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ENVIRONMENTAL POLLUTION: THE SCOURGE OF LIFEKIND

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1.0 INTRODUCTION

When I first attended FUTO's Senate meeting, the Vice-Chancellor, Engr. Professor C.O.G. Obah, stressed among other things the need to prevent from dying FUTO's tradition of inaugural and public lectures. I was impressed considering the fact that most Nigerian universities, unfortunately, no longer see such lectures as necessary any more. The reason is blowing in the wind: many administrators of Nigerian universities now spend many precious man-hours on scheming to ensure that peace reigns in their various campuses. Personally, I believe that one very important visible way to energise the university system and enhance its intellectual tone is through distinguished public and inaugural lectures. Such lectures from my experience help considerably to bridge the gulf between town and gown.

I must, therefore, use this forum to congratulate FUTO administration and Senate for creating the atmosphere for an academic carnival such as this, and for giving me this singular opportunity to contribute to the intellectual growth of FUTO - a fast growing, fascinating university. I was able with the facilities placed at my disposal to start and complete the writing of my forthcoming book, which focuses on science and technology in Africa within the first four months of my stay here. The preface boldly says it all - that the book was conceived of and crafted at FUTO. This book, as it goes into circulation, will in my humble estimation, assist in the projection of FUTO's image nationally and internationally.

Since my arrival here, I have met and interacted with old friends of mine, and have also made new ones. One intriguing feature of FUTO is its Church on Wheels; it brightens the mornings for staff on board, and it urges them to serve FUTO faithfully. All staff on board prayed, sang choruses, clapping hands with joy. I should mention also that once a staff refused to sing and clap his hands because he was hungry. I do hope that the Vice Chancellor will appoint before long a bishop to run the affairs of FUTO Diocese on Wheels.

FUTO, from its terrestrial size and projected combined population of staff and students may soon attain the gargantuan stature of an autonomous community. I do hope also that the Vice Chancellor will at that time confer chieftaincy titles on deserving staff and students during FUTO's New Yam Festival.

Now, the business of the day. Environmental pollution has become topical worldwide, so much so, that no day now passes without some discussion being centered on the issue somewhere in the world. The advanced countries are environment-conscious in the superlative, while many Third World countries have yet found no place for the environment either in their dictionary or in their national development programmes.

My sermon this morning is on **Environmental Pollution: The Scourge of Lifekind.** This sermon is of national and international interest, and it is hoped that at the end of the day I would be able to capture the souls of members of different religious groups and hardened unbelievers as well, to constitute a new club of virile born-again environmental evangelists.

There is need for one to understand what **environment** means and what **pollution** and **lifekind** stand for, for one to be able to appreciate the import of this lecture. **Environment**, according to the *Concise Oxford Dictionary of Current English* means surrounding. This definition fails to itemise the components of the surrounding. The environment, as spelt out in the Federal Environmental Protection Agency Decree of 1988, "includes water, air, land, all plants and human beings or animals living therein and the inter-relationships which exist among these or any of them."[1] Much as I find this definition plausible, I believe, nevertheless, that the one given by the UNESCO-UNEP International Environmental Education Programme is all-embracing: "the environment encompasses everything living and non-living objects, the interactions between these and the products of these interactions."[2]

Pollution has been defined, in my opinion, in as many ways as there are cherries in Damascus. However, I feel constrained to incline to a simple definition crafted for children in the *Macmillan Children's Encyclopedia:* Here, pollution is denied as the poisoning of the land, the seas and the air.

Lifekind is a newly coined term; just as the word **human kind** or **mankind** enables us to refer to all human beings at once, so does the word **lifekind** allow us to refer to all living things (including mankind) at once.[3]

Man in our time has successfully landed on the moon. Between 1969 and 1972 twelve US astronauts landed on the moon in six different voyages of space exploration. Man has over the years made numerous startling scientific and technological innovations. Despite all these feats, one of the delimmas of our time is that man himself has not been able to keep the air he breathes or the water he drinks pure enough, or the land on which he has his shelter or farms to obtain his food clean enough to sustain life and assure good health.

Now, a brief excursion to geological history. According to Michael Caduto[4] the formation of solar system and Earth occurred 4.5 billion years ago; the beginning of life on Earth 3.5 billion years ago; the first use of fire 500,000 years ago; the appearance of Neandethal man 100,000 years ago; and, the beginning of industrial revolution 200 years ago.

We need to acquaint ourselves with a few characteristics of our planet Earth before discussing environmental pollution and degradation because the Earth and its environment form a complex integrated system whose parts should not be viewed in isolation. The Earth is a system within systems - it is part of a much larger scheme of things. Our sun is an incandescent ball of gases, a star around which revolve nine planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto. Only the Earth has an atmosphere with oxygen. The mean average temperature on the surface of the Earth is 60^0 F; that of Venus is 720^0 F, while that of Neptune is - 380^0F. The average distance of the Earth from the sun is 150 million kilometres; Mercury is 58 million kilometres away from the sun; while the distance of Pluto from the sun is 5960 kilometres. The Earth makes one revolution around the sun in 365.26 days; Mercury does so in 88 days, and Pluto in 247.7 years. The Earth makes one rotation on its axis in 23 hours 56 minutes; Jupiter in 9 hours 50 minutes and Pluto in 6.4 days. The approximate diameter of the Earth is 12, 756 kilometres; that of Mercury is 4,800 kilometres; while Jupiter has a diameter of 142,800 kilometres[5]

One may cautiously say that environmental pollution began, perhaps, with the first use of fire - 500,000 years ago; of course, as the industrial revolution started, environmental pollution blossomed and snowballed over the years to the gargantuan scale which now frightens the entire world.

Man *ab origine* was a part of nature; but surprisingly, he is now an exploiter of nature through modern technology, which to a large extent, is ruthless towards nature. Thus, man is largely responsible for the pollution of the air, the seas and the land. This may be why Vaclav Smil says:

> No single species has ever
> transformed the biosphere as
> much as human beings
> have since the beginning
> of this century.[6]

This is not to say, however, that nature cannot be indicted for contributing, to some extent, to the pollution of the environment and the alteration of the ecosystem. Nature, for example, is responsible for the dispersal of pollen, micro-organisms and insects, or parts of insects such as hairs, wings and legs. These particles have deleterious effects on man - causing hay fever, bronchial asthma, various fungous infections and airborne bacterial diseases. An errupting volcano is also a natural source of pollution.

2.0 TYPES OF ENVIRONMENTAL POLLUTION

Because of the abuses of the environment and consequent inherent dangers, this lecture is designed for the purpose of public enlightenment to focus in particular on the following categories of environmental pollution:

(a) **AIR POLLUTION**

We shall discuss under this heading a number of things: air pollutants, self-pollution, vehicular emissions, industrial pollution, gas flaring, bush burning, noise pollution, acid rain, ozone depletion, greenhouse effect among others.

(b) **WATER POLLUTION**

This lecture under this cover will focus on oxygen-demanding wastes, disease agents, plant nutrients, organic chemicals, industrial effluent, eroded sediments, other solids, oil spillage and thermal pollution.

(c) **LAND POLLUTION**

Under land pollution such issues as oil spillage, gas flaring, garbage, harzadous wastes, radioactive wastes; land degradation: mining, quarrying, deforestation, desertification and erosion will be discussed.

This lecture focuses on environmental pollution and degradation globally,and also copiously X-rays specifically the Nigerian scene.

3.0 AIR POLLUTION

The presence in the atmosphere of unwanted elements that have adverse effects upon one or more of the following: human health and well-being, property, and non-human life forms - plants and animals, is referred to as air pollution. Although air pollution includes in a general sense contamination from volcanic ash and gases, smoke from natural fires, dust and even pollen, it is nevertheless, the pollution derived from the activities of man that represents the most significant long-term threat to the biosphere[7]

The atmosphere is a gaseous mass enveloping the Earth and rotating together with it. The mass of the atmosphere amounts to 5.15×10^{15} tonnes.[8] The atmosphere is subdivided into: *troposphere*, stratosphere, mesosphere, ionosphere and exosphere.[9]

The trophosphere is the lowest level of the Earth's atmosphere, in which temperature decreases with height and in which weather phenomena occur; it extends from zero to about eleven kilometres above the surface of the Earth.

The stratosphere is the region of the atmosphere above the troposphere in which temperature increases with height; it extends from 11 to 40 kilometres above the surface of the Earth. The stratosphere contains relatively large amounts of ozone formed by absorption of ultraviolet radiation.

The mesosphere is the part of the atmosphere that lies between the stratosphere and the ionosphere, that is, from about 40 to 80 kilometres above the surface of the Earth.

The ionosphere is the layer of the upper atmosphere, extending upwards from about 80 kilometres above the surface of the Earth, in which atoms tend to be ionized by incoming solar radiation.

The exosphere is the outermost layer of the Earth's atmosphere; it lies beyond the ionosphere, in which air density is such that a molecule moving directly outward has 50 per cent chance of escaping, rather than colliding with another molecule.

The Earth's atmosphere in an unpolluted state is composed of (in percentages): [10]

nitrogen	78.084
oxygen	20.9467
argon (inert gas)	0.934
carbon dioxide	0.0314
neon (inert gas)	0.001818
helium (inert gas)	0.000524
methane	0.0002
krypton (inert gas)	0.000114
hydrogen	0.00005
nitrogen protoxide	0.00005
xenon (inert gas)	0.0000087
sulphur dioxide	form 0 to 0.00001
ozone from	0 to 0.000007 (in summer)
	from 0 to 0.000002 (in winter)
nitrogen dioxide	from 0 to 0.000002

Traces of ammonia, carbon monoxide and iodine are detected in the atmosphere. Water vapour is also present in the atmosphere in greatly variable quantities. No life can exist on Earth without the atmosphere: oxygen is essential for all forms of life; carbon dioxide is necessary for photosynthesis (the manufacture of carbohydrates by plants); while ozone helps to protect life by absorbing ultraviolet radiation.

The air is polluted. All the air. Everywhere. There is even evidence of air pollution in the Arctic and Antarctic regions.[11]

The following are the effects of air pollution:

(a) Air pollution affects the atmosphere adversely; it reduces visibility; pollutants affect the weather by mechanisms such as fog formation and reduction of the amount of sunlight reaching the Earth.

(b) Air pollutants damage vegetation. In fact, at least half the forests of Central Europe are dying from air pollution and acid rain; this phenomenon is becoming evident in North America and China.[12]

(c) Air pollution has direct effects on man. Photochemical smog, a mixture of fog and smoke consisting of many toxic substances including ozone has tragic consequences. Ozone, which is a key ingredient of smog, forms when nitrogen oxides and hydrocarbons (emitted by vehicles, factories, power plants and hundreds of other sources) mix and react chemically in the presence of sunlight. Heavy deadly atmospheric pollution with smog was observed in:[9], [12]

(i) Donora, United States of America, on Tuesday, 20 October, 1948, in which 20 people died.

(ii) London, United Kingdom, on 4 December, 1952 resulting in 3000 - 4000 deaths; the London smog made 20,000 others sick and shortened the lives of thousands more. The smog lasted 4 days.

(iii) Los Angeles, United States of America, 1950; some people died.

(iv) The Meuse Valley, Belgium, 1930 in which 60 people died; made hundreds ill.

(v) London, United Kingdom, 1962, in which 700 died; the smog lasted 5 days.

(d) Air pollution caused the death of hundreds of people in New York, United States of America, in 1958, 1963, 1966 and 1975.

(e) The poisonous gas leak in Bhopal, India, in 1984 was a tragic incident; deadly methyl isocyanate gas from a pesticide plant caused the death of 25,000 people and injured 200,000 others.

(f) Air pollutants are injurious to animals; the poisoning of livestock by fluorides and arsenic has been established. For example, the American bald eagle used as a mascot at the Los Angeles Olympics died from lung disease caused by air pollution.[13]

(g) Air pollution affects the deterioration of materials; acidic pollutants cause the corrosion of metals, the weakening or disintegration of textiles, paper and marble. Hydrogen sulphide blackens leaded house paints.

Only in the last hundred years did serious atmospheric pollution problems begin. Two factors are responsible: more people and more burning of fossil fuels - coal, oil and gasoline. The fossil fuels are used by factories, home furnaces, power plants and motor vehicles. These sources dump 163 million tonnes of unwanted gases and tiny particles into the atmosphere every year. In fact, each year cars add to the atmosphere 100 million tonnes of unwanted gases and particles;

factories add 28 million tonnes; electric power plants add 19 million tonnes; and home furnaces add 11 million tonnes. Some of the gases added to the atmosphere by these sources are: sulphur dioxide, nitrogen oxide, hydrocarbons and carbon monoxide.[14] Believe it or not, there is another source of atmospheric hydrocarbons that has not been controlled - cows. American cows, for example, burp about 50 million tonnes of hydrocarbons to the atmosphere annually.[15]

The particles added to the atmosphere are: mercury, lead and carbon. An idling car will add 100 billion particles to the air every second.[11]

Motor vehicles account for most of air pollution. The number of vehicles in the world at present is 630 million, and it is expected to double within the next 20 - 30 years.[16] For every 1000 gallons of gasoline burned there is released into the atmosphere:[17]

3200 lbs of carbon monoxide;
300 lbs of hydrocarbons;
20 - 75 lbs of nitrogen oxides;
17 lbs of sulphur compounds;
plus solid particles.

The engine exhaust consists of carbon monoxide, carbon dioxide, nitric oxide and some hydrocarbons.

Factories and power plants are the second largest polluters of the air. They burn coal, oil and natural gas. Here again, nitric oxide, carbon monoxide, and carbon particles are added to the air. Sulphur dioxide is also given off (the sulphur comes from the fuel). We shall now discuss in some detail the major air pollutants:

3.1 CARBON MONOXIDE

Carbon monoxide is the gaseous product of incomplete combustion of carbon or carbon compounds. The gas is colourless, odourless, tasteless and non-irritating, but it is very toxic. Some 95 per cent of all atmospheric carbon monoxide is emitted in the northern hemisphere, and at least 65 per cent of it is created by gasoline combustion.[18] Even at low concentrations carbon monoxide affects the blood's oxygen-carrying capacity by combining with haemoglobin to form carboxy-haemoglobin; death can occur from carbon monoxide poisoning. Among the immediate effects upon humans are dizziness, blurred vision and distorted perception of time-certainly hazardous for drivers. Deadly level of carbon monoxide may be reached within short periods in garages, tunnels and buildings above highways.

3.2 SULPHUR-CONTAINING COMPOUNDS

The important oxides are sulphur dioxide and sulphur trioxide. For its harmful effects on man and the difficulties involved in preventing its discharge into the atmosphere, sulphur dioxide is probably the most significant air pollutant. Sulphur dioxide is produced when sulphur or sulphur-containing fuels are burned. Sulphur is present in coal and oil; burning of these substances for heat and power produces sulphur dioxide.

The other important oxide of sulphur is sulphur trioxide; it is produced in the atmosphere by the oxidation of sulphur dioxide. Some sulphur trioxide is introduced directly into the atmosphere from combustion processes along with sulphur dioxide. This oxide is also produced in the atmosphere when sulphur dioxide combines with oxygen. The moisture in the atmosphere reacts rapidly with sulphur trioxide to form corrosive sulphuric acid. When such conversions occur, the substance originally introduced to the atmosphere is called a **primary air pollutant**. The new materials produced by chemical reaction in the air are called **secondary air pollutants**. Sulphuric acid can do considerable damage to vegetation, fabrics, metal, paintwork and even stone.

Hydrogen sulphide is another important sulphur-containing compound; this gas has the odour of rotten eggs. This substance blackens lead paints, and is even more poisonous than carbon monoxide; it is however, not as widespread a pollutant as sulphur dioxide or hydrocarbons. Hydrogen sulphide is produced by the decomposition of organic matter, sewage, or some industrial operations.

3.3 HYDROCARBONS AND OXYGENATES

Hydrocarbons (e.g. methane, butane and benzene) are compounds which contain carbon and hydrogen, while substances which contain carbon, hydrogen and oxygen are referred to as oxygenated hydrocarbons or oxygenates; this group includes for example, alcohols and organic acids. Hydrocarbons and oxygenates are introduced into the atmosphere by incomplete combustion of carbon-containing fuels, along with carbon monoxide mentioned above. *Some* of these substances are *carcinogenic; some are irritating* or evil-smelling; some even undergo further chemical changes in the atmosphere to produce other pollutants; and, some are harmless. Surprisingly, as mentioned earlier, cows also give off hydrocarbons which pollute the air.

3.4 NITROGEN OXIDES

Nitrogen oxides (NO_x, pronounced like box) are substances formed from nitrogen and oxygen. Two important oxides of nitrogen which are pollutants are nitrogen oxide and nitrogen dioxide, both being produced by the process of combustion in air. The auto exhaust is a significant source of nitrogen oxides. The effects of nitrogen dioxide on man range from unpleasant odour and mild irritation to serious lung congestion to death depending on its concentration and duration of exposure.[9]

Nitrogen dioxide is also a significant air pollutant because it is one of the main substances involved in the chemical reaction that give rise to "smog" - fog and poisoned air.

3.5 PARTICULATES

One should not get the impression that ALL air pollutants are gases. Some, in fact, are airborne solid particles or liquid droplets. Therefore, the word **particulates** does not represent a class of chemical compounds; it is merely a generic name for all particles emitted into the surrounding air through some gaseous or atmospheric medium. Particulate pollutants have been described in various ways based on size, source and sometimes whether they are liquid or solid as shown below:

Diameter Less Than 1 Micrometre or Micron		Diameter Greater Than 1 Micrometre or Micron	
Name	**Remark**	**Name**	**Remark**
Aerosols	May be solid or	Dust	Solid particles
Smokes	liquid depending		
Fumes	on their origin	Mists	Liquid droplets

There is a great diversity among the types of particles in the air. They may be classified into three categories:

(a) VIABLE PARTICLES

These are capable of living; examples include pollen, microorganisms and insects or parts of insects such as hairs, wings and legs. These particles, as mentioned earlier, have detrimental effects on man.

(b) NON-VIABLE PARTICLES

Examples are materials from natural sources and from man's activities. The natural materials include sand and soil particles, salty droplets near the seashore, volvanic dust, and even particles of extraterrestrial origin. Man-made particles include both organic and inorganic substances. Smoke from the combustion of coal, oil, wood and garbage, insecticide dusts, and products released from food processing and chemical manufacturing are organic air particles. Inorganic particle pollutants originate largely from metallurgical operations, non-metallic mineral production industries, inorganic chemical manufacturing, and the lead used in gasoline.

(c) RADIOACTIVE PARTICLES

Probably the greatest possible danger in air we breathe is the fallout of radioactive materials from an atomic fission bomb.

According to the National Emission Standards Study, the US contribution to world-wide man-made air pollution in 1970 was 214 million tonnes of major pollutants, this represents about one-third of the world total (see Table 1).

TABLE 1: Major air Pollutants in the US and World (in million tonnes)

	US (1966)	US (1970)	WORLD (1970)
Carbon Monoxide	94	100	280
Sulphur oxides	31	37	146
Hydrocarbons	29	32	88
Nitrogen oxides	15	21	53
Particulates	22	28	110
Total	191	214	677

Source: *National Emission Standards Study.* Report of the Secretary of Health, Education and Welfare to the U.S. Congress in Compliance with Air Quality Act of 1967, pp 80 - 85; U.S. News and World Report August 17, 1970, p.40, and Environmental Science and Technology, Volume 4, February, 1970, p.89.

3.6 AIR POLLUTION IN NIGERIA

Compared to the developed countries and the threshold countries such as India and Brazil, Nigeria could be said to be only on the first rung of the industrial ladder. This is not to say that there is hardly any air pollution in the "giant" of Africa.

Many people in this country are clearly unaware of the dangers of cigaratte smoke, the particulate pollutant which, according to UNICEF, exposes even unborn babies to high levels of carbon monoxide, hydrogen cyanide, cadmium, nicotine and aromatic compounds. Experts say that female smokers compared to non-smokers produce smaller babies; female smokers also have a higher incidence of spontaneous abortion, prenatal delivery and mortality.[20] Recent studies have also shown that female smokers face higher risk of fatal breast cancer than female non-smokers. There is every indication that the population of Nigerian women addicted to smoking is increasing; this may be attributed I imagine, to the prevailing enhanced level of female activism.

increasing; this may be attributed I imagine, to the prevailing enhanced level of female activism. I pray that our women do not strive in the spirit of the popular slogan: what a man can do, a woman can do better, to outclass Nigerian men in smoking. Such a competition can only yield negative dividends. Is there any wisdom in competing for lung cancer, for example? Self pollution through the smoking of dangerous drugs may affect the quantity and quality of a man's sperm; it may also have devastating effects on the production of ova or eggs in women.[21]

Now, a word on indoor pollution. We are familiar with the story of the death of five people in Lagos in 1984 after inhaling so much of carbon monoxide from an electricity generator switched on when there was public power failure. Many people in Nigeria are often exposed to smoke from burning firewood in the houses in which they live, either when preparing food or sometimes when heating such houses during the cold season.

Vehicular emissions. Fumes from the exhausts of cars and buses are harmful to man. These vehicles use petrol with tetraethyllead, TEL, and such fumes fill the air.

This is the problem of many parts of Nigeria, particularly the cities. With the advent of SAP, vehicles that could have been better imagined than seen are now moving dead or alive on our roads. The deplorable state of many of these vehicles is beyond description - some have battered exhausts, some no windscreens, and some with body openings or crevices; in fact, some of these vehicles could pass for solid wastes.

The fumes of the exhausts of vehicles when inhaled do some havoc to the central nervous system. The air pollutants given off by vehicles (as mentioned earlier) include carbon monoxide, carbon dioxide, sulphur dioxide and oxides of nitrogen. The use of leaded fuel in vehicles is dangerous and has actually been banned in the advanced countries; it leads to an increase in the level of lead in the human blood. Lead additives often used to volatilize the lead out of engine with the exhaust gases are carcinogenic; lead in gasoline renders ineffective the catalytic converters designed to lower vehicular emissions.[22]

The various cement factories in Nigeria are pollution sites. The Ewekoro Cement Company had been in operation since 1960; cement dust from its towers had withered the surrounding vegetation, and polluted a nearby pond. The vegetation around the Shagamu Cement Company has also not been spared. Some investigations carried out have shown how notorious cement companies in Nigeria are in the pollution of the environment; they release dusts into the atmosphere higher, unfortunately, than the level permitted by WHO.[23]

According to Beecroft and his group[24] the principal source of sulphur dioxide in Kaduna metropolis is the Federal Superphosphate Fertilizer Company. This gas damages chlorophyll in

plants, causes the devastation of forests and causes respiratory ailments in human beings. Also in Kaduna the Nigeria National Petroleum Company Refinery emits sulphur dioxide, nitrogen dioxide and particulates. The polluting effects of these substances are readily seen during the harmattan when visibility becomes so poor as to warrant the disruption of scheduled flights in and out of the city airport. [24]

One can hardly discuss the deplorable state of affairs vis-a-vis air pollution in Nigeria without shedding tears- no crocodile tears; air pollution is caused to some considerable extent by the flaring of gas or burning of fossil fuels in the vast oil fields in the Niger Delta region. Sulphur dioxide and oxides of nitrogen are emitted into the atmosphere through gas flaring. Nigeria probably loses well over N5 billion annually through the senseless burning off of her natural gas. Professor Sylvester Adegoke once said that over 70 percent of Nigeria's associated gas which is enough to generate the electricity needs of the entire ECOWAS subregion is being flared in the delta area of this country. [24] Gas flaring has major adverse socioeconomic and environmental impacts such as: [25]

(a) atmospheric pollution by combustion contaminants;

(b) thermal pollution of air, land and water;

(c) destruction of vegetation and associated wildlife;

(d) damage of buildings and other structures by acid rain;

(e) damage to soil and crops by heat, and the deposition of primary and secondary contaminants;

(f) photogenic pollution (i.e, light glare) both by day and, particularly by night, nuisance that is experienced up to 50 kilometres away from oil wells in some regions;

(g) loss of sources of livelihood;

(h) severe discomfort and misery, particularly when wind carries fumes, odours, heat and combustion gases to communities in downwind locations;

(i) human illness;

(j) enforced modification of residential buildings to screen out some of the glare.

Bush burning is a common feature in this country. There were reports that U.S. satellites discovered high levels of carbon monoxide in the air as a result of bush burning in Nigeria and other West African countries.[26] The gas as mentioned earlier is harmful to man.

Some researchers on measuring the dust level of harmattan in Nigeria discovered that the air particles measured in Lagos were richer in cadmium than the ones measured in Kano. This shows that harmattan dust could be more dangerous to people in Lagos than to the inhabitants of Kano.[27]

Noise pollution, acid rain, ozone depletion and greenhouse effect are all aspects of air pollution; however, I have deliberately chosen to discuss them separately under a different umbrella later in this lecture for maximum stress.

3.7 AIR POLLUTION ABATEMENT

Motor vehicle emission and industrial fumes as discussed earlier, are the two major sources of air pollution. The ways for controlling air pollution are as follows:

(a) An emission control device is installed at the exhaust pipe of a motor vehicle or the smokestack or chimney of an industrial plant. An example is the catalytic converter, a device attached to the car exhaust pipe. As the car exhaust passes through the converter, the carbon monoxide and hydrocarbons combine faster with oxygen of the air. The products are harmless carbon dioxide and water that may be released into the atmosphere.

(b) Particulates are removed from industrial exhaust by means of giant vacuum cleaners known as fabric filter bags (baghouses) or by electrostatic precipitators, cyclones or wet scrubbers; mist eliminators are used for the collection of liquid particles.

(c) Sulphur emission from cars, factories and power plants can be reduced by using low-sulphur coal instead of high-sulphur coal. Research is also being done to convert sulphur dioxide into harmless valuable products such as fertilizers.

(d) Fewer petroleum-powered vehicles are desired; in fact, electric cars could replace the present motor vehicles. Electric cars are pollution-free, almost noiseless, fumeless, and more efficient in energy-conversion.

(e) The use of harmless fuel as an alternative to gasoline.

(f) The industries should strive to acquire the necessary technology to attain the zero emission level.

(g) Legislation e.g. the US Clean Air Act of 1970. Environmentally-conscious governments resort to taxation on effluents, pollution penalties, and licensing as social mechanisms for air pollution abatement.

4.0 WATER POLLUTION

Water is the cradle of lifekind: it accounts for 60 to 80 percent of the human body; 60 to 65 percent of the bodies of terrestrial vertebrates, and about 80 percent of fish. In algae and vegetables water accounts for 90 to 99 percent, and in terrestrial plants, 50 to 75 percent.[28] The US uses over 400 billion gallons of water a day.[29] Water pollution is cutting down on our supplies of pure water. Nature, itself pours some solutes into streams and oceans. Man, too, is responsible for pouring

a great variety of pollutants into streams, lakes and oceans. U.S. Congressman Brent Spence once said:

> I was born in sight of the Ohio River and I lived most of my life in a home that overlooked the river. I have seen it turn from a beautiful river in which I swam as a boy to a polluted sewer. [30]

For those of us born and bred in this country in river-side towns and villages the above summarises the ugly picture of our own once-beautiful rivers. I can without apologies describe the Ethiope River in the same vein. Three-quarters of our planet is sea; polluting this expanse of water means rendering three-quarters of the Earth unclean and dangerous.

The pollution of water is the addition of undesirable foreign substances that deteriorate the quality of the water. Water that is safe for drinking by man and animals, that supports a wholesome marine life, that is fine for the irrigation of the land and for recreation can be said to be of good quality.

The world has witnessed a number of incidents of severe water pollution; some of them are:[9]

(a) Amoco Cadiz accident; Amoco Cadiz, a Liberian-registered tanker owned by Amoco International Oil was shipwrecked near the north-western coast of France on 17 March 1978. The tanker released the whole of its cargo of 1.6 million barrels of oil, mostly light crude, to the sea. A layer of the oil spill 80cm thick spread 40 kilometres from the scene of the accident. Some 30 to 40 thousand tonnes of oil were deposited on the seashore while 40 to 50 thousand tonnes sank to the sea bed.

(b) Cavtat accident: Cavtat was a Yugoslav ship which sank in the Adriatic in 1974 carrying a cargo of drums containing tetraethyllead. The last of the drums was not recovered until April 1978, by which time some of them had begun to leak into the sea.

(c) Sangana accident: An oil well near the town of Sangana in Nigeria blew out on 19 January 1980, releasing 30,000 tonnes of crude oil into the Niger River, contaminating drinking water and fish in villages with a total pollution of 30,000-50,000 people.

(d) Minamata disease: In 1956, many villagers in Japan died or gave birth to deformed children because they ate contaminated fish-fish which had accumulated mercury in their tissues. One industry processing a mercury compound had discharged its wastes into the Minamata Bay and the Agano River where the fish were contaminated. In fact, some 115 persons died, 800 persons suffered extensive and irreversible brain damage, and another 2700 persons claimed to be victims. [31]

(e) Tanio accident: Tanio was an oil tanker that sank in a storm in the English channel on 7 March 1980, with a cargo of 24,000 tonnes of crude oil. The ship broke in half releasing 3000 tonnes of oil. The incident caused severe pollution to beaches in Britanny.

(f) Ixtoc 1 accident: Ixtoc 1 was an oil tanker off the coast of Yucatan, Mexico, which blew out on 3 June 1979, releasing oil into the Gulf of Mexico at a rate of 30,000 barrels per day, creating an oil pollution incident greater than the previous largest - Amoco Cadiz. By the time the well was finally sealed in March 1980, it had released about 3 million barrels.

(g) Irene Serenade accident: Irene Serenade was a Greek oil tanker that sank in the Bay of Pylos, Greece, on 23 February 1980, carrying a cargo of 100,000 tonnes of crude oil. The incident caused severe pollution to beaches in the bay and for some distance further along the coast.

(h) The Cayuga River near Cleveland, Ohio, caught fire in July 1969 and burned for 40 hours. The burning of this river was caused by the waste from refineries flowing into it.[32]

(i) In 1970, polychlorinated biphenyls, PCBs, dumped into the Irish sea resulted in the loss of 100,000 sea birds.

About one-third of the world population have no access to pure water. The level of water supply in developing countries is very low; approximately 90 percent of the population of these countries have no water pipe-lines, and therefore consume low quality water. Good fresh water thus becomes an export commodity; for example, China exports water to Hong Kong. Entire cities in some countries receive desalinated sea water e.g. Colling in the United States. Oil-rich Kuwait receives almost all of its drinking water from the sea. [33]

Though debatable, some scientists claim that pure water may be exhausted in our planet in the next century. The United Nations Conference on water supply problems held in Argentina noted among other things that a day would soon come when a drop of water would cost more than a drop of oil. [33]

4.1 WATER POLLUTANTS

The bulk of polluting matter discharged into water course world-wide is organic material in the form of domestic sewage and effluents from industries, particularly agriculture-based ones. The mighty Hudson River, for example, which has an average daily flow of 11 billion gallons, receives an estimated 400 million gallons of raw sewage each day.[34] Faecal contamination is a global problem; it contributes to the high disease and death rates of infants in large parts of Asia, Africa, Central and South America.[35] The streams, rivers and estuaries are filled with garbage. These and the seas are stained with oil from spills, coal dust, tar and dyes.

Industrial processing of raw materials and the use of chemicals in manufacturing usually involve the discharges of potentially toxic wastes into water bodies. Such toxic wastes include heavy mental and synthetic organic chemicals such as pesticides, herbicides, fertilizers and PCBs. Most of these chemicals destroy aquatic life. Some herbicides are carcinogenic, while some pesticides cause sterility or impaired fertility.

Detergents are synthetic, stable, cleansing agents; they firmly resist decomposition by bacteria and often pass through extremely fine filters. The results of investigations show that many U.S. wells contain detergents in varying levels of concentration. [35]

Man has turned the streams grey and murky with silt and sludge, and dumped billions of tonnes of trash and offal into the once lovely waters: beer cans, old tyres and mattresses, rusty oil drums, refuse from hospitals, broken glasses, plastics and dead animals. Radioactive wastes have also been dumped into the waters of the world.

Water pollutants maybe classified as conservative and non-conservative. Non-conservative pollutants are mostly organic wastes, and are easily reduced or chemically broken down by bacterial action; they are biodegradable. On the other hand, conservative pollutants are not broken down by bacterial action; they are non-biodegradable. Nature has provided no way to get rid of foaming hard detergents, poisonous heavy metals such ass mercury, persistent pesticides such as DDT and even plastics. Plastics normally take some 200 years to degrade.

Water can be thermally polluted. Thermal pollution is pollution by heat; it is the raising of the temperature of the environment by the discharge of substances whose temperature is higher than the ambient, for example, thermal pollution of rivers from discharge of cooling waters from industries. In fresh water, the amount of free dissolved oxygen decreases with increasing temperature, thus affecting living organisms. Discharges of water as hot as 80°F into bays and estuaries, where many fish species are spawned have been registered in some power stations in the U.S. Water temperatures below 55°F are ideal for spawning most of the fish eaten by man. Many fish cannot live in waters above 45°F. Nuclear power stations operate at about 4000°F and produce far more waste heat than coal-fired stations. [36]

4.2 WATER POLLUTION IN NIGERIA

Rivers in this country are heavily polluted, particularly with human excrement and industrial wastes. I have seen (and you have also probably seen) some Nigerians perching on the roots of trees defaecating without apologies into the rivers; some also "do their thing" from canoes. The Lagos Lagoon, for example, is contaminated with faeces, sawmill waste and petroleum hydrocarbons. Some fish caught around old Cater Bridge have been shown to contain certain metal ions such as lead, mercury ,iron and nickel .[37] According to Jerome Nriagu the level of

lead in the drinking water in Zaria is so high that one- quarter of it would cause concern in say, Glasgow or Boston.[38]

River Niger, Africa's third longest river, enters the Atlantic Ocean through the delta region of Nigeria. These days unimaginable wastes- domestic sewage, human, animal, crude oil (through spillage) industrial and agricultural- are dumped into this big river, streams and other rivers in this country. The organic wastes are decomposed by microorganisms called decomposers. These decomposers require oxygen from water. This biological oxygen demand, BOD, increases as pollution increases. The decomposers compete with fish and other aquatic organisms which need oxygen for respiration. Thus, in heavily-polluted water bodies, the oxygen dissolved in the water may be used up, resulting in the death of aquatic animals.[39]

Traces of faeces have been found in consumable water, large numbers of different types of bacteria and microorganisms being present in the faeces. Tapeworms and round worms as well as the organisms (pathogens) which cause typhoid fever, bacillary dysentery, cholera and schistosomiasis have been found in the Niger Delta water .[40]

The discussion of water pollution in Nigeria will be incomplete without a word on oil spillage. The Sangana incident in which an oil well blew out into Niger River contaminating water supplies and fish has earlier been mentioned. Permit me to tell you one short story.[41] In 1987, a Fulani cattle rearer once led his cows across the Rido River in Kaduna State . The cows were wet, of course, having passed through the river. A few metres ahead some bush was being burnt by someone. On getting near the burning bush there was a sudden flash, and the cows were all burnt to ashes.

The cattle rearer, who could not believe his eyes, ran to a nearby village, telling everyone that "some evil spirit" had set his cows on fire. He was not aware that some petroleum product which had spilled from the Kaduna Refinery into Rido River was the evil spirit after all.

Between 1976 and 1990, 2,796 oil spill incidents were reported by the oil companies operating in Nigeria. Also, within this period 2, 105, 393 barrels of oil spilled into our terrestrial, coastal and offshore marine environments .[42] According to Professor Imevbore the groundwater resources of Nigeria in the coastal environments are being contaminated as shown by the sharp rise in the maximum permissible concentration, MPC, of crude oil found in groundwater which is above the permissible level. The groundwater in Port Harcourt area in 1987 had MPC of 1.8 milligrams per litre as against 0.1 milligram per litre recommended by WHO.

In the Niger Delta area, where oil pollution of water is most serious, the effects have been catastrophic. The formation of a film of oil on water bodies effectively prevents natural aeration, leading to the death of organisms trapped below. Fish may also ingest spilled oil directly or indirectly, becoming unpalatable or even poisonous.[43]

Professor Osibanjo and his collaborators have found that fishes, snakes, frogs, toads and snails in the areas of petroleum production in Lagos and the Niger Delta have varying levels of petroleum hydrocarbon pollution in their bodies.[44] Dangerous chemicals are used for fishing in this country by some unscrupulous fishermen. Gammalin 20 is one of such chemicals of choice, and the fish "caught" with them are eaten by people. Seven years ago, there was a discharge of water containing ammonia from a fertilizer company at Onne, near Port Harcourt into Okrika River, which resulted in the killing of fish .[45]

One should emphasise here that companies prospecting for oil in the Niger Delta region have contributed considerably to the destruction of the fragile marine environment.

Eroded sediments. Sediment pollution of water bodies, as a result of accelerated soil erosion, is a serious and widespread problem in Nigeria. The areas particularly affected are the northern states, the erosion disaster areas of Abia, Anambra and Imo States, as well as other parts of the southern states where agricultural practices leave the soil bare at the start of the rainy season.[46]

Thermal pollution of water has been reported in this country, for example, around the Aladja Steel Rolling Mill, where cooling waters discharged into the streams have caused the death of fish.

The water weed, water hyacinth, merits mentioning here. Water hyacinth (Eichhornia crassipes) was first noticed in Nigeria in 1984; it is believed to have entered this country through Porto Novo creeks in the Republic of Benin which flow into the Badagry creek en route to Lagos Lagoon. The water weed has covered a substantial portion of our surface water and a considerable distance along the southwestern coast including Lagos, Ogun, Ondo, Edo and Delta States; and it is spreading fast to new areas. Water hyacinth is a menace which displaces and kills other aquatic organisms; it also seriously disrupts river navigation.[47] However, it must be pointed out that this water weed is being used for a number of things in other parts of the world: Malaysia uses it for cleaning industrial waste water; the Sudan uses it as fertilizer; the US produces from it gas, animal and poultry feed.

There is no doubt that so much havoc has been done to our rivers, now considerably contaminated and defaced. Mungo Park on discovering the River Niger described his unimaginable joy as follows:

> I saw with infinite pleasure the
> great object of my mission, the
> long sought for majestic Niger
> glittering in the morning sun,
> and flowing slowly to the eastward.[48]

I have a strong feeling that with the present deplorable condition of his darling river, Mungo Park must be tumbling restlessly with disgust in his grave as the Niger no longer glitters in "the morning sun."

4.3 WATER POLLUTION ABATEMENT

Something can be done to control or prevent water pollution considerably; some steps taken are as follows:

(a) Regular treatment of drinking water; the methods recommended include filtration, chlorination and irradiation. A few water weeds, interestingly, can be used as waste water purifying agents: since 1985, duckweed, Lemnaceae, has been used as a means of purifying municipal waste water in the U.S.;[49] water hyacinth has also been used for purifying waste water in Malaysia and Bangladesh.

(b) Recycling of industrial efflents.

(c) Regular treatment of sewage.

(d) Proper disposal of garbage.

(e) Legislation - which must be enforced, e.g. the US Clean Water Act of 1972.

5.0 LAND POLLUTION

Land pollution is the degradation of the Earth's land surface through misuse of the soil by poor agricultural practices, mineral exploitation, industrial waste dumping, and indiscriminate disposal of urban wastes.[50] The world's land surface is one-third grassland or cropland, one-third forest and one-third, barren or unusable.[51]

There have been cases of gross land pollution in different parts of the world; I shall in this lecture mention three of such incidents:

(a) The Love Canal incident.[9] Love Canal is an area in Niagara Falls, New York, where industrial wastes were buried in drums in the 1940s and early 1950s. The drums corroded, leaking substances that included suspected carcinogens. On 7 August 1978, Love Canal was declared a disaster area, and about 240 families were evacuated.

(b) The Times Beach incident.[9] The town Times Beach near St. Loius, Missouri was bought in February 1983 in its entirety by the US Federal Government and declared unfit for human habitation for reasons of contamination of the soil from chemicals, and floods.

(c) The Koko incident: In 1988, a West German-registered ship, the Line, carrying highly toxic chemical waste docked at Koko port in Delta State, Nigeria. Among the 900 tonnes off-loaded at the small port were 150 tonnes of waste containing PCB, an extremely dangerous poison. The man behind the deal is an Italian businessman, Gianfranco Raffaelli, who had been resident in Nigeria for over 20 years. The chemical waste was later removed by Italy (where it originated from), and major decontamination and clean-up project was carried out.

5.1 CONTRIBUTORS TO LAND POLLUTION

Hazardous chemical wastes are notorious land pollutants. Nearly a billion tonnes of hazardous chemical wastes are unavoidably generated in the industrilised countries every year; and the U.S. contributes one-fifth of them. They are generated by agriculture, hospitals, laboratories and other activities. They are, of course, produced by industry - even in the manufacture of such everyday necessities as paint, clothing and medicine. About 60 percent of the total hazardous chemical wastes come from the chemical industry.[52]

Most hazardous chemical wastes are found in liquid or sludge form; some are radioactive. The dumping of these hazardous chemical wastes and radioactive wastes has done so much harm to the land, and consequently to plants and animals. Solid wastes freely dumped on the land fall into the following categories:

(a) Rubbish - paper, glass, cans, leaves.
(b) Garbage - waste from food preparation
(c) Dead animals.
(d) Demolition waste - building materials including lumber.
(e) Sewage.

The volume of solid waste in the city of Quito in Ecuador is about 1000 tonnes per day;[53] while the 9 million inhabitants of Manila in Philippines create 3,500 tonnes of domestic wastes daily.[54] Many places in today's world have alarming volumes of solid waste. The average quantity of solid wastes in the US. was 2.75 pounds per capita per day in 1920 and 4.5 pounds in 1964. In urban areas the average is much greater, reaching as high as 8 pounds per capita per day in some cities. [55]

Discarded vehicles, furniture, electrical appliances and rugs among other things are also dumped as wastes on the land. Plastics are resistant to chemical change; the resistance persists long after they are discarded and dumped.

Oil spillage has, where it occurred, changed the character of the land, polluting it beyond description to the detriment of living organisms. Gas flaring also has devastating effect on land: as mentioned earlier it causes thermal pollution of land; it destroys vegetation and associated wildlife; and it damages the soil and crops by heat.

The forests of the world are fast disappearing. The famous cedar forests of Lebanon are gone. The tropical rainforests of Southeast Asia are ravaged almost beyond recovery. One cause of deforestation in developing countries is land clearing for agricultural production and gathering

of wood for fuel.[56] More trees have to be cut to meet rising demand for agricultural land and cooking fuel. In Africa, for example, 29 trees are cut for each one planted.[57] The fuel needs of the developing countries have exceeded the replacement capacity of local forests. A chain of events usually follow the disappearance of forests: reduction of wildlife species; soil erosion; flooding and drought; siltation of irrigation systems, rivers and lakes; and the disappearance of fish from the silted bodies of water.

Excavation and drilling do destroy natural ecosystems on land. Mining for coal and geothermal energy production may cause landslide, land subsidence and possibly earthquakes.[58]

Desertification, which is another example of environmental degradation, is caused by a number of factors including deforestation. The world's deserts are expanding. Every year about 6 million hectares of land are irretrievably lost to desertification.[59].

5.2 LAND POLLUTION IN NIGERIA

The use of fertilizer, pesticides such as DDT, and herbicides has contributed to the pollution of land in Nigeria. The highly toxic chemicals used for hunting in this country have also done some damage to our land. The dumping of 8000 drums of hazardous chemical wastes on Nigeria's soil by a dubious Italian businessman has earlier been discussed in this lecture.

Garbage here, garbage there, garbage everywhere. This summarises the ugly picture painted by the ceaseless dumping of domestic wastes in this country. Nigeria is fast becoming a country of dumpsites. Some toxic chemicals such as PCBs which destroy human organs were found in one of such dumpsites - the Isale-Eko/Adeniji Adele dumpsite, around where Lagosians are now building magnificent houses.[60] Wells located near these dumpsites may be contaminated with dangerous chemicals. They city of Ibadan is said to be sitting on a "time-bomb" of its unsanitary garbage dumps.[61]

The situation in Port Harcourt is as horrible as in Lagos; studies carried out have shown that there is virtually no barrier between the horrible-smelling dumpsites and the water table of the groundwater. Toxic substances called leachates from sanitary landfills and dumpsites could sip into boreholes and wells.[62] Lagos, Port harcourt, Aba, Calabar, Kaduna, Warri, Ibadan, and of course, Onitsha and others, stink owing to the piles of solid wastes that "grace" these Nigerian cities.

Oil spillage through petroleum production activities has done considerable havoc to the land, altering as it were, the terrestrial ecosystem. Such spillages have occurred primarily in the main

oil-producing states: Rivers, Delta, Abia, Imo and Akwa Ibom. Gas flaring has also damaged sizeable portions of land and vegetation in the oil-producing states.

Deforestation, resulting from poor agricultural practices, and from indiscriminate cutting of wood for firewood and charcoal, for various forms of construction, and for other domestic and industrial uses now poses a serious problem for Nigeria. There is thus visible desert encroachment in some parts of northern Nigeria affecting the terrestrial ecosystem aversely in line, so to say, with the popular saying: "when trees go, deserts come." The disappearance of forests causes soil erosion. The areas particularly affected by soil erosion are the northern states and the erosion disaster areas of Abia, Imo and Anambra States. One should also mention that mining and quarrying contribute significantly to land degradation in Nigeria.

5.3 LAND POLLUTION ABATEMENT

The waste treatment strategies with respect to land pollution are as follows:

(a) Compositing: Organic waste can be disposed of through compositing. In parts of Australia compositing is regarded as one of the alternatives to landfilling; the Swiss canton of Zurich treats 140,000 tonnes a year of organic materials in compositing plants.[63]

(b) Incineration: This is the process of burning solid wastes to ash. For example, in some incinerators there are huge furnaces which consume unsorted garbage at extremely high temperatures from 1800 to 3000°F, leaving ash that takes up as little as 10 percent of the space of the original solid waste.[64]

(c) Landfilling: This method involves the burying of wastes in landfills. In Germany the landfilling of wastes with more than 5 percent organic content is prohibited. A recent study has highlighted the hazards associated with the migration of landfill gas from sites.[65] Landfill operators, however, say that newer facilities pose few environmental dangers as they are highly engineered excavations with leachate - and gas-collection systems.[66]

(d) Recycling: Recycling is a very important aspect of the efforts being made to handle municipal waste – the throw-aways. Some examples are the recycling of

(i) Plastics and glass.

(ii) Garbage into fertilizers.

(iii) Sulphur from oil refineries into sulphuric acid.

(iv) Iron dust from steel plants into steel.

(v) Wastepaper into de-inked pulp; some journals are printed on recycled paper e.g.: World Action for Recycling Materials and Energy from Rubbish (WARMER).

(vi) Shoes (as done by Deja Shoe Company in the U.S.)

(vii) Electronic scrap (there are plants to reprocess telephones, fax machines and answerphones.

(viii) Used film into silver and gold.

(ix) Watches into rhodium.

The long established textile reclamation industry recovers and processes old clothes, curtains, quilts, blankets and countless other textiles which are regarded as waste. Used clothing is turned into wiping cloths for industries; it is "pulled" for re-manufacture into new garments or for padding and sound insulation applications such as mattresses, car body insulation, and protective cover for furniture industry.

(e) Legislation e.g. the FEPA Decree of 1988.

6.0 OTHER ASPECTS OF POLLUTION

Now, I shall discuss noise pollution, acid rain, ozone depletion, greenhouse effect, population and poverty.

6.1 NOISE POLLUTION

Noise is a serious threat to sanity. To define noise is not easy; it may be defined as unwanted sound. This cannot be the best definition because a given sound which is music to one person may be noise to another. Loudness is the most significant attribute that distinguishes between wanted and unwanted sound. Protracted noise could lead to loss of hearing. Noise pollution has three major sources: industry, transportation, and residential activities.

Noise pollution is a chronic feature of Nigerian urban life: the noise in the big cities such as Lagos, Ibadan, Kano, Port Harcourt, Onitsha, Warri and Aba is unbearable. In this country *many industrial estates are located too close to residential areas. Many vehicles now in use in* Nigeria are old and dilapidated and produce unimaginable noise while in motion. Obsolete aircraft certified unfit for the European and the U.S. air space are allowed into this country. Noise is big business in Nigeria: the noise from the stereo sets advertising the newest and latest records is deafening.

Yes, I should mention here the unbearable level of noise being produced by Nigeria's new breed evangelists. Once at my family residence, I could not read no matter how hard I tried; my eardrums were being pounded by the sound from the microphone located in a tiny new church 200 metres away. I rushed to have a word with the preacher. Angrily I said to him" "Is it your plan to deafen your followers first of all before they go to heaven? No response. Finally, he apologised and lowered the volume of the microphone for the comfort of his followers and the neighbourhood.

Some ways to abate noise pollution are:

(a) Reduction of the sound power.

(b) Use of muffled air compressors which reduce noise level; for example, sound of 86 decibels is reduced to 79 at a distance of 25 feet.

6.2 ACID RAIN

The gas, sulphur trioxide, as discussed earlier, reacts with moisture to produce sulphuric acid, a corrosive substance. Sulphur dioxide and oxides of nitrogen emitted into the atmosphere through various ways including gas flaring may be used in the formation of acid rain. Acidic deposition of precipitation in the form of acid rain has become an issue of international concern.

Normal rain is naturally slightly acidic with 5.6 on the pH scale. In some parts of the U.S. and Canada, for example, rain is 30 to 40 times more acidic than normal rain, averaging a pH of 4 to 4.3. In fact, rain as acidic as battery acid has fallen in West Virginia; and in Florida acidic rain once dissolved the paint on 2,000 imported BMWs. [67]

Acid rain causes lung disease; it threatens freshwater fisheries, agriculture and wildlife, and damages forests.

Acid rain is doing some havoc in the Niger Delta region of Nigeria; forests are being destroyed, but the extent of damage done by acid rain to both the terrestrial and aquatic ecosystems is not yet fully ascertained.

Acid rain can be abated when industries attain the zero emission level, and when gas flaring is halted.

6.3 THE GREENHOUSE EFFECT

Scientists have recently established that the world is warming: climatic zones are shifting and glaciers are melting.

The warming of the Earth's climate is a very serious environmental problem. Carbon dioxide and other greenhouse gases (methane, nitrous oxide and two chlorofluorocarbons - $CFCl_3$ and CF_2Cl_2) hold heat in the lower atmosphere, allowing temperatures to rise. The burning of coal and other carbon-based fuels such as oil and natural gas produces carbon dioxide; large-scale clearing of tropical forests adds additional carbon dioxide to the atmosphere.

Nigeria, as predicted by scientists may be seriously hit by the greenhouse effect. The greehouse effect can be reduced or prevented by reducing the amount of greenhouse gases emitted into the atmosphere.

6.4 DEPLETION OF THE OZONE LAYER

Ozone is the only gas in the atmosphere that prevents harmful solar ultraviolet radiation from reaching the surface of the Earth. The ozone layer is about 15 to 20 kilometres above the Earth's surface. Some chemical substances containing chlorine and bromine, released from industrial activities move up slowly into the upper atmosphere, the stratosphere, to deplete the ozone layer. This is now a global problem. In fact, a big hole has been discovered in the protective ozone layer; in 1984 the ozone hole was larger than the United States and taller than Mount Everest.[68]

This problem caused over 44 countries including Nigeria to sign and implement an international agreement called the Montreal Protocol in 1987. The agreement was meant to reduce or phase out totally dangerous substances that deplete the ozone layer. These dangerous gases include chlorofluorocarbons, CFCs, which are often used as coolants in refrigerators, airconditioners and spray cans; halons, used by fire fighters; carbon tetrachloride, a cleaning agent, and so on. Aerosols are the largest users of CFCs (see Table 2).

Table 2: Global CFC Use, 1985

Use	Share of Total (Percent)
Aerosols	25
Rigid foam insulation	19
Solvents	19
Air conditioning	12
Refrigerants	8
Flexible Foam	7
Other	10
Total	100

Source: Daniel F. Kohler et al, "Projections of Consumption of Products Using Chlorofluoro carbons in Developing Countries" (Santa Monica, Calif., Rand corporation 1987).

CFCs are not broken down in the troposphere, the layer of the atmosphere surrounding the Earth. They reach the upper layer of the atmosphere, the stratosphere, after six to eight years. Halons are also inert at ground level. They contain bromine, a more effective ozone destroyer than chlorine, and long-lived in the atmosphere.The global use of CFCs by various regions of the world is shown in Table 3.

Table 3: Global CFC Use, by Region, 1996

Region	Share of Total (Percent)
United States of America	29
Other Industrial Countries	41
Soviet Union, Eastern Bloc	14
Other Developing Countries	14
China and India	2

Source: The Ozone Treaty: A Triumph for All". Update from State, May/June, 1988.

The Earth receive more ultraviolet radiation from the sun as the ozone layer diminishes in the upper atmosphere. Ultraviolet radiation causes skin cancers and cataracts and depresses human immune system. Reduced crop yields, depleted marine fisheries, materials damage, and increased smog are also attributable to higher levels of radiation. The phenomenon is global and will affect the well-being of every person in the world. [69]
The depletion of the ozone layer will be considerably reduced or halted when there is a halt to the production of the gases that effect such depletion.

6.5 POPULATION

The number of people inhabiting the Earth is growing as shown in Table 4 below:

Table 4: Dynamics of Population up to the Twentieth Century (in million):

Year	Whole World	Russia	Europe Without Russia	Asia Without Russia	Africa	America	Australia and Oceania
5000BC	30	1	3	20	5	1	0.5
0	230	5	35	155	30	4	1.0
1000	305	10	43	195	40	15	1.5
1500	440	15	75	260	60	27	2.5
1650	550	20	82	330	100	15	3.0
1800	950	50	160	620	90	30	2.0
1850	1247	75	205	790	120	65	2.5
1900	1656	130	295	950	130	145	6.0

Source: "Living in the Enrironment : A Source book for Environmental Education" (ed. K.M. Sytnik), UNESCO- UNEP, 1985, p. 161.

From the above Table, one can see that the population of Nigeria (about 88.5 million) is almost three times the population of the world in 5000 BC. The population of Lagos State (about 6 million) is greater than that of the entire continent of Africa in 5000 BC (Africa's population being 5 million); while Imo State, Nigeria, with a population of about 2.5 million is half Africa's population in 5000 BC. Population Crisis now faces the world. There are more that 5 billion human beings now in the world; the population is growing at the rate of 89 million a year. According to the Christian Science Monitor the world population is expected to double in the next century. The indicators of environmental stress caused by increase in population include the growing loss of biodiversity, increasing greehouse gas emissions, ozone depletion and acid rain.

Population growth rates in developing countries range between 1.5 to 4 percent a year. Some European countries such as the U.K. and Sweden have essentially stopped growing. They have about reached zero population growth (ZPG); that is their birth rates are nearly equal to their death rates. Populations of Austria, Germany, Denmark and Hungary have actually begun to shrink gradually as their death rates are now slightly higher than their birth rates.

We should stop believing that there are unlimited resources and infinite air and water. Increase in population will lead to destruction of land, depletion of natural resources, production of wastes and pollution of the Earth. Believe it or not, by the year 2000, as many as 65 countries may not be able to feed their own people.

The world should aim at achieving zero population growth within the lifetime of today's children as suggested at the Population Summit of the World's Scientific Academies in 1993.[70]

6.6 POVERTY

Is there any connection between poverty and environmental degradation? While I leave you to ponder over it, I shall reproduce here the comment on poverty by the World Commission on *Environment and Development in the Brundtland Report:*

> Poverty pollutes the environment creating environmental stress in a different way. Those who are poor and hungry will often destroy their immediate environment in order to survive. They will cut down forests; their livestock will overgraze grasslands; they will overuse marginal land; and, in

> growing numbers, they will crowd into congested cities. The cummulative effect of these changes is so far-reaching as to make poverty itself a major global scourge.[71]

The Report says it all poverty can enhance significantly the level of environmental pollution and degradation.

7. CONCLUSION

To conclude this lecture I wish to observe, stress and perhaps, recommend as follows:

(a) Environmental pollution is now an issue of international politics; this topic will be dominant on the international agenda for as long as there is man on Earth. The world should therefore realise that a threat to the environment means, to some extent, a threat to national or global security.

(b) As societies grow richer, their environments grow poorer. This inverse relationship between societal wealth and environmental poverty cannot nurture for long any sustainable development.

(c) The deadly pollution effect of wars on the environment is unimaginable. People of the world should therefore live peacefully and harmoniously with one another to avoid wars and prevent or minimise environmental pollution and degradation.

(d) Industry must ensure that environmental protection has equal priority with profitability. The world will never grow cleaner without the cooperation of industry.

(e) The proportion of people who now choose to buy a product because of its environmental friendliness is increasing, while eco-labelling of manufactured products is gaining ground in the developed countries. Third world countries should without delay incline to this level of environmental consciousness.

(f) Environmental education should be made compulsory at the primary and secondary levels in the developing countries, and at the tertiary level, topics on the environment should, as a matter of course, be taught in the general studies programme.

(g) Some developing countries all in the name of business have callously and criminally consented to being used as dumping ground for hazardous chemical wastes generated

in the advanced countries. Some of the culprits are Haiti, Jamaica and most recently, Somalia. Third World countries should resist such temptations no matter the magnitude of the immediate financial reward. They should also not for any reason provide lax environmental regulations simply to attract investment from developed countries.

(h) Companies operating in the Third World should show greater interest in the environment as is the case with companies in Europe and the United States. Companies in the advanced countries are now spending staggering amounts of money on pollution control. Baeyer, a German chemicals group, spends 20 percent of its manufacturing costs on environmental protection. Chevron, an American company, expects environmental spending to grow by 10 percent a year. Albright and Wilson, a British company, spends half of its capital programme on projects related to environmental protection of products. Shell Petroleum Development Company operating in Nigeria, has also in my as sessment, shown visible concern for the environment.

(i) No doubt, Nigeria's real environmental consciousness was enhanced in 1988 when 12 Nigerian students in Italy informed us that toxic industrial wastes were being shipped from Italy to this country. These 12 Nigerians should be honoured without further delay by Nigeria for their unalloyed patriotism.

(j) The government should be commended for establishing the Federal Environmental Protection Agency, FEPA; however, FEPA requires not only legal teeth, but also adequate funds to be able to function to our satisfaction. This body should have well equipped laboratories and well trained personnel.

(k) There, is need for FEPA to have a Town Cryer's Division, TCD, charged with the responsibility of educating the Nigerian populace on the evils of environmental pollution and degradation. This Division should be well equipped for effective and mission-oriented operations: films on environmental pollution and degradation should be shown in harmlets, villages and towns; also public enlightenment lectures are to be given in English and in vernacular.

(l) Nigeria should wage full-scale war against ignorance and superstition to make our people appreciate the gravity and lethal consequences of environmental pollution. Listen to what the oldest man in Koko said by way of reacting to government call for the evacuation of Koko residents immediately after the discovery of toxic wastes in the village:

> If we move, what becomes of
> the graves of our ancestors? [72]

The man, of course, had the legitimate right to be sentimentally and culturally attched to his home and land of his ancestors, but if he were from a society that has imbibed science culture and environmental consciousness, he would have first of all considered his own health, the health of his fellow villagers, and the impending danger which the future generations might face.

(m) Sustainable development, it is now widely acceptable, depends on women; it is also widely accepted that women play the larger role in grassroots environmental protection. Nigerian women should therefore be seen to be involved in both the planning and execution of Nigeria's enviromental policies.

(n) The Niger Delta region of Nigeria should be declared a pollution-disaster area by government; the necessary machinery should be put in place by government to clean up, and halt further pollution of the area.

(o) Erosion has done unimaginable havoc to some parts of Nigeria. One is of the opinion that if Nigeria fails to control erosion now, erosion will deface and degrade the Nigerian terrestrial ecosystem. The Institute of Erosion Studies at FUTO has the technical know-how to control erosion; this Institute should therefore be designated Centre for Excellence by government and copiously funded by government, FEPA and well meaning non-governmental organisations.

(p) The sources of drinking water and the farm lands of some Nigerian communities are badly polluted by industrial activities. Such communities MUST be adequately compensated. However, I personally believe that the best thing really is the prevention of industrial pollution of the environment. What, after all, is the use of compensation for a community whose future generations may be limbless, blind, sterile or mentally retarded? What is the use of compensation for a community whose average life span may be considerably shortened as a result of environmental pollution? Let me say it loud and clear here that prevention is better than compensation.

Over four years ago, Prince Philip commented on our planet's environmental woes saying:

You can blow up a balloon so far,
and then it bursts;
You can stretch a rubber-band so far,
and then it snaps;
You can bend a stick so far,
and then it breaks.

> How much longer can the human
> population go on damaging the
> world's natural systems before they
> break down altogether? [73]

This is my response to Prince Philip's poser: NOT very long from now, if man fails to prevent or minimise environmental pollution for the good LIFEKIND.

> According to Henry David Thoreau:
> It takes two to tell the
> truth: one to say it and
> another to hear it.[74]

I have with all humility said the truth about environmental pollution and degradation, and you have heard it, I imagine. I hope and pray that the message of this lecture rings out as clearly as the hourly bells of Christ Church. I sincerely hope it dose. Here, I rest my case.

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