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A Review on Gas Flaringin Nigeria: A Case Study of Nigeria Crude Oil Hub of Niger Delta Region

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ABSTRACT: The Niger Delta of Nigeria is the crude oil hub of the country. However, extraction and refining of the product accompanied a lot of processes in Nigeria and gas flaring is one them; a practice that has huge effect on her environment. Instances of gas flaring have happened consistently since the start of extraction of raw petroleum in the Niger Delta of Nigeria. Gas flares affects the well-beingof man and his environment due to the excessive warming of the soil and vegetation. In this research work, a review was carried out on gas flaring, its effect on average populace of Nigeria, and efforts made so far to curb the menace. The outcome of this research work showed that gas flaring has been on with the inception of the extraction of crude oil in the region with the emission of poisonous gases/reagents into the atmosphere. This emitted gases/reagents, in the long run, has affected the local settlers and the region in general. It was observed that atsome gas flaring site, estimated 100% loss in crop yield were recorded. Furthermore, the highest source of air pollution in the Niger Delta was uncontrolled gas flaring that is gradually destroying the ecosystem of the region. This has brought about high socio-economic cost on the people in terms of repairing their corroded zinc roofing sheet, treating of sicknesses (breathing difficulties and pain, asthma, headaches, nausea, chronic bronchitis), buying of fertilizers, resettlement, and farming. Regrettably, these effects will linger for a long time if not forever because the existing law only charges companies monies for continuous flaring but do not ban gas flaring. More so all efforts put in place to stop gas flaring practice are all futile.

Keywords: Niger Delta, Gas Flaring, Pollution, Reagents, Crude Oil, Environment

I. INTRODUCTION

Exploration of crude oil and natural gas has been the source of revenue generation for Nigeria. Regardless of this commercial entity has been of enormous advantage to Nigeria yet it different ecological difficulties has been a significant issue to the oil producing territory of Niger Delta. Considering all effects, most especially the negative impacts of crude oil and natural gas, it can be said as a means of altering the standards of the environment and compelling the inhabitants of the affected areas into new ways of life and adaptations. Of importance, crude oil exploitationand processing in the Niger Delta region of Nigeria has budged the visible environmental and climatic changes rapidly and in turn dictating the nature and pace of social changes in the region. According to the UNDP Report, more than 70% of the populace depends on the natural environment for their livelihood. The over-reliance on crude oil production by Nigeria has led to the environmental degradation and economic exploitation, thus an inverse relationship between the wealth the community produces for the nation and the socio-economic growth of the indigenes. Niger Delta is situated in the southern region of the southern area of Nigeria [1] and is encircled by towns and towns of Escravos, Ekpan, and Batan with fishing and cultivating the primary businesses exercises that help the territorial economy. Niger Delta district comprises of nine oil creating states (Abia, AkwaIbom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo, and Rivers) which contains 185 neighborhood governments for more than 800 networks from 12 significant ethnic gatherings, with a populace of around 30 million individuals. The section of the continent happens to be Africa's major delta and the at the large extent world's third biggest mangrove forest. More so, it is one of the largest wetlands globally with an estimated 2370 km^2which consists of rivers, islands, creeks, swampy terrain and estuaries. Also, the stagnant swamps in this area cover 8600 km^2 and the coastline spans on the other hand cover over 450 km. Moreover, the mangrove forest covers 54,000 km^2 of the region and the landmass is estimated over 70,000 km^2[2]. Crude oil been the hub of all resources in Nigeria is the major source that drive the country economy since the discovery of mineral

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resources. An eatimated 97% of Nigeria foreign exchange earnings and around 79.5% of the Federal Revenue (FR) are derived from this sector [3]. Besides, it contributes majorly to the growth rate of the Gross Domestic Product (GDP) of the country economy. Although, on paper, the entire country is known to benefit from the revenues generated from oil and gas production, but the story is surprisingly different for the oil creating networks in the Niger Delta area [3].

The bulk of natural resources, consisting of mainly of natural gas and petroleum, in the nation of Nigeria are situated in the Niger Delta district. With admittance to the Atlantic Ocean and Lake Chad by methods for the numerous waterways, the Niger Delta is a various biological system of marine creatures perceived as a prime wellspring of amphibian food creation [4-6]. In this region, the degree of the unprocessed petroleum products emanating from the investigation industry in the Niger Delta, and the resulting ecological effect, harm and contamination that is related with it have affected the lifestyle, economies, and social well-being of the nearby occupants who procure a salary by method of fishing or rural cultivating. The flaring techniques of processing gaseous petroleum products has contaminated the yields from their harvestand as well affected the health and prosperity of the masses that live in the district [3]. From research investigation reports, raw petroleum accompanies a cost to be paid, and that cost is the extreme and unfavorable impacts on the earth, which is seen as a source towards encouraging environmental change which inside the previous decade collected a great deal of consideration [7].

Theextraction and processing of crude oil in this region is usually accompanied with flaring of natural gas and thishas done more harm than good to the populace of this region. For instance, the occurrence of the flaring of natural gas is one of the many factors that did not only contribute to the degradation of the surrounding environment but also increase pollutants contaminating the air of the Niger Delta region. As reported byJoyce Msuya, there has been continuous increase in the emission of carbon (IV) oxide since 2017, meaning it affects the gap to bridge global warming below 2^{o}C [8]. Despite the effort put together to minimize the impact of gas flaring by World Bank together with crude oil producing countries, oil companies and some development institutions to discuss ways to either conserve the gas, or create a market to sell it or use it for other environmental friendly productions [9], gas flaring remain a common occurrence in the Niger Delta of Nigeria. Thus, petroleum industry in this area has actually go under assault from a physical perspective from nearby inhabitants who guarantee that their condition is contaminated coming about because of impact of gas flaring. In certain examples, the oil business has occupied with confined battle fighting against neighborhood inhabitants with the taking of prisoners to additionally underline their cases for pay [10]. Accordingly, an orderly arrangement must be formulated with a system that guarantees that the earth of Niger Delta is appropriately secured to forestall misfortunes of salary and occupation because of gas flaring than exposing them to unlawful brutal strategies by the oil partnerships. A possible solution towards achieving eco-friendly working environment in the region will be a welcome development instead of continuous flaring of byproducts of crude oil[11].

1.1. Understanding the Concept of Gas Flaring

Niger Delta has recorded various environmental implications from all stages of exploration and production which include, emission of harmful chemicals (carbon and other harmful gaseous substances) into the atmosphere during gas flaring resulting to pollution. Both the onshore and offshore wells lead the way toward flaring of flammable gas [12] in the area, expectation of encouraging the decrease of weight in the well and saw by some as a wellbeing precautionary measure, however in many occasions are directed as a methods for arranging abundance gaseous petrol, as appeared in Fig. 1.

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Fig. 1 Gas Flaring in a site in Niger Delta (Farmlands in Rumuekpe, Rivers State), Nigeria

In the Niger Delta region of Nigeria, incessant gas flaring is a normaloccurrence. The process of flaring gases occurs in all oil exploration locations in this region, meaning that it takes place in across the nine states of the Niger Delta. The process can be simplyrefers to the combustion of gas in an open flame that burns unceasingly at the top of flare stacks in oil production sites unlike gas venting that is simply the discharge of unburned gases into the atmosphere which leads to the liberation of hazardous chemicals and gaseous components such as sulphur oxides, nitrogen oxides, carbon disulfide, carbonyl sulfide, carbon dioxide and volatile organic components into the atmosphere. The rate at which gas is flared in Nigeria is higher than anywhere in the world [30]. The incessant gas flaring in this region is a major environmental challenge of to the populace in this area. The petroleum gas produced in Nigeria until around two decades back was ordinarily flared and this was due to the fact that crude oil was the mainstream of hydrocarbon interest. As a result of this habit, Nigeria is rated among the top ten gasflaring countries in the world. More so, natural gas had not really been regarded as reserves until recent after Nigeria join the Zero Gas Flaring Project (GFP) of the World Bank [13]. As reported by World Bank (2005), about 75% of the gas Nigeria produces is flared because of the absence of a nearby market and foundation.

As bad it might be, some of the flares run for about 24 hours daily, with some which some exiting site have run over the past 30 years. The quantity of carbon released per day is about 2,525,000 tons as estimated by [14]. Gas flares has several negative effects just like oil spillage and it affects every part of the ecosystem,producing gases that limit the ozone layers, thus global warming to the microorganisms in the soil, thus poor crops yield. From the study conducted at Izombe flare site, farmlands close by the site have recorded loss of productivity in plants such as cotton and oil palm [15]. In an area such as Ijaw, gas flaring started as early as 1970 with 7957mm^3 and eventually increased to 2,5934 mm^3 in 1994 [16]. As shown in Fig. 2 is the bar chart representing the statistics for fifteen years from 2001 to 2016, the volume of gas flared by the accredited oil companies without the flares from the unauthorized producers or refineries is represented.

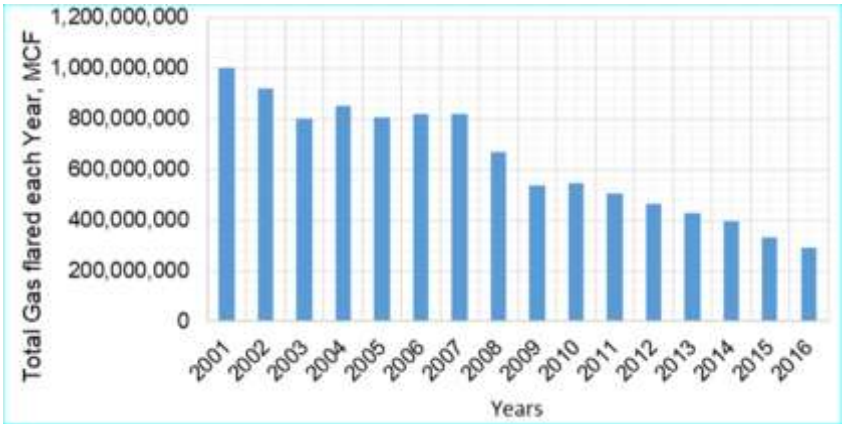

Fig. 2 Gas Flared in Niger Delta from 2001 to 2016 [17]

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II. GAS FLARING IN NIGER DELTA, NIGERIA

As reported and presented by UNDP/World Bank [32], it is on record thatan estimated 75% of complete process gas in Nigeria is flared. Also, around 95% of the "related gas" which is delivered as a side-effect of raw petroleum extraction from repositories in which oil and gas are blended [33]. Besides, as shown by Cedigaz, an estimated distributer in the gas business represent a volume up to 17.2% in Nigeria (Fig. 3) of the total flaring in 2001 alone and this is more than the second place country (Iran) and third (Indonesia) countries joined respectively [31]. Around half of the gas flared in Nigeria is by SPDC and this is in accordance with creation of several crude oil byproducts. The incessant gas flaring in Nigeria has contributed a quantifiable level of the world's complete emanations of ozone depleting substances. Also, as a result of the low effectiveness of huge numbers of these flares, a great part of the gas is liberated as methane which has a high global warming potential instead of carbon dioxide. Simultaneously, the low-lying Niger Delta is helpless and defenseless against this menace which as expected impacts on the ocean levels, thus continuous rising in the ocean leading flood yearly across the region.

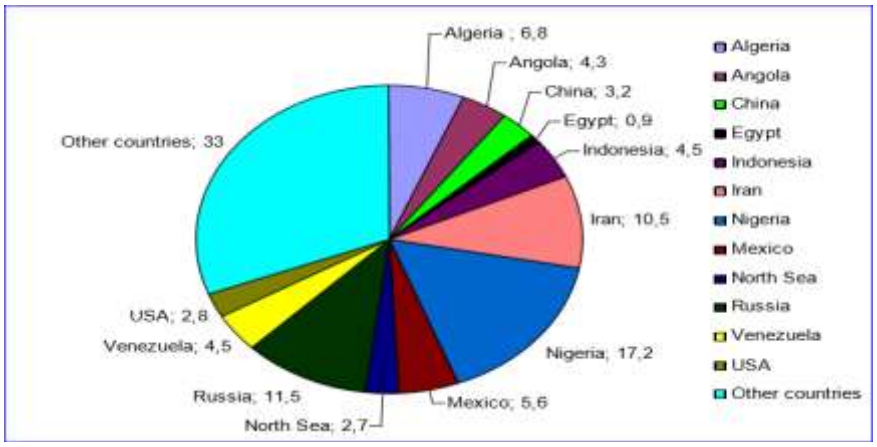

Fig. 3 Percentage of Flared Gas among Crude Oil Producing Nations

2.1Effect of Gas Flaring

Internationally, Nigeria is ranked the sixth country to flare gas. Of recent, the natural gas has been exploited as hydrocarbon reserves; all the gas after the discovery of oil in the 1900s was flared. This, in the long run, has affected the local settlers and the region in general. Besides, gas flaring has been the highest source of air pollution in the region understudy and the uncontrolled gas flaring is gradually destroying the ecosystem of the Niger Delta. Gas flaring goes on for twenty-four hours and some have gone on for as long as thirty years and in the process hydrogen sulphide is released into the atmosphere. Of no doubt, the oil companies operating in the region are not only destroying Niger Delta environmentally but also immensely contributing to global warming [18]. Also, the chemicals released aid in acid rain formation which corrodes the roofing sheets, causing skin diseases and among others [13]. From the findings of the research work of [19], gas flaring produces a raised degrees of lead at convergences of 0.56 mg/l in the climate and they are of the conclusion that huge grouping of oxides of nitrogen and sulfur from gas flares in the Niger Delta delivered into nature adds to corrosive downpour encounters in the district. The quantity of carbon released per day is about 2,525,000 tons as reported by Ubani andOnyejekwe [14]. These flares have affected vegetation, farming, fishing and the entire community in general. Ubani and Onyejekwe [14] noted that there has been massive destruction of aquatic life in communities due to acid rain. Also, no vegetation can have proper growth in an area close to flare sites. The leaves of cassava, waterleaf, and pepper near flare sites have decreased in dimension and the nutrients such as starch and ascorbic acid in the cassava in flare sites are less as compared to those located farther away from flare sites [20].

From the research work carried out at the Izombe flaring site shows that there is a 100% loss in crop yield within 200 meters of the station. Crops such as cotton and oil palm among other economic plants wither away at any instance where they are located close to flares [17]. This hasbrought about high socio-economic cost on the people in terms of repairing their corroded zinc

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roofing sheet, treating of sicknesses (breathing difficulties and pain, asthma, headaches, nausea, chronic bronchitis), buying of fertilizers, resettlement, and farming, thus, an eventually increase in unemployment and poverty in the region [21]. Regrettably, these effects will linger for a long time if not forever because the existing law only charges companies monies for continuous flaring but do not ban gas flaring [22].According to Orubu[16], the concentrations ofpollutant are most noteworthy in the Niger Delta in the wake of undertaking a correlation of centralizations of surrounding air toxins in the Niger Delta area and Lagos State. He contended that the radiated ozone harming substances, (for example, methane and carbon dioxide) at flare locales add to a dangerous atmospheric devation. Sufficiently tragic, most elevated quantities of the flare destinations are situated in the Niger Delta where the warmth temperature from the erupt locales could be as high as 1600 ^{o}C contributing to thermal pollution. Adewale and Mustapha [8], on the other hand confirmed that gas flaring has caused sicknesses, a damaged and unsustainable environment, toxic waterways, loss in productivity of fishing and farming activities from the findings of their research work on gas flaring atAkwaIbom, Rivers and Bayelsa states.

2.2Air Pollution and Related Health Effects

Air pollution by gas flaring operations contributes to some health implications. An expected 2,000,000 individuals live inside 4 km of a gas flare in this region that is richly in crude oil and located. The blend of harmful substances which has been produced in the process of flaring gas in this region for over 40 years that includes benzene and particulates, has uncovered the people of Niger Delta putting them in grievous dangers, causing harms to their property especially farm, and at the same time disregarding their common liberties. The flares did not only influence their work but at the same time open them to an expanded danger of unexpected losses, corrosive downpour, and health related issues such as kid respiratory diseases, asthma and malignancy. This introduction as delineated in Fig. 4 dismisses Nigerian established arrangement of the key rights to life as well as human balance. At the same time, it also dismisses the rights guaranteed in the African Charter on Human and Peoples' Rights. For example, it is expected of every individual to value the best doable state of physical and mental prosperity and surprisingly gatherings to a general pleasant condition useful for their new development. As shown by World Bank information (WBF), gas flaring from just one bit of the Niger Delta using Bayelsa State as a case study would in all likelihood cause yearly 49 misfortunes, 4,960 respiratory disorders among children and 120, asthma ambushes [28]. Besides,some chemicals released during gas flaring either by themselves or combined with other components of the environment affect the health of the people. Sulfur dioxide causes a variety of health problems among children, elderly and others already suffering from heart or lung diseases such as asthma. These diseases include lung cancer, allergic rhinitis, cardiac and respiratory diseases [23]. The whole air sample taken during the Ogoniland assessment by UNEP in 2011 contained a concentration of benzene within the range of0.155 and 48.5 µg/m^3. Around 10% of the total samples had benzene concentration higher than that of the equivalent quantity report by World Health Organization (WHO) and the United States Environmental Protection Agency (USEPA) of 1:10,000 cancer risk. Health implication by exposure to benzene includes disorders of the central nervous system, Leukaemia, aplastic anemia [24].

Fig. 4 Environmental Pollution Resulting fromAgip Gas Flares at Ebocha, Niger Delta [34]

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Besides, some sicknesses among others relatedthat has to do with the release of benzene into the environment by gas flaring have also been recorded by research conducted by [25-27].Their reports have confirmed their existence in the region in relation to benzene in the particular community where the research was conducted. As reported by World Bank on the health impact of gas flaring suggests that Bayelsa State alone is likely to record 4960 respiratory illness among children, 49 premature death cases, and 120 asthma attacks annually [28]. Besides, some other sicknesses of higher frequency are as follow; asthma, cough, breathing difficulty, eye/skin irritation, in the study area with a history of long exposure to gas flaring [29]. Similarly, diseases were sooth and the flare contain benzene, mercury, and chromium which lower the immunity of the inhabitants especially children, making them more liable to diseases like polio and measles [28]. Also, natural gas flaring in this region of Nigeria adds around 1% to the overall carbon monoxide which presents broad issues for nature [28], and is seen as a major pathway to issues related with nonattendance of buyer products, social and ethnic observations towards flaring as waste open door for financial advantage [28].

2.3 Consequencesof Gas Flaring to Niger Delta Communities

The consequenceof the impact gas flaring for Niger Delta people group varies starting with one area then onto the next, contingent upon:

i. The number of Local Government Areas/Communities really creating unrefined petroleum.
ii. The time allotment the zone has been engaged with oil/gas exercises.
iii. The accurate area or landscape of the oil and gas exercises in the state or Local Government Area whether it is on shore or seaward or both.
iv. The degree to which the network has other regulatory or social frameworks gave and oversaw by oil/gas organizations.

2.4 Economics Evaluation of Gas Flaring in the Niger Delta Region of Nigeria

From the review of research work on the economic assessment of gas flaring in Niger Delta regionof Nigeria indicated that an annually money related misfortune to Nigeria from gas flared in the district has been peg at an expected estimation of US $2.5 billion. Consequently, gas flaring leads to a huge financial misfortune and losses (lost open door esteem assessed at some US$2.5 billion, in light of LNG values [35]. Besides, apart from the deplorable state of the region, around 66% of the people that live in this region live on short of what US $1 every day as assessed by the World Bank. According to World Bank report based on country briefing [36], the GNP per capita, at about US$320, is underneath the level at opportunity forty years earlier and underneath the US$370 that it got in 1985. Also, an estimated 66% of the people falls underneath the poverty line of around one U.S. dollar day by day, appeared differently in relation to 43% in 1985.

Effort to Curb Gas Flaring in Niger Delta Region of Nigeria

As far as in 1969, Nigerian legislation mandated oil companies operating in the region set up facilities to efficiently make use of produced gas instead of the incessant flaring. Likewise, in the year 1979, further enactment was introduced and a period cutoff of April 1980 for organizations to create gas usage undertakings or face fines was set. By the by, without such gas usage extends set up; the administration couldn't solidly uphold this enactment. With the oil enterprises nonstop entryway, exclusions to this standard were endorsed in 1985, by a revision and guidelines, which permitted flaring in specific cases; yet regardless, the expenses to the working organizations of stopping flaring far exceeded the fines forced. SPDC in the year 1996 gave itself to the disposal of gas flaring at its offices by 2008 [37]. Also, in October 1996, she reported that it had granted a U.S.$500 million agreement for another gas preparing plant at Soku, Rivers State, which would gracefully the LNG plant at Bonny with a blend of related and non-related gas. More so, along with two different gas offices, at Odidi and Alscon, SPDC expects to gather 380 million standard cubic feet for each day (scf/d) of related gas, more than 33% of the volume of gas presently flared by the organization, before the century's end. Also to curb the effect of gas flaring in the region, another oil company operating in the area, Chevron's Escravos gas venture, set up a primary period of which started trading in September 1997 and it was expected to lessen flaring by 40% from its production facilities. Moreover, another oil firm Mobil's that operate in the Bonny area of Niger Delta region which went ahead stream in July 1998 delivering 50,000 bpd of LNG, and also gathers related gas and it was expected to lessen flaring from its Oso field. Additionally, with the advancement of the West African Gas Pipeline (WAGP) from Lagos, Nigeria, most of the gas generated during oil exploration, extraction, and processing were tapped, channeled and transported

to West African countries through constructed gas pipeline among the West Africa State. These undertakings were depended upon to help to curb gas flaring in the Niger Delta region of Nigeria.

III. CONCLUSION

This research work has shown that some activities arising from crude oil exploration in the Niger Delta region of Nigeria has caused immense environmental damage to the region. These environmental challenges are large due to gas flaring. The extent to which the environmental pollution has degraded the environment includes pollution of air by flares and other chemicals. Some chemicals released during gas flaring either by themselves or combined with other components of the environment affect the health of the people. Sulfur dioxide causes a variety of health problems among children, elderly and others already suffering from heart or lung diseases such as asthma. These diseases include lung cancer, allergic rhinitis, cardiac and respiratory diseases.

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