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Contribution of Automobile to Climate Change in Africa

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Abstract
Man depends on the automobile to commute to the spatially distributed activities in cities to satisfy his needs. The rapid urbanization experienced in the most part of the world has increased demand for travel and also the pollution therefrom. The carbon dioxide (CO_2) emissions released by automobile is a major greenhouse gas emission causing climate change. This study explores automobile usage and carbon dioxide (CO_2) emissions in Africa. The information utilised in this study were sourced mainly from World Health Organization, Energy Information Administration and Carbon dioxide Information Analysis Centre, United States. The finding of the study reveals that the continent is experiencing growth in vehicle ownership and usage and has a total of 57,566,330 registered vehicles. The CO_2 emission from the automobile is increasing in almost all countries in Africa. The continent recorded a total of 1,216,015.3 billion tonnes of CO_2 emissions in 2013, which represent 3.8% of world total. Surprisingly, only six countries South Africa, Egypt, Algeria, Nigeria, Morocco and Libya accounts for more than 80% of this emissions. The growth in CO_2 emissions in Africa can be attributed to rapid urbanization, the practice of buying used vehicles and use of low occupancy vehicles for public transport. The study recommends the introduction of strict vehicle emission control, conventional public transport system, use of low carbon emitting vehicles and establishment of an intergovernmental agency to monitor and collate information on greenhouse gases in Africa.

Keywords
automobile, climate change, CO_2 emissions, global warming, greenhouse gas

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1. Introduction

Transport is an essential component part of our daily life due to demand for commuting to spatially distributed activities, goods and services. It has been developed to meet the increasing travel demands of the population in cities. Although this has led to economic development, it has also caused damage to the environment [1]. Studies have shown that the CO_2 emission from transport sources is a major contributor to greenhouse gas emissions causing climate change [2 & 3]. [4] remarked that motorized transport depend majorly on fossil fuel usage. This made transport sector to account for 26% of global CO_2 emissions [5]. Within the transport sub-sector, road transport contributes more to CO_2 emissions than any other mode [6]. [7] remarked that automobiles account for about 82% of CO_2 emissions in European countries. Similarly, in the United States, CO_2 emissions accounted for about 82% of all greenhouse gas emissions from human activities in 2015 out of which transportation contributed 31% [8]. In Africa, transportation accounts for 57% of the total energy use in the region [9]. Two-thirds of this emission originates in the wealthier 10% of countries [10].

The tonnes of CO_2 emissions released from automobile are on the increase rising faster than other energy-using sectors in Europe, North America and Asia [11]. For instance, the tonnes of CO_2 released from automobile both passenger and freight transport is on the increase in USA, UK, China and India. [12] observed that the total number of passenger cars in the European Union (UE-15) reached 187 million in 2003, corresponding to an increase of 27% from 1990 figure. The trend is the same in the United States where there is growth in vehicle ownership until economic meltdown experienced in 2008 slowed down the growth but this has started to grow again [13]. [3] reiterated that transport sector contributes a quarter of CO_2 emission in the United Kingdom. Africa has experienced substantial growth in vehicle ownership

and energy consumption by transport has increased from 4.3 quadrillion Btu in 2002 to 10.1 quadrillion Btu in 2040 at 3.1% per year [9].

The increase in CO_2 emissions is due to growth in production and usage of personal transport and development of transport infrastructures. The identified factors that influence the growth of personal transport are increasing car ownership, falling real costs of motoring, falling car occupancy levels, increasing average trip lengths and increasing income [14]. The growth in income of individuals/family in most countries over the past few decades has increased the urgency for a personal car. [14] reiterated that the highest income group in the United Kingdom made twice as many trips and travelled over three times farther by car than those in the lowest income group. This is because most people perceived the private car as a status, making it difficult to travel in more sustainable modes.

[15] identified the pollutant emission from transport activities to include carbon monoxide, carbon dioxide, nitrogen oxide, particulates and volatile organic compounds. According to [16] the build-up of this pollutant (greenhouse gases) in the atmosphere due to continual combustion of fossil fuels cause global warming. The accumulation of these greenhouse gases in the atmosphere alters the world's weather. This manifest in the form of flooding, hurricane, drought, cyclone and storm and its occurrence is usually devastating due to loss of life, homes, properties, infrastructures and displacement of people.

Professionals have warned that climate change needed urgent attention. The Kyoto Protocol in 1997 calling for significant reductions in CO_2 emissions by industrialized nations was a right pointer in this direction. Transport was one of the key sectors identified in the Kyoto protocol. In order to ensure that the European Union meet its greenhouse gas emission targets under the Kyoto protocol, a comprehensive strategy to reduce CO_2 emissions from new cars and vans was adopted in 2007. Similarly, the governments of the United States of America, Canada and Mexico adopted Corporate Average Fuel Economy (CAFE) standards to improve fuel economy in automobiles. Other countries like Japan, China, South Korea and Brazil adopted different standards either improvements in fuel economy or reduction in greenhouse gas emissions.

Transport emission is rising faster in low-income and middle-income countries than in high-income countries. Africa too is experiencing growth in vehicle ownership and usage. This calls for action that addresses CO_2 emissions from automobile causing climate change. This study analyses vehicle ownership and usage in Africa and its contribution to CO_2 emissions. The study further provides information on the impact of CO_2 emission on the environment and measures that can reduce or mitigate its effect in an automobile.

2. Study area and method

The study area is Africa, second largest continent after Asia. Africa is divided into five regions namely: northern, eastern, central, southern and western. The continent has a total of 54 independent countries. The entire land area of Africa covers about 30.3 million km^2, which is equivalent to 20.4% of the total land area of the earth. Africa has a total population of 1.216 billion representing 16% of world human population.

This study focuses on automobile usage and its contribution to climate change. Hence, the study made use of information on registered vehicles and CO_2 emissions from fossil fuels burning by automobiles in Africa. The number of registered vehicles in Africa was sourced from World Health Organisation (Global Health Observatory Data Repository). Furthermore, information on CO_2 emissions was obtained from Energy Information Administration and Carbon dioxide Information Analysis Centre, both in the United States. The findings of the study were discussed using simple statistics such as a table in the subsequent sections.

3. Results

The finding of this study is discussed in the following sub-sections.

3.1 Vehicle Registration Trend in Africa

The private car continues to be the predominant transport mode globally, particularly in developed countries. This trend is also experienced in the developing countries especially those experiencing rapid economic growth. Generally, increase in light-duty vehicles usage is most likely to continue due to people's preference for personal transport. In Africa, the total number of registered vehicles in 51 countries was 57,566,330 in 2013 (see Table 4 in Appendix). The actual number of registered vehicles in Africa should be in excess of 60 million when other countries information is added. The distribution of registered vehicles in each country reveals that South Africa has the highest with a total of 9,909,923 vehicles. Algeria in the second position has a total of 7,308,539 registered vehicles while Egypt in the third position recorded 7,037,954 registered vehicles. Nigeria came fourth with a total of 5,791,446 registered vehicles while Libya and Morocco were in the fifth and sixth positions with a total of 3,553,497 and 3,286,421 registered vehicles respectively.

The continent has been experiencing growth in vehicle registration over the years. For instance, the number of registered vehicles in South Africa increased from 9,909,923 vehicles in 2013 to 11,964,234 vehicles in 2016 accounting for 20.7% increase in three years [17]. Also,

the number of registered vehicles in Nigeria and Ghana rose from 5,791,446 and 1,532,080 in 2013 and 2012 to 10,600,000 and 1,952,564 vehicles in 2015, which account for 83% and 27.4% increase respectively [18 & 19]. Furthermore, the number of registered vehicles in Egypt increased from 7,037,954 in 2013 to 9,400,000 in 2016 accounting for 33.6% increase while that of Kenya rose by 41.1% from 2,011,972 vehicles in 2013 to 2,839,463 vehicles in 2016 [20 & 21]. The growth in vehicle registration is also experienced in other Africa countries. This suggests that CO_2 emissions from automobile are most likely to be on the increase in the continent. The factors influencing private car ownership are age, family status and employment status; residential location in relation to the workplace and other activity areas; personal or household income; and cost of purchase, annual ownership and running costs to alternative forms of transport [6]. Personal car in Africa is a symbol of status and achievement and there is no satisfaction to the number of cars individuals is willing to acquire in their fleet.

The distribution of registered vehicles by regions in Africa is as shown in Table 1. The finding reveals that North Africa has the highest number of registered vehicles accounting for 40.4% of the total registered vehicles in Africa. This is followed by Southern Africa having 22.4% of the total registered vehicles, West Africa record 21.4%, East Africa account for 11.7% while Central Africa with the least number of registered vehicles has only 4.1%.

Table 1. Registered Vehicles by Regions in Africa

Region	No. of Registered Vehicles	Percent
North	23,242,724	40.4
Central	2,349,185	4.1
West	12,341,273	21.4
East	6,719,672	11.7
South	12,913,476	22.4
Total	57,566,330	100

Source: World Health Organisation (2015)

Majority of the vehicles in the continent are used. This is due to the high cost of acquiring a new one. Even the used vehicles are poorly maintained by most of their owners. Also, the para-transit mode such as minibuses, taxi, tricycles and motorcycles used for public transport has low occupancy capacity. They cause traffic congestion and release high CO_2 emissions that contribute to climate change.

3.2 Trend in CO_2 Emission from Fossil Fuels Consumption

Carbon dioxide (CO_2) emission from transport and industry sources is the major greenhouse gas contributing to climate change [2]. The concentration of atmospheric carbon dioxide has increased due to industrialization, deforestation and burning of fossil fuels [6]. Table 2 shows the annual CO_2 emissions from the use of fossil fuels by regions of the world. Asia and Oceania have the highest CO_2 emissions, which account for 44% of the world's total and an increase of 293.4% from its 1980 figure. The factors that account for high CO_2 emissions in Asia are high population, rapid urbanization and industrialization and growing motorization. This is followed by North America comprising of United States of America and Canada which account for 18.6% share of global CO_2 emissions while Europe that came third account for 12.9%. The share of Africa in the total CO_2 emissions is only 3.8%. Despite the low contribution, the continent experienced 123.1% increase in the CO_2 emissions from it's 1980 figure. This is a clear indication that Africa has been experiencing growth in CO_2 emission over the years due to increased motorization. This calls for policy action aimed at reducing CO_2 emissions from automobile and other related activities.

There has been a slight decrease in the developed countries' share of CO_2 emissions as shown in Table 3. The developed countries have been able to slow down their contribution of CO_2 emissions from automobile through measures such as adoption of Kyoto Protocol and CAFÉ standards, hybrid and electric cars, vehicle emission control, reduction in car usage, public transportation, cleaner fuels e.g biofuels, liquefied petroleum gas and compressed natural gas. On the contrary, in the middle and low-income countries in Asia, the Middle East and Africa CO_2 emissions from automobile have been increasing. [6] attributed the increase in CO_2 emissions to higher rates of growth and increasing reliance on private cars for urban mobility.

The CO_2 emission from burning of fossil fuels by countries in Africa is as shown in Table 5 (See Appendix). There has been growth in CO_2 emissions in almost all the countries except in Nigeria, Eritrea and Seychelles. There are three countries that are super emitters of CO_2 emissions in Africa South Africa, Egypt and Algeria accounting for 64.9% of the total CO_2 emissions in the continent. Further analysis reveals that three high emitter countries Nigeria, Morocco and Libya account for 16.3% of the total CO_2 emissions in Africa. The aggregate of these six countries accounts for 81.2% of the total CO_2 emissions from fossil fuels burning in Africa. Any initiative aimed at reducing CO_2 emissions from transportation and other sources in the continent will achieve its desired result if efforts are concentrated more on the six countries that contributed the largest portion of CO_2 emissions.

The result reveals that South Africa emitted the highest quantity of CO_2 emissions 471238.8 kilotonnes in Africa. The country's record for having the highest num-

Table 2. Annual CO_2 Emissions from use of Fossil Fuels by Regions of the World

Region	1980 (Million Metric Tons)	1990 (Million Metric Tons)	2000 (Million Metric Tons)	2006 (Million Metric Tons)	2012 (Million Metric Tons)	% Total	% Increase
North America	5488.11	5806.56	6820.19	6954.03	5900	18.6	7.5
Central & South America	627.76	716.95	992.81	1138.49	1800	5.7	186.7
Europe	4707.5	4568.17	4500.07	4720.85	4100	12.9	-12.9
Eurosia	3092.69	3834.05	2355.98	2600.65	2900	9.1	-6.2
Middle East	490.76	730.05	1093.74	1505.3	1900	6	287.1
Africa	537.76	728	892.07	1056.55	1200	3.8	123.1
Asia & Oceania	3558.55	5299.37	7365.81	11219.56	14000	44	293.4
World Total	18503.12	21683.16	24010.66	29195.42	31800	100	

Source: Energy Information Administration (2017)

ber of registered vehicles in Africa contributes to its high CO_2 emissions. Egypt in the second position emitted 213012.4 kilotonnes and Algeria in the third position emitted 134215.9 kilotonnes of CO_2 emissions. Furthermore, Nigeria in the fourth position emitted 95650.0 kilotonnes, Morocco in the fifth position emitted 58558.3 kilotonnes while Libya in the sixth position emitted 51041.0 kilotonnes of CO_2 emissions. The growth in CO_2 emissions in these countries and Africa generally can be attributed to increasing population, rapid urbanization and growth in motorization. Hence, controlling the rate of motorization can help to reduce CO_2 emissions and its impacts on the environment.

The regional analysis of CO_2 emissions from fossil fuels burning in Africa is shown in Table 3. The result reveals that Southern Africa marginally emitted the highest amount 39.8% of the total CO_2 emissions in Africa. The high quantity of CO_2 emissions suggests that the citizens use high emitting vehicles judging by the number of registered vehicles in this region (see Table 4) and possibly due to other activities related to the burning of fossil fuels. North Africa is in second position having 39.7% of total CO_2 emissions from fossil fuels burning in the continent. The high motorization contributed significantly to the high CO_2 emissions in this region. The share of Southern and North Africa in CO_2 emissions corroborates the fact that they are the major automobile users (62.8%) in the continent (see Table 1). The result for other regions reveals that West Africa accounts for 11.9% of the total CO_2 emissions, Central Africa records 4.4% while East Africa having 4.2% contributes the least amount of CO_2 emissions in Africa.

Table 3. CO_2 Emissions by Region in Africa

Region	CO_2 emissions	Percent
North	499,940.50	39.7
Central	55,727.50	4.4
West	150,042.60	11.9
East	53,431.80	4.2
South	501,872.90	39.8
Total	1,261,015.30	100

Source: Carbon dioxide Information Analysis Centre, Tennessee, United States (2017)

3.3 Impact of Automobile on Climate Change

The automobile is the largest net contributor to climate change [22]. The burning of fossil fuels in automobile releases carbon dioxide, which is the largest source of greenhouse gas emissions. The concentration of greenhouse gases leads to increase in the average atmospheric temperature causing global warming [16]. This occurs when the temperature rises higher than what is needed to keep the earth warm.

The concentration of atmospheric CO_2 has increased from a pre-industrial value of around 280 parts per million (ppm) to 379 ppm in 2005 and this is expected to rise to 550 ppm by 2050 without immediate intervention [11]. The annual CO_2 growth rate is larger between 1995–2005 averaging 1.9 ppm per annum than it has been continuous direct atmospheric measurement. The accumulation of these greenhouse gases in the atmosphere alters the pattern of the world's weather. This poses a serious danger as it leads to rising in temperature which increases the frequency and intensity of heat waves, droughts and storms, tropical cyclone and sea levels causing flooding and tsunamis [23].

[24] warned that 200 cities in the United States of America might not be liveable in the next 15 to 20 years and 490 by the end of century depending on the pace of sea level rise. The study believes that holding warming between 1.5 and 2 degrees Celsius by the end of the century could spare between 200 and 380 coastal communities including 50 major cities from chronic flooding. The study advocated global cooperation to avert this problem due to huge fund and expertise required.

According to [25] disasters resulting from a change in weather have been experienced in most parts of the world this year. There were flooding and landslide in South Asia which affected more than 41 million people in Bangladesh, India and Nepal. Also, Sierra Leone recorded more than 600 deaths and 6000 displacements due to heavy rainfall and flooding that sparked a huge landslide. Furthermore, the hurricane Harvey in Texas and hurricane Matthew in North Carolina, United States caused storms and heavy rainfall that led to flooding that destroyed homes, infrastructures and properties worth billions of US dollars. There were heavy rainfall and strong monsoon that led to flooding in Sri Lanka, a landslide in Mocoa, Columbia, severe rain and cyclone in Zimbabwe that killed hundreds of people and rendered thousands homeless. The effect of uncontrolled greenhouse gas emissions is severe and has caused devastating damage to the environment and human being.

3.4 Measures of Mitigating Impact of Automobile on Climate Change

The harmful effect of the automobile on the environment can be mitigated or reduced by adopting the following:

1. Technological improvement in the energy efficiency of vehicles. The technological development includes a hybrid and electric car. The hybrid car uses both batteries and electric motor in combination with an internal combustion engine, which is driven by petrol or diesel [26]. It has low CO_2 emissions compared to fossil fuel car but expensive to purchase. The electric car uses an electric motor for its propulsion with the aid of electrical energy stored in batteries. The benefit of an electric car is that it has low carbon emission than the vehicles fitted with an internal combustion engine. As a result, some government encourages their citizens to use them by providing incentives. The UK government gives a plug-in grant of 25% of total vehicle value for the new plug-in car (electric car) capped at £5000 and 5702 claims have been made as of 30 September 2013 [27]. Another innovation being used is to downsize engine capacity of internal combustion vehicle to achieve lower CO_2 emissions.

2. The use of cleaner fuels such as biofuel can reduce CO_2 emissions from vehicles. Biofuels are liquid or gaseous fuels produced from biomass [28]. They are produced from chemically processed biomass material that is lower in carbon compared to fossil fuel. The traditional biomass materials corn, wheat, sugarcane, soybean, rapeseed and sunflowers are expensive and compete with food production, which increases the price of feedstock [29 & 30]. The contemporary biofuels are produced from wood chips, meadows, pasture, straw, etc. and offer up to 90% reduction in CO_2 emissions than fossil fuel and have higher energy yield than traditional biofuel [30]. The main challenge is that the technology is still at the developmental stage. Another cleaner low carbon-emitting fuels are liquefied petroleum gas and compressed natural gas.

3. The adoption of fuel-efficient vehicles can improve the air quality. This can be achieved by introducing of stricter vehicle emission control. The European Union mandated automobile manufacturers to abide by the set carbon emission standards within her member states. The target set is 130g/km of CO_2 emissions for new vehicles by 2015 and a further target of 95g CO_2/km by 2020. The government can mandate prospective car buyers to buy fuel-efficient vehicles. Also, the customs tariff paid on vehicles can be graduated based on their emission level.

4. The encouragement of active travel especially for short commutes. This calls for a modal shift from driving to cycling and walking especially within the neighbourhood. It has the benefit of reducing the number of vehicles on the highway, improves air quality as well as the health conditions of the citizens and fosters greater cohesion [31].

5. The provision of high quality, convenient, accessible and affordable public transport system that uses the bus, tram and light rail in highly populated urban centres has proved successful in the reduction of CO_2 emissions from vehicles. It is energy-efficient and has higher occupancy capacity thus reducing energy consumption and pollution. Apart from this, it is cost-effective, reliable and capable of making commuters to use them in place of private cars.

6. The use of information and communications technology (ICT) as a substitute for trips. Many companies and government establishments in the developed countries encourage teleworking, that is, working from home.

Also, buying goods has been made easier through online shopping. The application of ICT to work and shopping reduces the number of vehicles and trips on the street daily, thereby reducing the contribution of the automobile to climate change.

4. Conclusion

This study focuses on the contribution of the automobile to climate change in Africa. The study analyses the vehicle ownership trend and CO_2 emissions from consumption of fossil fuels, the impact of the automobile on climate change and measures that can reduce its effect on the environment. The findings of the study reveal that there has been growth in vehicle usage in Africa. The reason for this can be attributed to rapid urbanization in most cities across the continent, increase in travel demand and believe that car is a symbol of status and achievement. Though the share of Africa in global CO_2 emissions arising from fossil fuels burning is small (3.8%), it is a thing of concern that the value has been increasing at an alarming rate over the years in most of the countries. One of the major contributors to the increase in CO_2 emissions is an automobile and especially the practice of buying used vehicles and adoption of para-transit modes for public transport in most of the Africa countries.

The impact of climate change caused by greenhouse gas emissions is very devastating as it resulted in flooding, tsunami, landslide, hurricane and cyclone in many countries across the world, Africa inclusive. This has led to the loss of lives, properties and investments, infrastructures and displacement of millions of people. The cost of the damage is usually high in monetary term running into billions of US Dollars. Though automobile is an essential part of our daily life, it is important that we control its uses so as to reduce its negative effect on the environment. Therefore, the study recommends that governments in Africa should introduce strict emission control for vehicles imported into their country as a measure to regulate CO_2 emissions. This will encourage the use of low carbon emitting vehicles such as hybrid and electric cars and cars with smaller engines. The customs duty paid on the vehicle should be calculated based on the level of its CO_2 emissions. Furthermore, there should be the introduction of conventional public transport system like a bus, tram and light rail with high passengers capacity, less congestion and low carbon emission in major cities across the continent. This will reduce energy consumption by road transport and CO_2 emissions on the environment. Finally, the intergovernmental agency should be set up to monitor and collate information on greenhouse gas emissions in African countries and help States to consciously reduce CO_2 emissions, especially from transport sources.

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1. Appendix

Table 4. Number of Registered Vehicles in Africa (2013)

S/N	Country	No. of Registered Vehicles	Motor Vehicles per 1000 people
1	Algeria	7,308,539	114
2	Angola	581,530	38
3	Benin	34,914	22
4	Botswana	520,793	133
5	Burkina Faso	1,545,903	11
6	Burundi	30,045	6
7	Cameroun	443,018	14
8	Cape Verde	56,690	101
9	Central Africa Republic	37,475	4
10	Congo	110,438	27
11	Cote d'Ivoire	594,071	20
12	Chad	622,120	6
13	Democratic R. of Congo	350,000	5
14	Egypt	7,037,954	45
15	Equatorial Guinea	8,503	13
16	Eritrea	70,319	11
17	Ethiopia	478,244	3
18	Gabon	195,000	14
19	The Gambia	54,471	7
20	Ghana	1,532,080	30
21	Guinea	33,943	-
22	Guinea Bissau	62,239	33
23	Kenya	2,011,972	24
24	Lesotho	122,997	4
25	Liberia	1,085,075	3
26	Libya	3,553,497	290
27	Madagascar	219,576	26
28	Malawi	437,416	8
29	Mali	289,828	14
30	Mauritania	416,190	-
31	Mauritius	443,495	378
32	Morocco	3,286,421	68
33	Mozambique	542,336	12
34	Namibia	280,583	106
35	Niger	315,600	7
36	Nigeria	5,791,446	61
37	Rwanda	107,411	4
38	Sao Tome & Principe	1,101	-
39	Senegal	401,910	22
40	Seychelles	18,606	173
41	Sierra Leone	68,802	5
42	Somalia	59,457	-
43	South Africa	9,909,923	165
44	Sudan	320,974	27
45	Swaziland	180,103	89
46	Tanzania	1,509,786	7
47	Togo	58,111	2
48	Tunisia	1,735,339	125
49	Uganda	1,228,425	8
50	Zambia	534,532	21
51	Zimbabwe	927,129	114

Source: World Health Organisation (2015) Note: Botswana, Malawi, C. Africa Republic, Eritrea, Guinea Bissau, Somalia, Guinea & Tanzania figures are 2014; Namibia, Cote d'Ivoire, Congo, Ghana & Rwanda figures are 2012 and Sao Tome & Principe, Equatorial Guinea, Burundi & D R Congo figures are 2010. Figures for motor vehicles per 1000 people are not up to date (ranges from 2004-2014)

Table 5. Annual CO_2 Emissions (Kilotonnes) from the use of Fossil Fuels by Countries in Africa

Countries	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% Increase
Algeria	89493.1	107127.7	101165.2	109496.6	110299.7	121432.7	119177.5	121187	129987.8	134215.9	50
Angola	18793.4	19156.4	22266	25152	25709.3	27792.2	29057.3	30340.8	33399	32464	72.7
Benin	2508.2	2394.6	3872.3	4495.7	4411.4	4660.8	5089.8	5306.1	5511.5	5797.5	131.1
Botswana	3898	4096	4136.4	4231.7	4506.7	3927.4	4796.4	4400.4	4448	5423.5	39.1
Burkina Faso	1103.8	1125.8	1360.5	1646.5	1917.8	1932.5	1961.8	2211.2	2629.2	3058.3	177.1
Burundi	198	154	187	187	190.7	190.7	212.7	242	282.4	293.4	48.2
Cameroun	3956.7	3696.3	3861.4	5834.2	5544.5	6725.3	6780.3	5768.2	6127.6	6813.3	72.2
Cape Verde	330	344.7	374	396	308	330	480.4	531.7	495	443.7	34.5
C. A. Republic	234.7	234.7	249.4	253	253	253	264	278.7	293.4	297	26.5
Congo	949.8	982.8	1118.4	1213.8	1309.1	1705.2	1925.2	2233.2	2383.6	2482.6	161.4
Cote d'ivoire	7664	7825.4	6996.6	6776.6	6776.6	5658.2	6164.2	6398.9	8390.1	8987.8	17.3
Chad	377.7	399.7	407	462	509.7	491.4	517	539	542.7	608.7	61.2
D. R. Congo	1199.1	1499.8	1595.1	1730.8	1829.8	1719.8	1991.2	2467.9	2559.6	2779.6	131.8
Egypt	150911.7	167207.9	178586.6	189092.5	198586.4	206734.5	202715.4	217163.4	217068.1	213012.4	41.2
E. Guinea	5218.1	4712.1	4756.1	4796.4	4503.1	4620.4	4679.1	6769.3	5830.5	5412.5	3.7
Eritrea	770.1	766.4	561.1	579.4	414.4	513.4	513.4	594.1	660.1	667.4	-15.4
Ethiopia	5295.1	5119.1	5504.2	6013.9	6578.6	6629.9	6585.9	7726.4	8562.4	10634.3	100.8
Gabon	4686.4	4888.1	4173	4118	4165.7	4330.7	4536.1	4470.1	4580.1	4756.1	1.5
Gambia	322.7	322.7	337.4	396	410.7	436.4	473	436.4	473	491.4	52.3
Ghana	7348.7	6993	9358.2	9827.6	9138.2	7708	9955.9	9831.2	11877.4	14620.3	99
Guinea	1342.1	1180.8	1180.8	1210.1	2189.2	2258.9	2603.6	2779.6	2581.6	2299.2	71.3
G. Bissau	201.7	212.7	216.4	231	227.4	234.7	238.4	245.7	253	256.7	27.3
Kenya	7623.7	8562.4	9574.5	9831.2	10241.9	12350.5	12174.4	13457.9	12515.5	13300.2	74.5
Lesotho		1419.1	1444.8	1474.1	2082.9	2112.2	2258.9	2200.2	2222.2	2295.5	61.8
Liberia	616.1	729.7	748.1	671.1	564.7	517	795.7	894.7	1030.4	957.1	55.3
Libya	50358.9	52108.1	53270.5	49959.2	55459.7	58660.1	61348.9	39390.9	52397.8	51041	1.4
Madagascar	1807.8	1741.8	1683.2	1815.2	1888.5	1771.2	1958.2	2313.9	2665.9	3076.6	70.2
Mali	876.4	898.4	942.4	1008.4	1070.8	806.7	964.4	1045.1	993.8	1026.8	17.2
Malawi	975.4	916.8	953.4	938.8	1096.4	1004.8	1191.8	1188.1	1129.4	1272.4	30.4
Mauritania	1536.5	1587.8	1609.8	1844.5	1936.2	2123.2	2236.9	2394.6	2654.9	2647.6	72.3
Mauritius	3091.3	3296.6	3630.3	3689	3769.7	3696.3	3916.3	3920	4070.4	3725.7	20.5
Morocco	43310.9	45771.5	47425.3	50267.2	52900.1	52482.1	55958.4	57685.6	62724	58558.3	35.2
Mozambique	1921.5	1822.5	1980.2	2262.5	2266.2	2530.2	2735.6	3223.3	3120.6	4019	109.2
Namibia	1961.8	2310.2	2328.5	2361.5	3329.6	3069.3	3098.6	2823.6	3373.6	2948.3	50.3
Niger	814.1	715.1	693.1	722.4	810.4	968.1	1173.4	1327.5	1866.5	1961.8	141
Nigeria	97039.8	104689.2	98891.7	95056	96148.7	76735.6	92016	96093.7	99636.1	95650	-1.5
Rwanda	528	528	528	557.4	542.7	575.7	590.4	663.7	737.1	799.4	51.4
Sao Tome & Principe	73.3	77	84.3	84.3	84.3	91.7	99	102.7	113.7	113.7	55.1
Senegal	5232.8	5812.2	4730.4	5181.5	5093.5	4583.8	7744.7	8368.1	7913.4	8423.1	61
Seychelles	737.1	689.4	733.4	641.7	693.1	740.7	689.4	597.721	704.1	645.4	-12.4
Sierra Leone	641.7	546.4	733.4	641.7	663.7	652.7	726.1	898.4	1030.4	1191.8	85.7
Somalia	594.1	594.1	594.1	608.7	601.4	597.7	612.4	575.7	638.1	623.4	4.9
South Africa	450186.6	416915.9	447894.7	467436.2	497593.6	503262.7	474099.1	475037.8	472071.2	471238.8	4.7
Sudan	11463	10982.7	12013.1	14125.3	14913.7	15562.7	15940.4	15658.1	14660.7	15445.4	34.7
Swaziland	1030.4	1019.4	1015.8	1063.4	1096.4	1045.1	1037.8	1048.8	1206.4	1089.1	5.7
Tanzania	4363.7	5504.2	6028.5	5896.5	6142.2	5918.5	7106.6	8093.1	9545.2	10751.6	146.4
Togo	1397.1	1338.5	1221.1	1408.1	1683.2	2783.3	2610.9	2409.2	2163.5	2229.5	59.6
Tunisia	22299	22662.1	22992.1	24110.5	24825.6	24788.9	27660.2	26021	27003.8	27667.5	24.1
Uganda	1738.2	2170.9	2537.6	2889.6	3190.3	3381	3920	4264.7	4085	4895.4	181.6
Zambia	2145.2	2288.2	2097.5	1778.5	2181.9	2526.6	2709.9	2933.6	3480	3824.7	78.3
Zimbabwe	9486.5	10770	10447.3	9886.2	7770.4	8335.1	9266.5	11628.1	12933.5	13780.6	45.3

Source: Carbon dioxide Information Analysis Centre, Tennessee, United States (2017)