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Models for Computing Emission of Carbon Dioxide from Liquid Fuel in Nigeria

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Abstract: In this paper, Carbon dioxide emission from the liquid fuel supplied in Nigeria by the Nigerian National Petroleum Corporation (NNPC) from 2009 to 2013 is analysed. The CO_2 emissions and CO_2 emission per capita within the given period are computed and projected emission from 2013 to 2025 made using the greenhouse training equation, artificial neural network (ANN) model and polynomial interpolation method and nonlinear fitting method. The available data from the Nigerian National Petroleum Cooperation (NNPC) is extrapolate from 2013 to 2020 using the polynomial interpolation method and the nonlinear fitting method is utilised to fit the data from 2009 to 2030. It is found that CO_2 emission and CO_2 emission per capita into the air for Nigeria decreased from 2009 to 2011 but, however, increasing continuously from 2012 to 2025. The increase of carbon dioxide in the Nigerian air space with will pose potential problems in future. Policy must be put in place to reduce carbon dioxide emission by reducing of flaring of natural gasses, introduce electric railways and other energy sources that are based on renewable energy. Enforcement of afforestation and greenhouse gasses emission reduction policies on the country for ecological development. There are other sources of pollution of the atmosphere with CO_2 such as flaring of gasses from refineries in Kaduna and Niger Delta areas of Nigeria and burning of bush and burning of solid fuel such as coal in the industries that our research did not cover. These other sources also contribute substantially to CO_2 emission in Nigeria.

Keywords: Carbon Dioxide, Greenhouse, Emission, Training Equation, Artificial Neural Network (ANN), Model and Polynomial Interpolation

1. Introduction

Simulation of the ice core model revealed that the concentration of carbon dioxide (Co_2) in the atmosphere over the last 10,000 years was on increase when compare with the available information from the ice core model in the last 50 years. This literarily means that the earth's solar radiation has increased ([3]). The Carbon dioxide level including the greenhouse gasses such as water vapour, carbon dioxide, methane, nitrous oxide, and ozone have risen in the last century. Methane is somehow stable since it can be converted through chemical reaction in the atmosphere to another compound in a span of ten years or so but carbon dioxide remains unstable in the air. The temperature of the earth is found to be increasing because of the greenhouse gasses ([3, 4]).

Our environment is being endangered by the human activities and climate change is now a major challenging problem to biodiversity conservation e.g. atmospheric Co_2 has increased this century as a result of combustion of hydrocarbon from the industries, automobiles and flaring of gasses from refineries, mopping up of oil spillages etc. ([11]). Moreover, migration of species polar ward and extinction of species have been established to be because of pollution (See [2-4]).

The burning of fossil fuels is believed to be the major source responsible for observed increase in the concentration of carbon dioxide in the atmosphere now measured at many locations around the world. Observations in the atmosphere show that the Northern Hemisphere CO_2 concentration is increasing more rapidly than the Southern Hemisphere concentration and that the most rapid increase is at 50°–60°N latitude. The greatest seasonal variation also occurs in this latitude band ([6]).

Flaring/venting during oil production operations emits

CO_2, methane and other forms of gases which contribute to global warming causing climate change, and this affects the environmental air and water qualities and health of the vicinity of the flares. This negates commitments made by countries under the United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol ([8]). Global environmental impact is due to the burning of hydrocarbon fuel associated gases, which produces carbon dioxide (CO_2) and methane (CH_4). These emissions increase the concentration of greenhouse gases (GHG) in the atmosphere, which in turn contributes to global warming ([2]). The Synthetic Paraffinic Kerosene (SPK) fuel which is the alternative fuel to aviation fuel has been found to lead to a decrease GHG emissions ([5, 6]).

In the recent times, modelling of greenhouse gas (GHG) emissions has been of great concerns to the environmentalists especially climate change experts. Several models have been developed, there are transportation fuel cycle emissions models for calculating nonspecific values of GHG emissions from crude oil production ([7]). Oil Production Greenhouse Gas Emissions Estimator (OPGEE) has been developed for GHG assessments for use in scientific assessment, regulatory processes, and analysis of GHG mitigation options by producers (see [7]). OPGEE uses petroleum engineering fundamentals to model emissions from oil and gas production operations.

The motivation for this paper is on how to use mathematical models to analyse the supply of liquid fuel in Nigeria by the Nigerian National petroleum corporation (NNPC) from 2009 to 2013. We intend to compute the CO_2 emission and CO_2 emission per capital within the given period and make projection for the emission from 2013 to 2025 using greenhouse training equation, artificial neural network (ANN) model and polynomial interpolation in the MATLAB software ([9]) to extrapolate the result from 2013 to 2020. The use of greenhouse training equation complies with the UNI ISO 14064-1:2006 international standard, which defines the application of criteria - recognised by the international scientific community - for quantifying and reporting greenhouse gas emissions/removal in a reliable and internationally accepted manner.

2. Methods

There are basically two types of mathematical models in nature, that is, the deterministic models and stochastic models. Deterministic models are designed to represent real life problem in concrete terms while stochastic model are more or less based on probability concepts which make use of statistical concepts to study real life problems. As for research on atmosphere using deterministic models are based on mathematical description of physical and chemical processes taking place in the atmosphere ([4]). Stochastic model are used for obtaining parameters for model for the atmospheric studies.

These models are divided into different categories on the basis of source characteristics as point, line and area sources or on the basis of topography of the region as flat or complex terrain (See [4]). Deterministic models can also be classified on the basis of size of the field they are describing:

- Short distance (distance from source less than 30-50 km);
- Mesoscale models (concentration fields of the order of hundreds of kms);
- Continental or planetary circulation models.

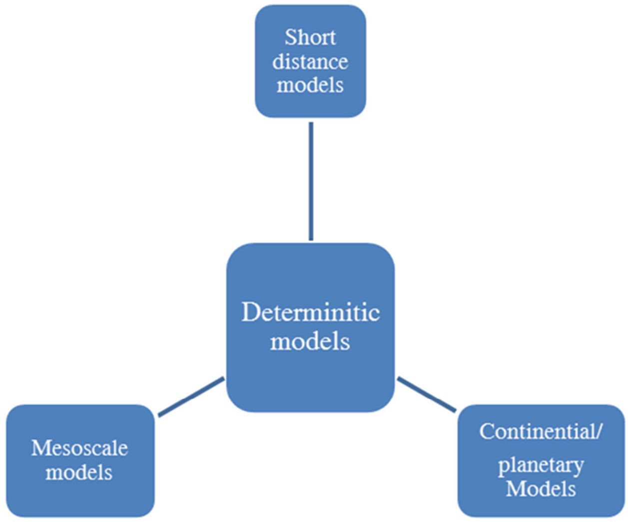

Figure 1. *Classification of deterministic models used for climate studies.*

Finally, models can also be classified on the basis of the time resolution of the concentration produced:

- Episodic models (temporal resolution of less than an hour)
- Short-time models (temporal resolutions greater than or equal to an hour and less than Or equal to 24h)
- Climatologically models (with resolution greater than 24h, generally seasonal or annual)

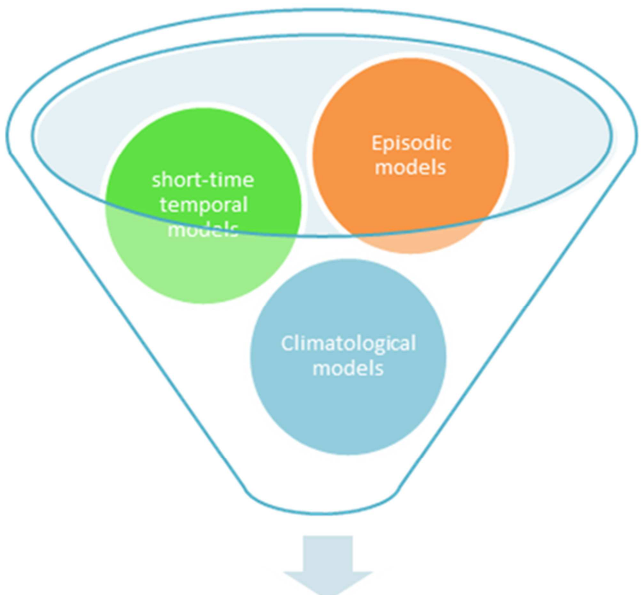

Figure 2. *Types of models for climate study classified on time resolutions.*

2.1. Models for Carbon Dioxide Emission

In studying the air quality there are several mathematical models in use for calculating the emission of greenhouse gasses (See for example [4]). The chemical reaction in the automobile exhaust ([1]) can be represented by the oxidation reaction as

$$\begin{aligned} &CO+\frac{1}{2}O_2 \rightarrow CO_2 \\ &C_3H_6+\frac{9}{2}O_2 \rightarrow 3CO_2+3H_2O \\ &H_2+\frac{1}{2}O_2 \rightarrow H_2O \end{aligned} \quad (1)$$

Where C_3H_6 represents hydrocarbon species whose reactions are fast enough in modelling the reaction process. We shall not go into detail stoichiometry of reaction rates, since our interest in this paper is to compute the emission of CO_2 only.

There several equations for modeling emission of carbon dioxide, methane and nitrous from liquid fuel in the literature (See for example [4]). The training of greenhouse gasses can be estimated from the following model:

$$E_{i,j} = \frac{q_i EC_i F_{i,j}}{1000} \quad (2)$$

Where $E_{i,j}$ is the emission of carbon dioxide, methane or nitrous oxide from each fuel type (i) released from operation of the facility during the year measured in CO_2 e- tones. q_i is the quantity of the fuel type (i) combusted (whether for stationary energy purposes or transport energy purpose) from operation of the facility during the year measured in cubic meters or gigajoules. EC_i is the energy factor of fuel type (i). $EF_{i,j}$ is the emission released during the year which includes the oxidation factor $F_{i,j}$ and it is measured in kilograms. CO_2 is measured in e-per gigajoule for both stationary and transport energy purposes.

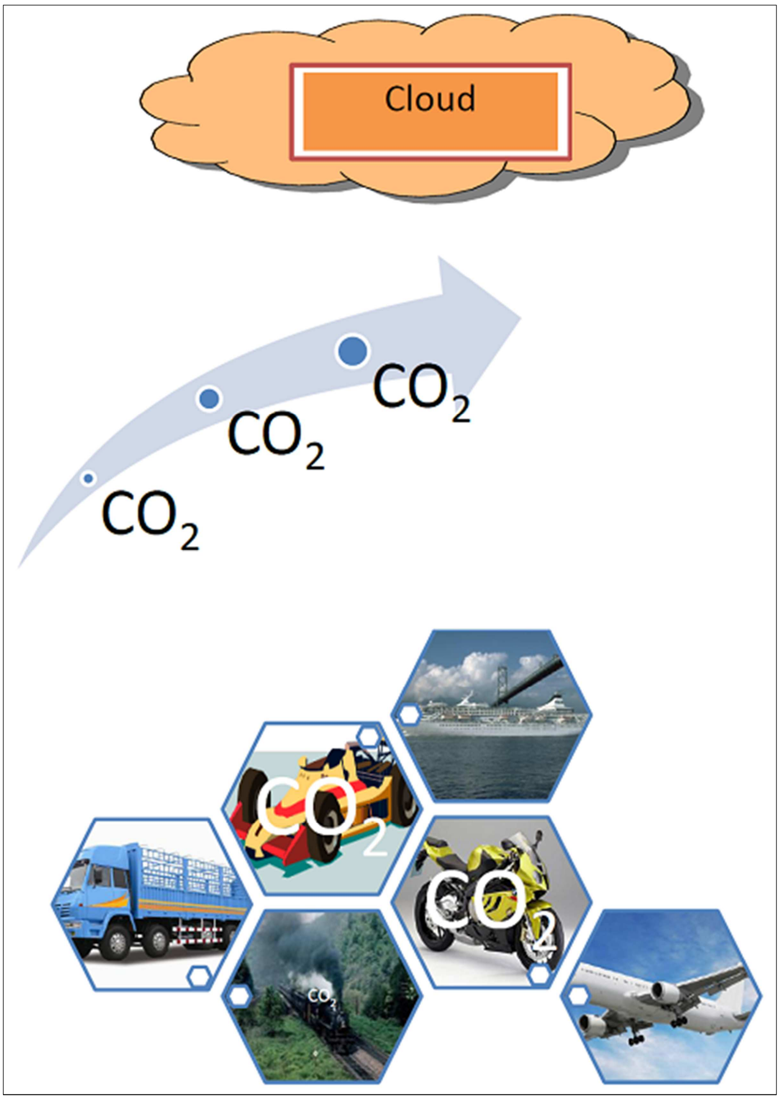

Figure 3. *Some sources of emission of Co_2 into the atmosphere.*

Let us define the following terms:

Definition 1

Stationary energy purpose: This means that fuel combustion that is not involved for transportation purposes.

Transport energy purpose: This means that fuel combustion that is involved for transportation by registered vehicles in railway, marine navigation, and land and air transportations (See Figure 3).

2.2. Computation of CO_2 Emission Liquid Fuel

Calculation of CO_2 emission for various types of fuel:

2.2.1. Diesel

1 liter of diesel weighs 835 grams and consists of 86.2% of carbon and 1920 grams of oxygen is needed to combust carbon to CO_2 . Therefore, an average consumption of 5litres per 100 km to $5\times$2640gl/100(per kg) =132g of CO_2 per Kg.

2.2.2. Petrol

1 liter of petrol weighs 750 grams and consists of 87% of carbon and 1740 grams of oxygen is needed to combust carbon to CO_2 . Therefore, an average consumption of 5litres per 100 km to $5\times$2392gl/100(per kg) =120g of CO_2 per Kg.

2.2.3. Natural Gas (CNG)

The natural gas (CNG) is a gaseous stored under high pressure. The consumption is under high pressure. The consumption is expressed in Nm^3 /1000 kg, but also Nm^3 is cubic meter at normal condition. For natural gas vehicles the consumptions are expressed in Kg/100 km.

Table 1. *Combustion information for liquid fluid.*

Fuel type	Weight (g)	Carbon content (g) (%)	Oxygen needed for combustion to CO_2	CO_2 (g)	Average consumption of 5 liters /100 kg (CO_2)
Diesel	835	720 (86.2)	1920	2392	132
Petrol	720	652 (87)	1740	1665	120
Low calorific CNG	1000	614 (61.4)	1638	2252	113
High calorific CNG	1000	727(72.7)	1939	2666	112

2.2.4. The National Inventory of Carbon Dioxide Emission

The national inventory of carbon dioxide emission from liquid fuel distributed in Nigeria by the Nigerian National Petroleum Cooperation (NNPC) from 2009 to 2013 will be made taken into consideration various fuel types. Moreover, the Apparent consumption, conversion factor (1/1000), energy factor (Gj/kg) and emission factor (kg/GJ) of the fuel types would considered to compute the CO_2 emissions.

2.2.5. Artificial Neural Network(ANN) Model

An artificial neural network (ANN) is a flexible mathematical structure which is capable of identifying complex nonlinear relationships between input and output data sets. ANN models have been found useful and efficient, particularly in problems for which the characteristics of the processes are difficult to describe using physical equations ([12]).

The total incoming signal which is passing through a non-linear transfer F to produce the outgoing signal is given by $Y = F(X)$ where $F(X)=\frac{1}{1+e^{-X}}$, $X=\sum_i w_i x_i$ where w_i of the weight function of the interconnected neurons. The process of optimizing the connection weights is known as training or learning of ANN.

We will make of nonlinear fitting facility in Maple to obtain nonlinear relationship between the CO_2 emissions with time.

3. Results and Discussion

We simulated the greenhouse training equation and the ANN model using the dataset in the Appendix. The calculation of CO_2 emission using the eq. (2) and information Table 1 is shown in the Table 2 below:

Table 2. *National inventory of the Carbon dioxide emission from Liquid Fuel Distributed by NNPC Nigeria For the year 2009 to 2013.*

YEAR	2009	2010	2011	2012	2013
CO2 emission (Kg)	29,318,282.40	20,015,402.64	19,553,628.99	16,261,334.69	51,714,808.39

We will make use of the population Nigeria which was published by the National Bureau of Statistics and it is shown in the Figure 4. Moreover, compute the Carbon dioxide emission density which is the CO_2 emission per land mass of Nigeria (923,768 km^2) and CO_2 emission per capita at the given period, that is, the total emission divided by Nigeria population at that period of time.

Source: See [13]

Figure 4. *Nigerian population from 2002-2012.*

The compution of emission density and emission per capita was made using the information in the Appendix, Table 2,the Figure 4 and land mass of Nigeria the result is shown in the Table 3.

Table 3. *Carbon dioxide emmision density and emission of capita.*

Year	Apparent CO_2 consumption	CO_2 emission(kg)	CO_2 /capita	CO_2 emission density
2009	12499640.00	29318282.40	0.1946	31.7377
2010	846689481.00	20015402.64	0.1324	21.6671
2011	8189016.66	19553618.20	0.1228	21.6672
2012	6823326.77	16261334.69	0.9891	17.6033
2013	21816292.92	51714808.39	0.3111	55.9824

The Bar chart in Figure 5 shows Carbon dioxide emission density and emission per capita the bar chart is the upper part together with vital statistic like maximum and minimum values for the emission. The bar chart in the lower part is for emission per capita which shows that the emission per capita decreased in 2010-2012 and rose up in 2012 and then dropped in 2013. We observe similar behaviour also in the corresponding curve in the Figure 6.

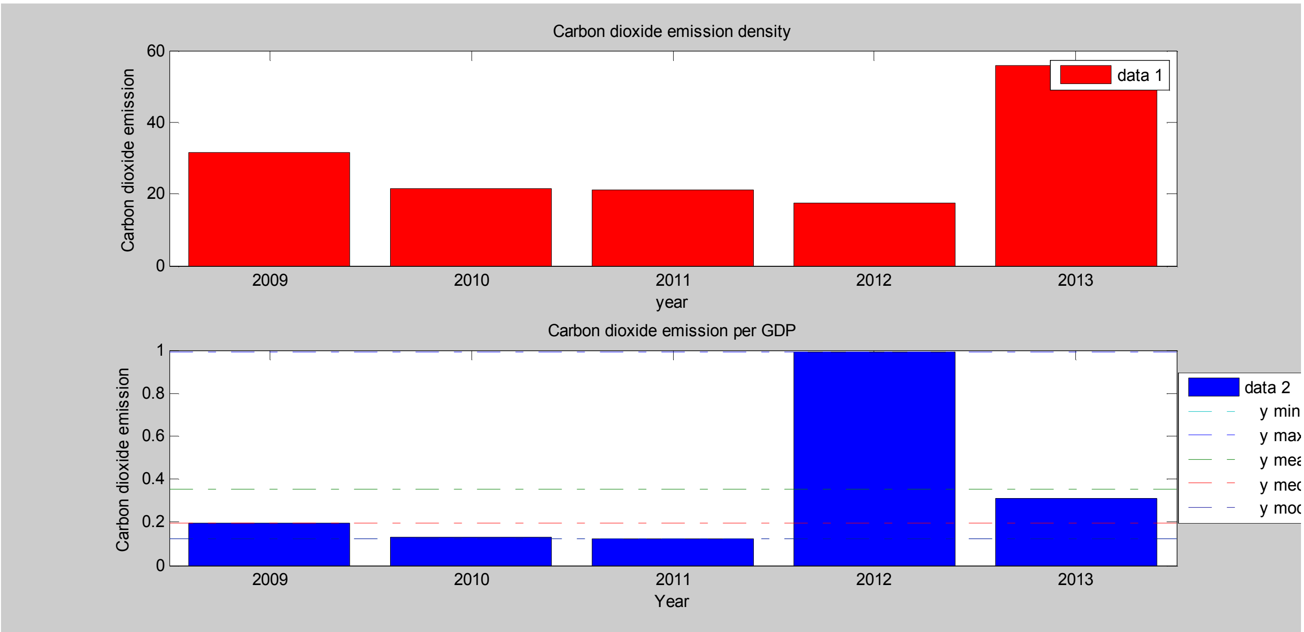

Figure 5. *Bar Charts showing Carbon dioxide emission density and emission per capita.*

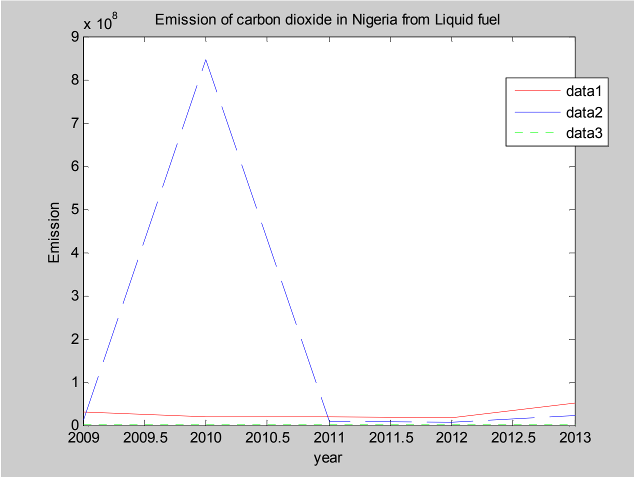

Figure 6. *Emission of CO_2 and emission per capita 2009-2013.*

We make use of ANN model to compute CO_2 emission from the Table 2, and use interpolation methods and non-linear regression methods to extrapolate the emission beyond the year 2013 (See the Figure 4).

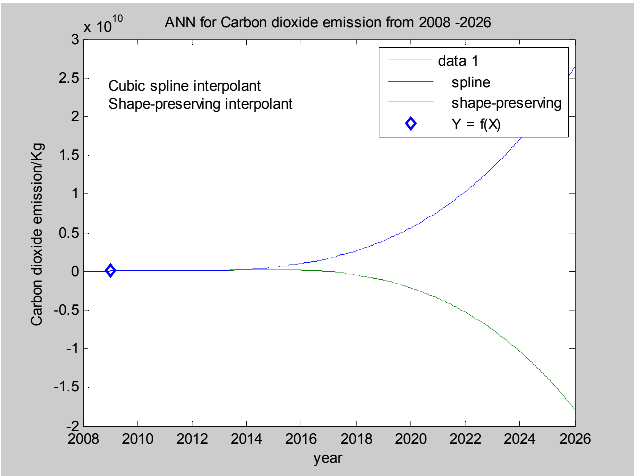

Figure 7. *Emission of CO_2 and emission per capital 2013-2020.*

The information from Table 3 was extrapolated using cubic spline interpolation and shape preserving function which was automatically generated by the Matlab software (See [9]) to produce the Figure 7.

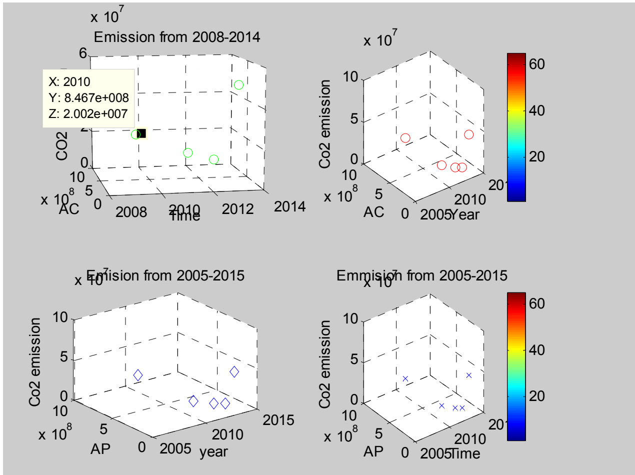

Figure 8. *3D of emission of CO_2 the Apparent consumption and consumption of fuel for various times.*

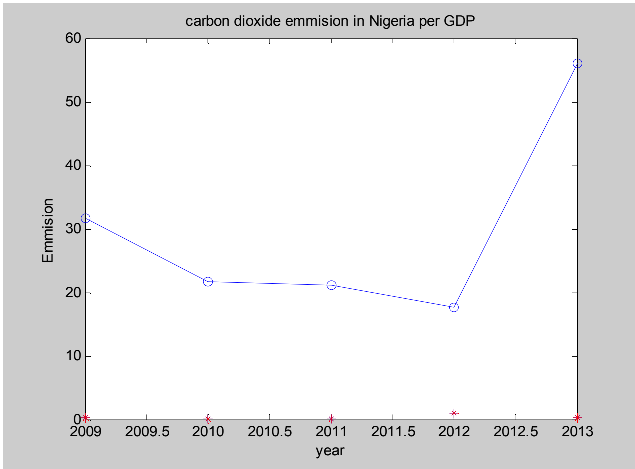

Figure 9. *Emission of CO_2 per capita.*

The basic statistic facility in the plotter of Matlab in the polyfit toolbox was used to extrapolate the curve in the Figure 9 from 2013 to 2025 using scatter diagram by use of the following polynomial of order six and seven respectively.

Table 4. *Polynomial interpolants used to extrapolate Co_2 emission from 2013 to 2020.*

$y = p1x^6 + p2x^5 + p3x^4 + p4x^3 + p5x^2 + p6x + p7$	$y = p1x^7 + p2x^6 + p3x^5 + p4x^4 + p5x^3 + p6x^2 + p7x + p8$
Coefficients:	Coefficients:
p1 = 4.0962e-013	p1 = -1.5833e-015
p2 = -1.6472e-009	p2 = 6.3748e-012
p3 = 1.656e-006	p3 = -6.4165e-009
p4 = 0	p4 = 0
p5 = 0	p5 = 0
p6 = 0	p6 = 0
p7 = 0	p7 = 0
	p8 = 0
Norm of residuals = 12.298.	Norm of residuals = 0.63648

Remark 1

We note that the cubic polynomial is sufficiently enough extrapolate the data used for simulation since other coefficient of the polynomials is zero. From standard theory on polynomial fitting since sample points are five we expected the degree of polynomial for extrapolation should be less than or equal to four.

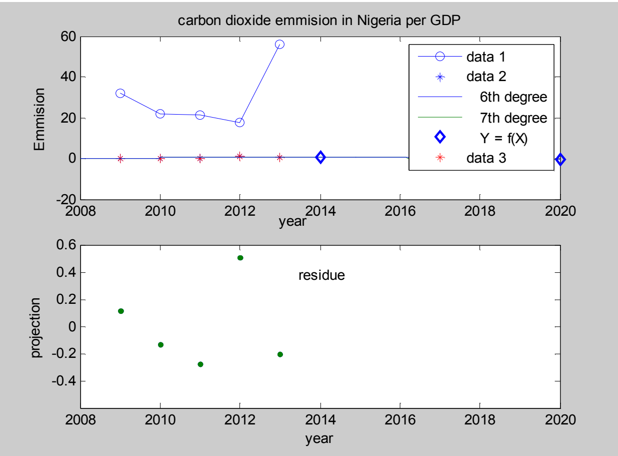

Figure 10. *Emission of CO_2 per capita together with plot of residue.*

In the Figure 10 & Figure 11 the graphs of residues were plotted. the residue value between 2010 to 2011 and 2013 were negative which shows that the model has least error, hence, the data was accurately fitted but at 2012 it was most likely the data was corrupted.

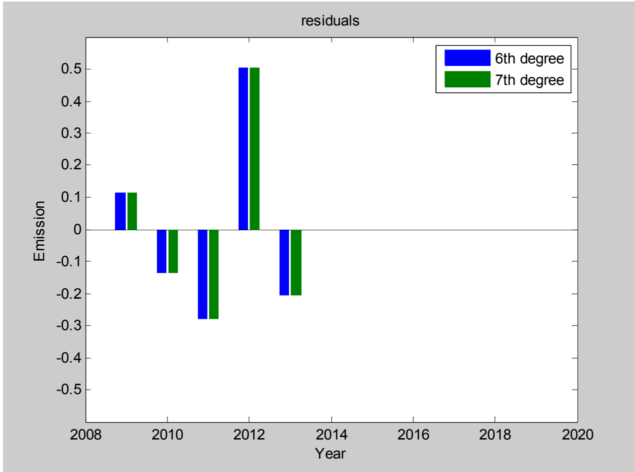

Figure 11. *Emission of CO_2 per capita with respect to residue.*

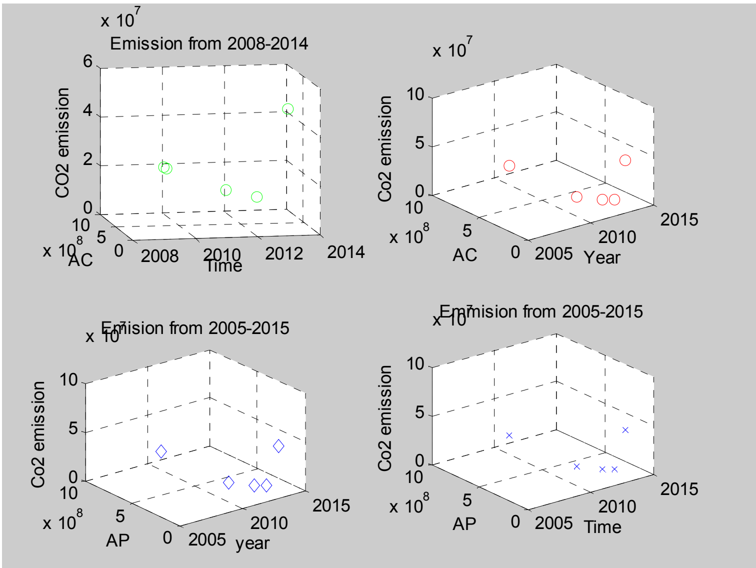

Figure 12. *3D of emission of CO_2 from liquid fuel for various times.*

From the Figure 9 CO_2 emission and emission per capita in the Nigerian air decreased from 2009 to 2011, but, however increased continuously from 2012 to 2025. The increase may be due to rapid influx of the country with vehicles couple with establishment of more independent power stations and the use of generator sets.

We make use of the following Maple Codes Used

$$> with(Statistics):$$

$$> X := Vector([1, 2, 3, 4, 5], datatype = float):$$

$$> Y := Vector([29318282.40, 20015402.64, 19553628.99, 16261334.69, 51714808.39], datatype = float):$$

$$> NonlinearFit\left(a + b\,v + e^{c\,v}, X, Y, v\right);$$

$$plot(\%, v = 1\,..5)$$

$$plot\left(1.82037727173890\,10^{6} + 2.36781850059690\,10^{6}\,(t - 2009) + e^{3.49138537353475\,(t-2009)}, t = 2009\,..2025, axes = framed, style = point, symbol = asterisk, symbolsize = 15, tickmarks = [spacing(1), default], axis = [gridlines = [10, color = blue]]\right)$$

To obtain the nonlinear fit of the form $y = a + bx + e^{cx}$ where a, b and c are determined from the Table 2 together with the above maple code and it was found that

$$Y = 1.82037727173890\,10^{6} + 2.36781850059690\,10^{6}\,v + e^{3.49138537353475\,v}$$

v is a dummy variable representing x.

The graphs for the above function are in figure 13 and figure 14 respectively. Obviously, the Co_2 emission continuously increases with time from the two graphs.

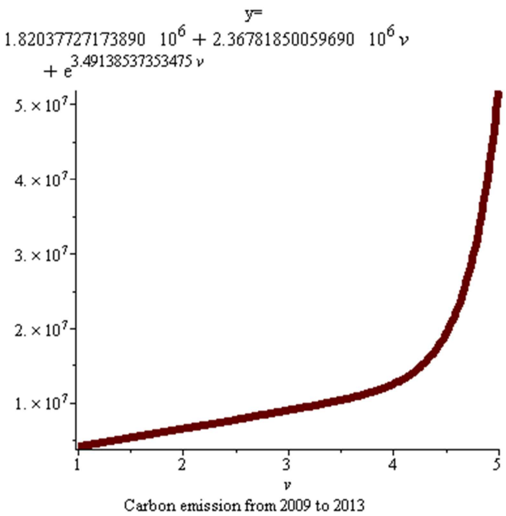

Figure 13. *Co_2 emission from 2009 to 2013.*

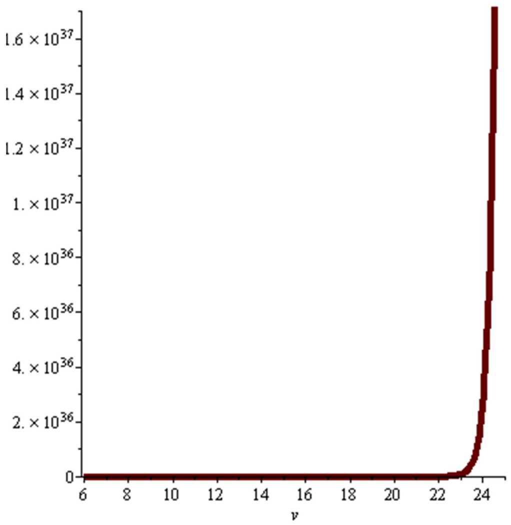

Figure 14. *Co_2 emission from 2014 to 2030, $v = t - 2009$.*

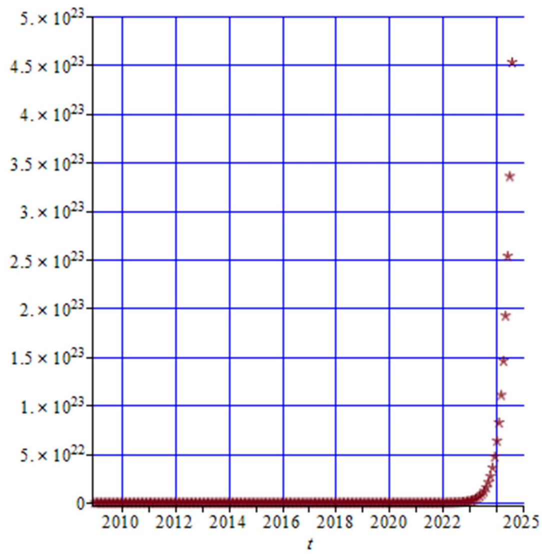

Figure 15. *Co_2 emission from 2009 to 2025.*

4. Conclusions

The increase of carbon dioxide in the Nigerian air space will pose potential problems in future. Policy must be put in place to reduce carbon dioxide emission by reducing flaring of natural gasses, introduce electric railways and other energy sources that are based on renewable energy. Enforcement of afforestation and greenhouse gasses emission reduction policies on the country for sustainable development. There are other sources of pollution of the atmosphere with CO_2 such as flaring of gasses from refineries in Kaduna and Niger delta areas of Nigeria and burning of bush and burning of solid fuel such as coal in the industries that our research did not cover. Some researchers have substantiated that CO_2 emission from these other sources are contributing to the increase in the pollution of atmosphere with CO_2. Further research need to be extended to other greenhouse gasses so as to have balance information on the gross emission of greenhouse into Nigeria airspace and attendant effect on eco-balance.

Acknowledgements

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Appendix

Table A1. *2013 National inventory of the Carbon dioxide emission from Liquid Fuel Distribution by NNPC Nigeria.*

S/No.	Fuel Type	Apparent Consumption (KL)	Conversion Factor (1/1000)	Energy Factor (GJ/KL)	Emission Factor (Kg/GJ)	Carbon Dioxide Emission (Kg)
1	LPG	-	0.001	25.7	59.6	-
2	PMS	15,894,471.33	.001	34.2	66.7	36,257,514.33
3	HHK	2,663,619.49	0.001	37.5	68.2	6,812,206.85
4	ATK	427,445.31	0.001	36.8	68.9	1,083,796.13
5	AGO	2,830,756.79	0.001	38.6	69.2	7,561,291.08
6	LPFO	-	0.001	39.7	72.9	-
7	LUBRICATING OIL	-	0.001	38.8	27.9	-
8	GREASES	-	0.001	38.8	27.9	-
9	BUTAMIN & ASPHALT	-	0.001	31.4	69.0	-
10	BRAKE FLUIDS	-	0.001	38.8	27.9	-
11	(SRG, LRS, VGO, TIN KERO)	-	0.001	34.4	69	-
TOTAL CO_2 EMISSION						51,714,808.39

Table A2. *2012 National inventory of the Carbon dioxide emission from Liquid Fuel Distribution by NNPC Nigeria.*

S/No.	Fuel Type	Apparent Consumption (KL)	Conversion Factor (1/1000)	Energy Factor (GJ/KL)	Emission Factor (Kg/GJ)	Carbon Dioxide Emission (Kg)
1	LPG	15,430.34	0.001	25.7	59.6	23,634.96
2	PMS	5,017,535.11	0.001	34.2	66.7	11,445,700.04
3	HHK	630,956.80	0.001	37.5	68.2	1,613,672.02
4	ATK	54,259.56	0.001	36.8	68.9	137,576.20
5	AGO	676,727.67	0.001	38.6	69.2	1,807,620.81
6	LPFO	415,447.29	0.001	39.7	72.9	1,202,358.47
7	LUBRICATING OIL	-	0.001	38.8	27.9	-
8	GREASES	-	0.001	38.8	27.9	-
9	BUTAMIN & ASPHALT	64.8	0.001	31.4	69.0	140.40
10	BRAKE FLUIDS	-	0.001	38.8	27.9	-
11	(SRG, LRS, VGO, TIN KERO)	12,905.201	0.001	34.4	69.0	30,631.79
TOTAL CO_2 EMISSION						16,261,334.69

Table A3. *2011 National inventory of the Carbon dioxide emission from Liquid Fuel Distribution by NNPC Nigeria.*

S/No.	Fuel Type	Apparent Consumption (KL)	Conversion Factor (1/1000)	Energy Factor (GJ/KL)	Emission Factor (Kg/GJ)	Carbon Dioxide Emission (Kg)
1	LPG	31,841.61	0.001	25.7	59.6	48,772.43
2	PMS	5,688,449.53	0.001	34.2	66.7	12,976,149.76
3	HHK	900,706.98	0.001	37.5	68.2	2,303,558.10
4	ATK	229,021.41	0.001	36.8	68.9	580,688.37
5	AGO	977,891.73	0.001	38.6	69.2	2,612,066.16
6	LPFO	319,607.77	0.001	39.7	72.9	924,986.44
7	LUBRICATING OIL	11,395.52	0.001	38.8	27.9	12,335.88
8	GREASES	69.64	0.001	38.8	27.9	75.39
9	BUTAMIN & ASPHALT	64.80	0.001	31.4	69.0	140.40
10	BRAKE FLUIDS	8.81	0.001	38.8	27.9	9.54
11	(SRG, LRS, VGO, TIN KERO)	39,958.93	0.001	34.4	69	94,846.52
TOTAL CO_2 EMISSION						19,,553,628.99

Table A4. *2010 National inventory of the Carbon dioxide emission from Liquid Fuel Distribution by NNPC Nigeria.*

S/No.	Fuel Type	Apparent Consumption (KL)	Conversion Factor (1/1000)	Energy Factor (GJ/KL)	Emission Factor (Kg/GJ)	Carbon Dioxide Emission (Kg)
1	LPG	24,712.43	0.001	25.7	59.6	37,852.52
2	PMS	6,353,517.99	0.001	34.2	66.7	14,493,264.03
3	HHK	668,548.09	0.001	37.5	68.2	1,709,811.74
4	ATK	205,546.72	0.001	36.8	68.9	521,167.82
5	AGO	879,367.55	0.001	38.6	69.2	2,348,896.25
6	LPFO	272,699.10	0.001	39.7	72.9	789,226.65
7	LUBRICATING OIL	42,242.87	0.001	38.8	27.9	45,728.75
8	GREASES	-	0.001	38.8	27.9	
9	BUTAMIN & ASPHALT	11,357.14	0.001	31.4	69.0	24,606.38
10	BRAKE FLUIDS	15.17	0.001	38.8	27.9	16.42
11	(SRG, LRS, VGO, TIN KERO)	18,887.80	0.001	34.4	69.0	44,832.08
TOTAL CO_2 EMISSION						20,015,402.64

Table A5. *2009 National inventory of the Carbon dioxide emission from Liquid Fuel Distribution by NNPC Nigeria.*

S/No.	Fuel Type	Apparent Consumption (KL)	Conversion Factor (1/1000)	Energy Factor (GJ/KL)	Emission Factor (Kg/GJ)	Carbon Dioxide Emission (Kg)
1	LPG	32,312.32	0.001	25.7	59.6	49,493.43
2	PMS	9,505,615.55	0.001	34.2	66.7	21,683,639.86
3	HHK	705,655.81	0.001	37.5	68.2	1,804,714.73
4	ATK	796,769.36	0.001	36.8	68.9	2,020,224.65
5	AGO	1,130,444.61	0.001	38.6	69.2	3,019,553.21
6	LPFO	186,386.48	0.001	39.7	72.9	539,426.70
7	LUBRICATING OIL	100,116.50	0.001	38.8	27.9	108,378.11
8	GREASES	114.20	0.001	38.8	27.9	123.62
9	BUTAMIN & ASPHALT	36,063.18	0.001	31.4	69.0	78,134.49
10	BRAKE FLUIDS	25.19	0.001	38.8	27.9	27.27
11	(SRG, LRS, VGO, TIN KERO)	6,136.81	0.001	34.4	69.0	14,566.33
TOTAL CO_2 EMISSION						29,318,282.40

References

[1] Avner Friedman (1991), Mathematics in Industrial Problems. The IMA Volumes in Mathematics and Applications. Springer Verlag, Part 4, NEW YORK, USA.

[2] Christiansen A. C. and Haugland T. (2001), Gas Flaring and Global Public Goods. FNI Report 20, Fridtjof Nansen Institute (FNI), Lysaker, 34 p.

[3] Diana Mackenzie (2007), Mathematics of Climate Change: A new discipline for an uncertainty century. Mathematical Science Research. Institute Berkeley CA, USA.

[4] Goyal P. and Anikender Kumar, Mathematical Modeling of air pollutants: An application to Indian Urban city, pp 101- Prof. Dagana Popovic (Ed) www.intechopen.com.

[5] Hassan M. El-Houjeiri, Adam R. Brandt, and James E. Duffy Open-Source LCA Tool for Estimating Greenhouse Gas Emissions from Crude Oil Production Using Field Characteristics. *Environ. Sci. Technol.*, 2013, 47 (11), pp 5998–6006 DOI: 10.1021/es304570m.

[6] Rotty, R. M. (1983), Distribution of and changes in industrial carbon dioxide production, J. Geophys. Res., 88(C2), 1301–1308, doi: 10.1029/JC088iC02p01301.

[7] Russell W. Stratton, Philip J. Wolfe, and James I. Hileman Impact of Aviation Non-CO_2 Combustion Effects on the Environmental Feasibility of Alternative Jet Fuels. *Environ. Sci. Technol.*, 2011, 45 (24), pp 10736–10743 DOI: 10.1021/es2017522.

[8] Malumfashi G. I (2007), Phase-Out of Gas Flaring in Nigeria By 2008: The Prospects of a Multi-Win Project (Review of the Regulatory, Environmental and Socio-Economic Issues)," Nigeria Gas Flaring Petroleum Training Journal, Vol. 4, No. 2, pp. 1-39.

[9] Patrick Marchland and Thomas Holland O (2003), Graphics and GUIs with MATLAB. Chapman & HALL/CRC, USA.

[10] Saheed Ismail O., Ezaina Umukoro G. Global Impact of Gas Flaring. Energy and Power Engineering. Vol. 4 No. 4 (2012), Article ID: 20231, 13 pages. DOI:10.4236/epe.2012.44039.

[11] Oyelami B. O. and Asere A. Corrosion in a petroleum industry. Proceeding of National Mathematical Centre of the Workshop on Mathematical Modeling of Environmental Problems. Vol.5, No.1. (2005), 48-67. www.nmcabuja.org/proceedings/workshop_Oyelami_Asere.pdf.

[12] Kuo-lin Hsu, Hoshin Vijai Gupta, Soroosh Sorooshia Artificial Neural Network Modelling of the Rainfall-Runoff Process. Water Resources Research. Volume 31, Issue 10, pages 2517–2530, October 1995.

[13] Nigerian population from 2002-2012. Available on: www.Tradingeconmics.com.