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Environmental Degradation Associated With Crude Oil Related Activities In The Niger Delta.

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ABSTRACT
The Niger Delta region of Nigeria has, for decades, faced unprecedented environmental challenges due to the combined effects of oil spill and gas flaring resulting in biodiversity loss. As put by (Ogwu, et al, 2015),due to petroleum pollution, the area is now characterized by contaminated streams and rivers, forest destruction and biodiversity loss, and in general the area is an ecological waste land. Following the incessant oil spill and uncontrollable gas flaring, the paper sought to establish the fact that re-engineering the existing management approach by adopting better implementation strategy and ensuring strict compliance to extant environmental laws and regulations will to a large extent address the teething environmental problems being faced in that region. The paper adopted the descriptive research method, sourcing data from Department of Petroleum Resources (DPR), Shell (SPDC), and Fourth National Biodiversity Report (2010) on biodiversity conservation and legislations. It was discovered that sabotage is the chief cause of spill, followed by equipment failure, while for gas flaring, within a period of seven years (2001-2007), the average gas utilization was 58.37% and the average flared was 41.63% (almost 50%).This was seen, both as a colossal economic waste in the face of excruciating scarcity and a devastating blow on the environment-a double tragedy. The paper, therefore, recommends, among other relevant approaches, a re-engineering of the current management strategiesto nip the problem at the bud.

I.   INTRODUCTION
Of immense concern, in recent years, is the un-abated increase in environmental degradation and deterioration in the oil-producing Niger Delta region, due to oil spill, gas flaring and other oil-related externalities.The combination of effects of oil spill and acid rain resulting from gas flaring has been soil degradation which affects crop yield and harvest, Ogwu, Badamasuiy, and Joseph (2015). Nigeria is a country with diverse economic activities which invariably leave traces of negative environmental impacts, but one that is of utmost concern, and has impacted most on the environment is oil exploration and exploitation. Since this resource was discovered and exploitation commenced, it has been a fierce battle between the major players in this industry, on one hand, the environment and the host communities who bear the brunt of these activities on the other hand. When crude oil spills into the environment, it comes in large quantities involving several thousands of barrels of oil and the incident could last for weeks leaving the environment in a state of decay for years, even after clean-up efforts which never returned the environment to its original state.

The Niger Delta,of which about 30% is wetland, consists of diverse ecosystems, predominantly the mangrove, fresh waterswamps, and the rain forest. It is Africa's largest wetland and among the ten most important wetlands and marine ecosystems in the world, but due to petroleum pollution, the area is now characterized by contaminated streams and rivers, forest destruction and biodiversity loss, and in general the area is an ecological waste land (Ogwu, *et al*, 2015). The poisoning of the waters, destruction of vegetation/agricultural plants as well as pollution of the air through oil spills and gas flaring, respectively, which occur during petroleum operations, make life very unbearable for the inhabitants of this area.

The most striking thing is that for more than the 30 years of operations in the region, there has been little or no effective means of at least controllingthe associated environmental devastation. Because of the frequency, the magnitude of crude oil spilled and the nature of the terrain, the task of

cleaning-up the effects of environmental pollution due to spill in this area is quite huge. Over a 20-year period, spanning 1976 and 1996, an average of 300 cases of oil spill per year were recorded in the Nigeria's oil region and on the average, some 370,000 barrels of crude spilled into the environment each year, out of which only about 40% was recovered (Nigeria2Day@aol.com, 2002).

However, the problem may not lie wholly on the quantity of gas flared and frequency of oil spill, but also, the management, which spans from the prevention of, and response to the discharge, are key to controlling the menace. This paper, therefore, aims at investigating the causes and the consequences of these two phenomena with a view to exploring better management procedures and approach for effective control to reduce the impacts.

II.　STATEMENT OF THE PROBLEM

According to Ajugwo (2013), Nigeria flares 17.2 billion m^3 of natural gas per year and the persistent gas flaring has approximately equaled one quarter of the current power consumption of the African continent. It is surprising to note that although oil activities have greatly and positively impacted on the country's industrial and economic sectors, a mere passing attention is given to the enormous environmental, health and social problems resulting from these activities. As succinctly put byOgwu, *et al* (2015), the unsustainable exploration activities have rendered the Niger Delta region one of the five most severely petroleum damaged ecosystems in the world.

The environment has been so devastated that the people can no longer continue to engage in their usual life-sustaining activities of farming and fishing as both the land and the water bodies have been grossly contaminated with spilled oil and other acidic contaminants emanating from gas flaring. The area is now characterized by contaminated streams and rivers, forest destruction and biodiversity loss, Ogwu *et al* (2015). Despite the above teething problems, there is still dearth of concerted efforts to stem the progressive degradation which started soon after the commencement of oil extraction in the region many decades ago. It is against this backdrop that, as a matter of urgency, serious attention should be given to the activities of all the oil companies operating within that region to ensure that the processes involved, from exploration, production to distribution of the products are done in the most environmentally friendly and sustainable manner through effective legislation and enforcement machinery, in conformity with international best practices.

Objectives of the Study

In view of the aforementioned problems, this paper, therefore, sought to vigorously pursue the following objectives in order to address the stated problems:
1. To examine the effects of oil spillage on the ecosystem of the Niger Delta area.
2. To examine the effects of gas flaring on the bio-physical environment of Niger Delta area.
3. To establish the strategy for mitigating these effects.

III.　MATERIALS AND METHODS

This study adopted the Descriptive Research Method which is geared towards assessing the situation on ground to understand clearly the subject matter, hence the use of secondary data in form of published materials in journals and reports from relevant bodies such as Department for Petroleum Resources (DPR), Shell Petroleum Development Corporation (SPDC) report on oil spill and gas flaring incidents and remediation efforts, and Fourth National Biodiversity Report (2010), on biodiversity conservation and legislations.

Sources and Causes of Oil Spill in Nigeria

According to Anderson and Labelle, (2000), oil spills may occur for numerous reasons such as equipment failure, disasters, deliberate acts or human error. Iloeje and Aniago (2016) opined that oil spill phenomenon is not without obvious causes which include but not limited to: dilapidated oil infrastructure, operational errors, sabotage, oil bunkering and willful damage of oil infrastructure by competing groups of rebels and agitators, faulty well heads, accidental discharge and transportation problems. According to Nwilo and Badejo (2001), 50% of oil spill occur due to pipeline and tankers accidents sabotage, 28%, oil production operation 21% with 1% of the spills being accounted for by inadequate or non-functional production equipment. Bronwen (2007), opined that one of the reasons whycorrosion accounts for high percentage of all spills is that as a result of the small size of the oil fields in the Niger Delta, there is an extensive network of pipelines between the fields, as well as numerous small networks of flow lines – the narrow diameter pipes that carry oil from well heads to flow stations-allowing many opportunities for leaks. In onshore areas most pipelines and flow lines are laid above ground and many of the pipelines which have estimated lifespan of about fifteen years are old and susceptible to corrosion as they have been there for more than twenty to twenty five years, he further opined.From Table 1,according to DPR Oil and Gas Industry Report (2015),a total of 32,756.8681 BBLs of crude oil spilled in 753 incidents in 2015 alone, and the causes distributed as shown with the highest coming under sabotage while natural accidents recorded the lowest.

Table 1. 2015 Spill Incidence Report

Summary of Spill Incidents								Total number of spills	Volume spilled(BBLs)
Month	Natural Accident[1]	Corrosion[2]	Equipment Failure[3]	Sabotage[4]	Human Error[5]	YTBDidents recorder[6]	Mystery[6]		
January	1	3	12	31	1	6	2	58	324.5624
February	0	5	10	39	1	8	0	63	515.4247
March	0	4	8	41	0	6	4	63	191.6814
April	1	5	20	35	0	18	3	82	139.0537
May	0	2	9	51	1	18	1	82	332.467
June	3	2	12	61	3	12	1	94	19445.92
July	0	2	7	32	1	7	5	54	3256.276
August	0	2	3	16	0	14	3	38	1338.548
September	0	3	8	33	0	1	3	48	598.1353
October	2	4	10	34	0	4	2	56	130.6736
November	2	3	2	58	4	5	2	76	1013.325
December	1	2	4	24	0	9	1	41	5451.201
Total	10	37	105	455	11	102	27	753	32756.8681

Source: DPR, 2015 Oil and Gas Industry Annual Report
1.   *Spills caused by natural disasters/events such as flooding, extreme weather conditions etc.*
2.   *Spills caused by corrosion of pipelines, vessels, tanks and other crude oil handling installations.*

3. *Spills caused by preventable failure of oil and gas installations/equipment.*
4. *Spills caused by third party intervention. This also includes cases of vandalism and crude oil theft that may not have resulted by hydrocarbon release to the environment.*
5. *Spills caused by operational errors involving a human interface.*
6. *This means "Yet-to-be-determined". The cause(s) of the spill(s) were not reported in the submitted oil spill reporting forms. Usually indicative that the form B was not submitted, or the joint investigation visit (JIV) was either not carried out or was inconclusive. Often, the quantity spilled for this category of spill may also not have been reported.*
7. *Spills identified or reported by operators who assert that the spill did not originate from their facilities. The origin of the spill is thus said to be inconclusive. Usually the operators are expected to take reasonable steps to respond to the spill in addition to the reporting of same.*

Table 2 summarizes the number of spills and quantity spilled from 2010 to 2015. The highest number of incidents occurred in 2014 with a total of 1087 recorded cases while 2013 recorded the least with 522 cases. The greatest volume was spilled in 2015 asearlier pointed out.

Table 2. 2015 Oil and Gas Industry Annual Report

Year	Number of Spills	Quantity Spilled (barrels)
2010	537	17,658.10
2011	673	66,906.84
2012	844	17,526.37
2013	522	4,066.20
2014	1087	10,302.16
2015	753	32,756.8681

Source: DPR, 2015 Oil and Gas Industry Annual Report

The problem is therefore fundamental. As a result of poverty, most youths engage in oil bunkering/oil theft by siphoning oil from these aged pipes. Sabotage and theft through siphoning have become a major issue in Niger Delta states as well, contributing to further environmental degradation, Anderson (2005). The business in now flourishing in spite of the security measures put in place which, of course, may not match the ingenuity of these desperate youths.Spills can equally occur through natural seepage from the ground and seabed due to fractures of the rocks-bearing crude. Clark, Washburn, Hornafius and Luyendyk (2000), stated that seeps may emanate from a single point or as many as 3x104 individual seepage signals may be merged onto a high resolution profile record. Such records are uncommon in the Nigeria Niger Delta region.

Effects of Oil Activities in the Niger Delta Ecosystem
1. Crude Oil Spill:
The impacts of oil spills are not limited to the direct effect on the ecosystem; it goes a long way to affect the social welfare, aggravates poverty, population displacement, social conflict, production reduction and also affects the profit margin of the companies involved, David and Joel (2013). Virtually all aspects of oil and gas exploration and exploitation have deleterious effects on the ecosystem and local biodiversity, Ogwu, *et al*(2015). Eze (2002) described environmental hazard as a situation that occurs when the ecological equilibrium in a place is disturbed by either natural forces or human activities.

Land degradation is a key environmental challenge to sustainable development. The ecosystem, into which the oil is released, suffers a great deal. The mangrove forest, brackish swamp,rainforest ecosystem are extensively and significantly depleted in event of spill. The mangrove isone of the most productive ecosystems with rich flora and fauna and is highly sensitive to crude oil and easily gets destroyed by it as the oil acidifies the soils and prevents the supply of oxygen to the roots thus disrupting the respiratory activities in the cells. When the mangrove dies, other organisms that depend on it are equally adversely

affected by the disappearance and nutrient cycling is impeded. Very hostile and unfavorable environmental conditions are thus created for the millions of ecosystem inhabitants.

When the spilled oil flows into water bodies, the fish populations as well as other aquatic animals are depleted. This adversely affects the fishing industry, creating artificial scarcity with the attendant hike in prices of fish. The major economic activity of the Niger Delta people, which is fishing is thus suspended due to spill, poverty sets in and the people begin to scamper for other sources of livelihood, both legitimate and illegitimate, as it were.The oil film on the water surface prevents oxygen from dissolving in the water thus starving the aquatic animals of the oxygen required for growth and sustenance. The general toxicity of the aquatic environment is abnormally increased causing high mortality of the flora and fauna with its associated impacts.

2. Gas Flaring:

Gas flaring, which is the burning of natural gas from crude oil is as a result of lack of investment opportunities to create the requisite infrastructure that will effectively utilize the natural gas. This gas is channeled through an elevated chimney and burnt off at its tip as a waste product, whereas it could have been stored and put to effective use in other areas of the economic production chain.It is one of the most lethal enemies of the Niger Delta environment. This phenomenon is going on, on a continuous basis even as at the time of this study. From tables 3 and 4, it is clearly evident that the quantity of gas flared is very substantial. The 2015 DPR Oil and Gas Annual Report, showed that a total of 330,933 MMSCF of gas was flared, representing 11.02 %, while 2,672,247 was utilized which represents 88.08%. In the 2001 report, 51.49% of gas was flared while only 48.51% was utilized and in 2002 the figures rose to 52.59% and 47.41% flared and utilized, respectively, as shown in table 4. Figure 1 shows the graphical representation from 2001 to 2015.

Table 3. Gas Production and Utilization

[[	Gas Production			Fuel Gas	Gas lift	Re-injection	(NGL/ LPG)	Sales			Total Gas Utilized	%Utilized	Total Gas Flared	% Flared
	AG	NAG	total					Gas to NIPP	Local (others)	NLNG (export)				
Jan	158,649	102,013	260,663	12,655	6,474	63,261	7,816	4,242	30,556	105,077	230,082	88.27	30,581	11.73
Feb	143,227	78,115	221,342	11,726	7,291	52,581	6,017	4,524	26,392	80,216	188,765	85.28	32,577	14.72
Mar	151,758	90,451	242,209	12,153	7,503	53,037	5,780	4,672	33,043	92,763	208,950	86.27	33,259	13.73
Apr	142,177	99,379	241,556	13,383	7,579	58,77	7,035	4,716	28,162	92,255	214,842	88.94	26,714	11.06
May	147,63	111,01	258,65	13,855	8,261	66,551	7,087	4,429	27,577	105,961	233,721	90.36	24,929	9.64

	2	9	0										
Jun	139,405	105,074	244,479	12,594	6,728	63,070	7,642	4,495	32,469	94,090	221,089	90.43	23,390	9.57
Jul	149,081	119,276	268,358	13.038	6,908	69,287	7,266	4,579	39,377	102,142	242,598	90.40	25,760	9.60
Aug	143,941	109,568	253,509	12,739	6,680	64,304	7,493	2,119	39,286	94,049	226,669	89.41	26,840	10.59
Sept	140,366	117,124	257,490	12,569	7,050	62,777	6,607	3,577	35,188	102,133	229,881	89.28	27,609	10.72
Oct	145,064	113,484	258,548	13,345	7,302	61,951	8,525	4,343	32,589	102,574	230,629	89.20	27,919	10.80
Nov	137,457	114,675	252,135	12,240	6,285	63,739	6,924	3,141	36,184	100,769	229,280	90.94	22,852	9.06
Dec	141,793	102,451	244,244	12,502	6,395	63,698	7,720	2,229	37,309	85,826	215,741	88.33	28,503	11.67
Total	1,740,550.	1,262,629	3,003,179	152,799	84,396	743,029	85,912.	47,128	398,132	1,157,835	2,672,247	88.96	330,933	11.02

All Volumes are in MMSCF/D
Source: DPR, 2015 Oil and Gas Industry Annual Report

Table. 4 Summary of Production and Utilization

	Gas Production			Fuel Gas	Gas Lift	Re-Injection	(NGL/LPG)	sales		Total Gas Utilized	% Utilized	Total Gas flared	% Flared
	AG	NAG	total					Domestic sales	NLNF (Export)				
2001	1,551,912	391,683,7	1,943,595	80,269,28	26,142,438	336,523,317	52,033,317	141,067,615	306,812,223	942,847,891	48.51	1,000,748,082	51.49

	,250	23	,973	7									
2002	1,340,591,744	410,542,712	1,751,134,456	75,008,164	28,948,137	306,475,680	27,435,764	111,435,703	280,903,198	830,206,646	47.41	920,927,810	52.59
2003	1,387,104,460	516,223,961	1,903,328,421	71,590,002	28,973,434	272,481,721	36,648,692	214,182,219	477,983,042	1,101,859,110	57.89	801,469,311	42.11
2004	1,584,922,039	525,256,005	2,110,178,044	83,627,321	26,611,460	398,179,304	43,181,065	262,897,801	444,033,291	1,258,530,242	59.64	851,647,802	40.36
2005	1,626,444,779	508,893,962	2,135,338,741	88,786,060	43,781,302	402,390,225	57,345,709	234,780,140	502,737,873	1,329,821,309	62.28	805,517,432	37.72
2006	1,542,136,671	747,754,914	2,289,891,585	89,025,509	59,662,180	391,968,180	44,295,798	326,264,627	558,256,752	1,469,463,046	64.17	820,428,539	35.83
2007	1,599,190,078	1,007,675,245	2,606,865,323	99,705,731	49,204,125	485,642,132	31,751,276	279,970,609	843,948,502	1,790,222,375	68.67	816,642,948	31.33

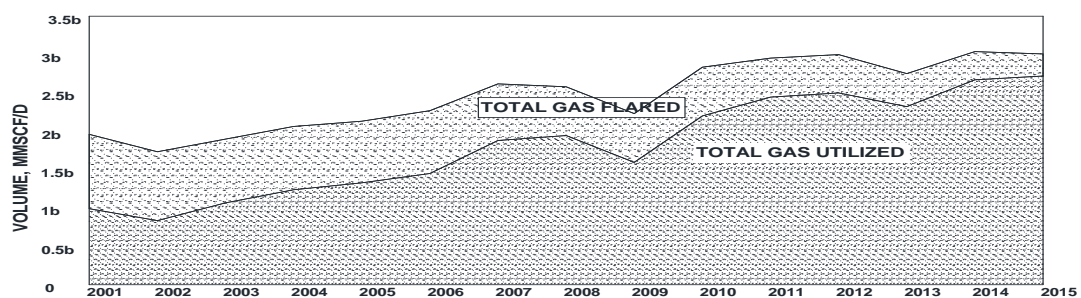**Source:** DPR, 2015 Oil and Gas Industry Annual Report

Figure 1: Gas Utilized versus Gas Flared

Source: DPR, 2015 Oil and Gas Industry Annual Report

The wide–spread effects of gas flaring is conspicuously evident in this region. Contamination of both the ground and surface water with poisonous gases such as benzene and toluene, deforestation, and other economic losses, stem from the effects of uncontrolled and uncontrollable flaring of gases. Oyinlola (1995) in his study revealed that there was about 100% loss in yield in all crops cultivated about 200 meters away from the Izombeflare station, 45% loss of those about 600 meters away and about 10% loss for crop about one kilometer away from the flare. The resultant poor crop yield has socio-economic as well as health implications on the people, malnutrition and vulnerability to sickness due to immune deficiency.Gas flaring in oil rigs and wells contribute significantly to greenhouse gases in our atmosphere, Ayoola (2011). This arrogant waste of resources not only account for huge economic loss but also severe environmental degradation. The oil companies found out that it makes more economic sense to them to burn-off the gas and pay the paltry fine than to re-inject it back into the wells; especially when there is no ready market for the product. The primary considerations, therefore, are economic and political benefits and not the environmental or health implications.

These are some externalities that ought to have been adequately internalized through appropriate measures and legislations. Billions of dollars which otherwise could have been re-injected into the economy are therefore lost in the process and as stated by Effiong and Etowa (2012), Nigeria has recorded huge revenue loss due to gas flaring and oil spillage, andaccording to Ajugwo, (2013), an estimated of 2.5 billion is lost annually through gas flaring.

On a global perspective, gas flaring is a significant contributor to climate change and global warming. The greenhouse gases created through gas flaring, and the burning of fossil fuel, put the world in a significantly and sustained high temperatures. The major greenhouse gases, carbon dioxide and methane are fingered to be responsible for a substantial percentage of global warming which is particularly a bad sign for non-resilient countries like Nigeria with little or no capacity to mitigate or even adapt to the situation.

Buildings within and around the immediate vicinity of flaring site suffer extensive leakages as the corrugated roofing sheets are adversely affected by acid rains primarily caused by Sulphur dioxide (SO_2) and Nitrogen oxide (NO) emissions which when in contact with atmospheric moisture form sulfuric acid and nitric acid respectively.These attack the sheets, creating perforations over time and subsequently leakages. It also distorts the aesthetic quality of the buildings so affected as it initiates the gradual decay of building materials thereby reducing the overall environmental beauty and increase maintenance cost. The same acids produced have damaging effects on plants and crops, thus drastically reducing yield and creating food shortage.

The atmosphere gets contaminated with these oxides of nitrogen, Sulphur and in fact carbon which when in contact with the soil, acidify the soil, affecting the pH value and greatly reducing the soil nutrients and, according to Imevbore and Adeyemi (1981), the nutritional value of crops within the vicinity of the flare.Gas flaring, generally, has the dual effects of both economic waste of resources which otherwise could have been put to effective use, and environmental damages, pollution, degradation and deterioration.

Management Strategy

Some efforts have been made in the past, in the case of oil spill, to clean-up the environment in event of spill. Bio-remediation has been found to be fairly successful in this area. It involves the use of biological methods to degrade the oil. Some plants have been found very effective. For instance an indigenous specie of herbaceous plant- the *Hibiscus Cannabinus,* has high rate of absorbency and can absorb oil on water when laid on top of it. The soil can also be detoxified by planting *Vetiveria Zizanioides*grass which has deep fibrous root network that can detoxify the soil.

The use of biological method for clean-up exercise has proved fairly effective because it encourages community participation. The members of the community who participate in the exercise see it as an economic opportunity to better their lives. They are, therefore, positively engaged and this calms them down, thus reducing tension, restiveness and frustration in the area. Other than the use of plants, some microbes have been found to have the capacity to break down large quantities of hydrocarbons.

However, these methods much as they are effective, the task is too enormous and so overwhelmingthat the overall effect is not very significant. The environmental effect of spill is time dependent and also a function of the nature of the hydrocarbon, volume of spills, nature of the receiving body and temperature. The sustainability of the method is also dicey as it depends on the cooperation of the people for better results. Also, the immediate impact of spill or flare is weighty and substantial damage may have been done. Clean-up exercise is just like treating the symptoms and not the cause.It, therefore, becomes necessary to put up aggressive security measures by the combined team of the oil operators, governments and youths from the community for appropriate surveillance of all oil installations to avoid spills. Also well-articulated programs should be mounted to meaningfully engage these teaming youths who engage in these oil thefts and sabotage for want of gainful activity. These measures, if put in place, will significantly reduce spills due to the above factors.

On the legal angle, Nigeria, being one of signatories to the convention on Biological Diversity, resulting from its participation in the United Nations Conference on Environment and Development (UNCED), is bound by the provision of that treaty.Sequel to that, environmental protection was made vital provision in the constitution of the Federal Republic of Nigeria, where in contains the country's environmental objectives.Pursuant to this, a number legislations and agencies were put in place such as the Environmental Impact Assessment Act, National Oil Spill and Detection Agency, National Environmental Standard and Regulations and Enforcement Agency and others which are presented in Table 5.

Table 5:Environmental Related National Legislations

Environmental Related National Legislations
Enacted by Nigeria
S/NEnvironmental Acts/Legislations
1Exclusive Economic Zone Act of 1978
2The Forestry ordinance 1937
3Wild Animal Preservation Laws of 2926

4Oil in Navigable Waters Act of 1968
5FEPA Act 1988, 59 of 1992
6FEPA Act of 1992
7EIA Act 86 of 1992
8National Parks Act 1979, 1991 and 1999.
9 Sea Fishing Act 1971 and listing regulation of 1972
10   The Endangered Species (Control of International Traffic) Act of 1983
11   NESRA Act 2006

Source: Fourth National Biodiversity Report Abuja 2010

The country, however, lacks the political will to enforce the implementation of these laws and that is where the problems lies. Sharp practices, connivance and other vices have short-change the country's ability to implement these laws without fear or favour and unless this is addressed, the environment will continue to decay for a very long time.

IV.   CONCLUSION

Oil spill and gas flaring have both contributed substantially to environmental degradation and biodiversity depletion. Both the policy, institutional and legal frameworks put in place may not achieve the desired objectives, if effective instrument is not deployed for enforcement and implementation of these laws. It is therefore more strategic to address the cause or causes of the problem rather than treating the symptoms.

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