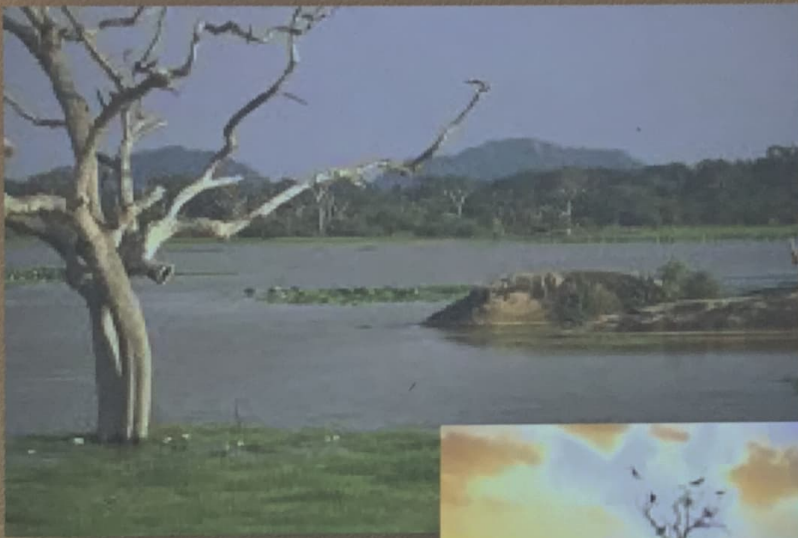


Water, Land and People in Climate Change



S. L. Tilakasiri



X

CONTENTS

	Page
<i>Dedication</i>	iii
<i>Preface</i>	iv
<i>Acknowledgements</i>	v
<i>Editorial Committee & Editorial Consultants</i>	vii
<i>Contributors</i>	viii
<i>Table of Contents</i>	xi
<i>Background Note</i>	xv

Part One – Issues and Perspectives

Chapter 1:	Global Warming and Climate Change: Past, Present and Future ... <i>S. L. Tilakasiri, R. M. Olanrewaju and A. A. Salami</i>	03
Chapter 2:	Changing Climate and its Challenges on the Future Development of Man-kind: Some Thoughtful Notes <i>Manfred Domroes</i>	31
Chapter 3:	Climate Change, People and Spirituality: A Quantum-Neuroscientific Perspective <i>Rohana Ulluwishewa</i>	41
Chapter 4:	What and Where is Nature in the Anthropocene? Some Notes on Public Environmental Relations at a Time of Climate Change..... <i>K. Sandell</i>	53
Chapter 5:	Paris Climate Change Agreement and the Road to Zero Carbon: Matters Arising for Developing Countries..... <i>U. A. Raheem</i>	69
Chapter 6:	Climate Change in Perspective..... <i>O. Soladoye</i>	79

Part Two – Climate Change and Natural Environment

Chapter 7:	Climate Change and Water Resources: Assessing the African Positions in Climate Change Discourses..... <i>M. Issah, A. A. Abdullahi and A. G. Olatunji</i>	91
-------------------	---	----

Chapter 8:	Influence of Climate on Groundwater Recharge: Clues for Sustainable Groundwater Development in Basement Complex Aquifers of Oshogbo, Nigeria.....	109
	<i>E. D. Ashaolu</i>	
Chapter 9:	Assessment of Land Surface Temperature Variations and the Contributing Factors in Kesbewa UC Area, Sri Lanka.....	129
	<i>L. Manawadu</i>	
Chapter 10:	Climate Change and Forest Resources: A Global Perspective	155
	<i>E. O. Oriola and O. Omofoyewa</i>	
Chapter 11:	Impact of Climate Change on the Incidents of Natural Hazards: A Global Perspective.....	167
	<i>H. I. Jimoh and O. D. Ajewole</i>	
Chapter 12:	Spatio-Temporal Patterns of Climate Variability in Sri Lanka.....	179
	<i>P. Wickramagamage</i>	
Chapter 13:	Environmental Monitoring and Control in Nigeria: The Case for Adaptive Management Cycle as an Effective Monitoring System..	197
	<i>L. T. Ajibade and I. Ishaku</i>	

Part Three – Climate Change and Livelihood

Chapter 14:	Environmental and Sustainable Agricultural Development in Nigeria: A Theoretical Discourse.....	213
	<i>J.W.D. Somasundara and A. Jibir</i>	
Chapter 15:	Food Security: Matters Arising and Way Forward	227
	<i>O. A. Omotesho and A. Falola</i>	
Chapter 16:	Climate Variability and Urban Agriculture: Lessons from Nigeria.....	241
	<i>A.M. Tunde, E.A. Adeleke and N.A. Malik</i>	
Chapter 17:	Climate Change Adaptation in the Sahel: Understanding the Role of Push Cart Vendors in Water Provision in Sokoto Metropolis.....	261
	<i>I. P. Ifabiyi and D. S. Adekeye</i>	
Chapter 18:	Perception of Climate Effects on Hyperthermia Diseases.....	279
	<i>R.M. Olanrewaju, C. E. Negedu, S. N. Senadheera, G. P. Akpan and P. S. Eneche</i>	

Chapter 19:	Seasonal Variations in Malaria Prevalence for Selected Towns in Southern Nigeria.....	291
	<i>E. I. Uzoma, A. O. Agbona and J. F. Olorunfemi</i>	
Chapter 20:	Climate Change – Related Human Migration: Concepts, Theory and Global Evidence.....	303
	<i>Adebisi Adedayo and Vide Adedayo</i>	
Chapter 21:	Climate Change and Poor Rural Women in Nigeria.....	311
	<i>A.M. Tunde</i>	

Part Four – Climate Change and Development

Chapter 22 :	Irrigation: Antidote for Climate Change Threat on Sustainable Food Production.....	325
	<i>E. O. Oriola</i>	
Chapter 23:	Resource Efficiency and Climate Change: Engineering and Technological Responses	337
	<i>A.A. Oloyede and H. A. Ajimotokan</i>	
Chapter 24:	Climate Change and Poverty: A Review	353
	<i>G.T. Ijaiya, M. A. Ojuolape and M.A. Ijaiya</i>	
Chapter 25:	Climate Change and Human Health: Issues, Problems and Challenges.....	365
	<i>A.G. Olatunji, A. A. Abdullahi and M. Issah</i>	
 Chapter 26:	The Role of Transportation in Greenhouse Gas Emission and Mitigation Strategies for Reducing Emission from Transportation	379
	<i>J.A. Ojekunle, Y. A. Ahmed and M. S. Oluwale</i>	
Chapter 27:	Urban Governance and Climate Change in a City of Nigeria.....	395
	<i>R.M. Olanrewaju, A. A. Salami and G. P. Afolayan</i>	
Chapter 28:	Impact of Climate Change on Tourism.....	411
	<i>Adebisi Adedayo and Herath Madana Bandara</i>	
Chapter 29:	Population Growth in Africa: Climate Change Issues and Challenges.....	419
	<i>I. Fashagba and J. F. Olorunfemi</i>	

Chapter 26

THE ROLE OF TRANSPORTATION IN GREENHOUSE GAS EMISSION AND MITIGATION STRATEGIES FOR REDUCING EMISSION FROM TRANSPORTATION

J. A. Ojekunle, Y. A. Ahmed and M. S. Oluwole

Introduction

Transportation is an integral part of modern economy, which increasingly relies on a mobile workforce, distributed production and transportation of goods and passengers which are essentially enabled by vehicle technology, fuels and transportation infrastructure (Onokala, 2011). The relationship between transportation and the environment is paradoxical in nature. On one hand, while transportation support increasing mobility demands for passengers and freight, on the other side, the same transport activities due to the growing levels of motorization and congestion is imposing grave dangers on the environment through sustained increase in greenhouse emission (Jean-Paul and Claude, 2013). All forms of transportation are closely dependent on the usage of several forms and sources of energy. The relationship between transport and energy is a direct one, but subject to different interpretations since it concerns different transport modes, each having a specific performance level. There is often a compromise between speed and energy consumption, related to the desired economic returns. Passengers and high value goods can be transported by economies of scale, mainly those achieved by maritime transportation are linked to low levels of energy consumption per unit of mass being transported, but at a

low speed. Comparatively, air freight has high energy consumption levels, linked to high speed services. Almost all transportation modes depend on the internal combustion engine, for the majority of internal combustion engines, gasoline (C_8H_{18} ; four strokes Otto-cycle engines) serves as fuel, but other sources like methane (CH_4 ; gas turbines), diesel (mostly trucks) and kerosene (turbofans of jet planes) are used. These technologies of transportation system generally have been linked to greenhouse gas emission because they rely heavily on the combustion of hydrocarbons from vehicle engine. This chapter therefore examines the concept of greenhouse, the various ways transportation has influences the greenhouse gas emission, strategies for minimizing emission from transportation.

The Concept of Greenhouse

The greenhouse effect is real and helps to regulate the temperature of our planet. It is essential for life on Earth and is one of Earth's natural processes. Result of heatabsorption by greenhouse gases (GHG called because they effectively 'trap' heat in the lower atmosphere) in atmosphere and re-radiation downward of some of that heat (CO_2 ; CH_4 ; Nitrous Oxide; Sulphur Hexafluoride; Hydro fluorocarbons and Per fluorocarbons). A Green House Gas (GHG) is a gas in the atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases in earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide and ozone. Without greenhouse gases, the average temperature of Earth's surface would be about $15^\circ C$ ($27^\circ F$) colder than the present average of $14^\circ C$ ($57^\circ F$), (Jean-Paul and Claude, 2013). Figure 1 shows countries of the world and their contributions to global carbon emission.

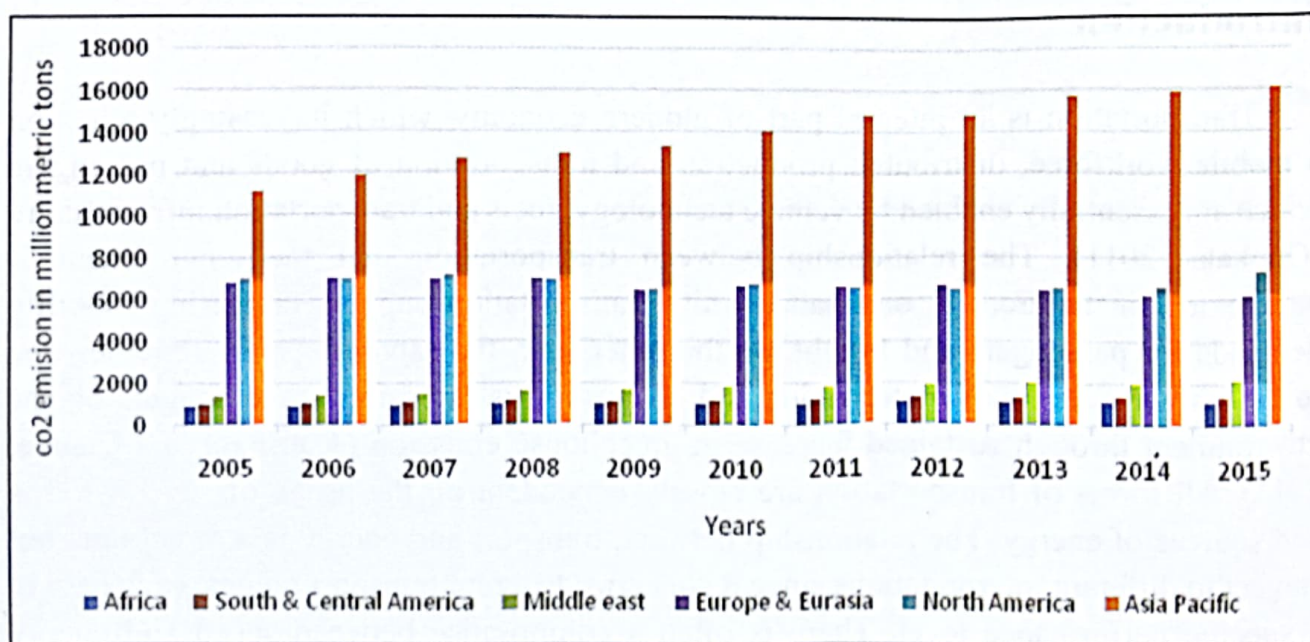


Figure 1: World Regional CO_2 Gas Emission between 2005 and 2015.

Source: <http://www.statista.com/statistics/205966/world-carbon-dioxide-emissions-by-region>.

Figure 1 shows that Asia Continent's contribution to the global emission is constantly high for past 11 years, followed by America. China is not only the highest contributor to the CO₂ emission in Asia but also worldwide, this is followed by America. The least contributor of global emission is Africa. There seems to be a strong relationship between global gas emission and the level of industrialization of different regions.

Transport Activities and Dimensions of Environmental Impacts

Transportation activities whether at land, air or water based support increasing mobility demands for passengers and freight within the local, regional and national setting. Due to the growing levels of motorization and traffic congestion in cities, the transportation sector is becoming increasingly linked to the greenhouse emissions (OECD, 1988, as reported in Jean-Paul and Claude, 2013). The most important impacts of transport on the environment relate to climate change, air quality, noise, water quality, soil quality, biodiversity and landtake (*ibid*).

Transport Influence on Climate change

The activities of the transport industry release several million tons of gases each year into the atmosphere. These include lead (Pb), carbon monoxide (CO), carbon dioxide (CO₂; not a pollutant), methane (CH₄), nitrogen oxides (NO_x), nitrous oxide (N₂O), chlorofluorocarbons (CFCs), perfluorocarbons (PFCs), silicon tetrafluoride (SF₆), benzene and volatile components (BTX), heavy metals (zinc, chrome, copper and cadmium) and particulate matters (ash, dust). Transportation as a human activity has had a great effect of the greenhouse gas emission like carbon dioxide (CO₂), methane (CH₄) and nitrogen oxide (N₂O). Over the past three decades, carbon dioxide emissions from transportation related activities have risen faster than those from other sectors and are projected to rise more rapidly in the future (Onokala 2011). Currently, carbon dioxide (CO₂) represent the largest proportion of Green House Emission (CGHs) covered by the Kyoto protocol. From 1990-2004, the carbon dioxide emission from the world's transportation has risen by 29 per cent in industrialized countries and 61 per cent in other countries in transition (IEA, 2006). In Nigeria, according to Earth's Trend (2003) as reported in Onokala (2011), the transportation sector contributed 36 per cent of the total carbon dioxide emission arising from anthropogenic activities, while IEA (2006), reports that the transport sector in Nigeria contributed 42.9 per cent of the total CO₂ emission due to anthropogenic activities. This means that the contribution of CO₂ emissions by the transport sector in Nigeria is on the increase. The gaseous chemical is greatly contributing to the global climate change through the following environmental impacts

Transport and Soil quality

The environmental impact of transportation on soil consists of soil erosion and soil contamination. Coastal transport facilities have significant impacts on soil erosion.

Shipping activities are modifying the scale and scope of wave actions leading to serious damage in confined channels such as river banks. The removal of earth's surface for highway construction or loosening surface grades for port and airport developments have led to important loss of fertile and productive soils. Soil contamination can occur through the use of toxic materials by the transport industry. Fuel and oil spills from motor vehicles are washed on road sides and enter the soil. Chemicals used for the preservation of railroad ties may enter into the soil. Hazardous materials and heavy metals have been found in areas contiguous to railroads, ports and airports.

Transport and Biodiversity

Transportation also influences natural vegetation. The need for construction materials and the development of land-based transportation has led to deforestation. Many transport routes have required drained land, thus reducing wetland areas and driving-out water plant species. The need to maintain road and rail right-of-way or to stabilize slope along transport facilities has resulted in restricting growth of certain plants or has produced changes in plants with the introduction of new species different from those which originally grew in the areas. Many animal species are becoming extinct as a result of changes in their natural habitats and reduction of ranges.

Transport and Landtakes

Transportation facilities have an impact on the urban landscape. The development of port and airport infrastructure is significant features of the urban and peri-urban built environment. Social and economic cohesion can be severed when new transport facilities such as elevated train and highway structures cut across an existing urban community. Arteries or transport terminals can define urban borders and produce segregation. Major transport facilities can affect the quality of urban life by creating physical barriers, increasing noise levels, generating odors, reducing urban aesthetic and affecting the built heritage.

Transport and Impacts on Water Bodies

Transportation contributes significantly to the pollution of the hydrosphere in various ways ranging from air pollution fallouts to the construction and maintenance of infrastructure such as roads, railways and ports. In some areas transportation may account for up to 25 per cent of nitrogen fallouts in water. It is estimated that acid rains may account for more than 75 per cent of the growth of acidity of lakes, (Jean-Paul and Claude, 2013). Since fallouts are a continuous accumulation and occur over a longer period than most water pollution sources, the most notable and destructive fallouts are sulfuric and nitric acids that may alter the pH of water if they are present in sufficient concentrations. Several northeastern United States and eastern Canadian lakes have seen their entire fish population destroyed as a result of increased acidity levels. It also includes damage to forests like reduced photosynthesis (sparse foliage) and acidified soils (limited nutrients). Nitrous oxides may affect the ecological balance of marine life by favoring algae blooms. Other fallouts such

as HC/VOC and lead are poisonous and may disrupt marine life if they accumulate in the aquatic food chain. A long term accumulation of air pollution fallouts of various natures will contaminate and disrupt whole aquatic ecosystems.

Oil products residuals carried by tankers are the major source of marine discharges. It is estimated that for every million tons of oil carried, one ton is spilled through washouts. From 1989 to 1992, 105 accidental oil spills by tankers were accounted worldwide, totaling 991,000 tons of oil being spilled. Annually, an average of 1.1 million tons of oil comes from discharges and 400,000 tons are spilled (Jean-Paul and Claude, 2013). The Exxon Valdez oil spill is a well-known example of such an occurrence.

Since road infrastructure (parking lots, roads, drainage systems) occupy a significant land surface in developed countries, it is the major source of runoffs. For instance, while highways occupy 5-8 per cent of the urban catchment area, it contributes for as much as 50 per cent of the total suspended solids, 16 per cent of the total HC and 75 per cent of the total metal inputs to a receiving stream. Runoffs from infrastructure will alter the turbidity and the oxygen level of water (warm water holds less oxygen), and contaminate the food chain. It may increase the eutrophication process of several lakes. During early springtime, nearly all the salt accumulated will be released in the hydrographic system where it will contaminate ground water and interfere with the growth of plants and the reproduction cycle of aquatic life. Infrastructure runoffs collected by the sewage system of urban areas often converge at evacuation points and contaminate whole hydrographic systems at high concentrations. Jean-Paul and Claude (2013), noted that most cities have 30 to 70 per cent of their surface occupied by roads and parking space. They thus represent important sources of runoffs. Several transportation infrastructures have important territorial handholds. When a transportation infrastructure is built over a hydrological environment like a river, wetland or a coastal area, disruption occurs. The maintenance of transportation infrastructure, particularly harbor and waterways (dredging) also, have a significant impact.

Air Pollutants Emitted by Transport System

Many pollutants identified as being closely related to transportation, for example carbon monoxide emission (which is the result of the incomplete combustion of hydrocarbons) accounted for about 70 to 90 per cent by transportation system. Carbon monoxide is present near major traffic intensive arterials in urban areas. Since carbon monoxide is not chemically stable, direct global effects are strongly limited. Indirectly, carbon monoxide contributes to the formation of greenhouse gases as a catalyst. Energy production and transportation still remain the main contributors to CO₂ even in United Kingdom (Taiwo, 2006). Table 1 shows emission generated in U.K. by different sources in percentage as observed in the table, energy is the main source followed by Transport sector.

Table 1: UK's CO₂ Emission by Sources.

Sources	Years							
	1995	2000	2003	2004	2005	2006	2007	2008
Transport	18.56	20.11	21.05	21.22	21.42	21.62	21.78	22.34
Energy	41.21	38.28	36.75	39.03	38.68	38.97	39.64	39.53
Supply								
Business	18.39	18.68	18.79	17.04	16.68	16.65	16.37	16.19
Residential	13.52	14.70	15.77	15.58	15.84	15.25	14.71	14.25
Other	8.32	8.23	7.63	7.12	7.38	7.52	7.50	7.69

Source: University of Newcastle (2013).

Nitrogen Oxide (NO or NO₂) a by-product of combustion accounts for about 45 to 50 per cent of total greenhouse emissions. Nitrogen Oxides are not very harmful to humans (particularly NO), but when released from an internal combustion engine, high concentrations are often toxic. Nitrogen Oxides are known to be associated with several global effects and have increased at a rate of 0.2 per cent annually over the last decades. They are a catalyst for ozone, a component of acid rain and a component of smog. Depositions of Nitrogen Oxides influence the nitrate cycle, particularly in water where it influences algae blooms. Hydrocarbons (HC) are a group of chemical compound composed of carbon and hydrogen. They are mostly the result of the incomplete combustion of gasoline. They include methane (CH₄), gasoline (C₈H₁₈) and diesel vapors, benzene (C₆H₆), formaldehyde (CH₂O), butadiene (C₄H₆) and acetaldehyde (CH₃CHO). Transportation accounts from 40 to 50 per cent of total emissions of HC/VOC. They can be emitted by incomplete combustion (70%), during refueling (10%) or by evaporation from storage units (20%), particularly gas tanks. All HC/VOC have several global effects. They are components of smog, catalysts for ozone and components of acid rain.

Particulates include various solids in suspension in the atmosphere such as smoke, soot, and dust and results of the incomplete combustion of fossil fuels, notably coal. Transportation accounts for around 25 per cent of total emissions of particulates. Diesel engines are the main emitters. Other important sources are thermal power plants using coal. Mixture of solid and liquid fog and smoke particles formed through the accumulation of carbon monoxide, ozone, HC/VOC, nitrogen oxides, sulfur oxide, water, particulates, and other chemical pollutants. Photochemical smog are those with a higher concentration of ozone and HC/VOC. Several large cities (like Los Angeles, Tokyo and Mexico) have serious smog problems to the point that emissions reduction policies are established. Smog impairs visibility considerably and causes different annoyances (odors, irritations, etc.). Because of its components, smog is highly associated with acid rains and greenhouse effects. Lead is a toxic metal mainly used as an anti-knock agent in gasoline (Lead tetraethyl – Pb (C₂H₅)₄) and in batteries (lead dioxide as an anode and lead as a cathode). Until recently, lead tetraethyl was a main source of atmospheric lead emissions in developing countries. This contribution has dropped in absolute numbers but still accounts for 30 to 40 per cent

of total emissions. Batteries are now an important source of lead for transportation, but a very limited amount of this lead is carried through the atmosphere (see water pollution). Extremely poisonous metal. When accumulated in the atmosphere Lead can also be transported in the atmosphere over wide distances.

Odors are the subjective perception of the sense of smell. They exist in different "shapes" of odors perceived as pleasant, neutral, or unpleasant. Diesel and gasoline engines are the major sources of odors accounted by transportation. Carbon dioxide composes 0.04 per cent of the atmosphere, whenever there is combustion (oxidation) of fossil fuels, there is an emission of carbon dioxide. Important temperature regulator for the atmosphere, keeping it at $+15^{\circ}\text{C}$ instead of -15°C if carbon dioxide was absent. Transportation accounts for around 30 per cent of total carbon dioxide emissions in developed countries (15% worldwide). About 66 per cent of carbon dioxide emissions from transportation come from the combustion of gasoline, 16 per cent from diesel fuel and 15 per cent from jet fuel. Carbon dioxide emissions by transportation have the following modal breakdown: cars (43%), light trucks (20%), heavy trucks (14%), airplanes (14%), rail and marine (7%) and non-oil based (2%). Growing quantities of carbon dioxide in the atmosphere are assumed to be linked with the greenhouse effect.

Sulfur dioxide is a heavy, colorless gas with a strong odor. It is the result of the combustion of fossil fuels like coal and hydrocarbons. Transportation accounts for around 5 per cent of total sulfur dioxide emissions. Sulfur dioxide has a counter effect on greenhouse gases by blocking radiation. This effect is significant enough to be included in climatic models. Ozone is a pale blue gas with a strong odor and a powerful oxidant. It is the most common photochemical oxidant. Ozone is created naturally in the high atmosphere when an oxygen molecule is broken apart by ultraviolet radiation and combines with another oxygen molecule. Ozone is also the result of the action of light over a mixture of HC/VOC and nitrogen oxides in the lower atmosphere. It is thus directly linked with transport emissions, notably in urban areas. Ozone is poisonous, hampers breathing and irritates the eyes and the respiratory system at concentrations higher than 0.15 ppm. The normal/natural concentration is around 0.01 ppm at ground levels.

Sulfuric acid is a corrosive, oily colorless liquid, which forms when sulfur oxides and water vapors are mixed. The level of formation of acid (sulfuric and nitric) is influenced by the level of exposition to sun light. It may also exist in dry form, which is called acid deposition. When dissolved in water, sulfuric and nitric acids lower the pH (higher concentrations of hydrogen ions). The standard pH of fresh water ranges between 6.5 and 7.5. Since transportation accounts for 5 per cent of sulfur dioxide emissions, 45 per cent of nitrogen oxides emissions and for 40 per cent of HC/HOV emissions, sources may range from 10 to 30 per cent of acid rains, depending on regions. This figure is of 25 per cent in Western Europe (Jean-Paul and Claude, 2013). CFCs are colorless and poison-less gases (or liquids). They are very stable, non-flammable and non-toxic components and they have been widely used as dispersing agents (aerosols) or as refrigerants (notably Freon, R-12). For transportation, motor vehicle air-conditioning systems are the main source and

account for about 20 per cent of all CFCs emissions. In fact, during its life cycle, an air-conditioning system will release 100 per cent of its CFCs in the atmosphere. With recent legislations, CFCs emissions have considerably subsided in developed countries but not in developing countries. Because of its chemical properties (stable and non-toxic), CFCs have no noticed effects on living organisms. Current concentrations of CFCs in the atmosphere reach about 0.35 ppm (all types of CFCs) but the most widely used type, R12, has 20,000 times more infrared absorbency than carbon dioxide. Thus one ton of Freon will have the same greenhouse effect than 2,000 tons of carbon dioxide. CFCs reduce the concentration of stratospheric ozone, which absorbs harmful ultraviolet rays. CFCs may stay in the atmosphere from 70 to 200 years, due to their extremely stable properties. They are a long term component of the atmosphere. CFCs emitted in the 1990s are likely to damage the ozone layer for 200 years (*ibid*). Even though transportation contributes significantly to the emission of air pollutants new technologies (catalytic converters) and policies have reduced emissions significantly, notably in the United States.

Noise Pollution Emitted by Transport System

Road Transportation Noise: Road accounts for approximately 70 per cent of total noise emissions by transportation. It must be noted that different road transportation modes have different scales of noise emissions. Main sources of noise come from the engine and the friction of the wheels over the road surface. Further, travel speed and the intensity of traffic are directly linked with its intensity of noise. For instance, one truck moving at 90 km/hr makes as much noise as 28 cars moving at the same speed. Ambient noise is a frequent result of road transportation in urban areas. The addition of all the noise generated by cars, trucks and buses creates a permanent ambient noise (ranging from 45 to 65 db) that impairs the quality of life in urban areas and thus the property values of residences. Nearby road arterials, ambient noise is replaced by direct noise and vibrations. The acoustics created by the surrounding environment (hills, buildings, trees, open space, etc.) alleviate or worsen local conditions. Noise level grows arithmetically with speed. For instance a car traveling at 20 km/hr emits 55 db of rolling noise, at 40 km/hr 65 db, at 80 km/hr 75 db and at 100 km/hr 80 db. Available evidence underlines that around 45 per cent of the population in developed countries live in high levels of noise intensity (over 55 db) generated by road transportation. Along major highway arterials in inter-urban areas, noise emissions are likely to alter the living environment of wildlife species, (Jean-Paul and Claude, 2013).

Rail Transportation Noise: Rail accounts for 10 per cent of total noise emissions by transportation. Noise comes from the engine (mostly diesel), the friction of wheels over the rails, and whistle blowing. Furthermore, when trains are moving at high speed, are acoustic noise becomes more important than other sources. Depending of the train aerodynamics, noise emissions are from 50 to 80 times the logarithm of train speed and become significant at speeds higher than 200 km/hr. When rail / truck transshipment is involved, the convergence of trucks towards rail yards provides an additional source of noise

related to rail transportation activities. Around 3 per cent of the population may be exposed to high noise levels from rail transportation in OECD countries. The level of exposure is obviously related to the importance and location of rail transportation infrastructure. The most important noise impacts of rail operations are in urban areas where the majority transshipment functions are performed. Furthermore, rail terminals are often located in the central and high density areas of cities.

Air Transportation Noise: Air transportation accounts for 20 per cent of total noise emissions by transportation, (Ogunmodede, 2004). As air transportation took a growing importance in inter-city transportation and that jet engines were predominantly used, noise emissions have increased significantly to the point of becoming a major concern near airports. Noise comes from the jet engine, the aerodynamic friction and ground craft operations. Even if the turbofan is the least noisy jet propulsion technology available, aircrafts are an acute source of noise in several urban areas. Noise from aircraft operation is known to have direct impact on property values around airports. This effect is distributed along major approach and takeoff lanes. The establishment of heavily used flight paths between major cities creates noise corridors where ambient noise is almost prevalent. This is particularly noted when those corridors are over densely populated areas.

The environmental impact of aviation occurs because aircraft engines emit heat, noise, particulates and gases which contribute to climate change and global dimming. Despite emission reductions from automobiles and more fuel-efficient and less polluting turbofan and turboprop engines, the rapid growth of air travel in recent years contributes to an increase in total pollution attributable to aviation. From 1992 to 2005, passenger kilometers increased 5.2 per cent per year. And in the European Union, greenhouse gas emissions from aviation increased by 87 per cent between 1990 and 2006, (Jean-Paul and Claude, 2013). There is an ongoing debate about possible taxation of air travel and the inclusion of aviation in an emissions trading scheme, with a view to ensuring that the total external costs of aviation are taken into account.

Transportation Emission and its Impacts in Nigeria

Transport is a known source of many air pollutants in most Nigerian cities. An EIA study carried out by Mechedec Construction (Nigeria) Ltd on behalf of Lagos Urban Transport Project (LUTP) in 1996 provided a description of atmospheric emissions of pollutants from three sources: stationary, mobile and industry. The profile of metropolitan Lagos by type and source reveals that road traffic is the major source of air pollution in the state. The reason for this is not far-fetched 60 per cent of all the activities are carried out using motor vehicles. Table 2 shows the estimated atmospheric emission from different sources, mt per year.

Table 2: Estimated Atmospheric Emission from Different Sources, Mt Per Year.

Source	Particulates	Sulphur Dioxide	Nitrous Oxide	Carbon Monoxides	VOCS
Stationary power plant	2	10	23	5	2
Industry/ Commercial	205	7290	4811	467	29
Domestic	6049	8618	7794	986	513
Mobile	-	-	-	-	-
Road Vehicles	4084	3378	29700	308840	52741
Rail Movement	1	4	3	3	2
Aircraft	27	33	297	1794	1137
Marine	6	460	139	21	70
Total	41118	3876	30139	310618	53950

Source: Mechelec Construction (Nigeria Ltd., 1996).

As observed in Table 3, air pollutants in Lagos state include Nitrogen Oxides, (NO, NO₂), SO, particulate matter, other atmospheric pollutants like dust generated during maintenance works through material handling, vehicle movements on loosely surfaced roads, transportation of uncovered construction materials like sand and exhaust emissions from static equipment made their respective significant contributions to the level of pollutants in the air. However, the volume and composition of vehicle emission depends on a variety of factors including like vehicle age, level of engine maintenance, road condition and engine temperature.

Transport as a major contribution to pollution in urban environment. According to Filani (2000), transport is believed to be one of the major defilers of the environment. Its effects on the health and people, community values and environmental ecology to say the least are deplorable. The effects manifest in the form of atmospheric pollution, noise pollution and degrading aesthetics" (Ogunmodede 2004). Urban traffic is characterized by many poorly maintained and sometimes unserviceable vehicles. These vehicles produced carbon-monoxide, unburnt hydrocarbons, nitrogen oxides and aldehydes. The automobiles are considered as the major source of more that 50 per cent of the pollution in Nigerian urban environment (Ogunsanya, 1985). In a similar way, while Ameyan (2002) reveals that road transport contributes more than 60 per cent of the emission with the exception of sulphur oxide and particular matter in the 1960s. The reason given by Ameyan (2002) why Nigeria is more polluted more than the industrialized countries include the fact that:

- i. Many vehicles are in poor conditions, following economic downturn of the 1980s, a barrage of vehicles which are unable to meet emission standards in Europe and elsewhere have flooded the country.
- ii. The use of low quality fuels.
- iii. More vehicles are concentrated in few large cities (Ogunmodede 2004).

The contributions of the transport sector to the total pollution in Nigeria are as shown in Table 3:

Table 3: Percentage Contribution of the Transport Sector to the Man-made Emission in Nigeria, 1998).

Emission Types	Nigeria	Lagos State	The United Kingdom	The Netherlands
CO ₂	40.81	45.65	N/A	N/A
CO	82.80	86.58	85	70
NO _x	58.60	61.31	45	54
SO ₂	97.74	26.91	5	N/A
VOC	21.97	98.77	N/A	N/A
N ₂ O	77.06	40.40	N/A	N/A
PM	77.02	83.41	N/A	N/A
Pb	97.76	100.00	N/A	N/A

Source: Obioh *et al.* (1994) was cited in Ogunmodede (2004).

Transport is responsible for most of the lead concentration which appear in the blood stream of most urban dwellers. Undoubtedly, transport related air pollution have been found to be more acute over congested urban streets where pollutants may produce conditions that are harmful to human health (Hoyle and Knowles, 1998).

Transport Environmental Pollution and Human Health

The various transport emissions have serious consequences on human health. For example, sulphur dioxide effect on man is the result of irritation by gas itself and product form in the atmosphere. 95 per cent of the inhaled high concentration of SO₂ is absorbed in the upper part of the respiratory system. It acts as an irritant and increase symptoms for patient and bronchitis, emphysema, chronic lung diseases and pulmonary fibrosis. Carbon monoxide has a unique mechanism of action differing from other air pollutants. Most common air pollutants irritate the respiratory tract but CO passes directly through the lung into the blood stream. In the bleed stream, CO shows a high affinity for the hemoglobin in the blood leading to brain damage, impaired perception and asphyxiation or in a lower doses weakness, fatigue, headaches and nausea. Allowable concentrations of CO is 100 mg/m³ for 15 min, 60 mg/m³ for 30 mg/m³ I hour, 10mg/m³ for 8 hours (Okolo, 2006).

Toxic air pollutants are associated with cancer, cardiovascular, respiratory and neurological diseases. Carbon monoxide (CO) when inhale affects bloodstream, reduces the availability of oxygen and can be extremely harmful to public health. An emission of nitrogen dioxide (NO₂) from transportation sources reduces lung function, affects the respiratory immune defense system and increases the risk of respiratory problems. The physical and chemical properties of particulates are associated with health risks such as respiratory problems, skin irritations, eyes inflammations, blood clotting and various types of allergies.

Oxides of nitrogen cause eye irritation, respiratory tract diseases, lung damage, decreased pulmonary functions and hearing stress. Allowed limits of concentration is 400 ug/m³ for 1 hour 150 ug/m³ for 24 hours. Nitric oxide in large concentration will react with haemoglobin in a similar way as carbon monoxide, thus resulting in oxygen deprivation effects. Symptoms of acute poisoning often expressed by people in traffic jams include headache, loss of vision, decrease muscular coordination and nausea.

Lead is another pollutant, which constitutes health hazards, forty percent of the gasoline used contains lead and the blood lead level in some studies is found to be 30 ug/dl. According to Okolo (2006), an action plan formulated between Nigeria and her West African neighbors in November 2001 is to the effect that leaded gasoline will be phased out by 2004.

Arising from the health implication of the air pollution is that of the economics of it. It is believed that the cost of air pollution in Lagos would have increased medical costs such as medicines and hospital visits and on productivity losses. It is a common occurrence that people who are sick lose days from work and mothers who stay at home to take care of the children who get sick. The pleasant news is that Nigeria no longer import, produce or market leaded fuel since December 2004. The cost of air pollution in terms of damage to human health, vegetation, and buildings and of reduced visibility is perceived as a serious problem in many developing country cities. World Bank (2002) report confirms that air quality is poorer than in most developed cities of equivalent size. The adverse effects of air pollution often fall disproportionately on the poor, compounding the impacts from other environmental problem in developing countries such as lack of clean water and sanitation.

Strategies for Minimizing Emission from Transportation

The number of transport vehicles around the world today is quite high and each one is a potential source of air pollution especially in large urban cities. The amount of pollution that are produced together can create a very big problems, this therefore create the necessity to evolve mitigating measures to reduce the impact of transport emission on the green house emission. Some of these measures include:

I Mandatory use of catalytic converters. A catalytic converter is a device used to reduce the toxicity of the emissions from an internal combustion engines. Today it has wide application areas in order to reduce emission from car engines, trucks, trains, buses and other engine-equipped machines. The catalytic converters performs three way simultaneous tasks of (reducing nitrogen oxides to nitrogen and oxygen: $2\text{NO}_x + \text{O}_2 \rightarrow x\text{N}_2 + \text{O}_2$, oxidation of carbon monoxide to carbon dioxide: $2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$ and oxidation of unburnt non-methane hydrocarbons (HC) to carbon dioxide and water: $\text{C}_x\text{H}_y + n\text{O}_2 \rightarrow x\text{C} + m\text{H}_2\text{O}$). These three reactions occur most efficiently when the catalytic converter receives exhaust from an engine running at the stoichiometric point of 14.7 parts oxygen to 1 part fuel. When there is more oxygen than required, then the system is said to be running lean and

the system is in oxidizing condition. In that case, the converter's two oxidizing reactions (oxidation of CO and Hydrocarbons) are favored, at the expense of the reducing reaction. When there is excessive fuel, then engine is running rich. The reduction of NO_x is favored at the expense of CO and HC oxidation.

II Rigorous inspection and maintenance of the vehicles: it is indeed very important for the engine of a vehicle to be in a very good condition as this will ensure that the pollutants emitted to the environment from such vehicle is very limited as the engine operates on a very effective and efficient level.

III Introduction of alternative fuels with environmentally friendly emissions: with the rising emission from transport at alarming rates, nine European cities: Amsterdam, Barcelona, Hamburg, London, Luxemburg, Madrid, Porto, Stockholm and Stuttgart have committed themselves to Clean Urban Transport for Europe (CUTE). Demonstration project in introducing fuel cell powered city buses. With hydrogen- based fuel cell technology, vehicle emission will tend to zero. A combination of this "cleaner" alternative with petrol will reduce pollutants. The Nigerian government has launched the alternative fuel project in 2005. Table 4 shows the relative advantages and disadvantages of some alternative fuels.

Table 4: The Relative Advantages and Disadvantages of Some Alternative Fuels.

Alternative Fuel	Advantages	Disadvantages
Natural Gas	• Low Nox emission compared to advanced diesel engines • Very low emission compared to diesel • Zero sulphate and SO₂ emission	• More complex refueling system • 4-times larger tank requirements • Reduced engine efficiency • Increased methane emission
Alcohol	• High octate number • Low Nox emission • Zero sulphate & SO₂ emission • Low evaporative loses	• Cold start problem • Increased odor • More corrosive than hydrocarbons • Larger fuel tank • Safety and handling problems
Dimethyl Ether	• Little modification to diesel engine requirements • Very low particle emission • Zero sulphate & SO₂ Emission • Low engine noise • Low NO_x levels without after treatment	• Low viscosity • The injection system need to be developed
Biodiesel	• High octate number • Good lubricity • Zero sulphate& SO₂ emission • Particulate of low toxicity (same mass emission)	• There are corrosion properties • Low heating value • Higher freezing points • Increase NO_x emission and • Increased odour

Source: Okolo (2006).

IV Developing Vehicle Emission Standard: for the preparation of an emission projection, it is important to make use of the experience and results of existing and new initiatives within international conventions. At the European level a comprehensive package of policy measures to reduce such emission have been initiated through the European Climate Change Programme (ECCP). Each of the 25 EU members states have also put in place its own domestic actions that built on the ECCP measures or compliment them. The ECCP is a multi-stakeholders consultative prices that has brought together all relevant players such as the commission national experts, industry and NGO community. Stakeholders' involvement is an essential element of the ECCP because it enables the programme to draw a broad spectrum of expertise and help builds consensus, thereby facilitating the implementation of the resulting policies and measures. Developing nations like Nigeria could walk the same route by developing that will enhance clean air and clean environment. There is need to establish a national ceiling for at least four pollutants: Sulphur dioxide (SO₂), Nitrogen Oxide (NO_x), Volatile Organic Compounds (VOC) and Carbon Monoxide (CO), causing acidification, eutrophication and tropospheric ozone formation. The deposition of acidifying pollutants (SO₂ & NO_x) onto vegetation, surface waters, soils, buildings and monuments reduces the alkalinity of Lakes Rivers and has serious effects on biological life. Acidification also makes many forests vulnerable to drought, diseases and harmful insects. Nitrogen supply to the soil is critical for plant nutrients. However, plants vary in their needs for nitrogen. The deposition of NO_x from the atmosphere leads to changes in terrestrial and water ecosystems, thereby altering vegetation and biodiversity.

Table 5: European Emission Standards (in gramme per kilometer).

Year	1970	1972	1976	1980	1984	1988	1992	1996	2000'	2005	2010
CO ₂	N/A	-	-	-	-	-	-	200	180	140	120
CO	N/A	60	25	21	15	7	2.72	22	2	1	-
HC	N/A	15	8	7	5	2.5	0.97	0.5	0.02	0.1	-
NO _x	N/A	-	-	-	-	-	-	-	0.25	0.08	-

Source: Okolo (2006).

To put in place a National Emission Standard (NES), certain legislation must exists. However, the first step towards this goal should be to establish a technical committee that will examine the technical feasibility of attaining whatever limit values which they will set, taking into consideration the followings

- Determination of different limit values for emissions by petrol and diesel cars using the EU standard as a guide (that tax incentive be granted to car importers and manufacturers to encourage compliance with whatever new limits that are developed before the set date for full implementation) of carbon monoxide, of unburnt hydrocarbons, of nitrogen oxides, and specifically for diesel engines, limits values for particulate pollutants.

- Determination of the range of vehicles affected by the emission standards and possible and possible need for differential standards with terminal dates.
- Determination of the necessary technologies needed for the successful launching and compliance with the standard. For example, actions needed in order to guarantee the availability of the following on the market: monitoring equipment and spare parts, good quality unleaded petrol, suitable lubricants etc.
- Determinations of incentives that will encourage stakeholders comply with these emission standards.
- Determination of the costs and benefits of a significant reduction in the fuel consumption of cars and analysis of the instrument available to achieve this and
- Determination of the nature of enlightenment campaign needed.

V. While in many cases technologies are available to control emissions, the main obstacles are lack of economic ability and the political will to do so. It is also imperative for government to discourage as much as possible the importation of old technology such as used cars from overseas (*Tokunbo* cars). Because, presently the average ages of *Tokunbo* cars that ply Nigeria roads are about 15 years old. Furthermore, there will the need to put in a place a system for close cooperation and coordination amongst inter-agency stakeholders, an administrative body empower to deal with the various aspects urban area in relation to transportation, the motor vehicle and public education as a road transport users may be instituted.

Conclusion

This chapter has discussed the concept of greenhouse, the influence of transportation on climate change, transportation emission and its impacts in Nigeria and strategies for minimizing emission from transportation. The need to raise awareness about the role of transportation in Green House Gas Emission is an important and urgent task for the transportation planners and geographers, it is only then that the mitigation strategies itemized above can be successfully implemented.

References

- CO₂ Gas Emission 2005-2115: <http://www.statista.com/statistics/205966/world-carbon-dioxide-emissions-by-region>
- Filani, M. O. (2000). Transport and the Environment. *The Nigerian Geographical Journal* 3&4:15-28 (new series).
- International Civil Aviation Organization (2008). Air Transport Bureau (ATB). *Aircraft Engine Emissions*.
- International Energy Agency (IEA) (2006). Carbon Dioxide Emission from Fuel Combustion 1971-2004 Edition, International Energy Association.
- Jean-Paul R. and Claude, C. (2013). *The Environmental Impacts of Transport in the Geography of Transport Systems*. Hofstra University New York, USA.
- Ogunmodede, F. (2004). Urban transport and the environment. In I. V. Chikolo, A. A. Ogunsanya and A. G. Sumaila (eds) *Perspectives on Urban Transportation in Nigeria*, Published by NITT Zaria (2004), pp101- 120.
- Ogunsanya, A. A. (1985). The Negative Aspects of Technological Development in the Transport Industry. In J. S. O. Adeniyi and M. A. Ibiejugba (eds), *Technological Development and the Nigerian Industries*, University of Ilorin Press pp 396-400.
- Okolo, A. I. (2006). Vehicle Emission Control - A Means to Achieve Clean Air in Nigeria. A Paper Presented at the National Conference on Clean Air, Clean Fuel and Vehicles organized by the Committee on the Phase-out of Leaded Gasoline in Nigeria and AFRICLEAN Nigeria organized in Abuja May 2-3 2006.
- Onokala, P. C. (2011). Climate Change and the Need for Curriculum Development in Geography. Being Presidential Address at the 52nd Annual Conference of the Association of Nigerian Geographers (ANG), Held at the Usman Danfodio University, Sokoto.(14th- 16th February 2016). Pp1-17.
- Rodrigue, J-P., Slack, B. and Claude, C. (2001). Green Logistics. In A.M. Brewer, K.J. Button and D.A. Hensher (eds) *The Handbook of Logistics and Supply-Chain Management*, Handbooks in Transport #2, London:Pergamon/Elsevier, pp. 339-351.
- Taiwo, K. (2006). Air Quality Management in Nigerian Cities: The Case of Lagos. A Paper Presented at the National Conference on Clean Air, Clean Fuel and Vehicles organized by the Committee on the Phase-out of Leaded Gasoline in Nigeria and AFRICLEAN Nigeria Organized in Abuja May 2-3 2006.
- World Bank (2002). Annual Report. World Bank, Washington 2002.