Olaifa, Eseoghene S.; Osabuohien, Evans; Issahaku, Haruna et al.

Article

Oil spillages and captured fish production in the Niger Delta of Nigeria

International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Olaifa, Eseoghene S./Osabuohien, Evans et. al. (2022). Oil spillages and captured fish production in the Niger Delta of Nigeria. In: International Journal of Energy Economics and Policy 12 (3), S. 175 - 183.
https://econjournals.com/index.php/ijeep/article/download/12890/6751/30536.
doi:10.32479/ijeep.12890.

IJEEP
INTERNATIONAL JOURNAL OF ENERGY ECONOMICS AND POLICY
EJ EconJournals
ISSN: 2146-4553

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2022, 12(3), 175-183.

EJ EconJournals

Oil Spillages and Captured Fish Production in the Niger Delta Region of Nigeria

Eseoghene S. Olaifa[1]*, Evans S. Osabuohien[1], Haruna Issahaku[2], Oluwatoyin Matthew[1]

[1]Department of Economics and Development Studies, Centre for Economic Policy and Development Research, Covenant University, Ota, Nigeria, [2]Department of Economics and Entrepreneurship Development, University for Development Studies, Wa, Ghana. *Email: suzie.olaifa@stu.cu.edu.ng

Received: 08 January 2022 **Accepted:** 10 April 2022 **DOI:** https://doi.org/10.32479/ijeep.12890

ABSTRACT

The Niger Delta is the oil-producing region in Nigeria; it is the largest wetland in Nigeria and among the 10 most important wetland and marine ecosystems globally. The incidence of oil spillages raised serious concerns about seafood safety. Hence, this study empirically examined oil spillages and captured fish production in the Niger Delta of Nigeria. This study used secondary data from 1986 to 2018, which was sourced from the Food and Agricultural Organisation (FAO), Central Bank of Nigeria (CBN), Federal Department of Fisheries (FDF) and Department of Petroleum Resources (DPR). The study engaged Auto-Regressive Distributed Lag (ARDL) Bounds estimation technique. The findings revealed that oil spillages negatively impact fish production in Nigeria at 5% level of significance. The ARDL error correction model (ECM) for the first simulation showed a relatively low value of -0.28. This implies a relatively low speed of adjustment, which captures the rate of return to equilibrium. Therefore, this study concludes that oil spillage decreases the quantity of captured fish production in the Niger Delta region of Nigeria. It is essential that fishing remains viable because it is the main employer in the region. This can be accomplished by sustainable exploitation, utilisation and management of oil resources in the Niger Delta region.

Keywords: Oil Spillage, Fish Production, Niger Delta, Energy Resource, Environmental Policy
JEL Classifications: Q1, Q22, Q4, Q49, O13

1. INTRODUCTION

The Niger Delta region of Nigeria is located in the Atlantic Coast of Southern Nigeria, where the River Niger divides into numerous tributaries. It is the oil-bearing region of the country. It is the second-largest delta in the world, with a coastline spanning about 450 km terminating at the Imo River entrance (Adewumi et al., 2018). The Niger Delta region, which spans over 20,000 km^2, is described as the largest wetland in Africa and among the three largest in the world. Izah (2018) noted that about 2370 km^2 of the Niger Delta area consist of rivers, creeks and estuaries, while stagnant swamp covers about 8600 km^2. The Niger Delta region also has the largest mangrove swamps in Africa (Izah, 2018).

Many of the people in the Niger Delta make their livelihoods from fishing and farming because the Niger Delta has diverse regions with rich mangroves and waterways rich in fish (Adebayo, 2019). The ecosystem in the Niger Delta region of Nigeria is highly diverse and supports numerous species of terrestrial and aquatic flora, fauna and human population. The ecosystem of the Niger Delta wetland is of high economic importance to both the locals and the nation at large. The region is known for its rich aquatic and terrestrial biodiversity, and it serves as the primary source of livelihood for the rural dwellers (Okonkwo et al., 2015). With high levels of involvement in fishing activities and increasing revenues from oil exploration, the Niger Delta region is expected to have high levels of fish production and low poverty levels, but the reverse is the case (Orebiyi and Ekang, 2018). According to the Nigeria Bureau of Statistics (2020), the poverty rate in the Niger Delta region using the poverty headcount rate, Abia State is 30.67%, Balyesa 22.61%, Akwa Ibom 22.82%, Cross River 32.29%, Delta 6.2%, Edo 11.99%, Imo 28.86%, Rivers 23.91% and Ondo 12.52%. Compared to the other Southern States without oil activities, such as Lagos 4.50% and Ogun 9.32%, it is clear that oil pollution affects the indigenes of the Niger Delta States. Oil spillage has a major impact on the ecosystem into which it is released and may constitute ecocide (Okon, 2017). Immense tracts of the mangrove forests, 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 the Nigeria mangrove have been wiped out by oil (Numbere, 2020).

Despite having a coastline of about 853 km closest to the Atlantic Oceans, as well as fresh and mangrove swamps, creeks, coastal rivers, estuaries, bays and both near and offshore waters, and recent efforts of Federal, States, Local governments and private sector involvement in the development of the fishery sector, it is ironic that Nigeria still depends on fish importation to meet most of her fish demands. This has resulted in a net import of about 60% of the fish consumed in Nigeria (Food and Agricultural Organisation-FAO, 2017).

The literature on oil spillages in the Niger Delta majorly focused on the chemical effects on marine animals (Ekpenyong and Udofia, 2015; Abii and Nwosu, 2009; Okon, 2017; Raji and Abejide, 2013), on human earth (Frank and Boisa, 2018; Binuomoyo and Ogunsola, 2017; Ekpenyong and Udofia, 2015; Ekanem and Nwachukwu, 2015; Atubi et al., 2015), mangrove forest and farmlands (Akpokodje and Salau, 2017; Okon, 2017; Ekanem and Nwachukwu, 2015; Emuedo et al., 2014) without much emphasis on the fish production in Nigeria.

2. CAUSES OF OIL SPILLAGE

The causes of oil spillage are many. The corrosion of oil pipelines happens to be the most significant cause of oil spillage, and this is due to oil companies' inadequate maintenance of the pipelines. The major reason that corrosion accounts for such a high percentage of all spills is due to the small size of the oilfields in the Niger Delta. There is an extensive network of pipelines between the fields and numerous small networks of flow lines allowing many opportunities for leaks. In coastal areas, most pipelines and flow lines are laid above ground. Therefore, pipelines with an estimated life span of about 15 years are old and susceptible to corrosion. Most of the pipelines are above 25 years (Amnesty International, 2018). This corroborates the finding of Adebayo (2019), who reported that corrosion of oil pipelines and tankers accounted for 50% of the total oil spillage in the oil-producing region of Nigeria.

The second most significant cause of oil spillage in the study area was sabotage, also known as bunkering, which is a process of damaging oil pipelines by saboteurs to steal oil from them. Shell Petroleum Development Company, however, claimed that oil spills caused by corrosion of pipelines had decreased drastically over the years due to the concerted effort to replace the pipelines. It further claimed that sabotage had taken over the lead in oil spillage, accounting for over 60% of the oil spills at its facilities in Nigeria (Adebayo, 2019). Other causes of oil spillage include drilling of oil wells, and vandalisation of oil pipelines caused by some members of the oil-producing communities due to neglect accorded them by both government and the oil companies. This evidence in the youth restiveness in the Niger Delta region in the past decades.

Table 1 shows that corrosion is the highest cause of spillage, as indicated by 50%. Item 4 covers engineering drills, inability to control oil well, machines failure, and inadequate care in loading and unloading oil vessels.

Table 2 indicates that the most significant quantity of spills occurs offshore, as shown by 69%, with that of land is only 6%. The major causes of spillage in the Niger Delta have been traced to leak or burst oil pipelines and tanks due to lack of regular maintenance.

3. SOME BACKGROUND FACTS

Oil spill incidents have occurred at different times along the Nigerian coast. From the records of the Department of Petroleum Resources (DPR) 2019, an estimated 1.9 million barrels of crude oil were spilt into the Niger Delta between 1976 and 1996 out of a total of 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 spilt into the environment. More than 70% was not recovered 69% of these spills occurred offshore, a quarter was in swamps, and 6% spilt on land (United Nations Development Programme 2006).

The Nigerian National Petroleum Corporation places the quantity of crude oil spilt into the environment yearly at 2,300 cubic metres with an average of 300 individual spills annually (Bronwen, 1999). However, the World Bank argues that the actual quantity of petroleum spilt into the environment could be as much as 10 times the officially claimed amount because the amount spilt does not consider "minor" spills. Also, Nwilo and Badejo (2005) stated that the most significant individual spills include the

Table 1: Causes of spills

S/N	Causes of oil spillage	Percentage of spillage
1	Corrosion	50
2	Sabotage	28
3	Oil production operation	21
4	Engineering drills	1
	Total	100

Source: Researchers' compilation with data source from department of petroleum Resources (DPR, 2018)

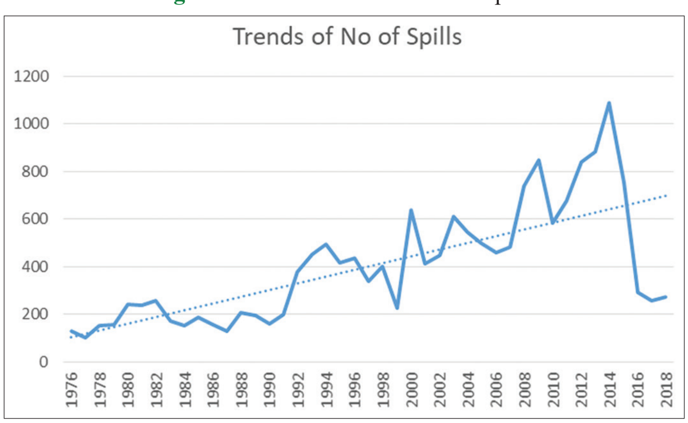
Table 2: Location of spillage

S/N	Location	Percentage of spillage
1	Offshore	69
2	Swamp	25
3	Land	6
	Total	100

Source: Department of Petroleum Resources (DPR, 2018) 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). Moffat and Linden (1995) opined that the total amount of petroleum in barrels spilt between 1960 and 1997 was upwards of 100 million barrels (16,000,000 m3). Baird (2010) reported that between 9 million and 13 million barrels had been spilt in the Niger Delta since 1958.

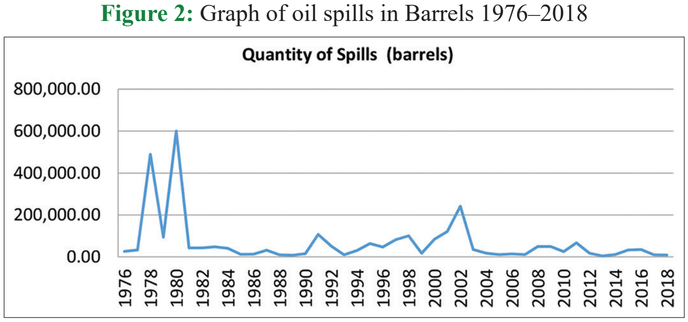
From the records of DPR (2019), from 1976 to 2018, a total no of 17,301 spills occurred on different occasions, and a total quantity of 2,854,193.05 barrels was spilt into the environment. According to the minister of environment, Mohammad Abubakar, in a hall meeting on protecting the oil and gas infrastructure in Nigeria, the impact of vandalism of oil facilities have not only caused pollution of the environment but had consequences on the local people, the national economy and security (Wasilat, 2021). National Oil Spill Detection Agency (NOSDRA) data also recorded that the total number of oil spills from 2015 to March 2021 is 4919, the number of oil spills caused by collation is 308. Operational maintenance is 106, while sabotage is 3628 and 70 is yet to be determined. In all, the total number of oil spills that occurred in the environment was 235,206 barrels of oil. This is very massive to the environment. From several statistics, Nigeria has been highlighted as the most infamous country globally for oil spills, with roughly 400,000 barrels daily (Wasilat, 2021). Figures 1 and 2 shows the number of times oil spills incidence occurred yearly and the graph of the quantity of oil spilled in barrels yearly from 1976 to 2018.

Figure 1: Trends of number of oil spills



Source: Author's compilation

Figure 2: Graph of oil spills in Barrels 1976–2018



Source: Author's compilation

4. METHODOLOGY

4.1. Theoretical Framework

This study is based on the theory of agricultural development, population growth and land utilisation developed from Boserup's (1965) work. In most less developed countries, agricultural development concerns are mostly related to the intensification of land utilisation in different forms. Boserup theory denotes that most societies economic problem is how best to adapt agricultural technology and land utilisation, given the supply of land and other factors.

Figure 3 shows the interrelationship between agricultural population, agricultural labour per worker, the productivity of land per acre and per worker average yield in agriculture,

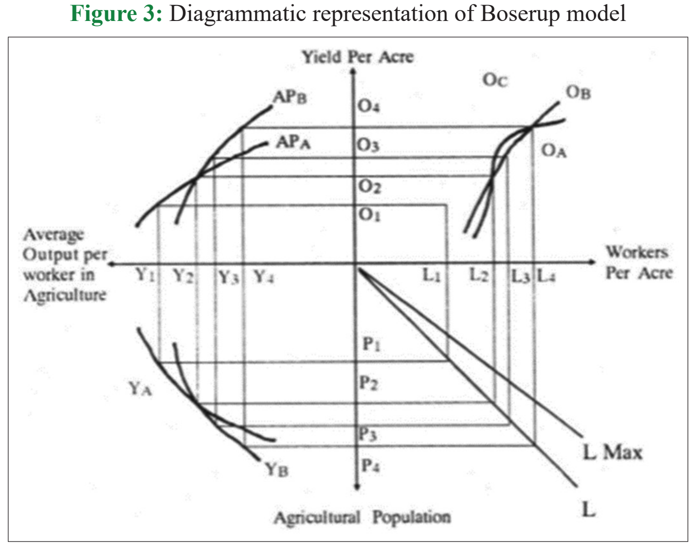
Figure 3 quadrant 1 shows that the relationship between agricultural population and labour per acre will be a straight line if the land is fixed and the labour force's participation does not change. This function can be written as:

$$L=f(P) \quad (1)$$

Where L represents the number of labour per acre and P agricultural population. An increase in cultivated agricultural land will rotate the line closer to the population axis. In contrast, an increased labour force participation rate will rotate the line nearer or closer to the labour per acre axis. The maximum labour force participation rate can be defined as the maximum labour potential supply from each population, where labour per acre is maximum if the land is constant.

Quadrant 2, island productivity and labour force per acre. A production function with one input, labour, imposes decreasing returns to scale examined using Cobb Douglas production function. The advantage of using the Cobb-Douglas function is its reasonable proximity with economic theory and facility for calculating the partial elasticity of output concerning input and returns to scale (Rahim et al., 2019). Estimation of returns to scale is essential

Figure 3: Diagrammatic representation of Boserup model



Source: Adopted from Bustanul Arifin work (1992) because it indicates the most efficient scale firms. In the Cobb Douglas model, if the sum of the coefficients is more significant than one, the production function has increasing returns to scale. If the sum of the coefficients is less than one, returns to scale decrease, while if they are equal to one, there are constant returns to scale.

Cobb Douglass production function may represent the relationship as:

$$Y/A=L^{a} \quad (2)$$

Where Y/A denotes output per acre or productivity of land with 0 a 1, when expressed in logarithm, the coefficient "a" illustrates labour elasticity or changes in output concerning changes in labour.

Quadrant 3, is a presentation of land productivity and labour productivity which shows that increase in land productivity leads to a decrease in labour productivity alongside a fixed amount of land, which shows diminishing returns of production. Labour productivity is measured as output per unit labour. Quadrant 3 function shows that greater intensity of land cultivation as population and labour grows will raise output yield and output per acre, but output per labour input steadily decline. This relationship can be represented as:

$$Y/L=Y/A*A/L \quad (3)$$

Where Y/L is the productivity of labour, Y/A is the productivity of land or output per acre, and A/L represents the inverse of labour per acre or ratio of land-labour.

Quadrant 4, shows labour productivity and agricultural population. The assumption is that labour force and population are linearly related, the relationship between labour productivity and agriculture and population may follow the standard average product curve. This can be expressed as:

$$Y/L=P^{b} \quad (4)$$

Where Y/L represents labour productivity at 0 b 1. Continuous labour force involvement rate also shows the average total product as an index of per capita income. Boserup model introduces the link between autonomous population and growing population function.

From the graph in Figure 3, attention should be on the shift in production due to technological progress, which may require human development (Ejemeyovwi et al., 2019). From Y_A as a starting point of the production function with a level of the agricultural population P_1 and equivalent level of labour per acre L/A_1. Land productivity would be Y/A_1 with the equivalent labour productivity or average product income per capital at Y/L_1. In a situation where land is fixed, assume the population grows to P_2, L/A_2 labour density will be the new equilibrium Y/A_2, land productivity and average income per capita of Y/L_2 which is still higher than Y/L_S substance level. There is no effect of this new equilibrium since both Y_A and Y_b production function intersected. Nevertheless, at the population level P_3, level of labour density Y/A_3 the system will choose Y_b with a new type of technology due to higher yield per acre. In holding everything constant, a new condition will lead to a decrease in income per capita, reaching the subsistence level Y/Ls. If the fixed land assumption is relaxed, the system expands the land to maintain per capita income.

4.2. Model Specification

$$FISP_t = f(OILS_t, FCAP_t, FLAB_t, FVES_t. SPIN_t) \quad (5)$$

Where:
$FISP_t$ denote the quantity of fish produced at time "t," $OILS_t$ represents the quantity of oil spills in barrels at time "t," $FCAP_t$ represents fish capital in the study, it covers for technological innovation as well as human capital development, and it is proxied by agricultural loan at time "t.," $FLAB_t$ is used to represent fish labour, and it is captured by the number of fishers at time "t," $FVES_t$ denotes fishing Vessels which is captured by the number of vessels at time "t" and $SPIN_t$ which represents the number of times oil spills incidence occurred at time "t."

The empirical model is stated explicitly as follows

$$FISP_t=\beta_0+\beta_1 OILS_t+\beta_2 FCAP_t+\beta_3 FLAB_t+\beta_4 FVES_t+\beta_5 SPIN_t+\varepsilon_t \quad (6)$$

To obtain an estimable linear function of equation (3.10), the variables on both sides would be transformed into their standard logs (L) to obtain the following:

$$LFISP_t=\beta_0+\beta_1 LOILS_t+\beta_2 LFCAP_t+\beta_3 LFLAB_t+\beta_4 LFVES_t+\beta_5 LSPIN_t+\varepsilon_t \quad (7)$$

The coefficient estimates, in this case, are interpreted as constant elasticities, which essentially capture the sensitivity of the dependent variable to a unit variation in each of the explanatory variables.

In the econometric specification in equation (6), oil spills and spills number is used to account for the environmental factor that affects fish production in the Niger Delta region. The use of fish labour (FLAB), fish vessels (FVES) and fish loan (FCAP) is appropriate under the assumption of the steady state. This steady-state occurs when the water body is free from oil spills and effectively monitored crude oil production (Akpokodje and Salau, 2017).

4.3. Data Source

This study employs quantitative and qualitative techniques of analysis. Data was sourced from the Federal department of Fisheries (FDF), Department of Petroleum Resources (DPR), Food and Agricultural Organisation (FAO), and Central Bank of Nigeria (CBN). The data was from 1986 to 2018.

4.4. Model Estimation Technique

4.4.1. The ARDL-bounds estimation technique

This study utilises time-series data of fish production in Nigeria. With the time series nature of the dataset, this study employed the Autoregressive Distributed Lag ARDL in carrying out the analysis. The ARDL was used to determine whether a long-run association exists among the dependent variable and independent variables. The long-run impact of the independent variables on the dependent variable when the presence of long-run association has been established was determined based on the stationarity properties of the data set.

The bounds testing cointegration procedure also known as autoregressive distributed lag (ARDL) estimation procedure as advanced in Pesaran, Shin, and Smith (2001) would be employed in this study to examine the long-run relationship between the dependent and independent variables. The strength of this estimation technique has to do with its ability to handle relationships irrespective of whether the regressors are I(0) or I(1). The ARDL technique can also avoid the pre-testing problems associated with the traditional cointegration analysis, which requires classifying the variables into I(1) and I(0). In ARDL estimation, it is usually essential to ascertain whether the variables are co-integrated by restricting the coefficients of the lagged level variables to be equal to zero (0). Therefore, the null hypothesis (H0) of no cointegration is stated as:

$H_O: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$

The null hypothesis (H_O) can be tested against the alternative hypothesis (H_1) of the presence of cointegration among the variables as:

$H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$

Thus, the long run model would be estimated as

$$LFISP_t = \beta_0 + \sum_{t=1}^{p} \beta_{1i} LFISP_{t-1} + \sum_{t=1}^{q1} \beta_{2i} LOILS_{t-1} + \sum_{t=1}^{q2} \beta_{3i} LFCAP_{t-1} + \sum_{t=1}^{q3} \beta_{4i} LFLAB_{t-1} + \sum_{t=1}^{q4} \beta_{5i} LFVES_{t-1} + \sum_{t=1}^{q5} \beta_{6i} LSPIN_{t-1} + \varepsilon_t \quad (8)$$

The ARDL (p, q_1, q_2, q_3, q_4, q_5) specification of the short-run dynamics can be derived from the error correction representative of the form:

$$\Delta LFISP_t = \beta_0 + \sum_{t=1}^{p} \beta_{1i} \Delta LFISP_{t-1} + \sum_{t=1}^{q1} \beta_{2i} \Delta LOILS_{t-1} + \sum_{t=1}^{q2} \beta_{3i} \Delta LFCAP_{t-1} + \sum_{t=1}^{q3} \beta_{4i} \Delta LFLAB_{t-1} + \sum_{t=1}^{q4} \beta_{5i} \Delta LFVES_{t-1} + \sum_{t=1}^{q5} \beta_{6i} \Delta LSPIN_{t-1} + \lambda ECM_{t-1} + \varepsilon_t \quad (9)$$

The symbol Δ is the difference operator,

It is pertinent to note the error correction model based ARDL (p, q) approach, with p as the dependent variable's lag and q as the independent variables' lag. Therefore, the general model specified accordingly as follows:

$$\Delta InY_t = \sum_{j=1}^{p-1} \beta_j^i \Delta InY_{t-j} + \sum_{j=0}^{q-1} \rho_j^i \Delta InX_{t-j} + \delta^i \left[InY_{t-1} - \left\{ \theta_0^i + \theta_1^i X_{t-1} \right\} \right] \quad (10)$$

where Y is fish production, X is the vector set of all independent variables included in the model including oil spillage, ρ is the respective short-run dynamic coefficients of lagged dependent and independent variables. θ represents the coefficients of the long-run, δ represents the coefficient of the speed of adjustment to the equilibrium in the long-run, t represents the years, and ε is the error term. The whole term in the square bracket represents the long-run regression derived from:

$$\text{In } Y_t = \theta_0^i + \theta_1^i X_t + \varepsilon_t \quad (11)$$

Where $\varepsilon_t \sim$ I(0).

Equation (10) can further be expressed in this study as;

$$ECM_t = LFISP_t = \beta_{1i} LFISP_{t-1} + \beta_{2i} LOILS_{t-1} + \beta_{3i} LFCAP_{t-1} + \beta_{4i} LFLAB_{t-1} + \beta_{5i} LFVES_{t-1} + \beta_{6i} LSPIN_{t-1} \quad (12)$$

The model was estimated using the ARDL-Bounds estimation technique. One of the major advantages of this methodology is that, unlike the Johansen Co-integration technique that asserts that long-run relationship could only occur among the variables of the same order of integration, the ARDL approach could be used even if the variables are of a different order of integration, i.e., I(0), I(1) or mixed. Also notable is that the ARDL estimator produces consistent estimates despite the possibility of endogeneity as it includes the lags of dependent and independent variables (Sulaiman and Abdul-Rahim, 2019).

4.4.2. Unit root and cointegration tests

Before going into the main estimation of the ARDL estimators, unit root and cointegration would be conducted to ascertain the order of integration of the variables and the probable existence of long-run relationship among the variables, respectively. Augmented Dickey-Fuller (ADF) unit root test will be used to identify the order of integration of the variables (Sulaiman and Abdul-Rahim, 2019). The augmented Dickey-Fuller (ADF) test is considered superior because of its popularity, wide application, and easy applicability (Nkoro and Uko, 2016).

These tests were chosen due to their power in detecting the order of integration of variables, as in the case of this study, whilst the long-run relationship among the variables would be tested.

5. ECONOMETRICS RESULTS

Table 3 shows the descriptive analysis of the variables. From an observation, all the variables had 33 observations, which makes the distribution to be approximately normal based on the central limit theory. Notably, the fish loan had an average of 114.3, the maximum value of 467.60 billion naira and the minimum value of 1.83 billion naira. On the other hand, fish produced in Nigeria had an average of 490,549 metric tons of fish produced, a maximum of 916,284 metric tons of fish produced, and a minimum of 238,409 metric tons fish produced. The number of fishers displayed on the fourth column of Table 3 showed a mean of 1,118,625 fishers while having a maximum of 2,015,785 fishers and a minimum of 274,470 fishers in Nigeria.

Also, on the descriptive statistics, Oil production had an average value of 777,000,000 barrels in Nigeria while having a maximum value of 925,000,000 barrels and a minimum value of 429,000,000 barrels. On the number of oil spills in the Niger Delta Region of Nigeria, an average value of about 448 spills was observed, while a maximum value of 883 and minimum value 129 number of spills was observed. Furthermore, on the value of oil spillage, an average of 43,189 barrels was observed, while a maximum of 241,618 barrels was observed. Notably, fishing vessels had an average value of about 77,196, while a maximum value of 77,422 vessels and a minimum of 77,134 vessels were observed.

The unit root test result presented in Table 4 shows that the variables are integrated of orders 0 and 1 (levels and first difference). This necessitates the utilisation of the autoregressive distributive lag (ARDL) estimation technique. More specifically, the variables that are stationary at first difference include fish production, fishing loan, fishing vessels, fishers, and spill number, while the variable that is stationary at levels include oil spillage and oil production.

The ARDL Bounds Test in Table 5 shows the presence of a long-run cointegration nexus between the areas of interest. The conclusion was made given that the F-Bounds Test Statistic for the 3 simulations are higher than the upper and lower bound values

Oil spillage in Table 6 was found to significantly impact fish production at a 5% level of significance because the t-statistics' values are greater than 2. Furthermore, the findings of the study show that a negative relationship exists between oil spillage and fish production in Nigeria. This finding follows the a priori expectation of a negative and significant relationship between the two core variables of interest. In addition, the coefficients show that an increase in the oil spillage impacted fish production with a less than proportionate decrease of about 0.27 (simulation 1), 0.05 (simulation 2) and 0.10 (simulation 3).

Table 6, row 15, also showed the ARDL error correction mechanism (ECM) for the first simulation showed a relatively low value of (-0.28). However, the value lies between 0 and 1 and is negative. This implies a relatively low speed of adjustment, which captures the rate of return to equilibrium if and when there are errors on the long-run equilibrium path. Simulations 2 and 3 showed impressive values of -0.93 and -0.88, which also are negative and lie between 0 and 1. The speed of adjustment for simulations 2 and 3 is far more impressive than that of equation 1. In sum, the overall error correction mechanism is suitable based on the relative comparison of the ECM.

Notably, the post estimation tests conducted for the study include the Ramsey reset test for omitted variables, Breusch-Godfrey Serial Correlation LM, Breusch –Pagan-Godfrey Heteroscedasticity, Jarque-Bera normality test and cumulative sum of squares

Table 3: Descriptive statistics

	Fish capital (Billions #)	Fish production (N'000) Tons	Fish Labour (N'000)	Oil production (N' 000,000) Barrels	Spill number	Oil spillage (Barrels)	Vessels
Mean	114.30	490.5	1118.6	777.0	448	43,189	77,196.52
Median	49.39	465.2	1159.4	80.8	435	30,283	77,239.00
Maximum	467.60	916.2	2015.7	925.0	883	241,618	77,422.88
Minimum	1.83	238.4	274.4	429.0	129	3,749	76,134.00
Std. Dev.	135.47	190.8	575.7	1.18	210	47,776	244.39
Skewness	1.18	0.45	–0.08	–1.17	0.40	2.43	–2.86
Kurtosis	3.06	2.30	1.52	4.19	2.35	10.11	12.50
Obs.	33	33	33	33	33	33	33

Source: Researchers' Computation using Eviews 10

Table 4: Unit root test

Variables	@ Levels		@ First Difference		Stationarity remark
	ADF test statistic	Critical values @ 5% Signif	ADF test statistic	Critical values @ 5% Signif	
Fish Production	–0.01	–2.96	–8.28	–2.96	1st difference I (1)
Fish Capital	–1.75	–2.95	–5.94	–2.96	1st difference I (1)
Fishing Vessels	–1.73	–2.98	–4.91	–2.96	1st difference I (1)
Fish Labour	–1.11	–2.95	–7.15	–2.95	1st difference I (1)
Spill Number	–2.31	–2.95	–6.81	–2.96	1st difference I (1)
Oil spillage	–3.42	–2.95			Level I (0)
Oil Production	–3.42	–2.95			Level I (0)

Source: Researchers' Computation using Eviews 10

Table 5: ARDL bounds test

	Model Simulation 1 F-Bounds test statistic	Model Simulation 2 F-Bounds test statistic	Model Simulation 3 F-Bounds test statistic	Upper bound @ 5% Signif	Lower bound @ 5% Signif
Value	4.86	6.32	6.21	2.947	4.088
Remark	presence of cointegration	presence of Cointegration	presence of cointegration		

Source: Researchers' Computation using Eviews 10

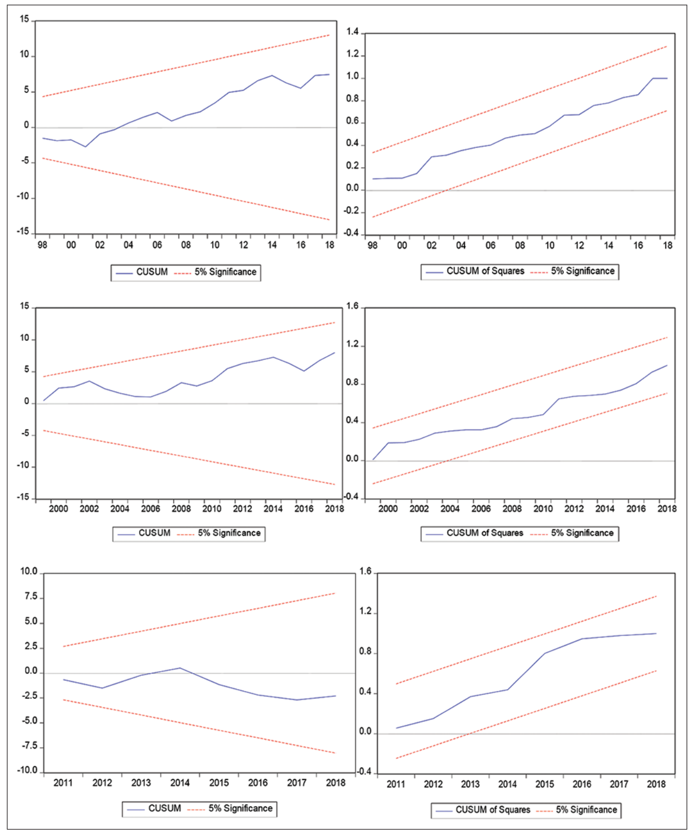
Table 6: ARDL Long-run, ECM and Post Estimation Tests' Results

Dependent variable: Fish production	Simulation 1	Simulation 2	Simulation 3
Oil spillage	–0.27 (2.12)**	–0.05 (–2.38)**	–0.10* (–2.88)**
Fish Labour	0.22 (1.26)	0.22 (3.72)***	0.16 (1.86)*
Fishing Vessels	238.06 (2.29)**	29.98 (1.86)*	121.31 (3.28)**
Spill Number	0.18 (1.22)		
Fish Capital		0.13 (5.49)***	0.13 (3.62)***
Constant	–1158.48 (–2.28)**	–142.16 (–1.81)	–588.00 (3.26)**
ARDL-ECM	–0.28	–0.93	–0.88
Ramsey Reset (Omitted variable) p value	0.63	0.48	0.32
Breusch-Godfrey Serial Correlation LM p value	0.18	0.43	0.34
Breusch –Pagan-Godfrey Heteroscedasticity p value	0.66	0.36	0.44
Jarque-Bera Normality p value	0.70	0.53	0.53

The t-statistic values are in round brackets ()*, ** and *** signifies the level of significance at 10%, 5% and 1%, respectively

stability tests. Overall, an observation of the p-values of the post estimation tests shows that there is an absence of omitted variables, serial correlation, heteroscedasticity and the dataset is normally distributed, which all ensure reliable estimation coefficients for policy recommendation. Furthermore, the stability tests carried out by the CUSUM and CUSUM squares tests, also show that the model is stable and reliable. The test results are seen in Table 3 and Figure 4.

Figure 4: CUSUM and CUSUM squares stability test



6. DISCUSSION OF FINDINGS

This study confirmed the adverse effect of oil spillage on fish production in Nigeria. These oil spills are usually due to continuous vandalism of oil pipelines that destroy aquatic life and pollute the environment such that agricultural activities become impossible in the affected area, especially in the Niger Delta region of the country. The long-term effect of this incidence is usually a reduction in fish yield and death of fish. A study by Osuagwu and Olaifa (2018) also found that oil spills are a major impediment to fishing activities in the Nigeria Delta region of the country. Also, several studies have shown that the pollution caused by oil spillage does not end with the mopping up of the spilt oil. Also, the health risk is not averted by abstinence from fish killed by spilt 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 that eat them. This will, in turn, cause infections in man coupled with other "side effects in the form of genetic mutations" (Agahlino, 2000; Anejionu et al., 2015).

Oil activity depresses fish production in the long run because of the unwholesome environmental degradation that accompanies crude oil exploration in the country. These oil-driven environmental factors affecting fishing activities include gas flaring, oil well blowouts, improper drilling mud disposal, and pipeline leakages (Ojakorotu and Okeke-Uzodike, 2006). Furthermore, this study finds that more fish farmers' involvement in fish production improves fish outputs in the country, exerting a positive and substantial influence on fish outputs. Sustainable improvement in fish production required skilled and able-bodied youths to engage in the fishing process. This would drastically increase fish production in the country, providing jobs for the unemployed youths and reducing incidences of restiveness in the county. However, credits to fish farmers through the agricultural credit guarantee scheme funds (ACGSF) positively affect fish outputs in the long run, only if fish farmers have access to loans. Some of the challenges include a high rate of loan default by farmers, a lack of full cooperation by participatory banks, and the failure of the government to extend the rural branch network to cover the rural fish farmers.

Also, fishing vessels positively affect fish production in Nigeria, indicating that every increase and improvement in fishing vessels will increase fish production in Nigeria. More licensed fishing vessels in Nigeria will increase fish production in the country. In 2019, the Deputy Director, Fisheries Department of the Ministry of Agriculture, Mrs Bola Kupolati, in vanguard maritime report, said that fishing vessels are licenced every year to monitor these vessels (FCWC-Fisheries Committee for the West Central Gulf of Guinea, 2019). She said these vessels got licenced for catching shrimps as against fishes. 143 was licenced, only 2 was for fishes, while the remaining 141 was for shrimps. She disclosed that while

N500, 000 is charged to license vessels for inshore fishing and Shrimping, N1million is charged for a vessel involved in distance water or deep-sea fishing (FCWC, 2019). This amount is relatively high for local fish farmers' involvement, especially because most of them do not have access to loans.

7. CONCLUSION AND RECOMMENDATIONS

The discovery and exploration activities of crude oil in the Niger Delta has had severe environmental and human consequences for the indigenous people who inhabit the surrounding area of oil extractions. Hundreds of thousands of households in the Niger Delta rely on fishing for money and sustenance, both in inland rivers and offshore. Damages to fishing activities in the Niger Delta region is widely recognised as one of the primary consequences of the oil industry by both governmental and non-governmental sources. Oil spills and other oil-related pollution have also severely harmed the mangroves of the Niger Delta, which are essential fish breeding habitats and difficult to clean when contaminated. Given the significance of fisheries as a source of revenue and food in the region, it is difficult to understand why oil pollution has not been monitored. The Niger Delta River is an important ecosystem that needs to be protected, for it is home to nearly 250 species of fish, of which 20 are endemic.

Oil spillages contaminate the water bodies due to the chemical content of crude oil. The release of such chemicals into the fishing environment affects the quality and quantity of fish and, in some cases, the complete extinction of some fish species in the region, thereby affecting the livelihood source of fish farmers that rely mainly on fishing to support their family. Environmentalists and people, in general, blame the oil companies, but the Federal Government provides the laws, legislations and licenses to the oil companies, which must be followed.

Lack of enforcement of existing regulatory laws is a major constraint in legislation. The majority of the laws that regulate oil companies' activities are poorly enforced and uncoordinated. Some of these laws are outdated; they need to be harmonised and reviewed according to reality on the ground. The Federal Government of Nigeria needs to take decisive and better steps, which they have started with NOSDRA, NDDC, UNEP, UN, SPDC, DPR and NGOs. To achieve sustainable development in the Niger Delta, the Federal Government should continue to allocate more revenue and monitor such revenues in the Niger Delta to find a permanent and lasting solution.

Nigerian oil firms should enhance their efforts to avoid oil spills, boost emergency response, and better repair the environment to comply with international best practices. Through the National Oil Spill Detection and Response Agency (NOSDRA), the Federal Government of Nigeria should thus examine spill response procedures, establish independent monitoring, modify legislation, strengthen enforcement measures, and better explain institutional roles and duties. In addition, the Nigerian government should evaluate spill compensation, establish a spill insurance fund, and conduct a full examination of the spilt environment.

8. ACKNOWLEDGMENT

This paper draws from the doctoral research thesis of the first author under the supervision of the second and third authors. The inputs of the faculty of Covenant University at the various seminar presentations are appreciated. Also, the support of Covenant University Centre for Research, Innovation and Discoveries (CUCRID) in preparation of the manuscript is acknowledged.

REFERENCES

Abii, T.A., Nwosu, P.C. (2009), The effect of oil spillage on the soil of Eleme in rivers state of the Niger Delta Area of Nigeria. Research Journal of Environmental Sciences, 3(3), 316-320.

Adebayo, B. (2019), Contaminated Lands, Water: New Major Enquiries in Oil Spills in Niger-Delta. Available from: https://www.vanguardngr.com/2019/03/contaminated-lands-water-new-major.

Adewumi, A.A., Agunbiade, O.R., Longe, O.O., Fadiya, O.O., Adewumi, I.K. (2018), Climate change and the Niger delta region. Advances in Social Sciences Research Journal, 5(9), 1-10.

Agahlino, S.O. (2000), Petroleum exploitation and agitation for compensation by oil producing communities in Nigeria. Geo Studies Forum, 1, 11-20.

Akpokodje, J., Salau, S. (2017), Oil pollution and agricultural productivity in the Niger Delta of Nigeria. Journal of Environmental Economics, 6(4), 68-75.

Amnesty International. (2018), Niger Delta Negligence. Available from: https://www.amnesty.org/en/latest/news/2018/03/niger-delta-oil-spills-decoders

Anejionu, O., Ahiarammunnah, P., Nri-Ezedi, C. (2015), Hydrocarbon pollution in the niger delta: Geographies of impacts and appraisal of lapses in extent legal framework. Journal of Resource Policy, 45, 65-77.

Atubi, A.O., Ogbija, T.E., Ojeh, V.N. (2015), Effects of environmental degradation on human health in selected oil communities in Delta state. Journal of Environment and Earth Science, 5(9), 72-88.

Binuomoyo, O.K., Ogunsola, O.A. (2017) Oil spills and the Niger Delta Bloodlines: examining the human tragedy. Journal of Life and Physical Science, 8(1), 8-18.

Bronwen, M. (1999), The Price of Oil, Human Rights Watch. Available from: http://www.scholarship.claremont.edu/cgi/viewcontent.cgi?article=1087&contex

Central Bank of Nigeria. (2019), Statistical Bulletin. Vol. 30. Nigeria: Central Bank of Nigeria. Available from: http://www.statistics.cbn.gov.ng/cbn-onlinestats/DataBrowser.aspx

Department of Petroleum Resources. (2019), Oil Spills Yearly Records, DPR Lagos Office, 7 Kofo Abayomi Street. Victoria Island, Lagos: Department of Petroleum Resources.

Ejemeyovwi, J.O., Osabuohien, E.S., Johnson, O.D., Bowale, E.I.K. (2019), Internet usage, innovation and human development nexus in Africa: The case of ECOWAS. Journal of Economic Structures, 8, 15.

Ekanem, J., Nwachukwu, I. (2015), Sustainable agricultural production in degraded oil producing and conflict. Journal of Agriculture and Sustainability, 8(1), 14-28.

Ekpenyong, N.S., Udofia, U.S. (2015), Crude oil spills and its consequences on seafoods safety in coastal area of Ibeno: Akwa Ibom state. Studies in Sociology of Science, 6(1), 1-6.

Emuedo, O.A, Anoliefo, G.O, Emuedo, C.O.E. (2014), Oil pollution and water quality in the Niger delta: Implications for the sustainability of the mangrove ecosystem. Global Journal of Human-Social Science Research, 14(6), 20-30.

FCWC-Fisheries Committee for the West Central Gulf of Guinea. (2019), Nigeria: Fisheries Department Licenses 143 Vessels for 2019. Available from: https://www.fcwc-fish.org/other-news/nigeria-fisheries-department-licenses -143-vessels-for-2019

Federal Department of Fisheries. (2018), Fisheries Statistics of Nigeria. 4th ed., Garki, Abuja: Federal Department of Fisheries.

Food and Agricultural Organisation. (2017), Fishery and Aquaculture Statistics. Global Production by Production source 1950-2015 (FishstatJ). In: FAO Fisheries and Aquaculture Department. Rome: Food and Agricultural Organisation. Available from: https://www.fao.org/fishery/statistics/software/fishstatj/en

Frank, O., Boisa, N. (2018), The effect of crude oil spill on the surface water of the Lower Niger Delta (Sombriero River). Journal of Industrial and Environmental Chemistry, 2(2), 19-24.

Izah, S.C. (2018), Ecosystem of the Niger Delta region of Nigeria: Potentials and Threats. Biodiversity International Journal, 2(4), 338-345.

Nigeria Bureau of Statistics. (2020), 2019 Poverty and Inequality in Nigeria: Executive Summary. Available from: https://www.nigerianstat.gov.ng/download/1092

Nkoro, E., Uko, A.K. (2016), Autoregressive Distributed Lag (ARDL) cointegration technique: Application and interpretation. Journal of Statistical Econometric Methods, 5(4), 3-10.

Numbere, A.O. (2020), The impact of landscape reclamation on mangrove forest and coastal areas in the Niger Delta, Nigeria. In: Landscape Reclamation - Rising From What's Left. India: IntechOpen.

Nwilo, P., Badejo, O.T.B. (2005), Oil spill problems and management in the Niger Delta. International Oil Spill Conference Proceedings, 1, 567-570.

Ojakorotu, V., Okeke-Uzodike, U. (2006), Oil, arms proliferation and conflict in the Niger delta of Nigeria. African Journal on Conflict Resolution, 2(6), 85-106.

Okon. O. G. (2017) Bioaccumulation of Heavy Metals in Cucurbita maxima Duch. and Telfairia occidentalis Hook. F. Grown on Crude Oil Polluted Soil. American Journal of Agricultural Science, 4(4), 88-93.

Okonkwo, C.N.P., Kumar, L., Taylor, S. (2015) The Niger Delta wetland ecosystem: What threatens it and why should we protect it? African Journal of Environmental Science and Technology, 9(5), 451-463.

Orebiyi, P.A., Ekong, C.N. (2018), Oil production and the poverty situation in the Niger delta region of Nigeria: A case of selected communities. Journal of World Economic Research. 7(1), 21-36.

Osuagwu, E.S., Olaifa, E. (2018), Effects of oil spills on fish production in the Niger Delta. PLoS One, 13(10), e0205114.

Rahim, A., Hastuti, D.R.D., Firmansyah, W., Syam, A. (2019), The applied of Cobb-Douglas production function with determinants estimation of small-scale fishermen's catches production. International Journal of Oceans and Oceanography, 13, 81-95.

Raji, A.O.Y., Abejide, T.S. (2013), An assessment of environmental problems associated with oil pollution and Gas Flaring in the Niger Delta Region, Nigeria C. 1960-2000. Arabian Journal of Business and Management Review, 3(3), 48-62.

Sulaiman, C., Abdul-Rahim, A.S. (2019), The impact of Wood Fuel Energy on Economic Growth in Sub-Saharan Africa: Dynamic Macro-Panel Approach. Sustainability, 12, 3280.

Wasilat, A. (2021) Nigeria records 4,919 oil spills in six years, says minister; The Cable Available from: https://www.thecable.ng/nigeria-recorded-4919-oil-spills-in-six-years-says-minister