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ESTIMATION OF GLOBAL WARMING AGENT FROM ROAD TRANSPORT SYSTEM IN NIGERIA

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Abstract

World attention has been drawn to the climate change as a result of global warming. Carbon dioxide (CO_2) is a greenhouse gas contributing 9-26 % to global warming. Hence this study focused on estimating CO_2 emission from road transport system in Nigeria from 2004 – 2007. Inventory of all the automobile on the roads of the selected states in Nigeria was taken for the years under review. CO_2 emission from this automobile was estimated using emission factor approach. The result showed Lagos state contributed highest total emission of CO_2 with 116007706.2 ton/annum in the years under review while Cross River State contributed the lowest emission of 1170712.9 ton/annum. Also, motor cars contributed the highest emission of CO_2 of 6720036.462 ton/annum to the ambient environment in the years under review while Lorries contributed lowest emission of 927541.18 ton/annum. The work provides an insight into the contribution of road transport system into the ambient level of CO_2. The result from this work will help to put in proper legislation in reducing the emission of these pollutants.

Keywords: *vehicular emission; carbon dioxide; pollution.*

1. Introduction

There is an unprecedented increase in surface temperature on the earth and this has been attributed to an anthropogenic increase in the rate of emission of greenhouse gasses [1-3]. Among the six greenhouses gases, CO_2 a has been identified as a major culprit for global warming contributing 9-26 % [1,4]. The effects of this temperature rise on human beings and the environment have been extensively reported [5]. Developing countries such as Nigeria has had her share of the effect of global warming, the devastating effects of recent flooding in some part of the of the country and the various prolonged droughts and heat meningitis experienced in some parts of the Northern region of in the are typical effects of global warming [6].

The vast majority of CO_2 emissions come from fossil fuel combustion (coal, natural gas, and petroleum), with small amounts from the nonfuel use of energy inputs, and emissions from electricity generation using non-biogenic municipal solid waste and geothermal energy. Other sources include emissions from industrial processes, such as cement and limestone production [7]. In Nigeria vehicular emission is an important source of carbon dioxide emissions contributing around 20% of Western Europe's CO_2 emissions as at the year 2000 [8]. Nonetheless, CO_2 emissions from vehicles are projected to continue to increase, so proportionally their role may become more significant.

It has been reported that between 1956-2005, the average earth's temperature rose significantly by 13°C per decade which doubled the rate for the 100 years from 1906 to 2005 [6]. Temperatures in colder areas, like the Arctic, also rose twice as fast as the average. This has led to the ice caps melting at a rate of 2.7% per decade since 1978. It also caused sea level

to rise at an average rate of 3.11mm per year between the periods 1993-2003, nearly double the rate between the periods 1961-2003 [7].

There has been an enormous growth in road traffic activity and the use of automobiles in Nigeria. The result of this trend is that air quality in some towns and cities in Nigeria is now dominated by emissions from road vehicles [9]. Global environmental impact due to the burning of associated or solution gas, which produces carbon dioxide (CO_2) and methane (CH_4) is worrisome. One of the sinks for these gasses is the stratosphere, where shortwave UV radiation photo dissociates the molecules, releasing chlorine (Cl) atoms. These Cl atoms are projected to reduce the steady-state stratospheric ozone concentration, in turn increasing the penetration of harmful UV radiation which causes global warming.

There are many methods for estimating emission of air pollutants to the ambient air; these include: direct measurement, mass balance, fuel analysis and emission factors. Among these techniques, emission factor method is a simplified technique for estimation of pollutant emission associated with an activity and has been widely used to quantify the number of pollutants released from an activity [9-11]. It is a representative value that attempts to relate the quantity of a pollutant that is released to the atmosphere with the activity associated with the release of that pollutant [12]. Hence this study is focusing on estimation the total emission of CO_2 from road transport system in Nigeria for the years under review; this is with the view of determining the contribution of the vehicular emission to the ambient level of CO_2 in the country.

2. Methodology

2.1. Study area

This study area is Nigeria with a population over 176 million according to World Bank estimation. Nigeria is situated on the West coast of Africa, lies on latitudes 4° north of the Equator and latitudes 3° and 14° on the east of the Greenwich Meridian. Shares boundaries with The Republics of Benin and Niger in the West, Cameroon in the East, Niger and Chad in the North and the Gulf of Guinea in the South.

2.2. Estimation of CO_2

An emission factor approach was used for emission calculation. The national vehicle statistics were collected from the Central Bank of Nigeria (CBN) and the National Bureau of Statistics of Nigeria (NBS) "Annual Abstract of 2010". Estimation of transport-related emissions was based on equation (1)

$$E = e * a \quad (1)$$

where "E" is the emission rate; "e" is the emission factor per unit of activity; and "a" is the amount of transport activity.

This equation was applied to each vehicle category since the emission factors, and the activity is different. The emission factor, e, is usually expressed in g/kg of fuel and primarily related to driving conditions and vehicle type. The activity, a, is the kg of fuel consumed for travelling a distance of 100km/hr by vehicle over the time unit, in km. Summarized in table 1 are the emission factors used for each of the vehicle types. This was done with the assumption that: the vehicles move at 100km/hr on highways.

Table 1. Emission factors of vehicle categories

Emission source	Uncontrolled fuel economy, L/100 km	CO_2	NOx g/kg fuel	CH4
Cars	11.2	3 183	0.059	0.83
Buses	13.6	3 183	0.059	0.783
Lories	22.5	3 183	0.036	0.653
Motorcycles	2.4	3 138	0.056	5.55

Source: Emission Inventory Guidebook 1 September 1999

3. Results and discussion

This study determined the CO_2 level as one of the global warming agents from fuel consumption by road transportation system in Nigeria. This was with the view to providing information on the current contribution of road transport in Nigeria to her national emission levels.

These emissions calculations are presented as annual emissions with units of ton/year which are presented in Table 2-5.

Table 2. Carbon dioxide (CO_2) from Nigeria roads in 2004 (ton/annum)

States	Cars	Buses	Lorries	Motorcycles
Abia	782 411.4	729 423.1	81 339.5	-
Akwa Ibom	1 057 137.0	66 942.5	17 003.2	1 468 045
Bayelsa	104 414.3	49 998.5	16 084.09	22 058.2
Cross River	195 370.8	-	-	188 965.0
Ebonyi	504 437.2	120 274.3	117 643.6	478 123.2
Edo	1 058 065	249 992.7	496 309	59 606.1
Gombe	27 147.73	21 388.26	9 190.907	13 823.1
Imo	402 111.2	168 883.9	28 032.27	367 685.3
Kaduna	768 489.4	281 380.6	-	318 863.2
Katsina	336 214.1	68 053.6	75 824.9	317 196.6
Kebbi	706 304.9	794 421.2	1 479 276.0	797 427.6
Kwara	712 105.7	393 599.6	108452.7	213 131.0
Lagos	1 3417 473.0	1 803 836.0	877 731.6	566 110.9
Niger	433 435.5	407 765.8	98 342.7	104 212.6
Osun	532 049.0	11 3330.0	19 300.9	81 762.3
Oyo	136 202.7	19 443.9	39 061.4	19 607.3
Plateau	218 109.9	137 773.7	8 731.4	103 624.4
Sokoto	1 081 500.0	369 711.4	488 037.2	714 684.9
Yobe	313 243.0	61 387.1	45 035.4	469 594.1
Zamfara	144 787.9	101 663.7	141 080.4	184 602.4

Table 3. Carbon dioxide (CO_2) from Nigeria roads in 2005 (ton/annum)

States	Cars	Buses	Lorries	Motorcycles
Abia	577 527.2	545 539.6	62 498.2	1 802 545.2
Akwa Ibom	1 153 198.0	73 331.2	52 388.2	1 084 478.0
Bayelsa	157 781.7	83 330.9	26 653.6	34 312.7
Cross River	240 617.0	-	-	169 259.7
Ebonyi	224 374.8	57 498.3	50 090.4	116 614.2
Edo	1 142 757.0	284 713.9	522 043.5	66 370.6
Gombe	36 661.0	27 499.2	22 058.2	11 715.3
Imo	332 269.6	147 773.4	20 679.5	428 222.7
Kaduna	768 721.5	111 663.4	-	53 135.7
Katsina	372 179.1	165 828.5	79 501.4	293 177.7
Kebbi	2 220 545.0	1 811 891.0	1 630 926.0	831 887.4
Kwara	1 266 198.0	699 423.9	193 009.0	574 983.1
Lagos	16 357 316.0	1 986 053.0	906 223.4	393 223.8
Niger	512 790.4	484 985.8	138 782.7	121 172.9
Osun	778 466.8	217 215.9	25 274.9	216 072.1
Oyo	390 045.5	81 942.0	24 815.5	127 251.2
Plateau	1 121 178.0	53 609.5	14 705.5	152 985.7
Sokoto	282 382.7	71 664.6	58 821.8	188 916.0
Yobe	375 427.5	114 996.6	36 763.6	500 475.5
Zamfara	144 787.9	101 663.7	141 080.4	184 602.4

Table 4. Carbon dioxide (CO_2) from Nigeria roads in 2006 (ton/annum)

States	Cars	Buses	Lorries	Motorcycles
Abia	688 902.5	520 262.5	99 721.3	583 071.1
Akwa Ibom	456 406.6	57 498.3	12 867.3	535 033.3
Bayelsa	185 625.5	138 884.8	38 142.3	59 066.9
Cross River	57 543.9	-	-	225 679.7
Ebonyi	73 322.1	47 776.3	7 812.27	219 601.4
Edo	1 403 792.6	291 658.1	206 795.4	59 066.9
Gombe	38 749.3	2 162 158.8	24 355.9	31 763.8
Imo	90 956.5	30 832.4	9 650.5	150 730.9
Kaduna	253 842.8	38 054.4	-	8 627.2
Katsina	230 639.7	91 663.9	29 410.9	118 231.8
Kebbi	914 437.5	1 066 079.9	487 577.6	790 614.1
Kwara	795 173.1	439 431.6	121 319.9	236 953.8
Lagos	27 402 728.1	4 104 046.4	2 194 329.1	580 669.3
Niger	542 954.5	551 928.3	154 866.8	125 290.4
Osun	668 483.7	217 771.4	5 054.9	249 992.7
Oyo	287 951.5	76 664.4	14 245.9	81 909.4
Plateau	1 222 575.8	587 482.8	10 569.5	266 560.8
Sokoto	157 317.6	60 831.5	39 520.9	101 026.5
Yobe	417 889.3	104 163.6	41 818.6	678 901.7
Zamfara	181 912.9	32 776.8	34 006.4	211 072.2

Table 5. Carbon dioxide (CO_2) from Nigeria roads in 2007 (ton/annum)

States	Cars	Buses	Lorries	Motorcycles
Abia	1 318 172.9	802 754.2	258 264.5	2 291 256.4
Akwa Ibom	338 534.5	40 554.37	21 139.1	878 552.7
Bayelsa	464 063.7	194 438.7	46 873.6	95 781.5
Cross River	93 276.8	-	-	-
Ebonyi	45 942.3	22 221.57	36 763.6	85 634.7
Edo	1 358 546.4	412 487.9	103 397.7	46 469.2
Gombe	48 958.7	31 943.51	31 249.1	5 588.1
Imo	12 761.8	46 943.07	6 433.6	165 828.5
Kaduna	428 562.8	1 771 059	-	312 539.9
Katsina	489 587.1	35 554.51	103 857.2	197 494.2
Kebbi	922 558.6	1 353 294	607 059.4	713 753.6
Kwara	616 044.5	340 545.6	93 747.3	187 494.5
Lagos	36 396 050.1	4 788 749	3 306 429.0	926 737.5
Niger	603 282.8	479 708.2	238 963.6	157 642.4
Osun	766 401.1	246 381.7	3 676.4	432 242.2
Oyo	463 831.645	144 995.7	39 520.9	110 290.9
Plateau	1 380 821.47	835 808.8	9 650.5	358 567.9
Sokoto	5420 26.375	108 052.4	2 757.3	305 383.2
Yobe	446 661.289	133 607.2	51 469.1	698 999.1
Zamfara	207 204.432	59 720.47	49 630.9	374 204.7

The emission of carbon dioxide (CO_2) from cars in all the states in 2004 were estimated to be 71 550-16 665 152 ton/annum with the highest emission in Lagos while the lowest estimated emission was in Gombe state. In the year 2005 estimated emission from all the states were ranged from 97 933.7-19 642 816 ton/annum, Lagos state has the highest emission and Gombe state with the lowest emission. Estimated emission ranged from 282 170.3-34 281 773 ton/annum in the year 2006 with lowest and highest concentration in Imo state and Lagos state, respectively. Estimated emission in the year 2007 ranged from 17 739.4- 45 417 966 ton/ annum, with the highest concentration in Lagos state and lowest in Gombe state. The result showed that Lagos state contributed the highest emission to the Nigerian tropospheric CO_2, this is connected with a large number of the automobile in the road of the state. Also, major Petroleum depot is located in Lagos which make it a hotspot for petroleum takers that convey the petroleum product to other parts of the country. Due to the number of the petroleum taker and longer time they spend on the road as a result of the holdup usually, experience in the metropolis a large

amount of CO_2 could be emitted from the exhaust of this vehicle which could cause a considerably increase in the ambient concentration of CO_2. Figure 1 shows the total emission of CO_2 from each state under review. The trend observed showed virtually in all the state a progressively increase in the total emission of CO_2 from the year 2004 to 2007 and this is connected with increasing in the number of the automobile in the roads of the states in view. However, some state estimated CO_2 decreases progressively in these years considered this could be attributed to some factors such as government policies on petroleum products. It has shown that whenever petroleum price is increased by the government low income earner are tend to dispose of their automobile thereby reduce the number of the automobile in this state and in turn reduce the emission of CO_2 at the particular year. Figure 2 shows the emission of CO_2 from the various automobile in Nigeria road; the result showed the motor cars contributed the highest emission of CO_2 to the ambient environment in the years under review this could be as a result of a large number of cars on the roads of the states under review. Buses contributed second highest followed by motorcycles and lorries. The trend also showed a progressive increase in the emission from virtually all the automobile from 2004 to 2007 this could be as result of a progressive increase in the number of this automobile as the year progressed.

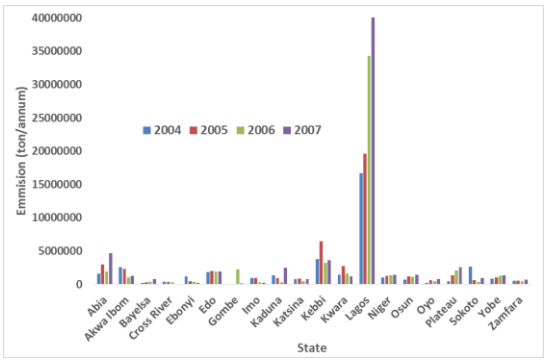

Figure 2. CO_2 Emission from each State of Nigeria

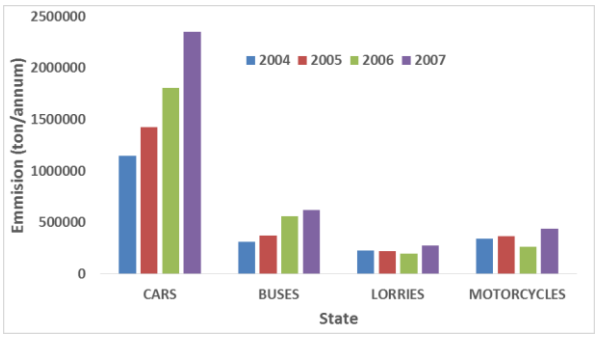

Figure 2. CO_2 from all automobile on the road in Nigeria

4. Conclusion

The work focused on estimation of emission rate of CO_2 from road transport system in the some selected state of Nigeria between the years 2004 to 2007. The result showed the emission CO_2 is a function of the population of the automobile in the road. Lagos state contributed highest total emission rate of CO_2 with 11 6007 706.2 ton/annum in the years under review while Cross river State contributed the lowest emission of 1 170 712.9 ton/annum. Also, motor cars contributed the highest emission of CO_2 of 6 720 036.462 ton/annum to the ambient environment in the years under review while lorries contributed lowest of 927 541.18 ton/annum. The work provides an insight into the contribution of road transport system into the ambient level of CO_2 and as such help in putting in place an appropriate mitigation measure for this emission.

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