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Impact of Oil Spillage and Gas Flaring on Economic Growth in Nigeria

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Abstract

This study assessed the impact of oil spillage and gas flaring on economic growth in Nigeria. The data used for this study are secondary obtained from several issues of Department of Petroleum Resources' Oil and Gas Annual Report, World Bank and CIED Reports. The statistical analysis used is the multivariate nonlinear regression model approach. Using SPSS 20.0, we consider two economic indicators and compute basic statistics to model the consequences of oil spillage, gas flaring responses on the two Nigeria's economic indicators. From the analysis, it was found that both oil spillage and gas flaring have depressing consequences on gross domestic product and per capital income of Nigeria and by extension economic growth and development of Nigeria; though government seems to enjoy some revenue from gas flaring due to the huge compensation enjoyed by the Nigeria Federal Government but at the detriment of the already impoverished coastal region where oil and gas activities are carried out. The study recommends that the use of biological remediation should be implemented in areas of the delta to detoxify and restore ecosystems damaged by oil spills and gas flares. Also, there should be multi-stakeholder platforms and environmental monitoring teams supported by Nigeria Stability and Reconciliation Programme (NSRP) on issues involving oil spills and gas flares in the delta region of Nigeria.

Keywords: *Multivariate Analysis, Statistics, Model Transformation, Hypothesis, Economic Growth, Environment, Oil and Gas.*

1.0 Introduction

The Nigeria coastal area also known as the Delta, covers 20,000 km² within wetlands of 70,000 km² formed primarily by sediment deposition. Home to 20 million people and 40 different ethnic groups, this floodplain makes up 7.5% of Nigeria's total land mass. It is the largest wetland and maintains the third-largest drainage basin in Africa. The Delta's environment can be broken down into four ecological zones: coastal barrier islands, mangrove swamp forests, freshwater swamps, and lowland rainforest (Nwilo and Badejo, 2001; Gwazah, 2015 and Adebayo, 2019). The key environmental issues in the Niger Delta of Nigeria relate to its petroleum and industry (Albert, Amaratunga, and Haigh, 2018). The consequence of environmental degradation from gas flaring, dredging of larger rivers, oil spillage and reclamation of land due to oil and gas extraction across the Niger Delta region costs about US$758 million every year, Unfortunately, 75% of the cost is borne by the local communities through polluted water, barren farmland and missing biodiversity (Ayanlade, 2015).

The Oil and Gas (O&G) industry has continued to be the mainstay of the Nigerian economy despite Government's best efforts at diversification into Agriculture and Mining. Even though the sector is less than 10% of the country's GDP, it contributes about 65%1 of Government revenue and 88%2 of Nigeria's foreign exchange earnings (Gwazah, 2015). It is no wonder that happenings in the industry tend to have an impact on the other sectors of the economy. It is, therefore, important for players in the Nigerian economy to continue to be aware of developments in the O&G industry and monitor the happenings therein. In October 2016, the Federal Government (FG) launched the7 Big Wins Agenda with the overriding objective of creating a stable and enabling environment. The expectation is that it will maximize investment opportunities in the sector and

generate increased and sustainable growth in the economy (Badejo, 2001). Consequently, the Government aspired to increase daily oil production to 2.8 million barrels (reduced from the 4million barrels the government had previously set as its 2010vision). The Government also resolved to transform the country from an oil-based economy to a gas-based economy by developing gas infrastructure, commercializing gas flare, implementing a gas commercial framework and maximizing the use of gas to power economic development. (KPMG, 2019)

The Department of Petroleum Resources estimated 1.89 million barrels of petroleum were spilled into the Niger Delta between 1976 and 1996 out of a total of 2.4 million barrels spilled in 4,835 incidents, approximately 220 thousand cubic meters (Vidal, 2010). A UNDP report states that there have been a total of 6,817 oil spills between 1976 and 2001, which account for a loss of three million barrels of oil, of which more than 70% was unrecovered (UNDP, 2006). 69% of these spills occurred off-shore, a quarter was in swamps and 6% spilled on land. Bronwen (1999) asserts that Nigerian National Petroleum Corporation gives the quantity of petroleum jettisoned into the environment yearly at 2,300 cubic meters with an average of 300 individual spills yearly. Nevertheless, because this amount does not take into account "minor" spills, the World Bank argues that the correct quantity of petroleum spilled into the environment could be as much as ten times the officially claimed amount (Moffat and Linden, 2015). The largest individual spills being the blowout of a Texaco offshore station which in 1980 dumped an estimated 400,000 barrels (64,000 m^3) of crude oil into the Gulf of Guinea and Royal Dutch Shell's Forcados Terminal tank failure which produced a spillage estimated at 580,000 barrels (92,000 m^3) (Nwilo and Badejo, 2001). *Baird (*2010) reported that between 9 million and 13 million barrels have been spilled in the Niger Delta since 1958. One source estimates that the total amount of petroleum in barrels spilled between 1960 and 1997 is upwards of 100 million barrels (16,000,000 m^3) (Moffat and Linden, 2015).

According to *Baird (*2010), Oil spills are a common incident in Nigeria. Half of all spills occur due to pipeline and tanker accidents (50%), other causes include sabotage (28%) and oil production operations (21%), with 1% of the spills being accounted for by inadequate or non-functional production equipment. Corrosion of pipelines and tankers is the rupturing or leaking of old production infrastructures that often do not receive inspection and maintenance (Nwilo and Badejo, 2001). A reason that corrosion accounts for such a high percentage of all spills is that as a result of the small size of the oilfields 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 wellheads to flow stations—allowing many opportunities for leaks. In onshore areas most pipelines and flow lines are laid above ground. Pipelines, which have an estimated life span of about fifteen years, are old and susceptible to corrosion. Many of the pipelines are as old as twenty to twenty-five years (Bronwen, 1999).

Okon (2017) is of the view that Oil spillage has a major impact on the ecosystem into which it is released and may constitute ecocide. He noted that immense tracts of the mangrove forests, which are especially susceptible to oil (mainly because it is stored in the soil and re-released annually during inundations), have been destroyed. An estimated 5 to 10% of Nigerian mangrove ecosystems have been wiped out either by settlement (AJSIR Index, 2020) or oil (Simire,2012). The rainforest which previously occupied some 7,400 km^2 of land has disappeared as well (Bronwen, 1999). Spills in populated areas often spread out over a wide area, destroying crops and aquacultures through contamination of the groundwater and soils. The consumption of dissolved oxygen by bacteria feeding on the spilled hydrocarbons also contributes to the death of fish. In

agricultural communities, often a year's supply of food can be destroyed instantaneously because of the careless nature of oil operations in the Delta (Ill*ing (2019*) and *Aljazirahnews (*2019*).* People in the affected areas complain about health issues including breathing problems and skin lesions; many have lost basic human rights such as health, access to food, clean water, and an ability to work (*Baird,* 2010; National Radio Project, 2010). On January 30, 2013, a Dutch court ruled that Shell is liable for the pollution in the Niger Delta (*Raymond,* 2013). In January 2015, Shell agreed to pay $80 million to the Ogoniland community of Bodo for two oil spills in 2008 after a court case in London (Ogoniland, 2019).

Robin (2020) stated that Nigeria flares more natural gas associated with oil extraction than any other country, with estimates suggesting that of the 3.5 billion cubic feet (100,000,000 m^3) of associated gas (AG) produced annually, 2.5 billion cubic feet (70,000,000 m^3), or about 70%, is wasted by flaring. This equals about 25% of the UK's total natural gas consumption and is the equivalent to 40% of Africa's gas consumption in 2001. Statistical data associated with gas flaring are notoriously unreliable, but Nigeria may waste US$2 billion per year by flaring associated gas (Friends of the Earth (2004) and World Bank (2008). Flaring is done as it is costly to separate commercially viable associated gas from the oil. Companies operating in Nigeria also harvest natural gas for commercial purposes but prefer to extract it from deposits where it is found in isolation as non-associated gas. Thus associated gas is burned off to reduce costs.

Gas flaring is generally discouraged as it releases toxic components into the atmosphere and contributes to climate change. Gas flaring in Nigeria began simultaneously with oil extraction in the 1960s by Shell-BP (Badejo, 2014). Alternatives to flaring are gas re-injection or to store it for use as an energy source. If properly stored, the gas could be used for community projects. According to Friends of the Earth (2014), gas flaring releases large amounts of methane, which has a high global warming potential. The methane is accompanied by the other major greenhouse gas, carbon dioxide, of which Nigeria was estimated to have emitted more than 34.38 million metric tons in 2002, accounting for about 50% of all industrial emissions in the country and 30% of the total CO_2 emissions. While flaring in the west has been minimized, in Nigeria it has grown proportionally with oil production. The international community, the Nigerian government, and the oil corporations seem in agreement that gas flaring needs to be curtailed. Efforts to do so, however, have been limited although flaring has been declared illegal since 1984 under section 3 of the "Associated Gas Reinjection Act" of Nigeria (Friends of the Earth (2014).

Oil spillage and gas flaring tend to aggravate the incidence of poverty. The Nigeria Coastal Region's enormous potentials for economic growth and sustainable development remains unfulfilled while its future is being threatened by worsening economic conditions that are yet to be addressed by present policies and actions. The problem of oil spillage and gas flaring in the Coastal Region has hindered sustainable increase and progress and led to the impoverishment of the people of the region. This study, therefore, assessed the impact of petroleum spillage and gas flaring in the Nigeria coastal region using data obtained from several issues of Department of Petroleum Resources' Oil and Gas Annual Report, World Bank and CIED Reports. Specific objectives of this study are, to:

(i) assess the impacts of petroleum spillage and gas flaring on the gross domestic product and per capital income of Nigeria
(ii) present an empirical model on the subject for Nigerians

(iii) Propose strategy and policies for mitigating the problems of petroleum spillage and gas flaring in the coastal region of Nigeria.

This study is categorically significant in that it will provide to the public adequate awareness on issues relating to petroleum spillage and gas flaring, particularly in the Nigerian coastal areas. Besides, the study will assist in regulating oil and gas industry activities in Nigerian so that they can be more environmentally friendly. Also, it will help to prompt the Nigerian government to mitigate Petroleum spillage and gas flaring in the Nigerian coastal region.

In this study, the following hypotheses are to be tested:

Ho_1: Nigeria gross domestic product is not affected by petroleum spillage

Ho_2: Nigeria gross domestic product is not affected by gas flaring

Ho_3: Nigeria per capital income is not affected by petroleum spillage

Ho_4: Nigeria per capital income is not affected by gas flaring

2.0 Literature Review

According to Badejo (2014) Oil spills in the Niger Delta have been a regular occurrence, and the resultant environmental degradation of the surrounding environment has caused significant tension between the people living in the region and the multinational oil companies operating there. According to Ekerikevwe, Elugwu and Ekerikevwe (2010), it is only in the past decade that environmental groups, the Nigerian federal government, and the foreign oil companies that extract oil in the Niger Delta have begun to take steps to mitigate the damage. Although the situation is improving with more stringent environmental regulations for the oil industry, marine pollution is still a serious problem (Okorodudu, Okorodudu and Ekerikevwe, 2016).

Onome, Godson, Michael and Oladosu (2020) studied oil spills, gas flaring and adverse pregnancy outcomes: a systematic review. They noted that Oil spills and gas flaring are major environmental problems and pose major source of adverse health outcomes to communities hosting oil wells and natural gas. Their systematic review identified and reviewed past studies on oil pollution and different types of pregnancy outcomes within a twenty-year gap, which is between 1999 and 2019. The review also discussed the exposure pathways of oil pollution. The review showed that oil spill and gas flaring may put pregnant women at high risk of hypertensive disorders of pregnancy, gestational diabetes mellitus, maternal depression, miscarriages via three pathways.

George (2019) carried out a research into stakeholder engagement and the sustainable environmental management of oil-contaminated sites in Nigeria: policy, management and sustainability. They opined that African nations are experiencing rapid economic growth and development, particularly within the energy sector; however, this growth has come at a cost to the environment and society. The study also noted that nowhere have these impacts been felt more precisely than in the oil and gas-producing regions of Nigeria where years of neglect and mismanagement have resulted in vast areas of hydrocarbon-contaminated lands. They show how constructive stakeholder engagement can be used to integrate the values and perspectives of affected communities and how this information can be used to inform environmental regulation and sustainable development. Their study concluded that the issues of contaminated land in the Niger Delta are complex and the unintended consequences of contamination are often unimaginable.

Table 1: Nigeria Active Rigs by Terrain

Year	Land/Swamp	Shallow Offshore	Deep Offshore	Total
2010	14	10	6	30
2011	13	14	6	33
2012	20	15	7	42
2013	20	19	7	46
2014	14	7	8	29
2015	15	6	8	29
2016	5	4	3	12
2017	10	3	3	16
2018	14	5	4	23
2019	16	6	5	27
2020	20	10	3	33

Source: DPR (2021)

Table 2: Crude Export Destination History (Percent)

Regio42.8n	2013	2014	2015	2016	2017	2018	2019	2020
Europe	42.8	45.8	45.6	34.9	37.3	19.4	N/A	N/A
North/South America	23.8	15.2	13.4	22.5	21.4	-	N/A	N/A
Asia	20.1	25.0	26.8	27.9	27.7	13.0	N/A	N/A
Africa	11.1	12.6	13.9	14.6	12.5	6.7	N/A	N/A
Oceania/Pacific	2.2	1.3	0.3	0.1	1	-	N/A	N/A
Latin America	N/A	N/A	N/A	N/A	N/A	2.1	N/A	N/A

Source: DPR (2020)

Olufemi, Ibrahim and Kolade (2020) asserted that following the industrial revolution and the subsequent expansion in the exploration of natural resources, the human environment has been impacted greatly. They said that in Nigeria, the activities of the oil industry in the Niger Delta Region have compromised the ability of the environment to provide many of its services. Although environmental laws such as the "polluter pay principle" have been adapted to checkmate oil spillage, it should be noted that these laws evolved over the

years and will continue to evolve with different approaches. Their study elicits several lacunas in the existing environmental laws in Nigeria and also addresses the challenges of reforming and enforcing environmental laws in achieving environmental sustainability. The study reviewed and referenced journal articles, technical reports, online archives, textbooks and the constitution of the Federal Republic of Nigeria. The study affirms that, environmental degradation as a result of oil exploration in the Niger Delta region has continued to cause negative effects on the wellbeing of the people as it renders a large portion of the environment unsafe with toxic waste proliferating at an alarming rate. In an attempt to immunize the environment against environmental degradation, their study suggests that environmental laws should undergo frequent review and enforced without any iota of compromise in Nigeria, integrating and engaging every stakeholder most especially, those in the oil-producing communities in the Niger Delta region.

Umar, AbdulKhanan, Ahmad, Sani, Abdul Rahman, Rahman (2019) in their study on "spatial database development for oil spills pollution affecting water quality system in Niger Delta" develop a database on how oil spills affects water quality which is one of the most crucial resources in the Niger Delta and uses existing oil spills data to show the areas and extent of oil pollution in the Niger Delta. Geospatial analysis was used to design an oil spill data base comprising the logical, physical, and conceptual data base design. Visio was used for the design of the entity relationship (ER) diagram of the study. The Kernel density and Getis-Ord G* statistic were used in GIS to map the oil spill areas in the region. Results of spatial spill distribution from the Kernel density and Getis-Ord G* statistic revealed that three states

of the Niger Delta namely, Bayelsa, Rivers, and Delta states are the hottest spots for oil spill occurrences and distribution. Their ER chart showed the relationships between the pollution sources, their pathways, and the receptors. Nsirim and Nkang 2018) observed several contributions on the ecological interaction between hydrocarbon and soil habitat relationship in different parts of Niger Delta potential of plants species. Their study was aimed at evaluating the suitability of three species (Peltophorumretusa Delta soil habitat). Standard field and laboratory methods of data collection and analyses were adopted in the study. Result showed varying increase in water repellency.

Osuagwu and Olaifa (2018) are of the view that the Niger Delta region is the oil producing area of Nigeria, which consists of highly diverse ecosystems that are supportive of numerous species of terrestrial and aquatic fauna and flora. Crude oil spills endanger fish hatcheries in coastal water and also contaminate valuable fish. Their study examines the effects of oil spills on fish production in the Niger Delta of Nigeria from 1981-2015 using an estimable Cobb Douglas production function. The findings of their study suggest that oil production and spills negatively affect fish production, while farm labour has a positive effect on fish production. On the other hand, fishery loan exerts a negative effect on fish production and this could be ascribed to the bottlenecks in accessing these loans. The study concludes that there is a trade-off between oil exploitation activities and fish production due to the effect of oil spills. They demonstrate that increasing levels of oil spillage and oil production negatively affects fish production in the Niger Delta region of Nigeria. However, changes in fish production may be stimulated by other seasonal and environmental factors not accounted for in our model of estimation and that, incidence of oil spills among other environmental factors depress agricultural outputs particularly fishing.

Nwokedi and Nnadi (2018) observed that failure of oil pipeline transport infrastructure in Nigeria's coastal ecosystem has continued to pose serious environmental problems with consequent economic effects. Their study estimated the theoretical and empirical probabilities of oil pipeline infrastructure failure modes in

Nigeria. The adopted historical research design approach with time series data of 10 years on Nigeria's coastal oil pipeline infrastructure failure modes were obtained from the Nigerian National Petroleum Corporation. Using the statistical method of probability theory to determine the theoretical and empirical probabilities of oil pipeline infrastructure failure modes in order to optimally deploy pipeline safety and security management strategies, the study found that pipeline infrastructure failure by Vandalism poses the highest empirical probability and risk of occurrence.

Jack and Zibima (2018) examined the problem of gas flaring and its contribution to energy poverty in the oil rich Niger Delta region of Nigeria. The study relied on primary data collected through interviews and Focus Group Discussions in selected communities of the region which includes Ogboinbiri, and Obunagha communities of Bayelsa state and Akala-Olu and Iguruta communities of Rivers state. The study argues that the abundant oil and gas resources in the region paradoxically has not translated into access to clean and affordable energy for the people as over 75% of the natural gas produced in the region is flared. Findings revealed that the pervasive energy poverty in the region predisposes communities to rely on fuel wood as the primary source of domestic energy. The paper hence concludes that gas flaring contributes immensely to the pervasive incidences of energy poverty in the region with severe implications for environmental sustainability in the region. The study amongst others recommends that the government takes urgent steps at halting gas flaring while enhancing alternative off grid gas to power and renewable energy solutions as well as making clean and efficient modern energy accessible and affordable for the rural poor.

Ekerikevwe, Adudgo and Eregare (2017) opined that the poor tend to be the hardest hit by oil spillage and gas fearing and the rich well equipped to protect themselves. Environmental degradation contributes to the risk of impoverishment. It depresses the poor people incomes by household tasks such as fuel wood collection and by decreasing the productivity of the natural resources from which the rural poor are most likely to wrest a living. Thus, environmental damage has contributed to higher unemployment rates and hence lower production especially in the Niger delta. The international community, the Nigerian government, and the oil corporations seem in agreement that gas flaring needs to be curtailed. Efforts to do so, however, have been limited although flaring has been declared illegal since 1984 under section 3 of the "Associated Gas Reinjection Act" of Nigeria (Okorodudu et. al, 2016)

While OPEC and Shell, the biggest flarer of natural gas in Nigeria, alike claim that only 50% of all associated gas is burnt off via flaring, these data are contested. The World Bank reported in 2004 that, "Nigeria currently flares 75% of the gas it produces. In November 2005 a judgment by the Federal High Court of Nigeria ordered that gas flaring must stop in a Niger Delta community as it violates guaranteed constitutional rights to life and dignity. In a case brought against the Shell Petroleum Development Company of Nigeria (Shell), Justice C. V. Nwokorie ruled in Benin City that "the damaging and wasteful practice of flaring cannot lawfully continue." As of May 2011, Shell had not ceased gas flaring in Nigeria (Bloomber, 2011). Finally, according to and Ekerikevwe and Orighoyegha (2018), the negative economic and social impact of the environmental damage has led to a volatile and general insecurity of life in the Nigeria coasts. This inevitably had a damaging effect on the social and economic development of the country in general.

Figure 1: Gas Flaring (Adebola and Olamide, 2018)

Table 3: Nigeria Natural Gas Reserves (2010-2021)

Year	Associated Gas, AG	Natural Gas Reserves (TCF)	Total Gas
2010	92.945	89.872	182.817
2011	92.904	90.530	183.434
2012	89.729	92.529	182.258
2013	89.652	92.298	181.950
2014	90.094	97.904	187.998
2015	97.208	94.857	192.065
2016	97.253	101.485	198.738
2017	96.36	102.730	199.090
2018	101.98	98.81	200.790
2019	103.67	100.05	203.450
2020	109.14	101.89	208.230

Source: DPR (2021)

Ekerikevwe et al (2017), in their paper, investigated the impact of oil spillage and gas flaring on economic growth; using multiple regression models they analyzed the impact of oil spillage and gas flaring, with Gross Domestic Product (GDP), Per Capita Income (PCY) and investments as economic indicators, and developed a logarithmic and exponential functions to describe a nonlinear tradeoff between environmental pollution (OIL_{SP}, GAS_{FL}) and economic development in Nigeria. This study adopts the multivariate regression model to examine the impact of oil spillage and gas flaring on economic growth in Nigeria.

3.0 Methodology

The methodological framework for this study is the method of multivariate econometric research, using the theory and technique of statistical inference as a bridge pier. The research adopts the multivariate regression model to examine the impact of oil spillage and gas flaring on economic growth in Nigeria.

Multivariate means involving multiple dependent variables resulting in one outcome. This explains that the majority of the problems in the real world are Multivariate. For example, we cannot predict the weather of any year based on the season. There are multiple factors like pollution, humidity, precipitation. **Multivariate analysis** (**MVA**) is a Statistical procedure for analysis of data involving more than one type of measurement or observation. It may also mean solving problems where more than one dependent variable is analyzed simultaneously with other variables. Multivariate models assist with decision making by allowing the user to test out the different scenarios and their probable impact.

The main variables used in the study are annual data collected from Nigeria Real Gross Domestic Product (RGDP), gas flared, oil spill, total federal government revenue, Total export of Nigeria and investment for the period of 1910-2021. The data used are reliably selected from well documented sources. The main sources of the data used are secondary derived from Statistical Bulletins of the Central Bank of Nigeria (CBN) various issues, the publications of Shell Petroleum Development Company (SPDC) and the published works from academic journals and relevant websites of government and nongovernmental agencies.

Because economic theory does not indicate the precise mathematical form of the relationship among the variables, different functional forms of the above models including the linear, semi-logarithm, logarithm and exponential functions were fitted. However, the lead equation was chosen on the bases of economic, statistical as well as econometric criteria. The logarithmic function was fitted for real gross domestic product and per capita income models to determine the impacts of oil spills and gas flaring on economic growth in Nigeria.

Using the statistic: $t = \frac{\hat{\beta}_i}{S\hat{\beta}_i}$, we test hypotheses *Ho_1* and *Ho_2* at *$\alpha=0.05$*

Decision rule: Reject H_0 if $t_{cal} > t_{tab}$, otherwise do not reject.

Alternatively, reject H_0 if $P < 0.05$, otherwise do not reject.

Using the statistics: $F = \frac{R^2/K}{(1 - R^2)/[n-(K+1)]}$, we test hypothesis *Ho_3* at *$\alpha=0.05$*

Decision rule: Reject H_0 if $F_{cal} > F_{tab}$ otherwise do not reject. Alternatively, reject H_0 if $P < 0.05$, otherwise do not reject.

The following multivariate econometric model is specified below:

$$\begin{bmatrix} Y_{1\ gdp} \\ Y_{2\ pcy} \end{bmatrix} = f\left(X_{1\ \exp}, X_{2\ fed}, X_{3\ inv}, X_{4\ osp}, X_{5\ gas}, \varepsilon\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

$Y_{1\ gdp}$ = GDP, used as Nigeria's economic indicator

$Y_{2\ pcy}$ = Per capital income, used as the second Nigeria's economic indicator

$X_{1\ \exp}$ = Total export

$X_{2\ fed}$ = Federally collected revenue

$X_{3\ inv}$ = Investment in Nigeria

$X_{4\ osp}$ = Oil spillage

$X_{5\ gas}$ = gas flared, and

ε = randomly distributed error term.

Using logarithmic function, equation (1) is transformed to obtain equation (2) below:

$$\log\begin{bmatrix} Y_{1gdp} \\ Y_{2\,pcy} \end{bmatrix} = \log\beta_0 + \beta_1 \log X_{1\exp} + \beta_2 \log X_{2\,fed} + \beta_3 \log X_{3inv} + \beta_4 \log X_{4osp} + \beta_5 \log X_{5gas} \ldots (2)$$

3.1 Data

Table 4: Total Gas Flared and Number of Oil Spills Incidence in Nigeria

Year	Total Gas Flared (mcf)	Number Of Spills	Quantity Spilled (Barrels)
2010	544,728,832	537	17,658.10
2011	503,944,277	673	66,906.84
2012	465,256,639	844	17526.37
2013	427,971,368	522	4066.20
2014	393,839,836	1087	10302.16
2015	330,933,000	753	32756.87
2016	288,917,198	434	1658.98
2017	324,192,401	429	9097.05
2018	321,290.35	569	9718.22

VARIABLE	ESTIMATED PARAMETERS	T-STATISTIC	SIGNIFICANCE
2019	311,171.05	401	9026.21
2020	30245,674.00	464	8137.07

Source: DPR (2021)

Table 5: Nigeria's Major Economic Indicators

Year	Nigeria Investment:% of GDP	Nigeria's Per capital Income	Nigeria's Gross Domestic Product per capital	Total Export of Nigeria	Total Federal Government Revenue (*MNaira*)
2010	17.028	2024	8.006	3188969.8	763608.8
2011	16.028	2045	5.308	5945723.3	1049187.9
2012	14.728	3145	4.230	6001230.8	11906159.7
2013	14.737	4187	6.671	6882668.2	6231532.9
2014	15.613	5198	6.310	7889846.7	7731837.5
2015	15.324	6245	2.653	7899967.8	8575095.9
2016	15.367	6298	-1.617	8987645.5	9634783.9
2017	15.474	7445	0.806	9056834.8	9798126.8
2018	19.864	9024	1.937	10409126.6	10976734.8
2019	24.42	9142	1.988	10612416.1	11567313.2
2020	29.40	9304	2.007	11003315.65	11286891.3

Source: CEIC (2021) @https://www.ceicdata.com/en/indicator/nigeria/investment--nominal-gdp

World Bank (2021)

@https://databank.worldbank.org/reports.aspx?source=2&series=NY.GDP.MKTP.KD.ZG&country=NGA

4.0 Results of analysis

Table 6: Model Estimation for Economic Indicator 1 (Gross Domestic Product)

X_1	6.133	4.120	0.011*
X_2	0.033	2.750	0.004**
X_3	0.281	0.354	0.037*
X_4	-2.405	-1.001	0.021*
X_5	0.302	1.114	0.031*
F-Statistic=73.053	**R^2(adj)= 0.675**	**N=48**	**Overall sig = .002[a]**

Table7: Model Estimation for Economic Indicator 2 (Per Capital Income)

VARIABLE	ESTIMATED PARAMETERS	T-STATISTIC	SIGNIFICANCE
X_1	4.262E-05	3.005	0.000**
X_2	0.002E-01	4.160	0.000**
X_3	0.22E-05	0.420	0.046*
X_4	-0.103	6.754	0.003**
X_5	0.321	1.880	0.018*
F-statistic=78.258	**R^2(adj)= 0.862**	**N=48**	**Overall sig = .002[a]**

4.1 Discussion of Results

The results of the estimated parameters in the multivariate statistical analysis of the impacts of oil spillage, gas flaring, gross domestic product and per capital income on economic growth in Nigeria are presented in Tables 6 and 7 respectively. The values of the R^2_a of 68%, 86%, respectively indicate that the fitted multivariate regression model is adequate to test the impacts of petroleum spillage, gas flaring on gross domestic product and per capital income of Nigeria. It therefore implies that the independent variables account for about 68% and 86% of the total variations in gross domestic product and per capital income of Nigeria respectively. The overall regression models contribute significantly for the prediction of gross domestic product (Tables 6) and per capital income (Tables 7) of Nigeria, as indicated by the F-statistic and their corresponding P-values; these demonstrate that the regression models are robust for the test of oil spills and gas flares' impact on gross domestic product. In terms of statistical significance, the individual estimated parameter coefficients are all statistically significant at 5% level as indicated by the t-values and corresponding p-values given in Tables (6)

and (7).The models indicate that a unit increase in the cases of oil spillage and gas flaring would lead to corresponding reduction of gross domestic product and per capital income; this implies that oil spillage and gas flaring have depressing shock on the gross domestic and per capital income of Nigeria (Nwilo and Badejo, 2001; Simire, 2012; Osuagwu and Olaifa, 2018).

The performance of the estimated parameters in terms of expected signs, with the exception of GAS_{FL} coefficients (i.e. $ß_4$& ϕ_4), is quite satisfactory as they conformed to apriori expectations. The positive influence of gas flaring on economic growth may be adduced to the fact that the Federal Government of Nigeria derives huge revenue from gas flaring. For instance, gas flared accounted for a receipted revenue of N4, 778,135,798.10 and N3,654,380,194.44 in 2003 and 2004 respectively (CBN BOD Annual Report, 2004: 56-57). Nevertheless, this has created an avenue for further research in this area. Furthermore, the model shows that Nigeria Real GDP (Table 6) and Per Capital Income (PCY) (Table 6) would increase by about 28.1% and 22.0% respectively if investment is increased by (one) 1 percent. This is an indication that investment is indeed a necessary condition for economic growth in Nigeria. Finally, the regression model, as indicated by the coefficient of the TIME variable, clearly shows that over the years Nigeria Real GDP was increasing abnormally by about 19% on the average. That is, the more oil spillage occurs the more the economy goes down. Meanwhile, Real GDP maintains its normal growth when oil spillage does not occur.

5.0 Conclusion

We used the aid of multivariate statistical analysis to empirically determine the impact of petroleum spillage, gas flaring, gross domestic product, per capital income of Nigeria and investment on economic growth in Nigeria. As expected, it was found that oil spillage impacts negatively on economic growth and development in Nigeria. However, rather than its expected negative impact on economic growth, gas flaring impacted positively on it. The reason may be that the Federal Government of Nigeria derives huge revenue from gas flaring activities. The amount paid is usually described as “penalty for gas flaring” in the receipt issued by Department of Petroleum Resources (DPR). The receipt is expected to suffice in the absence of a certificate issued by the Minister. The companies, therefore, deduct the payment as an allowable expense in arriving at their assessable profits when determining their tax position for the relevant period. Most times companies who paid these fines were issued certificates to further persist in the flaring of natural gas. Today, the Nigeria coastal environment is in turmoil, restive, poor, backward and neglected. The attitude of the Nigerian State and the oil companies has been that of insensitivity, negligence and contempt. Plunder and impoverishment are very strong words but they fail to capture the depth of poverty, misery and sorrow visited on this once beautiful region of Nigeria. The people of the Niger Delta are becoming restive day by day and are unleashing and at the same time suffering terror every moment.

According to Hyellaiet al (2021), the state of Nigeria's environment is at a critical stage, which can have more health risks that can affect an extended period beyond the present condition if not mitigated .Thus, the need to implement immediate actions for a healthy environment and increase life expectancy in Nigeria. In order to mitigate oil spillage and gas flaring in Nigeria, particularly in the coastal region, the following are therefore recommended for adoption and implementation:

1. Deadline to end gas flaring in the country should be feasible. However, there should be gas-to-liquid conversion projects in different parts of the country. This would provide gas feeds for oil recovery and significantly reduce routine gas flaring. Soonest, this would subsequently lead to zero gas flares in Nigeria.

2. Crude Oil Pipeline operators should seek to minimize environmental impact by carefully selecting routes and maintaining their equipment for safe, reliable operation.

3. Pipeline operators should use mobile mechanical devices to maintain and monitor pipelines from within.

6.0 References

Adebayo B. (2019). Major new inquiry into spills in Nigeria's Niger delta launched. CNN

Adebola, F. B. and Olamide, I. (2018). Trade-Off between Gas Production and Gas Flaring in Nigeria. The Pacific Journal of Science and Technology–79– http://www.akamaiuniversity.us/PJST.htm Volume 19. Number 1.

AJSIR Index (2020). www.scihub.org. 01-23.

Albert, Oshienemen N.; Amaratunga, Dilanthi; Haigh, Richard P. (2018). "Evaluation of the Impacts of Oil Spill Disaster on Communities and Its Influence on Restiveness in Niger Delta, Nigeria". Procedia Engineering. 212: 1054–1061. doi:10.1016/j.proeng.2018.01.136.

Aljazirah news (2019) "Oil Spill: IOCs Exploiting Communities, Exploring Laws". 2019-05-21.

Ayanlade,P. (2015). "Assessing wetland degradation and loss of ecosystem services in the Niger Delta, Nigeria." August 31.

Badejo O.T. and Nwilo P.C. (2014) Management Of Oil Spill Dispersal Along The Nigerian CoastalAreas.CiteSeerPublicationathttp://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.183.9439

Baird J (2010). "Oil's Shame in Africa". Newsweek, July 26.

Bronwen, M (1999). The Price of Oil Human Rights Watch. 1999.

CEIC Report (2018) @ https://www.ceicdata.com/en/indicator/nigeria/investment--nominal-gdp

Department Of Petroleum Resources (2018) Nigerian Oil And Gas Industry Annual Report (NOGIAR), December.

DOI: 10.24941/ijcr.31185.12.2018.

Ekerikevwe, I.K., Elugwu, F. and Ekerikevwe, A.S (2010) "Modeling the Effect of Environmental Pollution on Nigerian Economic Development." International Journal of Physical Science, published by Duncan Science Publication, Calabar. Vol. 5, No.3, 120-125. ISSN: 1597-8023

Ekerikevwe, K. I, Adugbo, B. O. and Eregare, E. (2017) "An Assessment of Oil Spillage, Gas Flaring and Economic Growth: The Niger Delta Experience." Peace and Environment Africa Journal, Published by the Center for Peace and Environmental Justice (CEPEJ) Nigeria, Vol.4, No.1, pg 189-212, ISSN: 2360 9966.

Ekerikevwe, K. I. and Orighoyegha, G. M. (2018) "Statistical Models Relating Petroleum Spillage and Some Nigeria Economic Indicators" Peace and Environment Africa Journal, Published by the Center for Peace and Environmental Justice (CEPEJ) Nigeria, Vol.5, No.1, pg 272-281, ISSN: 2360-9966.

Friends of the Earth (2004) Gas flaring in Nigeria : Media Briefing. FoE.

Friends of the Earth Nigeria (2014). Gas flaring in Nigeria: A human rights, environmental and economic monstrosity. FoEN.

George P., Kabari S. and Frédéric C (2019). Stakeholder Engagement and the Sustainable Environmental Management of Oil-Contaminated Sites in Nigeria: Policy, Management and Sustainability. Energy in Africa, pp.75-97. DOI: 10.1007/978-3-319-91301-8_4

Gwazah, A. C. (2015). Assessment Of The Environmental Impacts Of The Oil Spillage In The Niger-Delta In The Year 2015@ **DOI:10.13140/RG.2.1.1854.2160**

Hyellai T. P, Duan X., Olusola O.A, Narh D. T. (2021). Environmental health situation in Nigeria: current status and future needs. Heliyon, Volume 7, Issue 3, March.

Illing, S (2019). "It is absolutely time to panic about climate change". Vox J.

Jack, J and Zibima, T (2018). Gas Flaring And The Energy Poverty Paradox In The Niger Delta. Abuja Journal Of Sociological Studies, Vol. 5 No 2 (168-189), June 2018.

KPMG (2019).Nigeria Oil and Gas Update, Quarterly Newsletter, April

Moffat, R and Linden, P. (2015) Perception and Reality: Assessing Priorities for Sustainable Development in the Niger River Delta. Pj Vol. 3.

National Radio Project (2010) "Standing Up To Big Oil" Making Contact, December 14.

Nsirim E, and Nkang, A. E. (2018) The Ecological Restoration Of Soil-Water Infiltration Rate By Phytoremediation Treatment Of Crude Oil Polluted Tropical Niger Delta Soil

Nwilo, P. C. and Badejo, O. T (2001). Impacts of Oil Spills along the Nigeria coast. The Association for Environmental Health and Sciences.

Nwilo, P.C. and Badejo, O. T. (2001). Impacts of Oil spills along the Nigerian Coast. The Association for Environmental Health and Sciences.

Nwokedi, T. and Nnadi, K. (2018). Estimating the Theoretical and Empirical Probability Coefficients of Oil Pipeline Transport Infrastructure Failure Modes in Nigeria's Coastal Ecosystem: Panacea for Non Optimal Deployment of

Pipeline Safety and Security Management Systems. LOGI – Scientific Journal on Transport and Logistics, Vol. 9 No. 2 2018 DOI: 10.2478/logi-2018-0017. DOI: 10.2478/logi-2018-0017.
Ogoniland (2019)"In Nigeria's polluted Ogoniland, Signs of a cleanup". Phys.org.
Okon, O. (2017). "Bioaccumulation of Heavy Metals in Cucurbita Maxima Duch and Telfairia Occidentalis-Crude Oil Polluted Soil Citation". American Journal of Agricultural Science. 4: 88– 93.
Okorodudu F.O., Okorodudu P.O., and Ekerikevwe K. I. (2016). "A Model of Petroleum Pipeline Spillage Detection System For Use In The Niger Delta Region Of Nigeria." International Journal of Research - Granthaalayah, 4(12), 1-16. https://doi.org/10.5281/zenodo.221441.
Olufemi S. A., Ibrahim M. and Kolade O. (2020). The Place of Environmental Laws in Checking Oil Spillage in the Niger Delta Region of Nigeria https://www.researchgate.net/publication/339644502.
Onome, O; Godson, R. E. E. A; Michael A. O and Oladosu A. O. (2020). Oil Spills, Gas Flaring and Adverse Pregnancy Outcomes: A Systematic Review. Open Journal of Obstetrics and Gynecology 10(01):187-199 · DOI: 10.4236/ojog.2020.1010016

Osuagwu, E. S. and Olaifa, E. (2018) Effects of oil spills on fish production in the Niger Delta. PLoS ONE 13(10) , December 2018 DOI: 10.1371/0205114.
Raymond, R. (2013). "Shell and Ogoni People : (s)oil pollution in the Niger Delta". Peace Palace Library.
Robin, H. (2020). WAHALA | International Photography Magazine".
Simire, M. (2012). "Oil wealth and worrisome environmental challenges in Niger Delta". Enviro News Nigeria.
The Daily Independent (2009)."Shell And The N15bn Oil Spill Judgment Debt".07-19.
Umar, H. A., AbdulKhanan M. F., Ahmad, A., Sani, M. J., Abdulrahman, M.Z., Rahman, A. (2019). Spatial Database Development for Oil Spills Pollution Affecting Water Quality System in Niger Delta .6th International Conference On Geomantic And Geospatial Technology (GGT 2019), 1–3, Kuala Lumpur, Malaysia.
UNDP (2006) "Niger Delta Human Development Report". p. 76.
Vidal, J. (2010). "Nigeria's agony dwarfs the Gulf oil spill. The US and Europe ignore it". The Observer. Retrieved 27 July 2010. Government's national oil spill detection and response agency (NOSDRA) says that between 1976 and 1996 alone, more than 2.4m barrels.
World Bank (2008). Estimated flared volumes from satellite data, WB.
World Bank (2018) @
https://databank.worldbank.org/reports.aspx?source=2&series=NY.GDP.MKTP.KD.ZG &country=NGA