Effects of oil spills on fish production in the Niger Delta

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Abstract

The Niger Delta region is the oil producing area of Nigeria, which consist of highly diverse ecosystems that is supportive of numerous species of terrestrial and aquatic fauna and flora. This region is the largest wetland in Africa and it is among the ten most important wetlands and marine ecosystems in the world. Incident of oil spill raises concern about seafood safety. Crude oil spill endangers fish hatcheries in coastal water and also contaminates commercially valuable fish flesh. This study examines the effect of oil spills on fish production in the Niger Delta of Nigeria from 1981-2015 using an estimable model based on a Cobb Douglas production function. The variables included in the model are captured fish production, number of fishers, loan to fishery, oil spills and oil production. The findings suggest that oil spill and oil production negatively affects 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 trying to access these loans. The Pairwise Granger Causality test result shows that the number of times oil is spilled to the environment affects the level of fish production negatively. This study corroborates the findings in recent literature and proposes a cautious approach to oil exploration activities for sustainable economic development.

Keywords: environment; oil spill; fish production; aquatic life; sustainable environment; Niger Delta.

JEL Classification Code: P28, Q53, Q56

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1. Introduction

Fish is a major source of animal protein for inhabitants of the Niger Delta region and the society at large. The entire population depend solely on the marine ecosystem for their subsistence, and as a result any environmental degradation that affects water resources reduces the potential for sustainable livelihood, thereby increasing poverty. Because of the rich aquatic life and the large bodies of fresh water in the Niger Delta of Nigeria, there is a huge potential for the region to produce and supply a very high percentage of the domestic demand for fish, which was estimated at 2.2 metric tonnes per year in 2008 (Food and Agricultural Organization (FAO), 2017). Despite this potential, Nigeria still imports over 60 percent of its annual fish consumption. However, with increasing population and increasing environmental degradation in the Niger Delta as a result of oil exploration activities, the supply of fish is becoming increasingly diminished and the survival of the ecosystem is constantly endangered. In the main, fish have been recognized as major indicator for environmental contamination, providing evidence for transmission of pollutants in marine ecosystems (Plessl *et al.* 2017). In order to ensure the supply of quality fish protein, there is a fervent need to monitor the safety of the aquatic habitat with respect to human activities. In the Niger Delta, because of the huge oil reserves, oil spill is seen to be a major consequence of an inordinate exploitation of petroleum resources in the region. This study therefore examines oil spill as a major environmental problem that affects fish production in the Niger Delta drawing from econometric techniques of the Cobb-Douglas production function to ascertain a statistical relationship and suggest possible policy implications for a sustainable economic environment for fish production. This study differs from previous studies on environmental degradation of the Niger Delta and implications on agricultural productivity by specifically examining fish production from the perspective of analysing data on fresh water fishing.

The Niger Delta is the major oil producing region of Nigeria, which is located in the Atlantic Coast where River Niger divides into numerous tributaries. The region is known to be the second largest delta in the world of about 450 kilometres of coast line that terminates at the Imo River entrance (Awosika, 1995). The region spans through 20,000 square kilometres and has been described as the largest wetland in Africa and among the three largest in the world, consisting about 2,370 square kilometres of rivers, creeks and estuaries and stagnant swamp covering about 8,600 square kilometres. This highly diverse ecosystem supports numerous species of aquatic flora and fauna and terrestrial life, Iyayi (2004) describes the Niger Delta area as the one of the richest wetland in the world.

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Oil was first discovered in the region in 1958 and since the early 1970's oil has dominated the country's economy. Oil exploration has over the years impacted negatively on the physical environment of the oil-bearing communities. Elum, Monini and Henry-Ukoha (2016) observes that oil exploitation has increased the rate of environmental degradation and has perpetuated food insecurity as a result of death of fish and crops as well as loss of farm lands and viable rivers for fishing activities leading to loss of livelihood. There is no doubt that the disastrous effect of oil spill impedes agricultural productivity and fishing to be specific, which in the long-run has an adverse consequence on the economic life of the inhabitants of this region. Furthermore, studying the prospects and challenges of environmental impact of oil exploration in the Niger Delta region of Nigeria and the remediation of contaminated lands in the region, Zabbey, Sam and Onyebuchi (2017) was of the opinion that resolving the technical dilemma of the clean-up mechanism and identified social impediments will be the key success driver of the United Nations Environmental Programme action plan, which was recently adopted by the government of Nigeria for the clean-up of the Niger Delta. The study further recommends that bioremediation should be adopted considering its low greenhouse effect and the reduced cost burden on the weak and overstretched economy of Nigeria.

Oil spill obviously threatens subsistence peasant agricultural economy and environment; hence the entire livelihood and survival of the people (Stephen and Udofia, 2015). The release of petroleum substance or product into the streams, lakes, rivers, beaches, seas, oceans and land can be identified as the major cause of restiveness in the Niger Delta, which arises from the neglect of the environment resulting in extreme impoverishment of the peoples of the region.

Both actual and potential contamination of seafood can substantially affect commercial and recreational fishing and the attendant loss of confidence in seafood safety and quality can impact seafood market long after any actual risk to seafood from oil spill has subsided, resulting in serious economic consequences (Yender and Michel, 2002). When oil spill occurs, it becomes poisonous and thus makes water and land fouled and threatens the rich coastal habitat. The fish in the water is a major carrier of trace elements that could be detected in the understanding of pollutants and monitoring the quality of the environment for the survival of species in the aquatic habitat (Plessl *et al*. 2017).

The exploitation of oil in the Niger Delta region has brought to bear oil spillage and its numerous problems. Such problems include contamination of water bodies, danger to aquatic life, and destruction of farmlands, (Nwilo and Badejo, 2008). According to Eyinla and Ukpo, (2006), between 1976 and 1996, it was estimated that over 6,000 oil spills occurred in the Niger Delta region and about 2,369,471 barrels of crude oil leaked into the environment. Therefore, the main objective of this study is to examine the effect of oil spillage on fish production in the Niger Delta of Nigeria, drawing from the fact that none of the studies reviewed has specifically examined the effect of oil spill on fish production, which is a major source of animal protein and for the economic well-being of the peoples of Niger Delta. Hence the motivation for this study is driven by the increasing importance of fish to the economic life of the inhabitants of the region and the country at large, with the attendant effect of oil exploration activities. This study is presented in six sections, the first is the introduction, the second is a review of related literature, the third section presents stylized facts, while the fourth section features the method of analysis, fifth is the interpretation and discussion of results and the study is concluded in the sixth section.

2. Literature Review

Akpokodje and Salau (2015) examined oil pollution and agricultural productivity in the Niger Delta of Nigeria, the study employed an empirical analysis derived from a unique estimable production function based on Ramon Lopez's Cobb Douglas production function model, findings established that increasing levels of oil spill and forest loss negatively affect agricultural productivity, while land, labour and capital positively improved agricultural productivity in the Niger Delta. In the same vein, Ogwu, Badamasuity and Joseph (2015) explore the environmental effects of petroleum activities and policies in Nigeria employing descriptive techniques to attain logical interpretations. Findings from this study revealed that the actions of oil companies operating in the Niger Delta have tremendous influence on the health of ecosystems and biodiversity of the region.

Ekpenyong and Udeme (2015) investigate the consequences of oil spill on sea-food safety in coastal areas of Ibeno, Akwa Ibom State, observe the mean concentration of total petroleum hydrocarbons (TPH) in the tissues of various fish species sampled to be increasing as a result of oil spills. Similarly, Paul (2015) evaluates the historical influence of petroleum activities on various episodes of economic crisis in Nigeria. The study employed descriptive technique to analyse data obtained from secondary sources, affirming that the transmogrification of the economy from agricultural-based to petroleum-based laid the foundation for the current economic crisis in Nigeria. Also, Ekanem and Nwachukwu (2015) while exploring the extent of the environmental degradation in the Niger Delta region and examining the efforts of oil

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companies in remediating the degraded farmlands in the Niger Delta finds that oil pollution causes damage to human health, agricultural land and fish ponds as well as long-standing ecological malfunctioning.

Atubi, et al. (2015) examining the effects of environmental degradation on human health in nine selected oil communities in Delta State, Nigeria using cluster and principal component analysis, employed both primary and secondary data; the primary data was collected through administration of questionnaires while secondary data was from archival records of in-and-out patients from the Government hospitals or clinics located in Okpai, Kwale, Benekuku, Ubeji, Bomadi, Ekakprame, Erhoike, Afiesere and Uzere for a year. One-year hospital data was used based on data availability and consistency on the required ailments such as bronchitis, cough, asthma, cardiovascular diseases, eye infection and skin infection in order to ascertain the effect of gas flaring on human health. One important observation in the study is that gas flaring has a statistically significant, but dangerous impact on human health in the affected areas giving the high temperature and emission to the atmosphere.

The problem of illegal bunkering and vandalizing petroleum pipelines contribute immensely to oil spillage and degradation of the environment. Odalonu (2015) observes that oftentimes illegal bunkering and petroleum pipeline vandalization results from destructive tendencies of restive youths, who are aggrieved by government neglect of oil producing communities and corruption of the ruling class in amassing wealth through collaborations with oil companies. Unfortunately, these social vices perpetrated by the youths have a counter-effect in increasing the levels of oil spill in the environment and the negative effect on water and land agricultural produce. Also, Abdullahi, Madu and Abdullahi (2015) analyse the influence of petroleum on Nigerian economy using secondary annual data from 2000 to 2009. The technique employed for the analysis include linear regression model and found that petroleum has substantial direct influence on the economy. Unfortunately, the mismanagement of the proceeds from petroleum exploration imbues Nigeria into the resource curse dilemma.

Ebegbulem, Ekpe and Adejumo (2013) critically assess the effect of oil exploration on poverty in the Niger Delta region of Nigeria. The authors extensive review of the literature and drawing conclusion from the empirical findings restates the neglect of the region and the consequences of pollution as a drawback to economic progress. The study further concludes that the greatest negative tendency associated with the exploration and exploitation of oil in this region is environmental degradation. However, a recent study by Sam, Coulton and Prpich (2017)

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suggests soil screening and massive clean-up funding to enhance contaminated land legislation. The efforts of government in the recently commissioned clean-up exercise of affected areas could not be ascertained, but given the importance of oil exploration and exploitation to the economy one would expect that this initiative will yield positive results.

Kadafa (2012) examine the environmental impact of oil exploration and exploitation in Niger Delta of Nigeria using tabular analysis of data obtained from secondary sources. The study finds that the oil industry sited within this region has contributed enormously to the economic growth of the country but unsustainable oil exploration activities have rendered the Niger Delta region one of the five most severely damaged ecosystems in the World. Also, Adati (2012) assessed oil exploration and spillage in the Niger Delta region of the country, using comparative analysis of secondary data covering periods from 1976 to 2000 on descriptive techniques such as line and bar graphs, and found a decrease in oil spillage quantity but an increase in the number and times of oil spill.

Ojimba (2012) examining the effects of oil pollution on crop production in Rivers State, Nigeria on a sample of 296 respondents drawn from 17 out of 23 Local Government Areas, applied a stochastic trans-log production function in a multi-stage sampling technique, the results indicate that the effect of crude oil pollution on crop farms reduced the size of farmland, significantly at 1%, reducing marginal physical product (MPP), while in non-polluted farms output increased. Physical inputs, crude oil pollution variables and their interactions show strong negative (diminishing) returns to scale in oil polluted farms, but in non-polluted farmlands results indicate strong positive returns to scale. The technical efficiency results show that less than 22% of crop farmers were over 80% efficient in their use of resources in oil polluted farmlands, while technical efficiency in non-polluted farmlands indicates a high efficiency of 33%. Given the present circumstances in the Niger Delta and the need for improved economic activities for the population, it becomes very imperative for studies to explore the impact of environmental degradation on specific issues such as fish production to enable policy makers pin-point areas of concentration in the implementation of various policies for the economic development of the region.

3. SYLIZED FACTS

The Extent of Oil Spillage

Oil spill incidents have occurred at different times along the Nigerian coast. From the records of the Department of Petroleum Resources (DPR) an estimated 1.9 million barrels of crude oil

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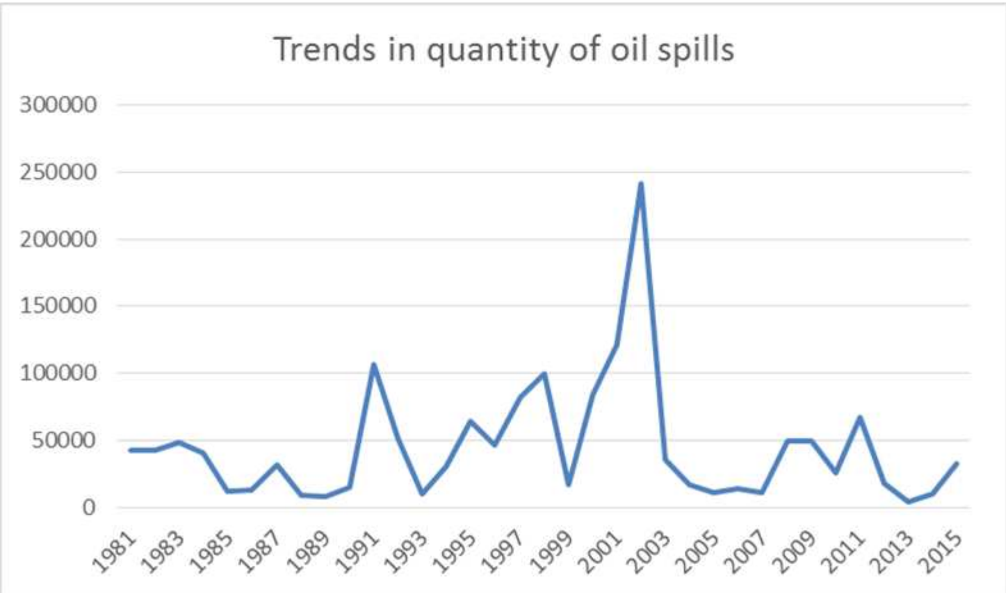
were spilled into the Niger Delta between 1976 and 1996 out of a total estimated 2.4 million barrels produced in 4,581 incidents. Also, DPR 2002 data on oil spills show that, a total of 6,194 oil spills between 1976 and 2001, which account for about 3 million barrels of crude oil spilled into the environment. More than 70% was not recovered 69% of these spills occurred off-shore, a quarter was in swamps and 6% spilled on land. (United Nations Development Programme 2006)

In Bronwen, (1999) the record from the Nigerian National Petroleum Corporation (NNPC) indicates that the amount of crude oil that is spilled into the Niger Delta is estimated at 2,300 cubic metres, on average over 300 spills occur every year. In contrast, the World Bank provides figures which estimates the oil spill to the environment at almost ten times the NNPC figures arguing that the official figures ignore the so called "minor" spills. In the same vein, Nwilo and Badejo (2008) categorically describes the largest individual spills to include the blowout of a Texaco offshore station in 1980, which dumped an estimated 400,000 barrels (64,000 m3) of crude oil into the Gulf of Guinea and Royal Dutch Shell's Forcado Terminal tank failure with an estimated spillage of 580,000 barrels (92,000 m3). Moffat and Linden (1995), finds that the total amount of petroleum products spilled into the environment between 1960 and 1997 is in upwards of 100 million barrels (16,000,000 m3). Baird (2010) has modestly estimated the quantity of petroleum products and crude oil spilled in the Niger Delta through oil exploration activities as falling between 9 million and 13 million barrels. From the records of DPR (2016), within the period of 1976-2015, a total no of 16,476 spills occurred at different occasions and a total quantity of 2,801,704.05 barrels spilled into the environment.

Figure 1: Graph showing the volume of oil spills in barrels 1981-2015



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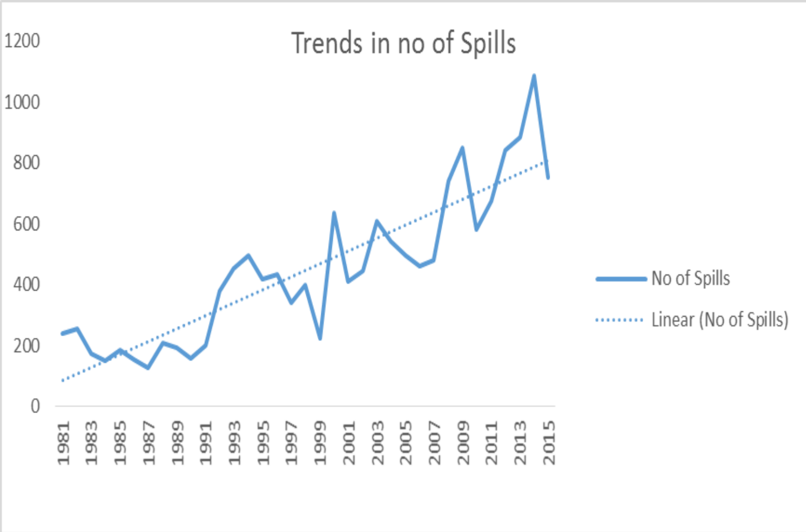
Source: DPR 2016: Arthur's compilation

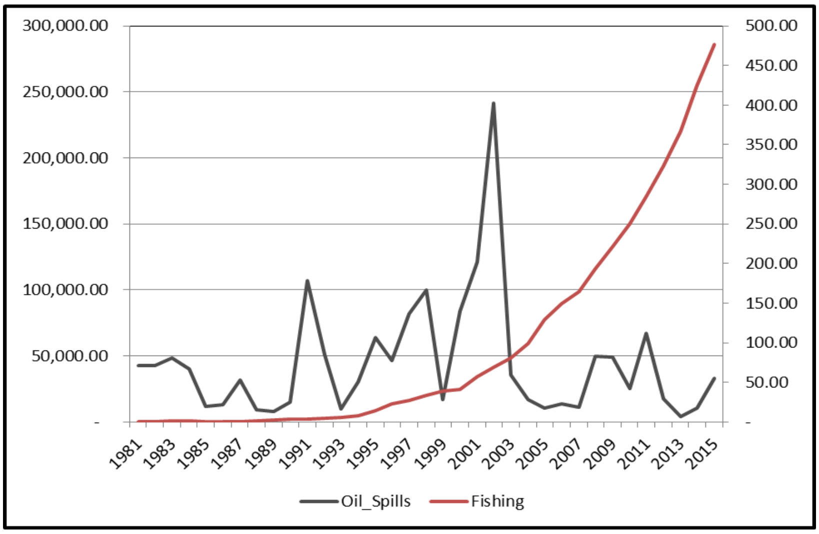
Figure 2: Trend of oil spills in barrels (1981 – 2015)



Source: DPR 2016. Arthur's compilation (2017)

Figure 3: Graph of Oil Spills (Barrels) and Fishing Outputs

(N' billions) of Nigeria (1981 – 2015)



Source: DPR 2016. Arthur's compilation (2017)

4. METHODOLOGY

4.1 Data

This study employs time series data covering periods from 1981 to 2015 sourced from Central Bank Statistical Bulletin (2015), Department of Petroleum Resources (2016), and Food and Agricultural Organisation (2017).

4.2 Model Specification

This study adopts a Cobb Douglas production model as specified by Akpokodje and Salau (2015) which was employed to assess the influence of oil pollution on agricultural productivity in the Niger Delta of Nigeria.

$$FISP_t = f(OILS_t, OILP_t, FCAP_t, FLAB_t) \quad (1)$$

Where;

$FISP_t$: Fish production by captured fish measured in tones at period t.

$OILS_t$: Quantity of oil spills in barrels in period t.

$OILP_t$: Oil production in barrels in period t.

$FCAP_t$: Fish capital proxy by number of fishery loan

$FLAB_t$: Fish labor captured by number of fishers in period t

The dependent variable is Fish production (FISP) and given as the total fish production or output captured from inland and marine measured in metric tons. Aquaculture value is excluded because this research work is natural fish production and not agricultural source. Also, the fishery statistical data presented excludes the production for marine mammals, crocodiles, corals, sponges, pearls, shells and aquatic plants. It is sourced from FAO (2017) and independent variables are: Oil spills (OILS) measured in barrel during production, transportation and vandalization process officially recorded annually by oil companies in barrels, Oil production (OILP) is the value of total quantity of crude oil produced and measured in barrels yearly in Nigeria that is officially recorded from the different oil companies, Fishery labour (FLAB) is the total amount of fishers involved in fish production, which include both artisanal and industrial sectors in fishing business and Fish capital (FCAP) is proxy by the value of Fish production loan through Agricultural Credit Guarantee Scheme Funds.

Equation (1) can be rewritten explicitly as follows:

$$FISP_t = A\ OILS_t^{\beta 1} . OILP_t^{\beta 2} .\ FCAP_t^{\beta 3} . FLAB_t^{\beta 4} . \varepsilon_t \qquad (2)$$

By adopting a double-log transformation of the model specified in equation (2) through taking the natural logarithm of both sides of equation and assuming linearity among the variables. The usefulness of this transformation includes minimization of the huge differences in the magnitude of different variables, thereby bringing out the coefficient of co-variation better and the explanation of the results in the form of elasticity with easily understandable interpretation devoid of complication from measurement unit.

$$LogFISP_t = \beta_0 + \beta_1 IogOILS_t + \beta_2 IogOILP_t + \beta_3 IogFCAP_t + \beta_4 IogFLAB_t + \varepsilon_t \qquad (3)$$

Where

Log: Natural log of the respective variables.

ε_t: stochastic term (with the usual properties of zero and non-serial correlation)

β_0: constant term;

β_1, β_2, β_3, β_4 are elasticities showing the degree of responsiveness of the dependent variable FISP to a proportional change in the independent variables; OILS, OILP, FCAP, FLAB

A priori Expectation

$\beta_1 > 0$, $\beta_2 < 0$, $\beta_3 \geq 0$, $\beta_4 > 0$

4.3 Estimation Techniques

This study employed econometric technique to assess the relationship between oil spillage and fish production among other associated variables. The descriptive method consists of trend graph as shown in Figure 1, 2 & 3 to show the trends of oil spillage and fish production thus explaining the behaviour of the variables from 1981 to 2015. This scope provides long period dynamic variables and their effect on fish production in the Niger Delta of Nigeria. The

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econometric methods adopted include Augmented Dickey Fuller Stationarity test, Johansen co-integration test, Fully Modified Ordinary Least Square (FMOLS) and Pairwise Granger Causality Test. This study employed the Augmented Dickey Fuller unit root to test for stationarity of variables because most time series are non-stationary at their levels, Co-integration is used to test for long run relationship between the dependent variable and the independent variables, Fully Modified Ordinary Least Squares is used to estimate the long run effect of the independent variables on the dependent variables after correcting for the endogeneity problem in the time series and Pairwise Granger Causality Test.

5. Interpretation and Discussion of Results

This section deals with the presentation and analysis of data, including the interpretation of findings from the specified model and a test of the research hypothesis. The parameter estimates were tested on econometric specifications. The logarithm of the variables is used to normalize data that are inherently asymmetric.

i. Stationarity Test

The decision rule for the Augmented Dickey Fuller (ADF) Unit root test states that the PP Test statistic value must be greater than the Critical Value at 5% absolute terms for stationarity to be established at level and if otherwise, differencing occurs using the same decision rule. Thus, the summary of results of the Augmented Dickey Fuller (ADF) unit root presented in table 5.1 shows that all the variables are stationary after first difference at 5% significant level. Therefore, this implies that the variables are **I (1)** series.

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Table 1. Results of Augmented Dickey Fuller (ADF) Unit Root Test

Variables	ADF Test Statistics		Critical Value		Order of integration	Remarks
	Level	1^{ST} diff	1%	5%		
LOGFISP	0.9628	-8.3643	-3.6463	-2.9540	I(1)	First Difference
LOGFLAB	-1.0359	-7.8305	-3.6395	-2.9511	I(1)	First Difference
LOGFLON	-0.5447	-9.3702	-3.6537	-2.9571	I(1)	First Difference
LOGOILP	-1.6021	-5.6437	-3.6394	-2.9511	I(1)	First Difference
LOGOILS	-0.3276	-6.2749	-2.6347	-1.9510	I(1)	First Difference

Source: Author's computation (2017) from E-view (8.0)

ii. Co-integration Test

The co-integration test establishes whether a long-run equilibrium relationship exist among the variables of interest. Since the unit root test revealed that all the variables are integrated of order 1, Johansen Co-integration test can be applied.

Test of co-integration Hypothesis:

H_0: φ = 0 (No Co-integrating equation)

H_1: φ ≠ 0 (Co-integrating equations)

The results of unrestricted trace co-integrating rank test suggest that the null hypothesis (H_0) of no co-integrating equation is rejected and suggests the presence of one co-integrating equation at 5 percent significance level. Also, the unrestricted max-eigen co-integrating rank test rejects the null hypothesis (H_0) of no co-integrating equation and suggests the presence of one co-integrating equation at 5 percent significance level (as shown in Table 2). Hence, we conclude that both unrestricted trace co-integrating rank test and unrestricted max-eigen co-integrating rank test confirmed the presence of co-integrating equation. Hence, there is a long run relationship between the dependent variable (LOGFISP) and the independent variables (LOGOILS, LOGOILP, LOGFLAB, and LOGFLON).

Table 2: Unrestricted Co-integration Rank Test Result

No. of CE(s)	Eigen Value	Trace Statistics	0.05 Critical Value	Max-Eigen Statistics	0.05 Critical value
None*	0.7183	85.2021	76.9728**	39.2774	34.8059**
1	0.4901	45.9246	54.0790	20.8779	28.5881
2	0.3570	25.0467	35.1928	13.6909	22.2996
3	0.2251	11.3558	20.2618	7.90561	15.8921
4	0.1053	3.45017	9.16455	3.45017	9.16455

Source: Author's computation (2017) from E-view (8.0)

NOTE: (**) denotes rejection of hypothesis at 5% level of significance. Trace test and Max-eigenvalue test indicate 1 co-integrating equation each at the 0.05 level

iii. Fully Modified Ordinary Least Square (FMOLS)

The long run adjustment dynamics can be usefully described by the Fully Modified Ordinary Least Square (FMOLS). FMOLS models are categories of multiple time series models that directly estimate the long run effect of the independent variables on the dependent variables after correcting for the endogeneity problem in the time series (Robin, 2008). FMOLS is also referred to as co-integrating equation model.

iv. Goodness of Fit

The goodness-of-fit is justified by the value of the coefficient of determination R squared. The adjusted R squared of 0.7013 indicate the explanatory variables in the model explains that 70 percent variations in fish production is jointly explained by number of fishers (FLAB), credits to fish, oil production and oil spills (independent variables) in Nigeria, while 30 percent of variation in the dependent variable was due to error term. The F statistics confirmed that the model is statistically significant at 5 percent significant level (as shown in Table 3)

v. Statistical Test

The long run estimates presented in Table 3 revealed that number of fishers (FLAB), oil production (OILP) and oil spills (OILS) in Nigeria are statistically significant at 5 percent significance level. But, loan to fishery or fish production is statistically insignificant to explain changes in fish production in Nigeria at 5 percent significance level.

Specifically, a 1% increase in the number of fishers induces 0.72 percent rise in fish production in the long run. However, 1 percent increase in oil production induces 0.43 percent decline in fish production and 1 percent raise in oil spills induces 0.04 percent fall in fish production in the long run (as shown in Table 3).

Table 3 Summary of FMOLS results

Dependent Variable: LOGFISP	Coefficient	Std. error	t-statistic	P-value
LOGFLAB	0.7153	0.019609	39.47806	0.0000**
LOGFLOAN	-0.0051	0.004644	-1.090872	0.2846
LOGOILP	-0.4319	0.036292	-11.90307	0.0000**
LOGOILS	-0.0359	0.006375	-5.638374	0.0000**
Constant	12.4855	0.647376	19.28704	0.0000**
Adjusted $\boldsymbol{R^2}$ = 0.70				

Source: Researcher's computation (2017) from E-view (8.0

NOTE: (**) denotes rejection null hypothesis at 5% significance level

vi. Pairwise Granger Causality Test

Granger (1981) concept of causality occurs when time series Xt and Yt are co-integrated; a linear combination of Xt and Yt must be stationary for further econometric tests to be carried out. Granger causality tests the difference between the two types of causation that exist between two variables (unidirectional and bidirectional causation). Unidirectional causality states that if A Causes B, B cannot cause A, while bidirectional causality test implies that if A Causes B then B causes A.

Table 4: Pairwise Granger Causality Tests

Sample: 1981 – 2015			
Null Hypothesis:	Obs	F-Statistic	Prob.
LFISP does not Granger Cause LNO_SPILLS	34	5.14301	0.305
LNO_SPILL does not Granger Cause LFISP		4.10906	0.0513

Source: Author's Compilation using EVIEWS 9.0

Using this concept, we do not reject the null hypothesis that fish production does not Granger cause the number of times oil is spilled on the environment since its P-value (0.30) is greater than 0.05 significance level. However, we reject the null hypothesis in favour of the alternative hypothesis which states that the number of times oil is spilled on the environment affect the level of fish production; thus, we make a case of unidirectional relationship arguing that the environmental effect of oil spillage as a proxy for the number of times oil is spilled influences the level of fish production in the Niger Delta of Nigeria.

Discussion of Results

The empirical tests confirm the adverse effect of increase in oil spills on fish production in Nigeria. Oil spills are usually due to continuous incidence of vandalism and corrosion of oil pipelines, which destroy aquatic life and pollute the environment such that agricultural activities become impossible in the affected areas of the Niger Delta. The long-term effect of an oil spill incidence is usually a reduction in crop yield and death of fish. This study corroborates the findings in Akpokodje and Salau (2015) that oil spill is a major impediment to agricultural activities in the Nigeria Delta region of the country. In addition, it provides an empirical impetus for the findings in Sam *et al.* (2017) for the management of petroleum hydrocarbon contaminated sites in Nigeria. Also, several studies have shown that the pollution caused by oil spillage does not end with the mopping up of the spilled oil in the land area or water (Agliardi *et al*. 2017). It is now known that health risk is not averted by abstinence from fish killed by spilled oil. Some of the fishes and animals that escape instant death from pollution are known to have taken in some of the toxic substances, which in turn get into human beings

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that eat them. This will in turn cause infections on man coupled with other "side effects in form of genetic mutations" (Agahlino, 2000; Anejionu et al., 2015).

In fact, oil activity depresses fish production in the long run because of the unwholesome environmental degradation that accompany exploration of crude oil in the country. Oil driven environmental factors affecting fishing activities include gas flaring, oil well blowouts, and improper disposal of drilling mud, and pipeline leakages as observed in Ojakorotu & Okeke-Uzodike (2006) and in Sam, Coulton and Prpich (2017), suggesting the prioritisation of sites for the clean-up exercise in the Niger Delta region noting that the high risk areas may not necessary imply the most contaminated zones, but based on the observed levels of hydrocarbon contamination and importance of the zone to the livelihood of the inhabitants.

Furthermore, this study finds that more labour involvement in fish production improves fish outputs in the country, exerting a positive and substantial influence on fish outputs. Sustainable improvement in agricultural sector requires skilled and able-bodied youths to engage in the agricultural process. This would drastically increase agricultural outputs in the country providing jobs for the unemployed youths and reducing incidences of restiveness in the region. However, credit to fish farmers through the Agricultural Credit Guarantee Scheme Funds (ACGSF) exert negligible, inverse and insignificant effect on fish outputs in the long run. This finding confirms the outcome of the studies by Anetor, *et al* (2016), Nwosu *et al.* (2010), and Akinleye, Akanni, & Oladoja (2005) that the Agricultural Credit Guarantee Scheme Fund (ACGSF) has no significant impact on agricultural production. This may be as a result of some challenges affecting the effectiveness of the scheme. Some of the challenges include a high rate of loan default by farmers; lack of full cooperation by participatory banks.

This study also supports the assertion that the nature of operating equipment used by the oil companies, including pipeline vandalization by errant youths of the region are contributory

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factors to the number of oil spills on the environment, which constitute a setback to fish production and agricultural productivity resulting from the destruction of the environment. This result is in tandem with the observation in Elum et al. (2016) on the socioeconomic consequences of oil spill on the environment, recommending an improvement in the infrastructure and equipment in order to prevent oil spills and the attendant youth restiveness resulting from deprivation.

6. Conclusion

This study concludes that there is a trade-off between oil activities and fish production due to the effect of oil spills. This paper has demonstrated that, increase in levels of oil spillage and oil production negatively affects fish production or productivity in the Niger Delta of Nigeria. The incidences of oil spills among other environmental factors depress agricultural outputs particularly fishing. Also, agricultural interventions in Nigeria such as Agricultural Credit Guarantee Scheme Fund (ACGSF) failed to substantially improve fish production in Nigeria. Furthermore, labour input in fishing agricultural sub-sector can be employed to improving productivity in the subsector. A major policy implication arising from the empirical evidence in this study is the need for an enhanced social protection policy for the inhabitants of the Niger Delta because providing credit for agricultural purposes may not yield significant results because of the short supply of arable land for cultivation and clean water for the survival of an aquatic ecosystem. In the same vein, since most inhabitants of these riverine communities are traditionally into peasant fish production, a destruction of the habitat for fish production completely dispossess them of their productive capacity. This informs why there is a high loan default, they need to be educated on the process of commercial fishing that is required for the repayment of a loan.

The Department of Petroleum Resources should enforce policies on pipeline life span duration, in order to reduce corrosion of pipelines. The adoption of the Special Partnership Framework (SPF) will help significantly in reducing oil-induced environmental diseconomies in the Niger Delta of Nigeria, including second-round consequences that undermine peace in the region which adversely affect both oil and agricultural outputs from the region. Improved pipeline quality and monitoring would also lessen the incidence of vandalism and restiveness in the area.

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On the other hand, government should be prompt in the clean-up of the affected areas, and the management of spills (both of catastrophic and local dimensions) will play a leading role by enacting and enforcing stringent environmental laws that will protect the oil producing areas. Government should be able to identify natural resources (such as wetlands and coastal zones) in Nigeria and monetary investment in environmental protection of vulnerable areas should be seriously looked into. There should be an operating standard for the examination of the existing water quality and monitoring, in addition to active monitoring and evaluation systems for water-related projects and services in the region.

Finally, the establishment of a framework for collaboration through training and financial support by government to strengthen environmental agencies and organizations in their role as watchdog for ensuring the exchange of information, especially for high risk oil production activities.

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STATEMENT OF CONFLICT OF INTEREST:

"The authors declare that they have no competing interests".

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