement like this on a global scale". Similarly, the administrator of the United States Environmental Protection Agency said:

> "The signing shows an unprecedented degree of cooperation among nations of the world in balancing economic development and environmental protection".

Chlorofluocarbons such as Freon are used as coolants in refrigerators and air conditioners, and they are important component in aerosol and plastic foams. The United States and European Community produce annually about 75% of the total world production of 1 million tons of CFCs. All of these will be reduced according to the Montreal Protocol; and which have actually started reducing (Fahey 2007 and Barnett, Adam and Lattenmaier 2005). This international pact also will limit the use of an ozone destroying group of fire suppressant chemicals called halons.

Fahey (2007), Barnett et al (2005) and, Cox, Betts, Jones, Spall and Totterdell (2000) believe that these compounds cause as much as 20 times the damage of CFCs. They are also of the view that up to 7% of the ozone belt, stretching 6 to 50 kms above the earth, has already been depleted. With the depletion of the ozone layer and its deterioration, ultraviolet radiation from the sun will cause a dramatic increase in skin cancer and cataracts. It will also lower resistance to infection and damage plant life, either directly or through a general warming of the earth – global warming. Hansen, Schnitzier, Strassmann, Doney and Roeckner (2007) assert that the earth and its atmosphere are warming up due to the greenhouse effect: The surface of the earth receives visible light and radiates heat back into the atmosphere as infrared rays. Some move on to outer space while a number of gases (mainly carbon dioxide CO_2) in the troposphere (the atmosphere, 0-16kms) catch these rays and reflect them back to earth. This causes warming of the earth similar to the conditions in a greenhouse.

Under normal and moderate conditions, CO_2 helps gases which come from man–made sources (electrical, transportation, industry and commercial building and homes) end-up trapping more heat and thus contribute to global warming. It is believed that the increase in gas concentration and especially CO_2 has caused an increase in global average temperature of about 0.4 ^{O}C since 1950 (Shaheen, 2000: 96).

However, why do we care about atmospheric ozone? The ozone in the stratosphere absorbs some of the sun's biologically harmful ultraviolet radiation. Because of this beneficial role, atmospheric ozone is considered "good ozone." In contrast, excess ozone at earth's surface that is formed from pollutants is considered "bad ozone" because it can be harmful to man, plants, and animals. The ozone that occurs naturally near the surface and in the lower atmosphere is also beneficial because it helps to remove pollutants from the atmosphere. In the absence of human activities on earth's surface, ozone would still be present near the surface and throughout the troposphere and stratosphere because ozone is a natural component of the clean atmosphere, (Fahey 2007). When ozone is massively "affected" and it reduces in amount, it leads to depletion of ozone layer which subsequently lead to global warming and climate change (Seinfeld and Dandis 1998 and Hansen, Schnitzerler, Strassmann, Doney and Roeckner, 2007). The detailed chemistry of the processes is beyond the scope of this work.

When coal, oil or other fossil fuels are burned, acid-rain precursors are emitted into the atmosphere. These include nitrogen oxides (NOx) and Sulphur dioxide (SO2). Once in the atmosphere, NOx and SO_2 are transformed, depending upon atmospheric conditions, into acid nitrate and acid sulphate otherwise known as nitric acid and sulphuric acid and fall back in rain, snow, fog, cloud water, particles, and gas. The term acid deposition encompasses all forms of inputs to acid.

But the questions therefore arise: what are the consequences of these phenomena, ozone depletion and global warming on the physical environment and social lives in Lagos Metropolis. Thus, the objectives of the paper are to briefly describe selected atmospheric chemistry that lead to depletion of ozone layer, global warming and unravel selected consequences of global warming in the metropolis with a view to making suggestions for sustainable growth and development. Emphasis is on inclement warmth and acid rain.

2. Materials and Methods

Modern transformation of cities and towns in Africa owes its growth and development largely to European colonial urban policies aimed at building markets and colonial administrative centres, (Emordi and Osiki 2008). According to them, these policies later broadened to make cities places of social, receptacles for talents and manpower, and places of investment (Bardo and Hartman 1982: 343–350). The policies and programmes gave rise to rapid urbanization, which not only resulted in the massive rural–urban migration, but also brought about changes in everyday lives of residents and visitors in the city. These changes came with improved communication system such as roads, railway, sea and airport facilities and of course telephone. All of these elevated Lagos to a pre-eminent position in the nation’s economic, political and social activities. No other city of Nigeria has such advantage as joint termini of major land, rail, sea as well as air routes. The position also attracted other urban functions, facilities and amenities; and a growing and relatively affluent population which formed a main consumer market when the process of industrial development began. These attributes, in addition to the sheer magnitude of the size of the city puts her in a class of its own; and compounded many of its problems (Mabogunje 1968: 239 and Barnes 1986: 11-15).

The location is highly favourably capitalizing on vast resources of Nigeria and West Africa as a whole. Table I shows the local government areas, area extent, and the population densities of the local government areas that make-up the metropolis. She has a population of 7.937 million that is unevenly distributed over 999.6 km^2 of the land area. Ikeja, the state capital, is also located within the Metropolis. Figure 1 shows the growth of the metropolis between 1900 and the present day.

Most of the Nigerian’s corporations chose to have their headquarters located within the Metropolis. Also, apart from being the administrative headquarters of the 16 Local Government Areas that make-up the metropolis, she was the capital of Nigeria until 1991 when the political power was moved to Abuja. Manufacturing, transportation, port activities, commerce, recreation and other hospitality activities, construction, reconstruction, renovation and related activities and others are highest probably more than in any African city. All of these have implications for the environment.

Table I: Local Government Areas of Lagos Metropolitan Area, Population, and Land use.

Local Government Areas	**Land Area (Km^{2})**	**Population (2006 Census)**	**Population Density/km^2**	**Major Land Use**
Agege	12.2	459,939	41,671	Residential/Agricultural
Ajeromi-Ifelodun	12.3	684,105	55,474	Residential/Industrial
Alimosho	185.2	1,277,714	6,899	Residential/Agricultural
Amuwo Odofin	134.6	318,166	2,364	Residential/Industrial
Apapa	26.7	217,362	8153	Transport/ Industrial
Eti-Osa	192.3	287,785	1,496	Residential/Commercial
Ifako Ijaiye	26.6	427,878	16,076	Residential/Agricultural
Ikeja	46.2	313,196	6,785	Commercial/Industrial
Kosofe	81.4	665,393	8,174	Residential/Agricultural
Lagos Island	8.7	209,437	24,182	Commercial/Residential
Lagos Mainland	19.5	317,720	16,322	Residential/Commercial
Mushin	17.5	633,009	36,213	Residential/Commercial/Industrial
Ojo	158.2	598,071	3,781	Commercial/Industrial/Educational
Oshodi-Isolo	44.8	621,508	13,886	Industrial/Commercial
Somolu	11.6	402,673	34,862	Residential/Commercial/Educational
Surulere	23.0	503,975	21,912	Residential/Commercial/Educational
Metropolitan Area	999.6	7,937,932	7,941	Industrial/Commercial/Transportation/ Education/ Residential

Source: National Population Commission Abuja; and Field Survey.

Today, Lagos metropolis stands as the commercial and financial centre of Nigeria and by extension, of West Africa; a major educational centre, ”a onetime best Nigerian city, best supplied with urban infrastructure such as potable water, road network and railway, electricity and employment opportunities,” (Emordi and Osiki, 2008). All these transformed the city into a major focus of the urbanization process. The Guardian of 22nd February 1987: 64 remarked that Lagos was seen by rural people as:

> “ ….. place away from home. A place to catch up with the wind of change sweeping across the world, to help wrestle the traditional gods of mud-huts, palm wine, cutlasses and hoes, and enthrone the western one of skyscrapers, champagne and tractors. …..”.

Even more recently, that is, over two and a half decades after, the same paper describes Lagos as:

> …. Great and beautiful, a heaven on earth endowed with everything and lacking nothing; a place where life is nothing but enjoyment: and a land of opportunities where jobs are provided and where fortunes are made easily…….
>
> Guardian 23 April, 2003: 17

Inspite of these, the metropolis is not without its challenges, noticed and/or unnoticed by the residents and governments. Lagos would have been living in its past glory if not for the current government that is magnanimously embarking on concerted efforts of renovation, construction and reconstruction, resuscitation and introduction of policies and programmes, projects and others to bring back the old glory and build on it.

Painting a graphic of slums in the metropolis, Socio-Economic Rights Initiatives (SRI) in 2006, a non-governmental organization as quoted by Emordi and Osiki (2008) noted:

> The houses are drab, dirty, and wrecking with unclean and decaying refuse. Water is scarce and must therefore, be rationed, excreta disposal is inadequate with litters of human waste being a common sight in a neighbourhood …. [There] are also inadequate drainage facilities with waste water forming mini puddles within the compound where mosquitoes and insect vectors exercise their respective potentials. The degree of environmental pollution emanating from such high level of squalor can be imagined by realizing that epidemics of cholera, typhoid fever and dysentery are frequent occurrence.
>
> Vanguard, September 18, 2006:42

They went further to assert that despite the relative urbanized nature of the metropolis and its modernity, it exhibits all the characteristics of a villagised city accommodating a large number of slum areas. Recent literature on ozone layer, global warming, and climate change were read, and so also those on urban land use, pollutants and pollutions. Newspaper cuttings were read. Reports, communiqués and/or proceedings of conferences, workshops and seminars on ozone layer and depletion, global warming, climate change and acid rain were perused. See the Appendix. The Appendix shows the developments in the study of Acid Rain between 1954 and 2002, (Cowling 1982 and Driscoll and Lawrence 2001). The researcher listened to television and radio documentaries on climate change, global warming and depleting ozone layer. Data/information derived from these sources is significantly represented in this work. Empirical investigations were carried out particularly on air and rain water. Data on weather elements were obtained from the Federal Meteorological Station, Oshodi. But emphases were on temperature, rainfall, Relative Humidity and particulates in the air.

In April, August and December 2010, as it was in the last five years before then, rain water was collected in 12 designated locations and analysed to ascertain the composition of the water particularly as acid rain was speculated. Federal Ministry of Environment, Lagos Office and Federal Environmental Protection Agency were visited and so also the State Ministries of Environment and Physical Planning. Documents/records were perused; and a director each from each of the Ministries and agency visited was interviewed. They responded to questions on pollution, pollutants, controls and challenges. Areas of concern were enumerated and suggestions for adaptation to effects of global warming were made.

Familiarization tours of the different suburbs of the metropolis and the rural suburbs were carried out in two months – March and April, 2009. During the period, the researcher came to understand the different land use, predominant human activities, and types of industrial processes, rural activities, productions and resultant effluents.

3. Results

Inclement warmth

Table II shows the variance from the established average monthly readings of temperature, rainfall and Relative Humidity. There is no noticeable variation shown for the five years of rainfall in the months of January, February and December. November shows a negative of 0.01mm. Other months of the year show positive variations. The least are 0.11 mm and 0.12 mm in March and April. It is as high as 1.10

mm in June; and 0.91 mm, 0.94 mm, 0.82mm, 0.61 mm and 0.68mm in the months of May, July, August, September and October respectively. The mean variation is 0.44 mm.

Table II: Average weather (climate) variability – Rainfall, temperature and humidity

Months	Rainfall (mm)	Temperature (CO)	Relative Humidity (%)
January	0.00	+ 0.4	+1.1
February	0.00	+ 0.4	+1.3
March	0.11	+ 0.8	+1.6
April	0.12	+0.6	+3.1
May	0.91	0.2	+4.2
June	1.10	0.0	+4.8
July	0.94	0.0	+4.2
August	0.87	+0.1	+4.2
September	0.61	+0.1	+4.1
October	0.68	+0.2	+4.1
November	-0.01	+0.2	+3.8
December	0.00	+0.4	+3.1
Mean	**0.44**	**+0.3**	**3.4**

Source: Field Survey

Similarly, the temperature has shown some positive variations for every month except June and July only, 0.0^{o}C. March experienced the highest, 0.8^{o}C. January (0.4^{o}C), February (0.4^{o}C), and April (0.6^{o}C) similarly experience positive change from the established figures. The mean is 0.3^{o}C. The mean Relative Humidity is 3.4%. There is no month with negative deviation. It is plus throughout. It is highest in June (4.8%), May (4.2%), July (4.2%), August (4.1%) and October (4.1%). It is lowest only in January, February and March, 1.1%, 1.3% and 1.6% respectively; Table II. More importantly, the August break is no longer obvious in the month of August; and neither do the double maxima noticeable.

Furthermore, Table III shows average change observed in elements of weather and composition of air around a landfill. The elements noted include cloud cover, temperature, air pressure, wind direction and speed, rainfall, sun illumination, organic bacteria, ionization (total) and others. There have been remarkable changes. Cloud covers increase by 2.6%, temperature by 1.7%, air pressure by 1.1%, and Relative Humidity by 4.8%. Wind speed decreased by -2 - -3%, visibility by -20 - -30%; organic bacteria is 75- 145 times more, nuclei solid is 41 times more and ionization (total) is 8-16 times more. Wind direction and rainfall do not show any noticeable change, but wind speed reduced by -2 - -3%. Table III.

Table III. Average Change in Elements of Micro-Climate Around a Landfill

Element	Average Change
Cloud Cover	2.6%
Temperature	1.7%
Air Pressure	-1.1%
Relative Humidity	4-8%
Wind Direction	Unnoticeable
Wind Speed	-2- - 3%
Visibility	-20 - -30%
Radiation Intensity	-17- -25%
Rainfall	Unnoticeable
Illumination	-12 - -50%
Gaseous (SO^{+}) Pollutant	10-30%
Nuclei Solid	41 times
Solid Dust	35 times
Organic Bacteria	75-145 times
Ionization (Total)	8-16 times
Others	8-20 times

Source: Filed Survey

Though these variations appear localized to the dumpsite and immediate surroundings, there seemed to be similar situations round the year and at least for average radius of 50 - 100 meter for each of the several massive landfills in the metropolis.

Again concentrations of particulates and sulphur dioxide (SO_2) in the dry air, on the average, were found to be 135 ug/m^3 and 171 ug/m^3, respectively. Highest concentrations of particulate were found at Amukoko, Ajegunle, Surulere, Oshodi and Ikeja with 148 ug/m^3, 144ug/m^3, 140 ug/m^3, 151 ug/m^3 and 154ug/m^3 respectively. It is lowest at Ikoyi (94 ug/m^3), Lagos Island (108 ug/m^3), Ajah (131 ug/m^3) and Victoria Island (98 ug/m^3). Similarly, the Sulphur dioxide concentration is lowest, less than 150 ug/m^3 at Agege (148 ug/m^3), Ebute Meta (142 ug/m^3), Ikoyi (119 ug/m^3), Lagos Island (129 ug/m^3) and Victoria Island (128 ug/m^3). It is as high as 201 ug/m^3 at Oshodi, 211 ug/m^3 at Yaba, and 281 ug/m^3 at Ikeja. These conditions are favourable for formation of water droplets and acid rains, (Seinfeld et al1998 Walther et al 2002 and Wikipedia 2002). Both particulates and SO_2 are highest along road transport routes, (Akanni, 2010)

Table IV: Typical concentrations of particulates and SO_2 in the atmosphere.

Community	Particle Concentration ug/m^3	SO_2 Concentration ug/m^3
Amukoko	148	166
Ajegunle	144	201
Itire	127	158
Agege	138	148
Surelere	140	204
Ebute meta	132	142
Oshodi	151	310
Ikoyi	94	119
Yaba	139	211
Ikeja	154	281
Ketu	138	188
Maryland	126	169
Mushin	131	158
Egbeda	128	181
Isolo	129	171
Alapere	131	188
Lagos Island	108	129
Ajah	91	131
Shomolu	134	182
Victoria Island	98	128
Bariga	131	161
Average	135	171

Source: Field Survey/ Federal Environmental Protective Agency, Lagos Office.

Acid Rain:

Occasional pH readings in rain fog and dew water of below 5.8 were observed for industrialized Ikeja (5.1), Ilupeju (6.2), Mushin (5.7), Isolo (6.1) and Apapa (5.2) industrial axis of the metropolis, leading to industrial acid rain. Table V. Combustion of fuels creates sulphur dioxide and nitric oxides. They are converted into sulphuric acid and nitric acid (Berresheim, Wine, and Davies, 1995): In the gas phase, sulphur dioxide is oxidized by reaction with the hydroxyl radicals via an intermolecular reaction thus:

Table V: Locations and dew/fog/rain water with their pH readings

Locations	pH Readings
Ikeja	5.1
Ilupeju	6.2
Mushin	5.7
Isolo	6.1
Apapa	5.2

Source: Field Survey

$$SO_2 + OH^{\cdot} \longrightarrow HOSO_2^{\cdot}$$

This is followed by

$$HOSO_2^{\cdot} + O_2 \longrightarrow HO_2 + SO_3$$

In the presences of water, sulphur trioxide (SO_3) is converted rapidly to sulphuric acid

$$SO_{3(g)} + H_2O_{(l)} \longrightarrow H_2SO_{4(l)}$$

When clouds are present, the loss rate of SO_2 appears to be faster than can be explained by gas phase chemistry alone. This is due to reactions in the liquid water droplets, (Likens, Discoll and Buso, Mitchel, Lovett, Bailay, Siccama, Reiner and Alewell 2002). There are hydrolyses reactions – sulphur dioxide dissolves in water and then, like carbon dioxide, hydrolyses in a series of equilibrium reactions follows:

$$SO_{2(g)} + H_2O \rightleftharpoons SO_2.H_2O$$

$$SO_2.H_2O \rightleftharpoons H^+ + HSO_3^-$$

Large volumes of traffic, electricity generating plants and facilities, wastes generated from different sources, pollutants and pollutions of the air, water and land, landfills, poor management and others resulted in the presence of these oxides, particulates and the reactions, (Akanni, 2010, Ogunnowo and Aderogba 2006, and Emordi and Osiki, 2008). Other noticeable changes are found in the:

- Total amount of rainfall per annum that is slightly increased but the spread per year and intensities have reduced, and other forms of precipitation have reduced; and
- Cloud covers appear to have increased.

4. Discussion

The foregoing has shown drastic departure from the known weather elements and characteristic components of normal air at normal temperature and pressure: inclement warmth and acid rain are becoming obvious. Specifically, there are various symptoms and behaviours of man and other life forms exhibiting these:

- Animals and birds prefer to stay more under shades, look for and drink more water;
- Human being complain more about heat, drink more, and preferably cool drinks;
- Umbrella and sunshades are becoming more popular and useful;
- Residents request for more ventilations in their new buildings, and offices while old structures are being renovated to provide for more and better ventilations;
- Though no electricity from national grids to effect cooling of houses and offices, residents were forced by circumstances to buy electricity generating plants and facilities to fan/cool their offices, houses and drinks;
- There have been unbearable stifling humidity that pervaded the atmosphere for weeks and the dense haze has been producing uncomfortable heat and dust in the months of dry seasons;
- Both days and nights are extremely very hot and the temperature becomes inclement- this is particularly unbearable during hot seasons - December to April. The extreme inclement warmth in March/April of 2010 is what Lagos residents are yet to come to terms with;

- Early rains are more acidic and turbid – wearing dull appearances;
- Sachet water (*pure water*) is now very common and it is taken sporadically and frequently by travellers and traders at parks, markets and business centres;
- Children now play more with water than they do with sand.
- Relatively, residents of the metropolis now patronise beaches, restaurants and bars more often to cool off from the hot days and inclement warms of offices and homes;
- Relatively, more drinks, bear, stout, beverages, soft drinks, chocolates drinks and others are sold and consumed more than ever before; and
- Heat related ailments/diseases are reported more often in hospitals for children, adults and aged;
- Some plant species are going into extinction, others are now emerging and aquatic ecosystems are assuming terrestrial attributes.

The suspected elevated levels of hydrogen ions (low pH) caused by the emission of compounds of ammonia, carbon, nitrogen, and sulphur react with water molecules in the atmosphere to produce acid; and acid rain - "acid deposition," (Likens, Discoll and Buso 1996 and Dinrinfor et al 2010).

The smoke stacks, and exhausts of electricity generating plants spew out basic ingredients of acid rain namely sulphur dioxide (SO_2) and nitrogen oxides (NO_x). These are suspected to have combined with water vapour in the atmosphere and return to the earth's surface in the form of acid rain. This has been taking place for a number of years, but little or nothing has been done about it. The problem is becoming graver. Incidentally, winds carry the acid rain pollutants for long distances, and the pollutants emitted from one community travel to cause serious arm to other communities far away from the source of emission.

There were fears and pandemonium about acid rain all over the metropolis (and in the entire country) probably as a result of all of these observations and the fallout of e-mails and text messages sent to individuals by the National Aeronautics and Space Administration (NASA), warning of an impending acid rain that read thus:

> There is a possibility of acid rain. The dark circle appeared around the moon on March 17 and this was an indication of an acid rain. Apparently, this happen once in 750 years. It rains like normal rain, but it may cause skin cancer if you expose yourself to it. This is coming from NASA, warn your family and friends.

The acid rain has gradual adverse impacts on forests, fresh water and soils, killing insects and aquatic life forms as well as causing damages to buildings, historical monuments (especially those made of lime stones, marble or other rocks containing large amount of calcium carbonate) and having impact on human health, (Bernessheim, Wine and Davies 1995 and Weathers and Likens 2006).

Wet deposition of acids have been occurring when any form of precipitation (rain, dew and fog) removes acids from the atmosphere and delivers it to the earth surface, on plants, buildings, rocks, and on man and animals. These result from the deposition of acids produced in the raindrops or by precipitation removing the acids either in clouds or below clouds. "Wet removal of both gases and aerosol are both of importance for wet deposition," (Seinfeld and Pandis 1995). Those that occur via dry deposition in the absence of precipitation were formed as a result of particulates and gas sticking to the ground, plants, building roofs, crops and other surfaces.

Though unconscious of the magnitude, it is already a threat to lives and property. In the weeks of 28th March, 2010, there were threats of rain and there were frenzied outburst made by residents as they dash in different directions following the shower that fell in various parts of the metropolis- Ogba, Agege, Mafolukun, Oshidi, Ijesha, Mushin and a few other suburbs. Within the few minutes of the light shower, all hell broke loose as people scampered from what they feared and earlier been announced as acid rain:

> *Comot for road, comot for road this rain no go meet me for here! E no go touch my body! I no won die for Lagos under acid rain: ….. acid rain! I cannot afford to die in Lagos through this rain. My people dey expect me at home …. Oh! No! acid rain…. Mba...God forbid acid rain hey...*

The phenomena of inclement warmth must be addressed. Emission of oxides and particulates that are impetus (ingredients) to acid rain must be reduced to zero. These are necessary because the inclement warmth is undesirable, makes lives uncomfortable and more expensive; and the effects of acid rain can last for generations.

For adaptability and sustainable growth and development

Lagos metropolis, in all ramifications, is significant to Nigeria, Nigerians and of course, to the world of commerce and industry. Therefore sustainability of the physical environment must be ensured:

- drastic and cogent measures must be taken to ensure that electricity is readily available and cheaper for urban dwellers to enable them cool their houses, offices, indoor recreation centres (towards adaptation) and to prevent heat related diseases such as stroke and measles and for other uses;
- The design and construction of buildings for both commercial and residential purposes must take cognisance of inclement warmth;
- Though the state government has embarked on tree planting, this should be intensified, encouraged and supported by all tiers of government, individuals, corporate bodies and philanthropies. The government could institute a programme to be titled “A Family, a Tree Project;”
- Water is life, sanitation is dignity: there must be concerted efforts to make potable water readily available for cooling, bathing, washing, drinking, recreation and production processes; and for sanitation so as not to compound the inclement warmth and likely associated ailments and diseases;
- Industrial, vehicular and domestic activities giving rise to air pollutants and pollutions, depleting ozone layer and also resulting in acid rain must be further comprehensively studied towards reducing it from sources. The developed world is targeting zero emission, Lagos, and of course Nigeria, should join the raise.
- Following from above, Nigeria should pass a bill that will be very decisive on emission, and target zero emission by 2015 while the existing Acts on Environment should be implement to the letter;
- The resources for environmental sustainability should be given very serious priority and in turn;
- Environmental education should be given high priority in schools’ curricular and at the adult and non-formal levels of education; and
- Environmental Impact Assessment (EIA) and certification of every project, be it government or non-governmental, must be carried out without prejudice.

Above all, governments must make effort to reduce the production of oxides and particulate into the atmosphere. Whatever could lead to acid rain within and around the metropolis need to be prevented as the effects of acid rain can last for generations: The effects of pH level change can stimulate the continued leaching of undesirable chemicals into otherwise pristine water sources; killing of vulnerable insects and fishes; and blocking efforts to restore native life.

A number of international treaties on the long range transport of atmospheric pollutants have emerged and agreed, for example, Sulphur Emission Reduction Protocol under the Convention on Long-Range Tran boundary Air Pollution. Government of Nigeria and Metropolitan Lagos in particular, should apply to be part of such bodies and their policies and programmes.

There are now emission trading. In the regulatory scheme, every current polluting facility is given, or may purchase on an open market, an emission allowance for each unit of a designated pollutant it emits. Operators can then install pollution control equipment, and sell portions of the emission allowance they no longer need for their own operations, thereby recovering some of the capital cost of their investment in such equipment. The intention will be to give operators economic incentives to install pollution controls.

5. Conclusion

The foregoing has established that the metropolis has come a long way; and it is now a melting port of nations. The various activities of man in the metropolis has given rise to pollutants that have aggravated the effect of global warming noticeable and specifically result in inclement warmth and acid rains among others, that are most worrisome during the dry seasons and early raining seasons respectively. With efforts towards reducing the emission and other air pollutants, the incidence/fear of acid rain should be allayed but the Appendix shows efforts that had been made in respect of acid rain. Nigeria also needs to be futuristic about urban activities that are producing ingredients for acid rain.

But for sustainable environment, and if the metropolis in particular and Nigeria as a whole is going to benefit from the Millennium Development Goals, every stakeholder must rise against global warming where and when necessary and harness its benefits to the fullest. Also research and development should be intensified and focused on global warming and its effects. Nigeria and Nigerians should also be identified with ozone recovery.

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APPENDIX

Developments in the Study of Acid Rain

1954-61	Gorham demonstrates the acidity in precipitation markedly influences geological weathering process and the chemistry of soils.
1963	Gordon and Gorham describe serious damage to vegetation downwind of an iron sintering plant. They categorize the damage as ranging “very serious” (reddened needles and crown thinning of hardwoods).
1968	Oden describes biological uptake and ion-exchange process whereby the natural acidification of soils would be accelerated by the atmospheric deposition of ammonia and other cautions. Acidity in precipitation is postulated as the probable cause of impoverished forest soils decreased forest growth, increased disease in plants, and other effects.
1972	Jonsson and Sundberg establish an experimental basis for the suspicion that acidic precipitation had decreased the growth of forests in Sweden. Overrein demonstrates accelerated loss of calcium and other cations from soils receiving acid precipitation. Likens documents the problem of acid deposition and its effects in North America.
1973	Wiklander proposes a general theory to account for the effects of acid precipitation on soil chemical properties.
1974	Shriner demonstrates that simulated rain that is acidified with sulfuric acid can accelerate erosion of the protective waxes on leaves, inhibit nodulation of leguminous plants, and alter plants' host-pathogen interactions.
1976	Schofield's work shows a decline in fish populations in the lakes of New York's Adirondack Mountains.
1979	Cronan and Schofield discover that aluminum ions in soils are leached by acid precipitation into streams and lakes in concentrations that are toxic to fish.
1980	Abrahamson determines that the negative effects of acid deposition on growth are most likely to occur when it increases nutrient imbalances or deficiencies. Ulrich demonstrates a significant correlation between the amount of soluble aluminum in forest soils, the death of feeder roots in spruce, fir, and birch forests, and widespread decline in the growth of these forests.
1981	The National Academy of Sciences notes that while the effects on soils, forests, and plants have not been proven, "long-term permanent damage to the ecosystem may result" from the leaching out of necessary nutrients.
1982	Siccama et al. describe the decline of red spruce on Camel's Hump in Vermont, noting foliar injury similar to drought under conditions of ample water availability. Nearly half of the large canopy red spruce died over an 18-year period. Vogelmann points out that the aluminum present in soil water at Camel's Hump could be responsible for the lack of water uptake through roots. He also reports a 15% - 30% decline in the basal area of sugar maple and beech since 1965 on Camel's Hump.
1983	The President's Office of Science and Technology Policy (OSTP) panel asserts that it is "especially concerned" about the deleterious effects of acidity on soils. Johnson and Siccama report high mortality among red spruce in New York, Vermont, and New Hampshire, which they attribute to synergistic effects of acid deposition and drought.
1984	Johnson et al. document a correspondence between incidents of highly acidic cloud water and red spruce winter injury in the Adirondacks and Green Mountains.
1988	Shortle and Smith identify aluminum-induced calcium deficiency in soils and its association with fine-root dysfunction.
1989	Nilsson and Grennfelt define critical loads of sulfur and nitrogen as levels below which harmful effects on sensitive elements of the environment are not expected to occur.

Based on critical analysis of available information, the NAP AP forecasts that up to 30% of southern forest soils would show major changes in soil chemistry within the next 50 years.

Aber et al. introduce the possibility that atmospheric inputs of nitrogen could exceed vegetation demand in the Northeast, with possible negative effects on forest productivity.

1991 Craig and Friedland quantify forest decline in the White Mountains to be ~25%.

1993 DeVries determines critical loads of sulfur and nitrogen for acidification of watersheds in the Netherlands.

1995 Cronan and Grigal determine that Ca:Al ratios < 1 in the soil correspond to a greater than 50% probability of impaired growth in red spruce.

1996 Likens et al. quantify the loss of available calcium from the ecosystem at Hubbard Brook, NY, finding that ~50% has been leached out by acid rain over the preceding 50 years.

1997 Long et al. find that liming significantly increases sugar maple growth and flower and seed crops, increases exchangeable base cations, and decreases exchangeable aluminum in soil.

1999 DeHayes et al. describe the mechanism for tree decline associated with acid deposition, including the loss of membrane-associated calcium in foliage.

Horsley et al. find that dieback of sugar maple at 19 sites in PA and NY is correlated with a combination of defoliation and deficiencies of magnesium and calcium.

2001 Driscoll et al. predict that even reductions greater than 50% of SO_2 and NO_x emissions from electric utilities would not restore soil chemistry to critical thresholds at sensitive sites for decades. They cite the slow rate of base generation from mineral soil and the accumulation of sulfur and nitrogen in soils as causes for the protracted recovery.

2002 Watmough and Dillon use a "critical loads" approach to estimate that sulfate deposition would have to be reduced by 37% - 92% in watersheds that are harvested in order to maintain ANC above critical levels in Ontario.

Sources: Cowing, E. B. 1982. Acid precipitation in historical perspective. *Environmental Science and Technology. Vol. 16* No 2 pp110A-21A; and Driscoll, C. T. and Lawrence, G. B. 2001. Acidic Deposition in the northeastern US: Sources and inputs, ecosystem effects, and management strategies. *Bioscience No 51*; pp180-98

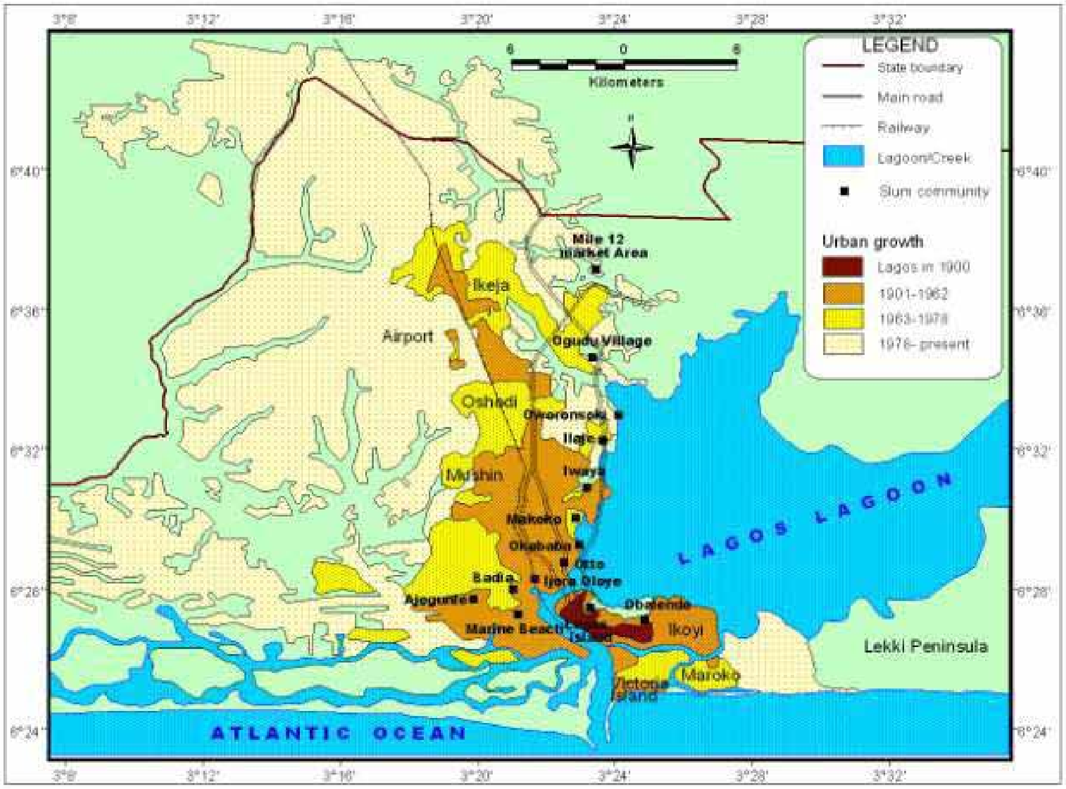

Figure1: Map of Lagos showing growth of the Metropolis