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ANALYSIS OF VARIABLES OF MARITIME-INDUCED OIL SPILLAGE IN NIGER DELTA REGION OF NIGERIA

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ABSTRACT: *This paper is an analysis of variables of oil spillage in Niger delta region of Nigeria. In order to carry out this research data were collected from National Oil Spill Detection and Response Agency (NOSDRA), and Nigerian Maritime Administration and Safety Agency (NIMASA) and analysed using statistical software. The analysis showed that oil theft has significant relationship with the total number of spill incidents in the Nigerian coastal waters, as against the other independent variables (mechanical failure, marine pipeline leakage and shipping activities) tested, but was found not to contribute significantly to spill incidents in the Niger Delta Region. Oil theft variable has significant impact on spill incidence occurrence in the Nigerian coastal waters. Mechanical failure, marine pipeline leakage and shipping activities has no significant impact on the number of spill incident occurrences in the Nigerian coastal waters. Oil spill response system should be upgraded by pipeline operators and owners, the creation of regional spill response centres along coastlines will help in managing oil spill problems and the causative factors should be taken care of by Government agency in charge of energy matters.*

KEYWORDS: oil spillages, maritime, coastal waters, oil theft and Niger Delta

INTRODUCTION

Oil Spills are caused by a multitude of factors in the Niger Delta. According to the European Environmental Agency, accidents such as oil spills constitute a unique class of environmental problem. The Agency recognizes oil pollution as resulting from accidental oil spills and natural oil seepage; In essence, there are diverse causes of oil spills. Ahman (1997) in her key note address at the opening session of a workshop during an Environmental Day states that the "immediate causes of the spillages range from break up or damage to oil tankers or storage vessels to sabotage by aggrieved people". Ofomata (1997) observes that in addition to blowout, cases of local oil spills can occur as a result of improper handling or mishaps such as burst pipes or from continuous seepage from the jetties during the loading of vessels, or from the deliberate action of foreign ships dumping their oil - Sodden ballast into our waters and gas flaring. Poorly maintain need infrastructure under high pressure. Accidents occur and pipelines running over ground get ruptured. The burgeoning trade in stolen oil means that local people tap into lines and wells damaging them or leaving them leaking. Sabotage of pipes is common, often by local people hoping to get cash compensation.

Drilling accidents have been a growing concern as more areas of the continental shelves are opened to drilling. Normally, the drill hole is cloned with a steel casing to prevent lateral leaking of oil, but on occasion, the oil finds an escape route before the casing is complete. This is what happened in Santa Barbara in 1979, when a spill produced 200- square -kilometers (about 80-square miles) oil slick. Alternatively, drillers may unexpectedly hit a high-pressure pocket that causes a blowout (Carla, 2002). Tank disasters are becoming larger all the time. In 1991, the war in the Persian Gulf demonstrated yet another possible cause of major oil spills; destruction of major pipelines and refinery facilities. Where the spills are due to failing equipment, the oil companies are clearly responsible. But where they are blamed on sabotage, the companies and government blame local people and criminal gangs.

Oil spills in Nigeria occur due to a number of causes, they include: corrosion of pipelines and tankers (accounts for 50% of all spills), sabotage (28%), and oil production operations (21%, with 1% of the spills being accounted for by inadequate or non-functional production equipment (Nwilo and Badejo, 2007). The largest contributor to the oil spill total, corrosion of pipes and tanks, is the rupturing or leaking of production infrastructures that are described as, "very old and lack regular inspection and maintenance". 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.

The transport of huge quantities of oil creates opportunities for major oil spills through a combination of human and natural hazards. Militancy conflict in the Middle East destabilizes shipping routes. More importantly, drilling and transport in stormy seas cause spills. Plans to drill for oil along the seismically active California and Alaska Coasts have been controversial because of the damage that spills could cause to these biologically rich coastal ecosystems (Cunningham and Cunningham, 2002). In onshore areas, most pipelines and flow lines are laid above ground. Pipelines, which have an estimate 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 (Human Rights Watch, 1999). Even Shell admits that "most of the facilities were constructed between the 1960s and early 1980s to the then prevailing standards. SPDC [Shell Petroleum and Development Company] would not build them that way today." Sabotage and theft through oil siphoning has become a major issue in the Niger River Delta states as well, contributing to further environmental degradation (Anderson, 2005). Damaged lines may go unnoticed for days, and repair of the damaged pipes take even longer. Oil siphoning has become a big business, with the stolen oil quickly making its way onto the black market while the popularity of selling stolen oil increases, the bodies are piling up. In late December 2006, more than 200 people were killed in the Lagos region of Nigeria in an oil line explosion. The 2006 explosion started after the oil line was tapped by people siphoning the oil, with intentions of black market resale.

Oil development occurred in the Niger Delta without a comprehensive, strategic plan which would have protected its natural resources. More than four decades of oil exploration, production activities have left a severely degraded environment in the Niger Delta oil region of southern Nigeria. Exploration activities in this region over the past four decades have not employed best available technological practices. With this and other problems enumerated above, the researcher

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was moved to research into the incidents of oil spillage resulting from maritime activities, oil exploration and exploitations in the Niger Delta. The degree of availability of pollution in the marine industry and in the Niger Delta in various seaports in Nigeria and in West and Central African ports has remained unabated as many contributor to this has not been ascertained. To tackle this scenario, the major contributors to oil pollution need to be examined and established. Against this background, this research will empirically study on oil spillage in Nigerian coastal waters a study of Niger delta region, Nigeria.

LITERATURE REVIEW

When there is an oil spill on water, spreading immediately takes place. The gaseous and liquid components evaporate. Some get dissolved in water and even oxidize, and yet some undergo bacterial changes and eventually sink to the bottom by gravitational action. The soil is then contaminated with a gross effect upon the terrestrial life. As the evaporation of the volatile lower molecular weight components affect aerial life, so the dissolution of the less volatile components with the resulting emulsified water, affects aquatic life (Akpofure et al, 2000). Once Oil is released on water, the process of spreading takes place immediately. This process stands to be the most significant. Some forces influence the lateral spreading of oil on even calm water. These forces include: (a) Gravitational force which brings about decrease in film thickness and (b) Surface tension and inertial forces.

The force of gravity is found to be proportional to the film thickness, the gradient thickness and the density difference between the oil and water. The surface tension causes co-efficient of spreading which gives the difference between air/oil and oil/water surface tensions. This force that is independent of the film thickness is the dominant process gotten in the final phase of spreading. The inertia of the oil body and the oil/water friction causes retardation on the surface tension. The inertia of a specific oil slick, which is a function of the density and thickness, readily diminishes alongside spreading. Another factor that affects spreading is water temperature (Akpofure et al, 2000).

The spreading of an oil slick is one of the most important processes in the early stage of the oil slick transformation, because of the influence of the surface area of the oil slick on weathering processes such as evaporation and dissolution. The balance between gravitational, viscous and surface tension forces determines the spreading of an oil slick. The spreading of an oil slick passes through three phases. In the beginning phase, the gravity and inertia forces are balanced. In the intermediate phase the gravity forces are balanced by viscous force. In the final phase, the surface tension force is balanced by viscous force. Fay considered an oil slick to pass through three phases of spreading. Immediately after the spill, the oil slick is rather thick. Therefore, in the first phase, gravity and inertia forces dominate the spreading process with gravity being the accelerating force and inertia the retarding force. As time progresses, the oil slick becomes thin and inertia forces become relatively unimportant. In the second phase the gravity and viscous forces dominate the spreading with viscous force being the retarding one. As the slick gets thinner, interfacial tension forces become important. A third phase is reached in which interfacial tension and viscous forces dominate the spreading (Reddy and Brunet, 1997).

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Oil spills can occur when there is a problem with an oil well, when a pipeline ruptures or leaks or when there is a transportation accident such as the Exxon Valdez oil spill of 1989. Since conditions are different with each spill, different methods of spill control may be used. Some of the tools used to control oil in a spill include booms, which are floating barriers used to clean oil from the surface of water and to prevent slicks from spreading, skimmers which use pumps or vacuums to remove oil as it floats on water and sorbents which absorb oil when they are placed in a spill area.

Sometimes chemicals called dispersants are used to break down oil and move it from the top of the water. Moving the oil in this way keeps it from animals which live at the surface of the water and allows it to eventually be consumed by bacteria. Oil spill control on land is often conducted manually. Scooping, cleansing and scraping of the rocks and sand are performed until the oil has been removed. A variety of approaches to damage control following an oil spill have been tried. In calm seas, if a spill is small, it may be contained by floating barriers and picked up by specially designed "skimmer ships" that can skim up to fifty barrels of oil per hour off the water surface (Carla, 2002).

Some spill control products can convert liquid spills to solid waste, making the substance easier to clean up and discard. Others help convert chemical gases to liquid or solid form, to prevent them from escaping or dissipating. Other chemical spill control products work by absorbing the chemicals. Special containers are often used with spill control products to capture and hold the by-products of a spill absorption or neutralizes Some French workers used ground chalk to absorb and sink oil. Sinking agents like chalk, sand, clay and ash is effective in removing an oil spill from the sea surface, but the oil is no healthier for marine life on the ocean bottom. The British mixed some 2 million gallons of detergent with part of the spill, hoping to break up the spill so that decomposition would work more rapidly. The detergent, in turn, turned out to be toxic to some organisms too (Anderson, 2008).

Major oil spills heavily contaminate marine shorelines, causing severe localised ecological damage to the near-shore community. Ever since the discovery of oil in Nigeria in the 1950s, the country has been suffering the negative environmental consequences of oil development. The growth of the country's oil industry, combined with a population explosion and a lack of environmental regulations, led to substantial damage to Nigeria's environment, especially in the Niger Delta region, the center of the country's oil industry. Oil spills pose a major threat to the environment in Nigeria. If not checked or effectively managed, they could lead to total annihilation of the ecosystem, especially in the Niger Delta where oil spills have become prevalent. Life in this region is increasingly becoming unbearable due to the ugly effects of oil spills, and many communities continue to groan under the degrading impact of spills (Oyem, 2001). In the Nigerian Coastal environment a large areas of the mangrove ecosystem have been destroyed. The mangrove was once a source of both fuel woods for the indigenous people and a habitat for the area's biodiversity, but is now unable to survive the oil toxicity of its habitat. The oil spills also had an adverse effect on marine life, which has become contaminated; in turn having negative consequences for human health from consuming contaminated seafood. Oil spill has also destroyed farmlands, polluted ground and drinkable water and caused drawbacks in fishing off the coastal waters.

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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. 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. The harmful effects of oil spill on the environment are many. Oil kills plants and animals in the estuarine zone. Oil settles on beaches and kills organisms that live there; it also settles on ocean floor and kills benthic (bottom-dwelling) organisms such as crabs. Oil poisons algae, disrupts major food chains and decreases the yield of edible crustaceans. It also coats birds, impairing their flight or reducing the insulative property of their feathers, thus making the birds more vulnerable to cold. Oil endangers fish hatcheries in coastal waters and as well contaminates the flesh of commercially valuable fish.

In a bid to clean oil spills by the use of oil dispersants, serious toxic effects will be exerted on plankton thereby poisoning marine animals. This can further lead to food poisoning and loss of lives. Another effect of oil slicks is loss of economic resources to the government when spilled oil is not quickly recovered, it will be dispersed abroad by the combine action of tide, wind and current. The oil will therefore spread into thin films, dissolve in water and undergo photochemical oxidation, which will lead to its decomposition. The movement for the survival of Ogoni People (MOSOP) and other Ogoni activists has on several occasions called on the Nigerian Federal Government to regulate the oil exploration, drilling, and processing activities of Shell Oil and other oil companies in the oil producing regions of Nigeria. The Ogoni have received virtually none of the $30 billion from oil pumped out of their lands, and they have been actively demonstrating against such injustices. Mr. Ken Saro-Wiwa, along with eight other MOSOP members, were arrested and charged with the murder of four traditional chiefs belonging to a pro-government group in the Ogoni region. The murders occurred during a bloody clash in May 1994 between Ogoni activists and Federal Government soldiers. On October 31, 1995, a Federal military tribunal sentenced them to death. On November 10, 1995 the Nigerian Federal Government hanged Ken Saro-Wiwa and eight others, in Port Harcourt. The death of the Ogoni activists led to the suspension of Nigeria from the Commonwealth of Britain (a group comprising of Britain and its former colonies); Under extreme pressure, the International Finance Corporation cancelled a proposed $100 million loan and $80 million equity deal to Nigeria LNG, a company owned by the Nigerian Government and the top oil producers in Nigeria (Shell, Elf and AGIP), to produce a gas plant and pipeline in the Niger Delta.

Oil spills are the uncontrolled discharge of oil or its by-products including chemicals and wastes, into the environment. When an oil spill occurs, the oil being less dense than water floats. The highest most volatile hydrocarbons start to evaporate initially decreasing the volume of spill somewhat but polluting the air. Then a slow decomposition process sets in, due to sunlight and bacterial action. (Magini, 2011). After several months, the mass may be reduced to about 15 percent of the starting quantity, and what are left are mainly thick asphalt lumps.
These can persist for many months more. (Carla, 2002).

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METHODOLOGY

For the purpose of this study, data was collected form secondary source. Since this research focuses on oil pollution, data were obtained majorly from National Oil Spill Response Agency (NOSDRA) spill data website, Nigerian Ports Authority annual bulletin and Nigerian Maritime Administration and Safety Agency (NIMASA). All data collected was subject to analysis, verification and classification. The quantitative technique to be used is the OLS model. It defines the relationship between quantity of oil spilt, sabotage, equipment failure, ship/operational discharges and pipeline rupture and is used to obtain the coefficients associated with oil pollution in the Niger delta region. The regression line which defines this relationship is expressed as:

$$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + u$$

Where:

Y = Total number of oil spill incidences; B_0 = Constant; X_1 = Oil theft; X_2 = Shipping activities X_3 = Marine pipeline leakage; X_4 = Mechanical failure u = Error term (which accounts for variables that affect quantity of oil spilt not reflected in the model). B_0 is the baseline while B,, B_2, B_3 and B_4 are coefficients of the regression parameters to be estimated. The values of the coefficients are obtained using the ordinary least square method. The values will be gotten from the output of SPSS. The sign and value of the estimators indicates the proportionate direction and magnitude of effect each independent variable (input) will have on the dependent variable (output). For instance, a positive sign will indicate a direct proportionate effect.

RESULTS AND DISCUSSION

This paper aims at appraising the management of oil pollution from maritime activities in the Nigerian coastal waters through the analysis of a number of spillages per year under study and its relationship with the causation factors of marine- source spill incidents. This involves analyzing the relationship between all variables identified in the study.

Table 1: Total Number of Spillages and Variables of Oil Spill Incidence

Year	No Of Spill Incidence	Oil Theft	Mechanical Failure	Marine Pipeline Leakage	Shipping Activities
2009	80	60	6	9	12
2010	125	100	4	12	20
2011	98	80	2	5	16
2012	110	94	9	13	14
2013	626	295	12	45	39
2014	546	307	18	55	25
2015	652	463	23	64	14
2016	785	578	14	53	26
2017	936	740	39	74	20
2018	755	740	81	99	20
2019	1071	1060	91	121	32

Source: National Oil Spill and Response Agency (NOSDRA) and Nigerian Maritime Administration and Safety Agency (NIMASA)

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The relationship parameters are: coefficient of correlation (R) = 99.8%, coefficient of determination (R^2) = 99.5%, and adjusted coefficient of determination (99.1%). The above imply that 99.5% of the variation in the number of spillages per year can be explained by the variation in the independent variables (oil theft, mechanical failure, marine pipeline leakages, and shipping activities).

This implies that there is a high goodness of fit between the dependent and independent variables. It further indicates that only 99.5% of spill incidents/ pollution generated in the Niger Delta are explained by oil theft, mechanical failure, marine pipeline leakages, and shipping activities, 0.5% could be explained by parameters not included in the model. The adjusted R-square of 99.5% means that the model has accounted for 99.5% of the variance in the independent variable. The remaining 0.05% of the variation is explained by stochastic factors.

The regression model is:

$$\boldsymbol{Y = -84.3 + 0.83X_1 + 5.64X_2 + 6.58X_3 - 6.17X_4}$$

Table 2: Panel Data Estimation Results for Variables of spill Incidences

Variable	**OLS Model**
Oil theft	**0.833*** **[0.002]**
Shipping activities	**5.636*** **[0.021]**
Pipeline leakage	**6.584**** **[0.003]**
Mechanical failure	**-6.174**** **[0.006]**
Constant	**-84.348*** **[0.051]**
R^2	***0.995***
Adjusted R^2	***.991***
F	***262.001***

1. Model: Dependent variable = In (Number of spill Incidences);
2. Standard errors in brackets are robust to heteroskedasticity and serial correlation;
3. * p < 0.05, ** p < 0.01, *** p < 0.001; Statistics of the first stage.

The significance of the above model is tested by way of the F-test and the student t- test. The interpretation of the regression line is that, there is a direct proportionate effect on the independent variable such that the value of number of oil spillages generated within the Niger Delta environment will increase by; 0.83 barrels for every act of oil theft, -6.17 barrels for every mechanical failure of oil equipment, 6.58 barrels for every marine pipeline leakage, and 5.64 barrels for every 1 unit increase in shipping activities. The regression intercept have a negative value which shows an indirect proportionate effect on the dependent variable. The F statistics can be calculated using the ratio of mean square regression to the mean square regression. To test the Null hypothesis, if the calculated F exceeds the tabular F distribution at 0.05 (95%) confidence level of significance, or if the sig-value is less than 0.05 or the value 1-sig is greater than 95%

confidence level, then the Null hypothesis is rejected, otherwise it is accepted. Generally, the above finding reveals that the model is reliable and able to predict and estimate the total number of spill incidences in the Nigerian coastal waters.

CONCLUSION

The positive sign of oil theft, marine pipeline leakage and shipping activities variables indicates a direct proportionate mathematical relationship with the total number of oil spill incidences, suggesting that an increase in any of these input variables will reasonably increase the number of spill incidences while the negative sign of mechanical failure variable indicate an inverse proportionate mathematical relationship with the total number of spill incidences, showing that mechanical failure is not significant as an oil spill causation factor. This research work could aid further researches especially in the area of oil spill risk analysis, Also further researches can be done on oil spill damage cost estimation, environmental evaluation of the Nigerian coastal waters as regards oil spill incidences, challenges of management of oil pollution, importance of pipeline insurance to operators and owners in Nigeria coastal waters.

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