AIR POLLUTION ARISING FROM VEHICULAR EMISSIONS IN LAGOS AND THE NIGER DELTA AREAS IN NIGERIA AND THE ADMINISTRATIVE AND SOCIO-ECONOMIC MEASURES FOR ABATEMENT

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Abstract
Pollution results from social and industrial activities of man. The dependence on the atmosphere for disposal of industrial and automobile exhaust fumes has made air pollution an important issue in environmental health. This is so because the health hazard posed by air pollution to human population and the quality of the environment in general is quite enormous. Information on air pollution in Nigeria is not extensive but reports available in literature have highlighted the threatening high level of air pollution with particular reference to Lagos and the Niger delta areas. Both areas are characterised by extremely high vehicle density. Consequently, the air pollution levels in both areas have been all-time high due to the substantial amount of automobile emissions. Available data on pollution levels in Lagos and the Niger delta areas were observed to be far in excess of the standards set by the Nigerian Federal Ministry of Environment (FMEnv) and World Health Organisation (WHO). Unfortunately little or nothing has been achieved in addressing the problem. Transport control measures and the use of some economic instruments are recommended as strategies in policy formulation to complement the efforts of FMEnv towards air pollution control in Lagos and the Niger delta areas. The invigoration of state environmental protection agencies is also suggested to enhance their effectiveness at local level.

Key words: Vehicular emissions, air pollution reduction, socio-economic measures, Nigeria.

Introduction

Pollution no doubt constitutes a source of degradation generally to man and to the environment. Over-utilization of the environment aggravates pollution problems to the extent that environmental quality is reduced considerably (Smulders, 2000). However, it has to be established that economic growth, which generally increases the demand for products of convenience leads to a fall in the value and productive capacity of land and the environment in general. This is the reason why it can be safely stated that the theoretical basis for the material balance approach or the law of mass conservation can be used to explain the economic and social problems that environmental depletion gives rise to (Kneese and Bower 1976). This approach emphasizes the actual effect pollution has on productive economic activities which, inevitably, should call for a redirection of policy so as to favour economic activities on the land and on the overall growth and development of a nation.

There is no arguing the fact that the air remains a major source of life to mankind. There is also no contesting the fact that the use to which man subjects the air, has made it to become a major source of harm to the health of man. It turns out that increased air pollution in today's modern society is a direct consequence of industrialization and associated economic growth, with the latter generating greater output levels, demand for energy, as well as higher levels of consumption and living standards. And yet there is no easy market for trading in environmental quality, thus justifying the need for policy intervention to reduce the negative effects of social and economic activities on the environment.

Urban air pollution arises mainly from industrial activities and vehicular emission. The latter alone accounts for approximately half of total air pollutants (Jack Faucet Associates 1992; Obioh *et al.* 1992; USDT/USEPA 1993). However, very few studies concentrated on pollution research with the specific experiences of developing countries like Nigeria. Also, vehicular emission as a source of air pollution has not been given the attention it deserves in modern studies.

Many reports on Nigeria's pollution experience focused more on industrial pollution (Akeredolu 1989; Faboya 1997; Iyoha 2000; Magbagbeola 2001). However, a number of studies have dealt with the gravity of the problem of pollution from automobile or vehicular emission (Oluwande 1977, 1979; Akeredolu 1989; Ogunsola *et al.* 1993, 1994; Baumbach 1993; Baumbach *et al.* 1995; World Bank 1995; Garba and Garba 2001). There are, however indications that the potential for increased pollution sources particularly in Nigerian cities have increased in recent years. This is evident from the thick and black smoke haze always in the air in many Nigerian cities resulting from cars, motorcycles, industrial and other fumes. Statistics show that since the early 1990s the total number of vehicles registered annually have been increasing substantially (Federal Office of Statistics (FOS) 1995, 1999), implying that per capita ownership of vehicles has been on the increase, leading to greater traffic congestions in many Nigerian city roads. This has generally increased the concentration of pollutants in the air in the city, with potential adverse effects on the health of human population. The effects may be in form of impaired circulatory, nervous and reproductive systems, as well as kidney malfunction. One component of the emission, Lead (Pb), had been incriminated for hyperactivity and lowered mental ability in children (WHO 1991). In Nigeria, mini-markets shops and kiosks are usually established by the roadsides and around bus stops and individuals therein are exposed to high concentrations of aromatic hydrocarbons, carbon monoxide and other particles usually present in automobile emissions. At present, Nigerian government has not stipulated emission standards for air pollution from mobile sources.

The objective of this paper therefore, is to assess the present knowledge as it pertains to air pollution due to vehicular emissions, and based on this, proffer solutions based on socio-economic policy measures.

Air Pollution resulting from automobile emissions in Nigerian cities

Population growth rate of urban communities in developing countries is put at 3.5 percent per year as opposed to less than one percent in the more developed nations (United Nations, 1994). This rapid growth has vast implications both for human well-being and for the environment. Air

pollution and solid waste generation continue to increase worldwide in both absolute and per capita terms, thus constituting pollution problems in urban settlements.

The term "pollution" is a very broad concept. The World Health Organisation (WHO) defines pollution as the undesirable alterations of the physical, chemical, social and biological properties of the land, air and water or such discharge of liquids, gaseous or solid substance into the environment by man which is likely or could create nuisance or render the environment harmful, detrimental or injurious to human or public health, safety or welfare.

Pollution due to vehicular emissions arises mainly from inefficient combustion of hydrocarbon fuels. Hydrocarbon gases unite with oxides of nitrogen through photochemical reactions in sunlight to produce photochemical oxidants commonly termed "smog". Ozone, one of the photochemical products, has devastating effects on vegetation. Hydrocarbon fuels also contain varying amounts of sulphur. The combustion of hydrocarbon fuels therefore has the potential of producing oxides of sulphur, which can combine with water in the atmosphere to form acids of sulphur (acid rain). Carbon monoxide is produced as a result of inefficient combustion of hydrocarbon fuels and is highly toxic to humans even at small levels of concentration. Consequently, cities that rely on a large number of vehicles for the bulk of daily commuting, transportation, and which offer few efficient public mass transportation modes, may suffer from extreme carbon monoxide and other transportation-related emissions.

It should be noted that perfectly operating motor engines would emit pollutants which levels are, at least, tolerable. However, in the real world of imperfect engines, improper fuel grades, lack of regular maintenance, physical ageing of engines, intensive use of vehicles, all these factors combine to produce a constraint on perfect fuel combustion. The ultimate effect is the emission of poisonous gases from the exhaust system and engine parts of motor vehicles, particularly those using diesel as fuel. The danger posed by air pollution due to mobile transportation should therefore enhance the formulation of environmental policy directed at reducing the effects hence improving air quality.

Under a *ceteris paribus* assumption, countries with larger populations will exhibit higher traffic pollution potentials due to larger absolute ownership of vehicles and tonnage of fuel consumption. With a population estimated at 108.2 million in 1998 (Central Bank of Nigeria (CBN), 2000), Nigeria stands as the most populous country in Africa. The cost of petroleum products, particularly premium motor spirit (petrol) and automotive gas oil (diesel) is generally lower in Nigeria than in other OPEC countries (Federal Government of Nigeria (FGN), 2000). This has in a way encouraged single occupier vehicle (SOV) ownership. In 1990, the total number of newly registered saloon and station wagon cars in Nigeria stood at 5,985. This rose to 27,308 in 1991. By 1997, the annual figure had gone up to 574,971. Indeed the total number of all categories of annually newly registered vehicles went up from 9,303 in 1990 to 1,081,938 in 1997 (FOS, 1995, 1999; see Table 1), with the cumulative figure for the period 1990 – 97 standing at 1,468,483 vehicles.

Table 1. Number of newly registered vehicles in Nigeria (1990 – 1997). Source: Federal Office of Statistics (1995 and 1999)

Year	Saloons & Wagons	Buses	Lorries, Trucks & Tippers	Tractors	Others	Total	Cumulative
1990	5,985	832	536	81	1,869	9,303	
1991	27,308	1,100	830	159	7,737	37,134	46,437
1992	37,442	4,558	766	350	5,551	48,667	95,104
1993	63,586	1,407	698	242	12,783	78,716	173,820
1994	45,401	6,804	593	468	4,617	57,883	231,703
1995	46,097	8,558	616	498	1,702	57,471	289,174
1996	62,504	16,094	5,733	976	12,014	97,371	386,545
1997	574,971	333,454	51,003	56,246	66,264	1,081,938	1,468,483

The World Bank (1995) had estimated that the number of vehicles per 1000 inhabitants in Nigeria is above the average for other African countries, assuming the ownership ratio to be in the neighbourhood of 30 vehicles per 1000 inhabitants Consequently, fuel consumption in both absolute and per capita terms were also found to be higher for Nigeria (Table 2), for both petrol and diesel. For example, in 1992, total petrol consumption in Nigeria was estimated at 3,969 thousand tons, with a per capita equivalent of 0.043 thousand tons. For diesel, this was 2,280 tons, with a per capita equivalent of 0.024. For the same year, the total consumption of gasoline in Kenya stood at 376.7 thousand tons, with per capita equivalent of 0.013 thousand tons. For diesel, the total was 537.3 thousand tons, with per capita equivalent of 0.019. As also shown in Table 2, traffic volume is higher in Nigeria compared with other African countries. The World Bank (1995) study also reported that an average Nigerian vehicle runs considerably more distance than an average European car per year, with the former covering as much distance as 30,000 km/year.

Thus, the combination of the large number of motor vehicles in Nigeria, higher ratio of vehicle ownership and fuel consumption, distance covered per vehicle per year, is responsible for the large contribution by automobile emissions to air pollution. It should also be noted that the average age of motor vehicles in Nigeria is generally high. Since the adoption of the Structural Adjustment Programme in 1986, new vehicles have been generally out of reach of private individuals due to falling real incomes. For example, whereas a new 504 brand of Peugeot (saloon) car sold for less than ₦7000 in 1985, its average price has been as high as ₦1,800,000, since the 1990s. Consequently, only companies as well as government departments and parastatals are generally able to buy new vehicles. Some of these establishments that are less buoyant have resorted to purchasing used vehicles for official use. These used vehicles are imported from Europe in different varieties ranging from trailers, trucks, tippers, buses, to saloons cars and station wagons, and special vehicles (such as tractors and motorcycles). Many of these vehicles are well over fifteen years old before importation into the country, and will continue to be used for the next twenty years or more. Thus vehicles in Nigeria are characterized by old age, and overused. Furthermore, the general lack of maintenance culture and use of low-grade fuels combine with the factors to increase the propensity of automobiles in causing air pollution in Nigeria.

Table 2. Traffic volume and fuel consumption in selected African countries. Source: World Bank (1995).

Country	Population (million)	Traffic Work (million vehicles/km)	Gasoline Consumed (thousand tons)		Diesel Consumed (thousand tonnes)	
			Total	Per Capita	Total	Per Capita
Nigeria (1992)	91.3	8,220	3,969	0.043	2,280	0.024
Kenya (1987)	27.3	4,865	376.7	0.013	537.3	0.019
Madagascar (1989)	13.0	-	75.3	0.005	181.3	0.013
Togo (1991)	4.1	-	20.2	0.003	70.7	0.017
Zimbabwe (1992)	10.8	7,820	1.1	0.0001	2.9	0.0002
Ghana (1989)	16.7	5,160	92.2	0.005	61.0	0.003

Statistics on pollution intensity for all cities in Nigeria are generally not available. However, existing figures for Lagos and the Niger Delta area characterised by high oil industry concentration (Orubu, 2001) provide some useful clues. Lagos, Nigeria's former capital city remains the largest urban commercial and industrial centre in the country. On the other hand, Port-Harcourt and Warri are two major cities in the Niger Delta area with fairly large populations and industrial establishments. Comparative figures from Lagos and the Niger Delta area (Table 3) can therefore be used to make some deductions on the intensity of pollution from automobile sources.

Table 3. Ambient air pollutants in Lagos and Niger area. (TSP = Total suspended particulate matter, NO*x* = Nitrogen oxides, SO_2 = Sulphur dioxide, and CO = Carbon monoxide). Source: Jerome (2000).

Pollutant	Lagos Area		Niger Delta Area		FEPA Standards
	Non-traffic Urban Zone	Traffic Zone	Oil Communities	Cities	
TSP $\mu g/m^3$	31.4 – 746.5	72 – 950	92.2 – 348.5	396.8 – 583.3	250
NO_X (ppb)	81 – 81.5	34 – 131.6	22.0 – 295.0	35 – 370	40 – 60
SO_2 (ppb)	0.5 – 43	20 – 250	7.0 – 97.0	16 – 300	100
CO (ppm)	0.5 – 3.9	10 – 250	5.0 – 61.0	1.0 – 52	10
CO/NO_x	0.0 – 6.0	50 – 200	20	15 – 130	–

The measured pollution intensities are high, exceeding the FMEnv's limit (20 ppm) and that of WHO (48 ppm) for carbon monoxide. With respect to the traffic zone of urban Lagos, Table 2 shows that the implied average concentrations recorded for TSP, NO_x, SO_2 and CO are far in excess of the standards recommended by FMEnv. This is also generally true for the cities in the

Niger Delta. The concentration of CO emissions for Lagos road corridors is quite high, being in the range of 10–250 ppm recorded, higher than the ranges of 5.0–61.0 ppm and 1.0–52 ppm recorded for oil communities and cities respectively in the Niger Delta. These ranges show maximum values exceeding WHO standards (Baumbach *et al.*, 1995). For Lagos, being the city with the highest concentration of traffic in Nigeria, it is expected that CO emissions in its road corridors will be higher than what obtains in other parts of the country. The TSP concentrations recorded are also high, when compared to WHO's standard of 75 $\mu g/m^3$. Similarly, Ogunsola *et al.* (1993) had earlier recorded TSP values ranging between 100 and 2000 $\mu g/m^3$ in Lagos compared with 120 and 720 $\mu g/m^3$ at Ile-Ife. The traffic densities in Lagos and Ile-Ife when the data were collected were 1000-10,000 vehicles per hour and 450-1,500 vehicles per hour, respectively.

Generally, the figures recorded above indicate that air pollution due to automobile emissions can pose public health hazard to the population. This assertion is supported by the increasing intensity of the "black smoke" phenomenon in the typical Nigerian city. Such city is usually associated with old diesel engines of trailers, lorries, trucks, buses and other categories of vehicles. Indeed, the potential for increased pollution from this source is very high, given the large number of old and second-hand vehicles imported into the country annually, a situation that has also led to more congested city roads and increased pollutant concentration levels. A proactive policy is therefore required to address the problem. Some of the instruments that can be used to reduce automobile pollution in Nigeria are examined in the next section.

Vehicular control and socio-economic measures aimed at reducing air pollution.

Generally, mobile source abatement can result from successful implementation of transportation control measures (TCMs) aimed at decreasing motor vehicle trips, and vehicle mile travel (VMT), reducing congestion by encouraging off-peak period travels (or driving under more optimal conditions), and by encouraging the use of transportation modes other than single-occupant vehicle (SOV) travel. Mobile source abatement can also result from better vehicle maintenance practices, retrofitting older vehicles with newer emissions control technology and replacing existing vehicles with lower-emitting ones.

On a broad line of classification, we can identify two categories of TCMs. In the first category are those TCMs that focus on the supply of alternatives to SOVs. This category includes regulations that encourage the adoption of public transit transportation modes, traffic flow improvements, high occupancy vehicles, the provision of travel lanes and non-motorised vehicle paths and accommodation. The regulation aims at reducing traffic density. In the second category are those TCMs, which more specifically place restriction on automobile travel demand. Successful implementation of the supply and demand–oriented TCMs should reduce pollution from automobile sources. A large number of TCMs fall within the "control and command" (CAC) approach to environmental policy. The success of the CAC instruments depends significantly on monitoring of the standards set and ensuring that non-compliance is punished.

Economic instruments (EIs) can also be used to reduce pollution from automobile sources. Such instruments include general charges and taxes per unit emitted, subsidies for each unit abated,

tradable permit systems in which the polluter must acquire a permit for each unit emitted, and deposit refund systems. Other economic measures include congestion pricing and higher parking fees. Although economic-based instruments of environmental policy have a strong theoretical foundation (see for example, Baumol and Oates 1988; Barde 2000), they have only a short history of actual application in pollution control. The implicit objective of these economic instruments, however, is to increase the cost of SOV travel, which should ultimately reduce pollution per capita, as well as enhance the relative attractiveness of alternative and cleaner modes of transportation.

A combination of TCMs and economic instruments can therefore be profitably used to reduce pollution due to automobile emissions, which is conspicuously visible in most Nigerian urban centres. As already noted, no definite action is currently being taken to reduce emissions from motor vehicles by the authorities beyond the use of slogans of moral persuasion. This is in spite of strong recommendations that have been made in some reported research findings (Ogunsola *et al.* 1993, 1994; Baumbach *et al.* 1995). Enactment of laws to prevent the existence high emission engines as well as ensuring reduction in the lead content of petrol are inevitable. Similar laws have been in existence since the 1970s even in some developing countries (e.g. see Vincent *et al.* 1997).

Suggested combination of TCMs and EIs, which can be used to reduce pollution from automobile sources in Nigeria are summarized in Table 4. As already noted, the ultimate objective of TCMs is to reduce the demand for SOVs, VMT, and to encourage the provision of alternative and more environmentally friendly modes of transportation. In its 2002 budget, the Federal Government of Nigeria proposed a restriction on the importation of pre-1995 used vehicles into the country. Although there is general opposition to this policy proposal, it will provide one sure way of reducing automobile source emissions in Nigeria. The economic instruments suggested implicitly work through the reduction of demand for vehicle ownership by increasing the cost of ownership and maintenance. In this way, SOVs will be greatly reduced. A judicious combination of some of the TCMs and EIs listed in Table 4 can therefore be used in an environmental policy formulation to reduce pollution from automobile transportation sources in Nigeria.

Conclusion

This paper identifies pollution as a consequence of man's economic activities, highlighting automobile transportation as one major source. Although information in literature relating to pollution from transportation sources in Nigeria is few, evidence based on empirical data from Lagos (Akeredolu 1989; Ogunsola *et al.* 1993, 1994; Baumbach *et al.* 1995) and the Niger Delta area (Jerome 2000; Orubu 2001) point to increased air pollution from transportation sources. A combination of TCMs and EIs is therefore suggested within a proactive framework in an environmental policy formulation to reduce air pollution from this source.

Table 4. Suggested transport control measures (TCMs) and economic-based instruments (EIs) for reducing air pollution due to automobile emissions in Nigeria.

Category of Instruments	Programme	Remarks
A TCMs	1. Improvement of public transit, provision of high occupancy and shared rides.	Require good roads in cities to reduce to-work journey time.
	2. Programmes to improve traffic flow and restriction of movement of trailers and heavy trucks to off-peak periods in areas of dense traffic.	Could reduce extreme pollutant concentration during peak traffic periods.
	3. Programmes to reduce idling period for motor vehicles.	May require provision of alternative roads for different categories of vehicles. Costly to implement
	4. Programmes to encourage use of non-fuel vehicles for individuals e.g. bicycles.	Must take into account safety considerations. Provide bicycle lanes and packing facilities. Likely to face social resistance.
	5. Encouraging voluntary withdrawal of old vehicles from use and the market, and restricting the purchase of older vehicles.	May face resistance, on economic grounds, but one sure way of reducing automobile pollution.
	6. Retrofitting old vehicles with emission reduction gadgets and engines.	Must take into account technological and economic feasibility.
	7. Programmes for construction of tracks solely for the use of pedestrians.	Will reduce the effect of pollutant doses on individuals.
	8. Empowering the traffic police and Road Safety Corps to check and sanction motor vehicles emitting "black smoke," and maintenance history of vehicles.	Long overdue. Absence of 'black smoke" should be a key requirement--in issuing certificate of road worthiness.
B Economic Instruments	1. Introducing emission tax for all categories of vehicles based on: (a) annual distance covered by vehicle; (b) age of vehicle; (c) fuel type used.	Requires establishment of environment unit in the Revenue Department of Government to monitor hartridge smoke units.Implementation requires cooperation of police and other agencies such as Road Safety Corps
	2. Reduction or removal of subsidy on petroleum products.	Effect is to increase cost of maintaining vehicles and may reduce SOV. Increased revenue for government.
	3. Hike in vehicle fees and operation charges (e.g. license and insurance fees, registration fees based on age of vehicles etc).	May reduce demand for SOV, increase revenue, and decrease pollution per capita.
	4. Clear definition of economic liability arising from damage due to pollution. 5. Imposition of high packing fees	Would require legislative framework in line with the polluter pays principle To be implemented by local authorities
C Others	1. Programmes of effective town planning. 2. Education and voluntary approaches 3. Better communication facilities (e.g. improved telephone services)	Potential for emissions reduction quite high. Reduction of congestion and VMT

The reduction of pollution due to automobile sources would also require structural organisational modifications in the mechanisms of environmental policy and planning in Nigeria. There should be concerted efforts to make environmental policy exist and work at the local levels. It will therefore be necessary to evoke the *subsidiary* principle, which advocates some degree of

decentralisation of environmental policy action to guide the design of policy instruments to reduce pollution due to automobile emissions. In line with this principle, policies aimed at making state environmental protection agencies (SEPAs) more effective are inevitable. There is however the strong need to take into account the cooperation between different government Ministries such as those of Environment, Finance, Economic Planning, Health, Urban Planning, Transport, as well as the Police and other agencies, such as the Federal Road Safety Corps, even at the local level. In addition, socio-economic measures such as the imposition of high vehicle registration, operation and parking fees, aimed at reducing single-occupant vehicle (SOV) travel and motor vehicle trips should be adopted.

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