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Models for Environmental and Business Management in the Oil and Gas Industry

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Abstract: To meet the United Nations 2030 Agenda for Sustainable Development and the United Nations Frame Work conventions on climate change, there is need to develop new business and environmental management models to mitigate the impact of the emission of Carbon (IV) Oxide (CO_2) into the environment by the Oil and Gas industry taking into consideration the advantage provided by the digitalization of technology. This research presents new models for environmental management and Carbon taxation within the frame work of environmental sustainability. This study focused on the sources of the Hydrocarbon rather than the sink for its analysis and modelling. Every Oil and Gas producing country is viewed as an Isolated Thermodynamic system in space whose emission of CO_2 must be sustainable. An Isolated thermodynamic system is one in which no transfer of mass or energy occurs across its boundary. Hence, Oil and Gas producing countries that benefit from the revenues of Oil and gas production are held directly responsible for the unfavourable impact of CO_2 emission rather than the sink (consumers) in accordance with the "Polluter Pays Principle". Viewing every country as an Isolated Thermodynamic system ensures that each country strives to live sustainably. The model for computing the CO_2 Ecological Footprint (EF) was developed with MATLAB 7.5.0 Software based on the total Oil and Gas production from the Oil and Gas producing country (Nigeria was used as a case study). Based on the Computed CO_2 EF, model for the size of the forest required for sequestering all the emitted CO_2 was developed for environmental sustainability. Two of the available technologies for CO_2 sequestration (Ocean Fertilization and Ocean Injection of CO_2) were used to develop environmental cost models as a basis for taxation. The result of the research shows that by viewing each Oil and Gas producing country as an Isolated Thermodynamic System that will be held accountable for CO_2 emission, the attainment of the UN 2030 Agenda for sustainable development and the UN conventions on Climate change are easily achieved. Empirical analyses of data obtained with regard to CO_2 released during Oil and Gas production in Nigeria suggests that the CO_2 release by the Nigerian Oil and Gas Industry is unsustainable. Digitalization technologies will rely on the new models developed in this research to develop new business tools for national and inter-country trading of CO_2 emissions and management of Forests for CO_2 sequestration.

Keywords: Ecological Footprint, Sustainability, Thermodynamic System, Sequestration, Modelling

1. Introduction

Every business utilizes resources from the planet and generates waste products that the planet must then deal with. This is leading to questions such as "Will this planet be able to meet or satisfy the needs of the future generations?" "Are we living within the earth's carrying capacity?" The exploration, transportation and the use of Oil and gas have potential for a variety of impacts on the environment. Some of these impacts threaten the existence of humans and the environment in which they live. There is therefore need to estimate these impacts and whether these impacts can be considered sustainable or not.

According to BP sustainability report (2016), the energy transition underway poses a significant challenge – how to meet the world's increasing demand for energy while, at the same time, reducing carbon emissions.

The demand of energy and its supply in the recent world has many consequences associated with it. Numerous green energy options are being explored in the interest of saving the world environment. (Japen, 2014).

Oil and gas companies face environmental risks, health and safety risks, and liability risks and ultimately, reputational risks, the management of which is central to the companies' long-term success (David, 2010).

The international Oil and gas industry is undergoing a period of fundamental and rapid change. In 2008 Brent Crude reached $140 per barrel and in 2015 it was still trading at around $ 110 per barrel. By January 2015, however, the price had dropped to around $45 per barrel. This sudden and significant fall has had a profound and complex effect on the entire industry. (Wallace W., 2016). This challenging environment should not reduce the importance placed on efforts towards environmental sustainability.

Hartman et al., (2014) aver that while environmental regulation can add costs to business operations and restrict business choice, they can also provide opportunities for business. This position is against the general tendency to believe that environmental challenges always create a burden on business and that environment and business interests are always in conflict.

A according to William (2013), a business may be described as sustainable once it meets three criteria: incorporating sustainability principles in most of its business decisions; supplying products and services that are environmentally friendly; and forming a commitment towards environmental principles within its business operations.

The concept of sustainability has grown out of the recognition that economic development on a global level cannot be separated from questions of social justice and ecological stability. Furthermore, sustainable living and sustainable development will require a changed economy and changed society (Desjardins, 2005).

According to Andrew et al., (2013), oil and gas companies have made sizable investments in their safety and environment functions. These investments have made the companies' systems more sophisticated, and have enabled the companies to become much more ambitious in their safety goals, yet for most companies, the ambitious goals have remained elusive.

Policies and actions that come from higher scale structures, such as international bodies and national governments, are not always compatible with the realities and perspectives of smaller scale units including indigenous communities (Jayalaxshmi et al, 2016).

In the context of offshore oil and gas development, the environmental footprint is regarded as the spatial extent of exploration and production activities as perceptible modifications to the sea bottom or sea surface as well as any quality-related influence on the air, water or marine ecology (The National Petroleum council, 2011). According to the council, minimizing and managing environmental footprint is a shared purview of technology and regulations.

The need to measure the sustainability of human activities cannot be over-emphasized. The earth which is the home of humanity is limited, it is not infinite, its radius is defined, its surface area is known, so the human community cannot continue to deplete the resources of the earth as though it is infinite. The use of the resources of the earth has consequences on the Well being of humanity if it is not within the regenerative capacity of the earth as seen in the increase in the frequency of natural disasters, increasing surface temperature of the earth, floods, hurricanes, Typhoons etc. According to Ewing et al., (2010), "Without a way of comparing the demand on resources to the capacity of the planet to supply those resources, policy makers could ignore the threat of Overshoot, and remain entangled in the discussion over the "affordability of sustainability", one way to measure the sustainability of human developmental strides is the ecological footprint methodology. Wackernagel and Rees (1996) introduced the concept of ecological footprint (EF). Its basic theory is that every human being has real area of the Earth's surface dedicated to us for our survival: Food to eat, land to build houses, garbage dump, etc. According to Weidmanne and Barrett (2010), ecological footprint is "an indicator that accounts for human demand on biological resources. It compares the available bio-productive land and sea area with the level of consumption to see the possibility of exceeding the sustainability threshold. The concept of ecological footprint was developed to promote human progress and development without stifling the environment".

On the global stage, the United Nations organization has been in the forefront of the campaign for sustainable development. The 2030 Agenda for Sustainable development was launched by the United Nations between the 25th and 27th of September, 2015. The sustainable development agenda has 17 goals and 169 targets. Upon analysis of the 17 agenda, it is seen that five (Agenda 7,12,13,14, and 15) have direct relationship with environmental protection. According to the United Nations committee of experts of international cooperation on Tax Matters (2010), there are two broad types of government responses to climate. They are the so-called "command and control methods" which involves direct governmental regulation, and the market based approaches, such as subsidies, taxes and emission trading schemes.

This paper will present models for managing the Oil and gas industry of nations using the isolated thermodynamic system approach. An isolated thermodynamic system is one in which there is no transfer of mass and energy across its boundary. With this view, all business activities within the isolated system must be sustainable, with the three dimensions of sustainability respected: Environmental, social and economic. Using this method, all the Carbon (IV) oxide (CO_2) emission resulting from the economic activity of the Oil and gas industry within the isolated thermodynamic system must be sequestered by the system or traded to other thermodynamic systems (who must have the capacity to sequester the emitted Carbon (IV) Oxide). Nigeria will be used as a case study of the Isolated Thermodynamic system. The models for estimating the ecological footprint, the cost of CO_2 sequestration by Ocean storage via direct CO_2 injection or Ocean fertilization and the models for Carbon taxation were developed in this research and are very useful tool for the digitalization process for business and environmental management.

2. Statement of Problem

To develop a means of using the Oil and Gas production data of an Oil and Gas producing country; the concept of ecological footprint and the isolated thermodynamic system approach to develop business and environmental models for the Oil and Gas industry. This will serve as a very useful tool in the digitalization of business and environmental management as well as the attainment of UN 2030 agenda for sustainable development.

3. Methodology

This study will use the data of the Nigerian Oil and gas industry as a case study. The geographical space of Nigeria was viewed as an isolated thermodynamic system where mass or energy transfer is not allowed across the boundary. With this view, the activities of the Oil and Gas industry including the result of the combustion of Oil and Gas shall be sustainable. The three dimensions of sustainability shall be respected: Environmental, social and economic. By viewing every country as an isolated thermodynamic system, all the CO_2 emissions resulting from the economic activity (Oil and Gas production) must be sequestered within the bio-capacity of the country under consideration. The Ocean, Forests and the atmosphere of the geographic space under consideration must take up the emitted green house gases without resulting in climate change or any irreversible change of the system. See figure 1 for the illustration of an isolated thermodynamic system.

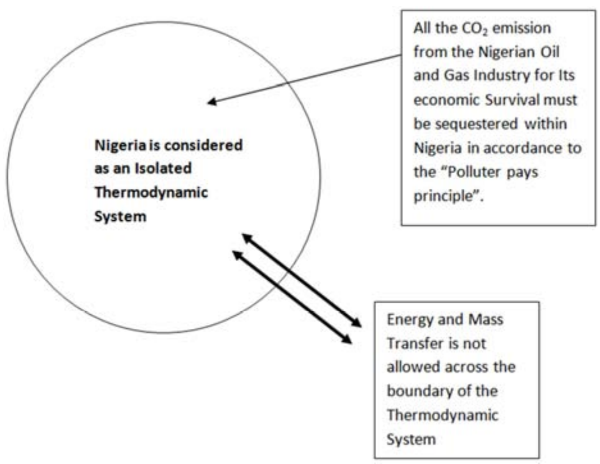

Figure 1. *Nigeria as an Isolated Thermodynamic System.*

By analyzing the data from the Nigerian Oil and Gas industry, the ecological footprint of CO_2 emission by the Oil and Gas industry was be computed, furthermore, based on the ecosystem of Nigeria, the bio-capacity (BC) was computed. By comparing the EF and BC, any gap between them was considered as an "overshoot" that needs to be traded at a cost to a willing buyer country that has proven spare bio-capacity to accommodate the overshoot of the Nigerian Oil and Gas industry. The summary of the methodology for EF and BC computation is shown in figure 2. Cost models for the overshoot have been developed based on two main methods of CO_2 sequestration: Direct CO_2 injection and Ocean fertilization. A CO_2 Tax model was then developed as an average of the cost of CO_2 sequestration by Ocean fertilization and direct CO_2 injection.

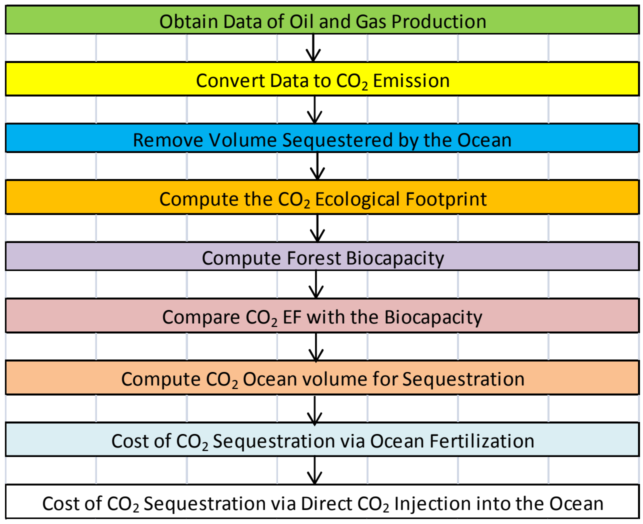

Figure 2. *Methodology for Ecological Footprint and Bio-capacity Estimation.*

The ecological footprint of the emitted CO_2 and Bio-capacity were calculated as follows as per Ewing et al., (2010):

$$\boldsymbol{EF = \frac{P}{Y_N} \times Y_F \times EQF} \quad (1)$$

Where P is the amount of CO_2 emitted in million tonnes per year (Mt/yr); YN is the national average forest sequestration rate for CO_2 in tonnes per hectare per year (T/H/yr) yield. YF is the yield factor and EQF is the equivalence factor (Global hectare/hectare) for the Forest land.

The Forest land Bio-capacity is estimated as follows:

$$BC = AF_L \times Y_F \times EQF \quad (2)$$

Where BC is bio-capacity, AFL is available forest land for CO_2 sequestration; Y. F is the yield factor and EQF is the equivalence factor.

The total CO_2 produced by the Oil and Gas industry is absorbed by three components: the terrestrial environment (Forest), the Ocean and the atmosphere. To get the quantity of CO_2 responsible for global warming, we deduct the quantity absorbed by the Forest and by natural uptake by the Ocean. The quantity of CO_2 left in the atmosphere is now used as a measure of the ecological footprint. According to IPCC (1995), the ocean uptake of CO_2 is 2 GTC per 7 GTC. Hence, about 28.6% of released CO_2 by the Nigerian Oil and gas industry is sequestered by the Ocean. The remaining CO_2 is to be absorbed by the Forest or left in the atmosphere.

The average national forest sequestration rate for Forest $\text{land}= 3.455 \text{ t } CO_2 \text{ per Hectare/yr}$

The yield factor $= 1$. The equivalence factor $= 1.26 \text{ Global hectare/hectare}$

Based on the analysis carried out during this research, the mass of CO_2 (Kg) emitted from the combustion of Oil and gas can be calculated as follows:

$$\mathbf{X\,(Kg)} = \mathbf{0.58289}\, \boldsymbol{\rho_o} \left(\frac{\boldsymbol{Kg}}{\boldsymbol{m^3}}\right) * \boldsymbol{V_o}\,(\boldsymbol{bbl}) + \mathbf{1.9386} \boldsymbol{V_{CH4}} (\boldsymbol{m^3}) \quad (3)$$

or in terms of Gas-Oil Ratio (GOR (Sm3/Sm3)) as follows:

$$\mathbf{X\,(Kg)} = \boldsymbol{V_o}\,(\boldsymbol{bbl})(\mathbf{0.58289}\, \boldsymbol{\rho_o} \left(\frac{\boldsymbol{Kg}}{\boldsymbol{m^3}}\right) + \mathbf{12.2} * \boldsymbol{GOR} \left(\frac{\boldsymbol{Sm^3}}{\boldsymbol{Sm^3}}\right)) \quad (4)$$

Where:

$$\rho_o \left(\frac{Kg}{m^3}\right) \textit{ is the density of the Crude Oil}, V_o\,(bbl) \textit{ is the volume of crude oil produced}$$

$$\textit{and } V_{CH4}(m^3) \textit{ is the volume of natural gas produced.}$$

The ecological footprint for the Nigerian Oil and gas industry is modelled as follows:

$$EF = \frac{0.58289\, \rho_o\left(\frac{Kg}{m^3}\right) * V_o\,(bbl) + 1.9386 V_{CH4}(m^3)}{1000 * Y_N} \times Y_F \times EQF \quad (5)$$

This expresses the ecological footprint as a function of crude oil density (Kg/m^3), oil production in barrels, and volume of methane (Sm^3).

The ecological footprint estimation can also be expressed as a function of gas oil ratio as follows:

$$EF = \frac{V_o\,(bbl)(0.58289\, \rho_o\left(\frac{Kg}{m^3}\right) * + 12.2 * GOR\left(\frac{Sm^3}{Sm^3}\right))}{1000 * Y_N} \times Y_F \times EQF \quad (6)$$

4. Result and Discussion

From the data in appendix I and II, and the result of computation of ecological footprint of the Nigerian Oil and gas industry between 1961 and 2014, MATLAB 7.5.0 software was used to develop the ecological footprint model. The ecological footprint of the Nigerian Oil and gas industry between 1961 and 2014 the follows the Gaussian model:

$$EF_{CO_2} = a_1 * e^{\left(-\left(\left(\frac{x-b_1}{c_1}\right)\right)^{\wedge}2\right)} + a_2 * e^{\left(-\left(\left(\frac{x-b_2}{c_2}\right)\right)^{\wedge}2\right)} + a_3 * e^{\left(-\left(\left(\frac{x-b_3}{c_3}\right)\right)^{\wedge}2\right)} + a_4 * e^{\left(-\left(\left(\frac{x-b_4}{c_4}\right)\right)^{\wedge}2\right)} \quad (7)$$

Where EF_{CO_2} (Mgha) is the Ecological footprint of CO_2 production by the Nigerian Oil and gas industry and x is the year under consideration. The coefficients with 95% confidence bounds are: $a_1 = 17.12$; $b_1 = 2005; c_1 = 1.633; a_2 = 80.63;\ b_2 = 2000; c_2 = 19.52; a_3 = 65.89;\ b_3 = 1975; c_3 = 6.073; a_4 = 32.82;\ b_4 = 2013; c_4 = 4.531$. The coefficient of determination for the model R^2=0.9511.

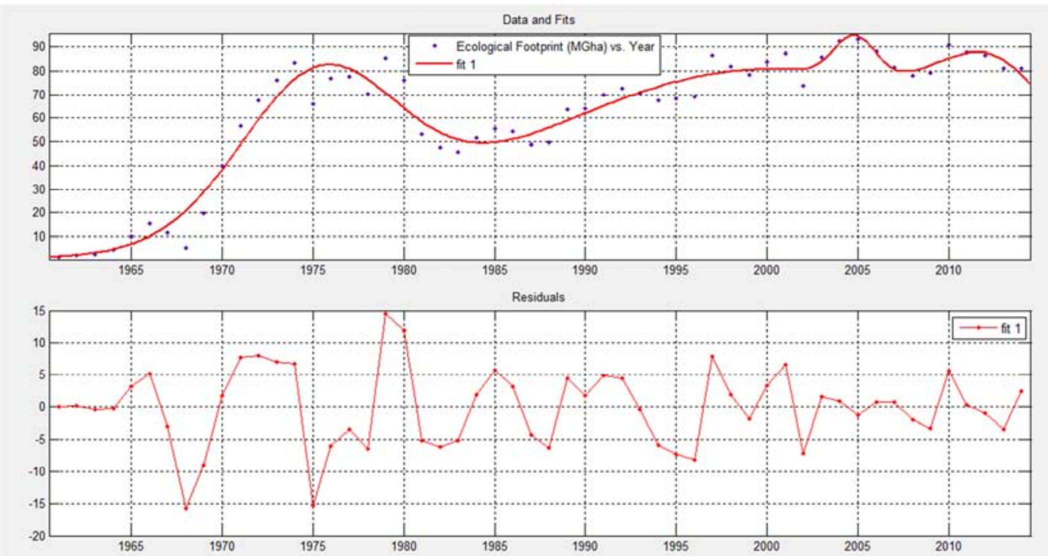

Figure 3. *MATLAB modelling of the Ecological footprint (Mgha) of the Nigerian Oil and Gas Industry from 1961 to 2014.*

The bio-capacity available for sequestering the CO_2 released by the Nigerian Oil and Gas industry can be modeled by the exponential equation below:

$$BC = a * e^{b*x} \quad (8)$$

Where BC(Mgha) is the Bio-capacity of Nigeria available for CO_2 sequestration and x is the year under consideration. The coefficients within 95% confidence bounds are: $a = 38.48; b = -0.4987$. The coefficient of determination for the model $R^2 = 1.0$.

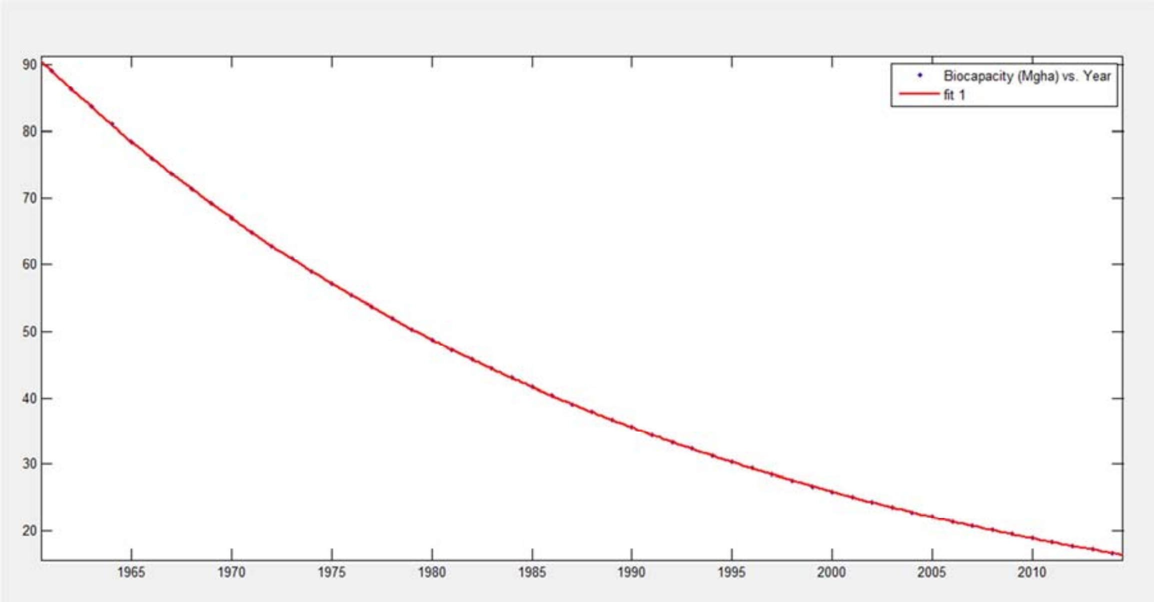

Figure 4. *MATLAB modelling of the available Bio-capacity (Mgha) for sequestering CO_2 in Nigeria from 1961 to 2014.*

This research work agrees with the "polluter pays principle". Based on this study, two methods are presented for introduction of Carbon tax on the Oil and Gas Producing countries. This approach will impose penalty on the polluting country based on the quantity of CO_2 released into the environment. The methods of CO_2 sequestration considered for this costing is the direct injection of CO_2 to a depth above 3000m and the option of Ocean fertilization with highly enriched nutrients. In this methodology, the average cost of using the two methods was used for imposing the tax on the polluting Country based on the quantity of CO_2 emitted to the environment. The cost can be adjusted for different years based on the consumer price index for the year under consideration. The costing is based on the works of Williams and Druffel (1987) for Ocean fertilization and Akai et al (2004) for Ocean storage.

$$\boldsymbol{C_{Ocean\ injection}}(\mathbf{US\$}) = \boldsymbol{p_{O1}} * \boldsymbol{x^3} + \boldsymbol{p_{O2}} * \boldsymbol{x^2} + \boldsymbol{p_{O3}} * \boldsymbol{x} + \boldsymbol{p_{O4}} \quad (9)$$

Where: $p_{O1} = 7.87e^{-8}$; $p_{O2} = -1.924e^{-5}$; $p_{O3} = 0.02016$;$p_{O4} = -0.03215$

$$\boldsymbol{C_{Ocean\ fertilization}}(\mathbf{US\$}) = \boldsymbol{p_{F1}} * \boldsymbol{x^3} + \boldsymbol{p_{F2}} * \boldsymbol{x^2} + \boldsymbol{p_{F3}} * \boldsymbol{x} + \boldsymbol{p_{F4}} \quad (10)$$

Where: $p_{F1} = 1.334e^{-8}$; $p_{F2} = -3.27e^{-6}$; $p_{F3} = 0.003426$;$p_{F4} = -0.005464$

$$\text{Carbon (IV) Oxide Emission Tax (US\$)} = \mathbf{0.5} * [(\boldsymbol{p_{O1}} + \boldsymbol{p_{F1}})\boldsymbol{x^3} + (\boldsymbol{p_{O2}} + \boldsymbol{p_{F2}})\boldsymbol{x^2} + (\boldsymbol{p_{O3}} + \boldsymbol{p_{F3}})\boldsymbol{x} + \boldsymbol{p_{O4}} + \boldsymbol{p_{F4}}] * [\frac{\mathbf{CPI\ (year) - 177.1}}{\mathbf{177.1}}] \quad (11)$$

Where x is Mass of CO_2 (Mtonnes) released by the country under consideration, $\boldsymbol{C_{Ocean\ injection}}$ and $\boldsymbol{C_{Ocean\ fertilization}}$ are the cost of CO_2 sequestration by Ocean Injection and Ocean Fertilization technologies respectively.

5. Conclusion

Several mathematical models have been developed and presented for the management of CO_2 emissions by Oil and Gas producing countries. The use of the Isolated Thermodynamic system approach for attaining the UN 2030 Agenda for sustainable development is a novel approach. This approach holds the Oil and Gas producing countries accountable for CO_2 emission as their economies benefit from the unfavorable impact of Oil and Gas production. This is in agreement with the "polluter pays principle". The method for estimating the cost to be imposed on Oil and Gas Producing countries has been presented in this study using the Nigerian Oil and Gas Industry as a case study.

6. Limitations of the Study

The following are the limitations of the research done:

i The existing methods of computing the Ecological footprint can be narrowed down to CO_2 and are applicable to the Nigerian situation.

ii The reliance on available government data who are an interested party.

iii The release of CO_2 as a result of the activities of Oil and Gas Industry has been assumed to be a sensitive indicator of ecological footprint.

iv The developed models like all models are necessarily simplified and cannot include all interactions.

Acknowledgement

I thank the management of Nigerian National Petroleum Corporation for making the data on the Nigerian Oil and Gas Industry available through the annual publication of the

Annual Statistical Bulletins.

Appendix

Appendix A. *Nigerian Oil Production from 1961 to 2014.*

S/NO	Year	Annual Production (bbl/Year)	Daily Production (bbl/Day)
1	1961	16801896	46032.6
2	1962	24623691	67462.2
3	1963	27913479	76,475.30
4	1964	43,996,895	120,210.10
5	1965	99,353,794	272,202.20
6	1966	152,428,168	417,611.40
7	1967	116,553,292	319,324.10
8	1968	51,907,304	141,823.20
9	1969	197,204,486	540,286.30
10	1970	395,835,825	1,084,481.70
11	1971	558,878,882	1,531,175.00
12	1972	665,283,111	1,817,713.40
13	1973	750,452,286	2,056,033.70
14	1974	823,320,724	2,255,673.20
15	1975	651,509,039	1,784,956.30
16	1976	758,058,376	2,071,197.70
17	1977	766,053,944	2,098,777.90
18	1978	692,269,111	1,896,627.70
19	1979	841,226,770	2,304,730.90
20	1980	752,223,285	2,055,254.90
21	1981	525,500,562	1,439,727.60
22	1982	470,687,221	1,289,554.00
23	1983	450,974,545	1,235,546.70
24	1984	507,998,997	1,387,975.40
25	1985	547,089,595	1,498,875.60
26	1986	535,296,671	1,466,566.20
27	1987	482,886,071	1,322,975.50
28	1988	490,440,000	1,340,000.00
29	1989	626,449,500	1,716,300.00
30	1990	630,245,500	1,726,700.00
31	1991	690,981,500	1,893,100.00
32	1992	716,262,000	1,957,000.00
33	1993	695,398,000	1,905,200.00
34	1994	664,628,500	1,820,900.00
35	1995	672,549,000	1,842,600.00
36	1996	681,894,600	1,863,100.00
37	1997	855,736,287	2,344,483.00
38	1998	806,443,999	2,209,435.60
39	1999	774,703,222	2,122,474.60
40	2000	828,198,163	2,262,836.50
41	2001	859,627,242	2,348,708.30
42	2002	725,859,986	1,983,224.00
43	2003	844,150,929	2312742.271
44	2004	910,156,486	2493579.414
45	2005	918,660,619	2516878.408
46	2006	869,196,506	2381360.29
47	2007	803,000,708	2200001.94
48	2008	768,745,932	2106153.238
49	2009	780,347,940	2137939.562
50	2010	896,043,406	2454913.441
51	2011	866,245,232	2373274.608
52	2012	852,776,653	2336374.392
53	2013	800,488,096	2193118.071
54	2014	798,541,589	2187785.175

Source: Nigerian National Petroleum Corporation Annual Statistical Bulletins, 2010- 2014

Appendix B. *Nigerian Gas Production from 1961 to 2014.*

S/NO	Year	Gas Produced (MCM/Year)
1	1961	310
2	1962	486
3	1963	626
4	1964	1029
5	1965	2849
6	1966	2908
7	1967	2634
8	1968	1462
9	1969	4126
10	1970	8068
11	1971	12996
12	1972	17122
13	1973	21882
14	1974	27170
15	1975	18656
16	1976	21274
17	1977	21815
18	1978	20486
19	1979	27450
20	1980	24551
21	1981	17113
22	1982	15382
23	1983	15192
24	1984	16251
25	1985	18569
26	1986	18738
27	1987	17170
28	1988	20250
29	1989	25129
30	1990	28430
31	1991	31460
32	1992	32084
33	1993	33680
34	1994	33680
35	1995	35100
36	1996	35450
37	1997	37150
38	1998	37039
39	1999	43636
40	2000	42732
41	2001	52453
42	2002	48192
43	2003	51818
44	2004	59009
45	2005	59331
46	2006	61847
47	2007	68456
48	2008	64826
49	2009	52066
50	2010	67810
51	2011	58050.12
52	2012	59895.04
53	2013	47712.33
54	2014	53195.52

Source: Nigerian National Petroleum Corporation Annual Statistical Bulletins, 2010-2014.

References

[1] British Petroleum sustainability Report. 2016.

[2] Japen G. 2014: International Journal for Innovative Research in Science and Technology, Assessment of a residential property for improvements in energy efficiency & renewable energy production, Vol 1, issue 3.

[3] David B.S. 2010. Corporate Social Responsibility in the Oil and Gas Industry: The Importance of Reputational Risk, Chicago-Kent Review, Article 4, Volume 6.

[4] Wallace W. 2016. Project Management for the Oil and Gas Industry. Edinburgh Business School, pp 1.

[5] Hartman, P.L, Desjardins, J. and MacDonald C. 2014. Business Ethics, Decision Making for Personal Integrity & Social Responsibility, Business and Environmental Sustainability, Chapter 9, pp 7.

[6] William A.L 2013. Small Businesses Environmental Sustainability: Student applied practices, Journal of Sustainability and Green Businesses. Pp2.

[7] Desjardins J. 2005: Business & Professional Ethics Journal: Business and Environmental Sustainability, Vol. 24, Nos. 1&2.

[8] Andrew C., Richard V. Sean W., Rose L. 2013. Safety and Environmental Management in the Oil and Gas Industry. Strategy &. Pp 4.

[9] Jayalaxshmi M.; Andrea B.; Celine, T., Elisa B., Lakeram H., Ryan B. Grace A., Rebecca X., Bernie R., Odacy D., Deirdre J. Geraude D-V. 2016. Ecology and Society, Community owned solutions: identifying local best practices for social-ecological sustainability, 21(2):42.

[10] The national petroleum council (NPC). 2011. Offshore Environment Footprints and regulatory reviews, Environmental Footprint and Rgulatory Reviews, Paper 2-8.

[11] Ewing, B., David, M., Steven, G., Anna O., Anders, R, and Mathis, W. 2010. Ecological Footprint Atlas 2010. Global footprint Network, Oakland, California, p5.

[12] Rees, W. and Wackernagel, M. 1996: Urban Ecological Footprint: Why Cities Cannot be Sustainable- and why they are a key to Sustainability, Environmental Impact Assess Rev. 16: 223-248, Elsevier Science Inc.

[13] Weidmann, T. and Barrett, J. 2010. A review of the Ecological footprint Indicator – Perceptions and Methods. Sustainability, Vol. 2.

[14] Document of the United Nations Summit for the Adoption of Post 2015 Development Agenda. 2015. Transforming Our World: The 2030 Agenda for Sustainable Development. United Nations Publication, A/RES/70/1.

[15] IPCC, Climate Change (1995): The Science of Climate Change Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change, JT Houghton, LG Meira Filho; BA Callander, N Harris, A Kattenberg and K Maskell (Eds) Cambridge, England (1996).

[16] Akai, M., Nishio, N., Iijima, M., Ozaki, M., Minamiura, J. and Tanaka, T. 2004. Performance and Economic Evaluation of CO_2 Capture and Sequestration Technologies. Proceedings of the Seventh International Conference on Green House Gas Control Technologies.

[17] Williams, P. M. and Druffel, E. R. M. 1987. Radiocarbon in Dissolved Organic Carbon in the Central North Pacific Ocean. Nature, Vol. 330, pp 240-248.

[18] Nigerian National Petroleum Corporation.2010. Annual statistical review 2010, 1st(Ed), 2008, pp 5-10.