International Journal of Academic Engineering Research (IJAER)
ISSN: 2643-9085
Vol. 4 Issue 10, October - 2020, Pages: 32-39

# Negative Effects of Gas Flaring In Niger Delta, Nigeria: Case Study, Oporoma

***Ozogu Agbe N.[1], Chukwurah N. C.[2], Muhammed Z. A.[3], and Anyim P. B,[3]**

[1]Petrochemical and Allied Department, National Research Institute for Chemical Technology, P.M.B. 1052, Basawa-Zaria, Kaduna State, Nigeria.
[2]Department of Chemical Engineering, School of Engineering Delta State Polytechnic, Ogwashi-Uku, Delta State, Nigeria.
[3]Scientific and Industrial Research Department, National Research Institute for Chemical Technology, P.M.B. 1052, Basawa-Zaria, Kaduna State, Nigeria.
**Email:** donagbe@yahoo.com (Ozogu, Agbe N.)

**Abstract:** *Gas flaring is a combustion device to burn associated, unwanted or excess gases and liquids released during normal or unplanned over pressuring operation in many industrial processes, such as oil gas extraction, refineries, chemical plants, coal industry and landfills. Gas flaring is a significant source of greenhouse gases emissions. It also generates noise, heat and provided large areas uninhabitable. The environmental and health implications were examined in Oporoma community, Niger Delta region as a case study. All investigations and information depict the negative effects of gas flaring on the environment and humans. Gas flaring has impoverished the community where it is practiced, with attendant environmental, economic and health challenges. Reluctance on the part of government and policy makers is also a factor. These difficulties faced by the community from gas flares are a sufficient justification for ending gas flaring practice. Fines by defaulting companies should be so exorbitant so as to deter them. Most of the gases that is being flared can be processed and produced into cooking/domestic gas, and for electricity generation. The time to stop gas flaring is now, especially in the Niger Delta (Oporoma Community).*

**Keywords:** Gas flaring, Greenhouse gas emissions, climate change, natural gas, and pollution.

## 1. INTRODUCTION:

Gas flaring is a process whereby natural gas associated with crude oil during production of crude oil is been burnt. Gas flaring is the controlled burning of natural gas that cannot be processed for sale or use because of technical or economic reasons (*Canadian Association of Petroleum Producers, Flaring & venting, Retrieved Oct. 10, 2012, Available at:*

*http://www.capp.ca/environmentCommunity/airClimateChange/Pages/FlaringVenting.aspx*). Gas flaring can also be defined by the combustion devices designed to safely and efficiently destroy waste gases generated in a plant during normal operation. It is coming from different sources such as associated gas, gas plants, well tests and other places. It is collected in piping headers and delivered to a flare system for safe disposal. Flaring is a major concern in petroleum producing areas where there exists insufficient infrastructure to utilize the produced natural gas. It serves as a way of disposing the gas produced in those areas. This as simple as it may sound, creates series of negative impacts on the people as well as the environment in general (Orimoogunje *et al*., 2010).

These adverse effect causes series of hazards to human health, such as respiratory attack, allergies, skin disease, asthma, sick building syndromes (SBS), organs attack, chronic respiratory disease, cardiovascular and nervous system attack, and even cancer induced by VOCs (Huang et al., 2017a; Shu et al., 2018; Cai et al., 2014; Lyu et al., 2017),

In the early days of petroleum exploration, natural gas was not considered a useful product because of the difficulties in transporting it to where it can be utilized or the problems associated with it storage. As a result, gas was simply burned off at the well or vented into the atmosphere, to create rooms for other operations and supposedly to save the whole system from being burnt down by gas explosion. Table 3 shows the top ten gas flaring countries in the world as at 2012.

**Table 1: Top Ten Gas Flaring Countries in the World (World Bank).**

| S/N | Country | Gas flared (106 cm$^3$) | Rank |
|---|---|---|---|
| 1. | Russia | 35,000 | 1st |
| 2. | Nigeria | 17,000 | 2nd |
| 3. | Iran | 10,000 | 3rd |
| 4. | Iraq | 10,000 | 4th |
| 5. | United States | 5,000 | 5th |
| 6. | Algeria | 4,800 | 6th |

| | | | |
|---|---|---|---|
| 7. | Kazakhstan | 4,700 | 7th |
| 8. | Venezuela | 4,300 | 8th |
| 9. | Saudi Arabia | 4,100 | 9th |
| 10. | Angola | 4,000 | 10th |

Gas flaring is therefore a dangerous activity and human rights violation that is not tolerated in advanced developed nation because the gas pollutants contain over 250 toxins that are harmful, poisonous and unfriendly to the natural ecosystems and human habitats. With reference to the Niger Delta in Nigeria, gas flaring manifests in the forms of gas leakages directly into the atmosphere causing fire incidents and heating up the atmospheric air. Nigerian Liquefied Natural Gas (NLNG) pipelines have been reported to have leaked and caught fire in several communities, which burned uncontrollably for days destroying plants, and animals living in the affected areas and communities (Zabbey, *et al*., 2004).

## 2. FLARE STACK CONFIGURATION:

A flare stack is a gas combustion device used in industrial plants such as petroleum refineries, chemical plants, and natural gas processing plants as well as at oil or gas production sites having oil wells, gas wells, offshore oil and gas rigs and landfills. In industrial plants, flare stacks are primarily used for burning off flammable gas released by pressure relief valves during unplanned over pressuring of plant equipment. During plant or partial plant startups and shutdowns, flare stacks are also often used for the planned combustion of gases over relatively short periods. When industrial plant equipment items are over pressured, the pressure relief valve is an essential safety device that automatically releases gases and sometimes liquids. Those pressure relief valves are required by industrial design codes and standards for safety purposes (Madueme *et al*., 2010). The released gases and liquids are routed through large piping systems called flare headers to a vertical elevated flare. The released gases are burned as they exit the flare stacks. The size and brightness of the resulting flame is a function of the flammable material's flow rate in joules per hour (or Btu/hour). Steam is very often injected into the flame to reduce the formation of black smoke. When too much steam is added, a condition known as "over steaming" can occur resulting in reduced combustion efficiency and higher emissions. To keep the flare system functional, a small amount of gas is continuously burned, like a pilot light, so that the system is always ready for its primary purpose as an over pressure safety system. Figure 1 shows a flow diagram and typical components of an overall industrial flare stack system. The major components of a flare stack are:

- Knockout drums to remove any oil and/or water from the relieved gases.
- A water seal drum to prevent any flashback of the flame from the top of the flare stack.
- An alternative gas recovery system for use during partial plant startups and/ or shutdowns as well as other times when required. The recovered gas is routed into the fuel gas system of the overall industrial plant.
- A steam injection system to provide an external momentum force used for efficient mixing of air with the relieved gas, which promotes smokeless burning.
- A pilot flame (with its ignition system) that burns all the time so that it is available to ignite relieved gases when needed.
- The flare stack, including a flashback prevention section at the upper part of the stack.

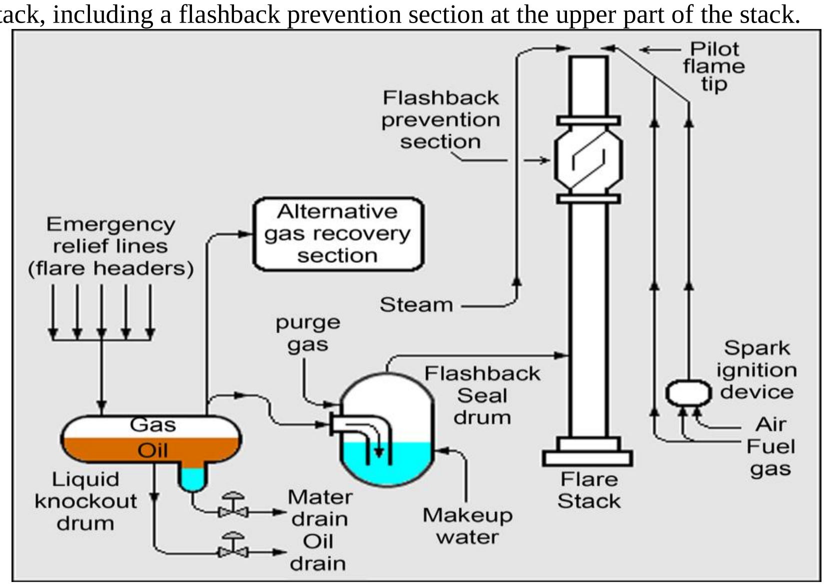


**Figure 1:** Schematic flow diagrams of an overall vertical, elevated flare stack system.

## 3. THE STUDY AREA:

### 3.1 The Niger Delta and the Nature of Environmental and Health Challenges:

Nigeria flares 17.2 billion $m^3$ of natural gas per year in conjunction with the exploration of crude oil in the Niger Delta. The Niger Delta consists of nine states (Figure 2) with over 37 million inhabitants who constitute 22% of Nigeria's population (*National Population Commission, 2006*). Within these are over 1500 communities who act as hosts to the oil industry (Forest and Sousa, 2006) The region is largely consists of rural communities, but includes some important Nigerian towns such as Port Harcourt, Warri, Yenagoa, Calabar, and Akwa-Ibom. The inhabitants in the region generally live below the poverty line and rely on fishing and agriculture to survive (*United Nations Development Programme*, *2006*). The Niger Delta region is home to the oil wealth that has made Nigeria the largest producer of petroleum in Africa and the sixth largest oil producer in the world (Watts *et al*., 2004). In the Niger delta, oil spills are a common occurrence and have been linked to corrosion of pipelines, poor maintenance of infrastructure, spills or leaks during processing at refineries, human error, and intentional acts of vandalism or oil theft (*Amnesty International*, *2009*). *The United Nations Development Programme (2006),* estimates that between 1976 and 2001 there were approximately 6800 spills totaling 3,000,000 barrels of oil. Likewise, it was reported that there were 253 oil spills in 2006, 588 oil spills in 2007, and 419 cases in the first six months of 2008 (Yakubu *et al*., 2008). According to data from the *Shell Petroleum Development Company (2014)*, around 324,000 barrels of crude oil in about 1500 incidences were spilled from its facilities between 2007 and 2013 (Figure 2). Shell reports that of the total volume of oil spilled from SPDC facilities in 2013, about 75% is due to sabotage/theft, and 15% due to operational spills resulting from corrosion, equipment failure, or human error.


**Figure 2:** Figure 2: Niger Delta Region Showing Nine State (Source: Cartography and GIS, Dept. of Geography and Env. Mgt. UNIPORT, 2018).

### 3.2 Oporoma Community:

Oporoma community is the head quarter of Southern Ijaw Local Government Area, and is one of the populated places in Bayelsa State, Nigeria. It is located at an elevation of 215 meters above the sea level. Its coordinates are 4°48'17" N and 6°4'44" E in DMS (Degrees Minutes Seconds) or 4.80472 and 6.07889 (in decimal degrees).

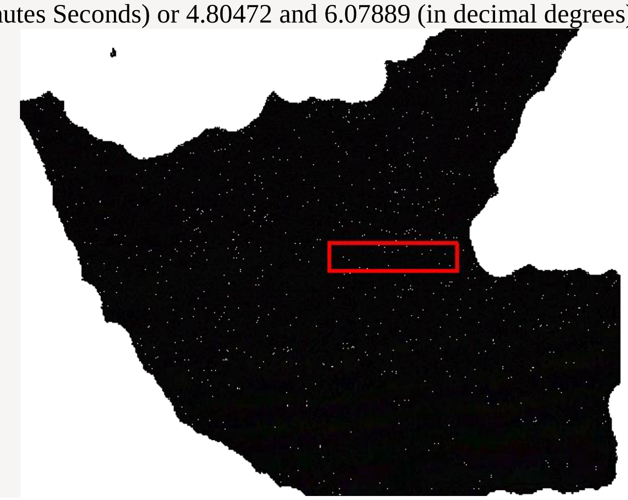

**Figure 3:** Map of Bayelsa State showing all the Local Government Headquarters.

Oporoma community is one of the major production facilities of Shell Petroleum Development Company (SPDC) located within the Niger Delta region. It is occupied by the Ijaw ethnic group and located at the head quarter of Southern Ijaw Local Government Area of Bayelsa State, in the Niger Delta region. Oil production and Gas flaring take place at Shell facility known Nun River Flow Station since 1965. About 90 persons from the community of age between 18 – 80 years was interviewed, and their opinion on gas flaring and pollution close to the community is that, the situation of the environment is very bad and little attention is being given to the livelihood within the regions. The villagers said that for a long period now, the community representatives have tried a lot of efforts to inform the operating company (SPDC), to operate in an environmental friendly way and to integrate the community in their affairs, but instead they were kept away. They believe that the operating oil servicing company does not comply with the standard environmental policies such as ISO-14001 and OSHAS 18009, based on the present condition of their environment. These conditions they referred to as the land, air, and water condition, constantly mixed with oil particles and carbons from gas flares and power plants, which are not conducive for humans, fishes and other sea/river creatures. Therefore, their fishing business has been rendered useless and their farm land has also been badly polluted that it is no longer suitable for agriculture. The indigence also complained that gas flaring has contributed to acid rain, and that the rain corroding their buildings roofs, and they do drinks from that same rain water during rainy session. The particles from the flare fill the air, covering everything with fine layer of soot. People that have farm land around the SPDC flow station also complain about the roaring noise and the intense heat from the flares they live and work alongside with no protection. They believed that most cases of respiratory problems they are facing, such as asthma and bronchitis, lung disease, heart attack, miscarriage, and skin disease are as a result of dinking contaminated water, and exposure to heat from oil exploration related activities. Over the past fifty years, gas flaring and venting associated with petroleum exploration and production in the region have continued to generate complex consequences in terms of energy, human health, natural environment, socio–economic environment and sustainable development (Ite *et al*., 2013). Indeed, widespread gas flaring has inflicted untold hardship and damage to human, plant and animal life.

**Figure 4:** Corroded Building Roofs with Acid Rain.

**Figure 5:** Polluted fishing Lake in Oporoma community.

## 4 ENVIRONMENTAL IMPLICATIONS OF GAS FLARING:

Gas flaring is one of the most challenging energy and environmental problems facing the world today. Environmental consequences associated with gas flaring have a considerable impact on local populations, often resulting in severe health issues. Generally, gas flaring is normally visible and emitted both noise and heat (Adewale *et al*., 2015). The effects of gas flaring are:

### 4.1 Climate Change:

Gas flaring contributes to climate change, which has serious implications for both Nigeria and the rest of the world. The burning of fossil fuel, mainly coal, oil and gas, greenhouse gases has led to warming up the world and is projected to get much, much worse during the course of the 21st century according to the intergovernmental panel on climate change (IPCC). This scientific body was set up in 1988 by the UN and the World Meteorological Organization to consider climate change. Climate change is particularly serious for developing countries, and Africa as a continent is regarded as highly vulnerable with limited ability to adapt. Gas flaring contributes to climate change by emission of carbon dioxide, the main greenhouse gas. Venting of the gas without burning, a practice for which flaring seems often to be treated as a synonymy, releases methane, the second main greenhouse gas. Together and crudely, these gases make up about 80% of global warming to date (Anslem *et al*., 2013).

### 4.2 Acid Rain:

Acid rains have been linked to the activities of gas flaring (*Friends of the Earth (FOE), 2004; Medilinkz, Nigeria, 2010*). Corrugated roofs in the Niger Delta region have been corroded by the composition of the rain that falls as a result of flaring. The primary causes of acid rain are emissions of sulphur dioxide ($SO_2$) and nitrogen oxides (NO) which combine with atmospheric moisture to form sulfuric acid and nitric acid respectively. Acid rain acidifies lakes and streams and damages vegetation. In addition, acid rain accelerates the decay of building materials and paints. Prior to falling to the earth, $SO_2$ and $NO_2$ gases and their particulate matter derivatives, sulfates and nitrates, contribute to visibility degradation and harm public health.

**Figure 6:** Air Pollution from Gas Flaring.

### 4.3 Effects on Agriculture:

The flares associated with gas flaring give rise to atmospheric contaminants. These include oxides of Nitrogen $NO_2$, Carbon $CO_2$, and Sulphur $SO_2$, particulate matter, hydrocarbons and ash, photochemical oxidants, and hydrogen sulphide ($H_2S$) (Obioh *et al*., 1999; Kindzierski *et al*., 2000). These contaminants acidify the soil, hence depleting soil nutrient. In some cases, there is no vegetation in the areas surrounding the flare due partly to the tremendous heat that is produced and acid nature of soil pH (Ubani *et al*., 2013). The effects of the changes in temperature on crops included stunted growth, scotched plants and such other effects as withered young crops (Orimoogunje *et al*., 2010).

### 4.4 Pollution:

Gas flaring leads to the emission of pollutants which are harmful to both humans and the society at large. Incomplete combustion of gas leads to the production of carbon monoxide which is one of the major pollutants with adverse effects on human health and the society at large. The economic and environmental ramifications of this high level of gas flaring are serious because this process is a significant waste of potential fuel which is simultaneously polluting water, air, and soil in the Niger Delta.

## 5 HEALTH IMPLICATIONS OF GAS FLARING:

### 5.1 Adverse Effects:

The implication of gas flaring on human health are all related to the exposure of those hazardous air pollutants emitted during incomplete combustion of gas flare (Anslem *et al*., 2013). These pollutants are associated with a variety of adverse health impacts, including cancer, neurological, reproductive and developmental effects. Deformities in children, lung damage and skin problems have also been reported (Ovuakporaye *et al*., 2012).

### 5.2 Haematological Effects:

Hydrocarbon compounds are known to cause some adverse changes in hematological parameters. These changes affect blood and blood forming cells negatively. And could give rise to anemia (aplastic), pancytopenia and leukemia (Kindzierski *et al*., 2000.

### 5.3 Economic Loss:

Aside from the health and environmental consequences of gas flaring, the nation also loses billions of dollars' worth of gas which is literally burnt off daily in the atmosphere. Much of this can be converted for domestic use and for electricity generation. By so doing the level of electricity generation in the country could be raised to meet national demand. Nigeria has recorded a huge revenue loss due to gas flaring and oil spillage (Effiong and Etowa, 2012). Though more than 65 % of governmental revenue is from oil, it is estimated that about $2.5 billion is lost annually through gas flaring in government revenues (Arowolo and Adaja, 2011).

## 6 ALTERNATIVE SOLUTIONS TO GAS FLARING:

Flaring of natural gas doesn't solve any problem, it rather creates more problems. It affects lives of people and pollutes the environment. There are so many alternative solutions to gas flaring such as;

### 6.1. Reinjection for Secondary Oil Recovery:

Natural gas produced in association with crude oil can be used for either gas injection or gas lift which is more profitable and economical compared to gas flaring. Gas injection is when gas is introduced into a depleted oil reservoir in order to increase the pressure within the reservoir and thereby increase the production of crude oil from the reservoir. This is not to be confused with gas lift, where gas is injected into the annulus of the well rather than the reservoir. After the crude has been pumped out, the natural gas is once again recovered. Since many of the wells found around the world contain heavy crude, natural gas can be used to increase the production of this heavy crude. The process of injecting natural gas serves as a way of increasing the pressure in the oil well, thus causing more gas molecules to dissolve in the oil lowering its viscosity and thereby increasing the well's output.

### 6.2. Source of Energy and Feedstock for Petrochemical Plants:

Natural gas is most times referred to as "clean burning" because it produces fewer undesirable by products per unit energy than coal or oil. Like other fossil fuels, its combustion emits carbon dioxide, but at about half the rate of coal per kilowatt hour of electricity generated. It is also more energy efficient (Gervet *et al*., 2007). Natural gas is a major source of electricity generation through the use of cogeneration, gas turbines and steam turbines. It is also well suited for a combined use in association with renewable energy sources such as wind or solar. Particularly high efficiencies can be achieved through combining gas turbines with a steam turbine in combined cycle mode. Natural gas burns more cleanly than other hydrocarbon fuels, such as oil and coal, and produces less carbon dioxide per unit of energy released. For an equivalent amount of heat, burning natural gas produces about 45 percent less carbon dioxide than burning coal for power. The US Energy Information Administration reports the following emissions in million metric tons of carbon dioxide in the world for 2012:

- Natural gas: 6799.
- Petroleum: 11,695.
- Coal: 13,787.

### 6.3. Liquefied Natural Gas (LNG):

Another alternative solution to gas flaring is to liquefy the gas and stored in vessels or bottles as liquid natural gas. This is relatively safer and more economical compared to flaring of gases. The natural gas produced from either a gas well or in association with crude oil production can be liquefied in series of processes. And in most cases, start with the removal of impurities like water, acid gases among others produced with the gas. Solid particles may also be present in the produced gas and must be removed before processing to maximize the mechanical efficiency in the LNG equipment. The major composition of natural gas is methane and for liquefaction to occur. To liquefy methane gas, the temperature of the system must be brought down to −160˚C. This of course is also a function of other factors such as the components part of the gas to be liquefied. The stored LNG can be used domestically and also for industrial purposes.

### 6.4. Compressed Natural Gas (CNG):

Compressed natural gas refers to methane stored at high pressure. It is made by compressing natural gas to less than 1% of the volume it occupies at standard atmospheric pressure. It is stored and distributed in hard containers at a pressure ranging from 20 - 25 MPa, usually in cylindrical or spherical shapes. In transportation, natural gas is used either as compressed natural gas (CNG) or as liquefied natural gas (LNG) (Hassan *et al*., 2013). Because natural gas has a lower energy density than liquid petroleum fuels, it is either compressed or liquefied to store more energy. Therefore, to use natural gas, vehicles must have a CNG or LNG specific fuel storage and delivery system installed. The cost and placement of fuel storage tanks is the major barrier to wider/quicker adoption of CNG as a fuel. CNG is also used in internal combustion engine automobiles that have been modified or in vehicles which were designed for CNG use, either alone or with a segregated gasoline system to extend range or in conjunction with another fuel such as diesel. The United States Environmental Protection Agency regulates emissions for all vehicles in the United States. In recent years, the emissions benefits of natural gas fueling have been reduced because all vehicles are held to higher standards (Davies *et al*., 2001). Using CNG reduces some regulated emissions, including hydrocarbons, oxides of nitrogen, and carbon monoxide. These reductions differ based on the type of vehicle and its duty cycle (Azeez *et al*., 2017).

## 7 RECOMMENDATIONS:

The difficulties faced by the community (Oporoma) from gas flares are a sufficient justification for ending gas flaring practice. SPDC should try and find a means of cleaning up the environment, and to meet up the demands of the operating community. Government should as a matter of urgency, put more effort to strengthen their laws, and to penalize the defaulting companies. The gas can be processed and produced into cooking/domestic gas, and for electricity generation.

## 8 CONCLUSIONS:

Gas is one of the major sources of energy to speed up developmental needs especially in the developing countries, like Nigeria. Gas is being wasted through flaring, creating harmful air pollutants in Nigeria. The natural gas being flared in Nigeria can serve the purpose of cooking to about 320 million people. Petroleum exploitation and production in the Niger Delta over the years have resulted in a number of environmental, socio-economic and political problems in the region. Oil spillage and gas flaring have caused severe environmental damages, loss of plants, animals and human lives, and loss of revenue to both the oil producing companies and the government. In order to address the problems of gas flaring, it is necessary to understand why the natural gas is being flared. Because oil and natural gas are mixed in every oil deposit, the natural gas called "associated gas" (AG) must be removed from oil before refining. Gas flaring is currently illegal in most countries of the world, where gas flaring may only occur in certain circumstances such as emergency shutdowns, non-planned maintenance, or disruption to the processing system. The draft Petroleum Industry Bill (PIB) stipulates that "natural gas shall not be flared or vented after 31st December, 2012, in any oil and gas production operation, block or field, onshore or offshore, or gas facility, except under exceptional and temporary circumstances", this draft is yet to be passed into law. Legislative backing and governmental bureaucracy still remains a stumbling block.

## 9 REFERENCES:

1. Adewale O.O. and Mustapha, U. (2015) The Impact of Gas Flaring in Nigeria. International Journal of Science, Technology and Society , 3, 40-50.
2. Amnesty International Publication (2009), Nigeria: Petroleum, Pollution and Poverty in the Niger Delta. International Secretariat, London, United Kingdom: Amnesty International Publications.
3. Anslem O. Ajugwo (2013). Negative Effects of Gas Flaring: The Nigerian Experience. *Journal of Environment Pollution and Human Health, Vol. 1, No. 1, 6-8* Available online at http://pubs.sciepub.com/jephh/1/1/2 © Science and Education Publishing DOI:10.12691/jephh-1-1-2.
4. Anslem O. Ajugwo (2013). Negative Effects of Gas Flaring: The Nigerian Experience. *Journal of Environment Pollution and Human Health, 2013, Vol. 1, No. 1, 6-8.*
5. Arowolo, A. A. and Adaja, I. J,. "Trends of natural gas exploitation in Nigeria and the implications on the socio-economic stability and governance," in 35th Nigerian Statistical Association annual conference. 2011.
6. Azeez G. Aregbe (2017). Natural Gas Flaring: Alternative Solutions. World Journal of Engineering and Technology, 5, 139-153 http://www.scirp.org/journal/wjet ISSN Online: 2331-4249 ISSN Print: 2331-4222.
7. Canadian Association of Petroleum Producers, Flaring & venting, Retrieved Oct. 10, 2012, Available at: http://www.capp.ca/environmentCommunity/airClimateChange/Pages/FlaringVenting.aspx.
8. Davies, P. (2001) The New Challenge of Natural Gas' Paper Presented at OPEC and the Global Energy Balance Towards a Sustainable Future, Vienna, September 2001.
9. Effiong, S. A. and Etowa, U. E,. "Oil spillage cost, gas flaring cost and life expectancy rate of the Niger Delta people of Nigeria," Advances in Management & Applied Economics. 2(2). 211-228. 2012.
10. Forest .J.F. and Sousa .M.V. (2006), Oil and Terrorism in the New Gulf: Framing US Energy and Security Policies for the Gulf of Guinea. New York: Littlefield Pub.
11. Friends of the Earth (FOE), Gas flaring in Nigeria, 2004. [E-book] Available: http://www.foe.co.uk.
12. Gervet, B. (2007) Gas Flaring Emission Contributes to Global Warming. Renewable Energy Research Group, Division of Architecture and Infrastructure, Lulea University of Technology, Lulea, 2-14.
13. Hassan, A. and Konhy, R. (2013) Gas Flaring in Nigeria: Analysis of Changes in Its Consequent Carbon Emission and Reporting. Accounting Forum, 37, 124-134. https://doi.org/10.1016/j.accfor.2013.04.004.

14. Ite, A. E. and Ibok, U. J., 'Gas Flaring and Venting Associated with Petroleum Exploration and Production in the Nigeria's Niger Delta', (2013) 1(4), American Journal of Environmental Protection, pp. 70-77.
15. Kindzierski, W.D, "Importance of human environmental exposure to hazardous air pollutants from gas flares," Environmental Reviews, 8, 41-62, 2000.
16. Kindzierski, W.D, "Importance of human environmental exposure to hazardous air pollutants from gas flares," Environmental Reviews, 8, 41-62, 2000.
17. Madueme, S. (2010) Gas Flaring Activities of Major Oil Companies in Nigeria: An Economic Investigation. International Journal of Engineering and Technology, 2, 610-617.
18. Medilinkz, Nigeria: Focus on the environmental impact of gas flaring, 2010. Retrieved from: http://www.medilinkz.org/news/news2.asp?NewsID=294 [Accessed on June5, 2010].
19. National Population Commission, (2006), Population and Housing Census of the Federal Republic of Nigeria, 2006 Census: Priority Tables. Abuja, Nigeria: National Population Commission.
20. Obioh, I. B,."Environmental Impact Assessment of Emissions from Major Facilities at QIT," Atmospheric Emissions and Dispersion Modeling. Faithlink Consults Nigeria Ltd., PortHarcourt. 1999.
21. Orimoogunje, O. I., Ayanlade, A., Akinkuolie, T. A. and Odiong, A. U,. "Perception on the effect of gas flaring on the environment," Research Journal of Environmental and Earth Sciences. 2(4). 188-193. 2010.
22. Orimoogunje, O.I., Ayanlade, A., Akinkuolie, T.A. and Odiong, A.U. (2010) Perception on the Effect of Gas Flaring on the Environment. Research Journal of Environmental and Earth Sciences, 2, 188-193.
23. Ovuakporaye, S. I., Aloamaka, C. P., Ojieh, A. E., Ejebe, D. E. and Mordi, J. C,. "Effects of gas flaring on lung function among residents of ib Gas flaring community in Delta State, Nigeria," Res. J. Env. Earth Sci. 4(5). 525-528. 2012.
24. Shell Petroleum Development Company (2014), Oil Spill Data. The Shell Petroleum Development Company of Nigeria Limited (SPDC). Available at: http://www.shell.com.ng/environmentsociety/ environment-tpkg/oil-spills.html (assessed 15 May 2015).
25. Ubani, E. C. and Onyejekwe, I. M,. "Environmental impact analysis of gas flaring in the Niger delta region of Nigeria," American J. of Scientific and Industrial Research. 4(2). 246-252.2013.
26. United Nations Development Programme. (2006) Niger Delta Human Development Report. Lagos. Nigeria: United Nations Development Programme.
27. United Nations Development Programme. (2006) Niger Delta Human Development Report. Lagos. Nigeria: United Nations Development Programme.
28. Watts .M, (2004), Resource curse. Governmentality, oil and power in the Niger Delta, Nigeria. Geopolitics 9: 50–80.
29. Yakubu L (2008) Nigeria Loses N5.8b Daily to Gas Flaring. The Guardian, 5 August 2008, Lagos, Nigeria.
30. Zabbey, N.(2004). Impacts of Extractive Industries on the Biodiversity of the Niger Delta Region Nigeria. Presentation at a 3-Day National Workshop on Coastal and Marine Biodiversity Management Held in Pyramid Hotel, Calabar, Cross-River State, between 7-9 September, 2004. Jointly Organised by Akpabuyo Bakassi Green Movement (Agremo), Calabar and Special Unit for Technical Co-Operation among Development Countries of UNDP (SU/TCDC/UNDP).