Mba, Ifeoma Christy; Mba, Emmanuel Ikechukwu; Ogbuabor, Jonathan Emenike et al.

Article

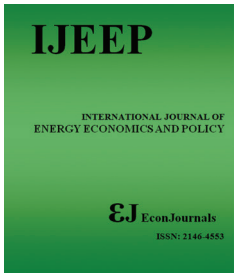
Causes and terrain of oil spillage in Niger Delta region of Nigeria : the analysis of variance approach

International Journal of Energy Economics and Policy

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

Reference: Mba, Ifeoma Christy/Mba, Emmanuel Ikechukwu et. al. (2019). Causes and terrain of oil spillage in Niger Delta region of Nigeria : the analysis of variance approach. In: International Journal of Energy Economics and Policy 9 (2), S. 283 - 287.
doi:10.32479/ijeep.7332.

This Version is available at:
http://hdl.handle.net/11159/3183



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2019, 9(2), 283-287.

Causes and Terrain of Oil Spillage in Niger Delta Region of Nigeria: The Analysis of Variance Approach

Ifeoma Christy Mba[1]*, Emmanuel Ikechukwu Mba[2], Jonathan Emenike Ogbuabor[3], Winnie Ogochukwu Arazu[4]

[1,3,4]Department of Economics, University of Nigeria, Nsukka, Nigeria, [2]Department of Statistics, University of Nigeria, Nsukka, Nigeria. *Email: Ifeoma.mba@unn.edu.ng

Received: 31 October 2018 **Accepted:** 01 February 2019 **DOI:** https://doi.org/10.32479/ijeep.7332

ABSTRACT

Oil spillage in Niger Delta region of Nigeria has been on an increase and almost on a regular basis. The objective of this study is on the causes and terrain of oil spillage in the Niger Delta with emphasis on which causes have significant effect on the volume of oil spillage, the terrain that is most affected. The two way analysis of variance statistical tool was employed and it was discovered that the "sabotage" cause was significant at a 5% level of significance and from the pairwise multiple comparison the "sabotage" cause was seen as the major causes of oil spillage in the Niger Delta followed by the "operational" and "mystery spill" causes respectively. It was also discovered that the incident site that was most affected was the swamp terrain with 82% while water was 46% and land with 6.5%. The study concluded that to reduce or manage oil spillage in Nigeria, the Federal government and Federal environmental management agency should enforce the laws governing oil spill incident in Nigeria.

Keywords: Terrain, Causes, Niger Delta
JEL Classifications: P28, Q53, Q56

1. INTRODUCTION

Oil was first discovered on commercial basis in the Niger Delta region of Nigeria at Oloibiri (the present day Bayelsa state) in the year 1956, more discoveries were made after that of Olobiri and exports began in the year 1958 almost 2 years after discovery at Olobiri. Although the quantities only became significant in the year 1965 and this was because the terminal at Bonny Island in Rivers State and the necessary pipelines to feed the terminal were completed. The Nigerian export was put at an average of 2.5 million barrels each day in the year 2004 and its reserve at 35 billion barrels (CAB, 2005).

Niger Delta is an area with strong cultural diversity. The Niger delta occupies a total land mass of 7.5% it has 9 states and 186 local government areas housing at least 25 million people. The Niger Delta to the southern part of Nigeria is 70,000 km^2 through which the two rivers; Niger and Benue, these rivers bare into the Atlantic Ocean all it possesses. There are other main rivers; rivers like Benin, Brass, Bonny, Cross, Kwa-ibo, Forcados, Nun and other streams and creeks or brooks which are linked and interwoven by a network of creeks (NDES, 1997).

The Niger Delta according to Nwilo and Badejo, 2005 is an area in which the main river, that is, River Niger reaches the base level and further branches into different tributaries releasing, distributing and thus disposing of the water discharge and the water sediment load. The Niger Delta has the shape of the Nile Delta (Sexton and Murday, 1994). The Delta according to Nwilo and Badejo (2005) is regarded in the world as one of the largest wetlands.

Man's environment can be called also his immediate family this is because just as his immediate family are close to him so also his environment. Man's environment has also experienced some

levels of attack from activities of man himself. These activities in one way or the other have impacted negatively on man hence results from these activities are majorly pollutions of all manner of degree. Pollution can be said to be an introduction or discharge of substance into the environment that is very poisonous and thus harmful. Thus terrain such as land, water, air can also be polluted likewise one can have noise pollution amongst others. It can be said in a jiffy that the release of toxins in the atmosphere contaminates or pollutes the air, poisonous substance also introduced in the hydrosphere contaminates water and finally poisonous substance in the lithosphere pollutes or contaminates the land. Thus, land, water and air are basically the three major types of pollution, the interesting part of this story is that these three components, once affected, will definitely affect the fourth which is called the biosphere (that is, an artificial enclosure that is an ecosystem, thus, life can exist there). Oil spillage is a form of pollution, it is a process whereby liquid petroleum hydrocarbon is been discharged or one can say released into the environment. Oil spillage, though a form of pollution is not good for the environment.

Oil spill, a common outcome of oil exploration and exploitation in the Niger delta region has an estimated spillage incident of over 7000 over a 50-year period (UNDP, 2006).

Oil spillage occurs usually from activities of humans in their environment and witnessed especially in the marine ecosystem but oil spillages can also happen on land. Whatever the terrain is, whether land, water or swamp, its effect is not encouraging, its health threatening, it is harmful and should be avoided.

In Nigeria, there are serious environmental issues ranging from drought to flood, to oil spillages, to illegal refining and so on but it is interesting to note that the major environmental issues hinging around the Niger Delta are from the petroleum industry. Oil theft, operations, illegal refining, mystery spills and sabotage are amongst major causes of oil spills in our environment. Whatever the cause may be, be it sabotage or mystery spills or whatever, there must be a joint investigation followed by the clean-up and remediation processes which is done by the shell petroleum development company of Nigeria limited joint venture (SPDC JV).

The thrust of this paper is on the causes and terrain of oil spillage in the Niger Delta with emphasis on which causes have significant effect on the volume of oil spillage, the terrain that is most affected. The two way analysis of variance would be employed to capture the objectives of the work.

1.1. Causes of Oil Spillage in Nigeria

Oil spillage in Nigeria can be of a natural cause or of a human cause. Although, a third cause can be said to be the Mysterious cause. The natural spill causes are those spills that come naturally, that is, they occur naturally examples are those that happen due to natural disasters, shift of tectonic plates, these plates are seen beneath the ocean floor, once there is a shift, oil is thus released thereby causing a natural seepage and spillage occurs. There are also cases of inadequate trap system.

Human causes are manmade causes, usually done by humans. Examples include vandalization of oil pipe which could bring about spillage, carelessness on the side of both workers (this cause is what is referred to as operational), carelessness on the side of the tanker drivers (accidents can happen during delivery or production operations which can cause spillage), carelessness that could also lead to oil bunkering, sabotage and oil siphoning.

Mysterious causes are those causes that aren't known, that is, one cannot pin down the exact cause of the spillage. Wang et al. (2001) reported a case of mystery spill which was from Quebec in the year 1999, seen at the river banks of St. Laurence river directly in front of Thermex Company. Investigation as regards where the spill was from was carried on but the interesting part of the investigation was that their earlier on suspicion that the spill was from a nearby factory though was true but the chemical composition wasn't the same. The mystery spill had less amount of diesel relatively to the oil found in the factory and elsewhere. The one from the mystery spill was fresh to compare with (Wang et al., 2001).

In Nigeria, there are also causes of mystery spill; which according to shell data, on the second of July, 2017, the estimated volume of oil in barrels (bbl) was put at 0.1, sixteenth of august, 2016, the estimated volume was 5 bbl. On sixth of November, 2015; 0.5 bbl, on twenty ninth of September, 2015, the estimated spill volume was 30 bbl and so on.

1.2. Oil Spill Incidents

In Nigeria, there are numbers of oil spill incidents which have occurred in different part of the country at different or same time period. Over the years, Nigeria had experienced a lot of oil spill incident but the most striking one is that of January 17th, 1980 which was publicised as having an estimated spill volume of 37.0 million litres which was caused by a blow out at Funiwa 5 offshore station (Nwilo and Badejo, 2005). Table 1 shows some prominent oil spill incident in nigeria, the date of the spillage, the terrain, the site, the estimated spill volume and the cause(s) of the oil spill. Although from the table below, one would discover that some of the estimated spill volume are much bigger than what was seen in the eighties.

2. LITERATURE REVIEW

Smith et al. (1982) developed oil spill risk analysis model to help in estimating the hazards caused by oil spill in the environment. The model, though computerized was used in analysing the probability of spill occurrences and also the paths where the spill occurred. They used sample of 500 spills per season and the resulting model output included conditional impact probability tables and probability for oil spill occurrences. Their model is still in use in the United States under the oil spill risk assessments (Smith et al., 1982). Another research on oil spill was that carried out by Olujobi et al. (2018), they adopted a development strategy that was also sustainable, it was sustainable in the sense that it could maintain prudent management of oil resources. Olujobi et al. (2018) also applied an enduring model that could aid in natural environment conservation. The aforementioned terms according to them;

Table 1: Oil spill incident in Nigeria (September 2018)

Date reported	Incident site	Terrain	Cause	Estimated spill volume (bbl)
September 03, 2018	24" Nkpoku-Bomu Pipeline at Bera.	Land	Sabotage	19
September 04, 2018	Imo River 2 Well 31L Flowline at Odagwa-Umuadeokwara	Land	Sabotage	0.1
September 06, 2018	14" Okordia-Rumuekpe Pipeline at Akaramini	Land	Sabotage	81
September 08, 2018	20" Otumara - Escravos Pipeline at Ugboegungun	Swamp	Sabotage	172
September 09, 2018	36" Nkpoku - Bomu Pipeline at Rumuesara Eneka	Land	Sabotage	622
September 11, 2018	Imo River Well 59T Flowline at Igiriukwu_Owaza	Land	Sabotage	0.2
September 14, 2018	6'' Obigbo North - Ogale Pipeline at Ogale	Land	Sabotage	72
September 15, 2018	16'' Egbema - Assa Rumuekpe Pipeline at Assa	Land	Sabotage	34

Source: Shell Nigeria oil spill data (the data above is the most current)

prudent management, sustainable development strategies and environment conservation were imperative and necessities for the Nigerian economy. Olujobi et al. (2018) employed the descriptive legal analysis and secondary data sources and concluded that the oil spills in Nigeria should be addressed and that positive attitude should be put in place by the oil operators and the government alike so as to reduce the health hazard caused by these spillage (Olujobi et al., 2018).

Another group of researchers employed a multi-resolution analysis of polarimetric SAR data by the use of wavelet frames in observing the sea oil spill (Gambardella et al., 2008). Gambardella et al. (2008) obtained a vector of covariance matrix elements from the set of polarimetric data and the corresponding variances were also obtained. They concluded that wind speed can affect sensitivity to polar dependency and that their analysis can aid in oil description (Gambardella et al., 2008).

Wegeberg et al. (2017) described techniques for combating main oil spills: The chemical dispersants, the mechanical recovery and *in situ* burning and also looked at their possible application in the Arctic, the Arctic according to them were described as part I and in their part II, the description of the techniques used in ascertaining the environmental effects was investigated and in Part III, they monitored the effect of the spills and its responses and so on. They concluded by saying that wildlife shouldn't be exposed to these oil spillage likewise humans (Wegeberg et al., 2017). Bayesian supervised and unsupervised segmentation algorithm and markov random field were applied by (Bioucas-Dias and Pelizzari, 2010), although they first applied the Markov random field prior to the Bayesian on the oceanic segmentation of SAR images. Bioucas-Dias and Pelizzari (2010) later considered the least squares fit methods and it was discovered that with the Bayesian surpervised algorithm, higher accuracies of the observed algorithm was achieved while the unsupervised algorithm was seen as an improvement to algorithm 1 and II. Consequently, three researchers applied 3 salinity values and 3 different oil (that is, light refined oil, light crude oil and medium crude oil) since the effectiveness of dispersant application on oil slick would give rise to factors such as salinity, temperature and wave-mixing (Chandrasekar et al., 2006). Chandrasekar et al. (2006) used a full factorial experiment and discovered that the impact of salinity was significant only at different weather for light crude oil with dispersant. Subsequently, still on oil spill but with emphasis on oil classification, Vogt and Sjoegren (1989) investigated both statistical methods and chemical compositions (i.e., fluorescence spectrometry, infrared spectrometry, liquid chromatography with flame ionization (GC/FID)) for oil spill classification. They further employed 5 procedures for 23 oil groups from 4 geographic regions considering their discriminating power, thus applying ANOVA, and some other statistical test and concluded that the fluorescence spectrometry, sulphur, nickel and vanadium contents are useful for oil classifications (Vogt and Sjoegren, 1989). Ndeh et al. (2017) identified oil spillage in Upenekang village in Ibeno local government area of Akwa Ibom state in Nigeria. They used water samples from spill site, they also looked at the effects of these spillage and also investigated the oil spillage site. Their concerns were on the chemical content, water conductivity, pH, temperature etc., they concluded that the pH of all the samples used for the underground and surface stream displayed that the spill site was acidic and the ANOVA results showed that there is insignificant influence of distance away from spill (Ndeh et al., 2017). Other researches done were on impact of crude oil; researchers such as (Al-mawali et al., 2016; Moreira et al., 2004; Ohanmu et al., 2018) but the works of Gingerich (2018) was totally different from all others since her focus was on how to maintain and store clean renewable energies irrespective of the climate change like drought, flood, to mention but a few. She also looked at how less developed countries could become major global exporters of these renewable energies (Gingerich, 2018).

Ohanmu et al. (2018) aimed at ascertaining the changes in the physicochemical properties and heavy metals level of crude oil polluted soil using the randomized block design, it was discovered that crude oil affects soil properties irrespective of seasons (Ohanmu et al., 2018). Moreira et al. (2004) evaluated both the spatial and temporal impact of oil spill on the shore, different laboratory test on toxicity were performed and it was concluded that the biomarkers were sensitive to exposures with respect to these kind of pollutions. Al-mawali et al. (2016) constructed a simple macroeconomic model that modelled the impact of oil sector on the Sultanate of Oman's economy. They discovered that the oil sector displayed large and strong positive impact on the Oman's GDP and the impact was also felt on all other non-oil sectors of the economy. According to them, the major influence of oil was on the gas sector and finally, they disclosed that the Oman's economy cannot be diversified.

3. METHODOLOGY

The statistical tool used for the analysis is a two way analysis of variance with replication that is, with more than one observation

Table 2: Two way ANOVA table

Source	Degree of freedom (df)	Mean squares (MS)	F	Significant
Causes*	3	2314.274	2.671	0.047*
Terrain	2	161.963	0.187	0.830
Causes* Terrain	4	311.43	0.359	0.837
Error	390	866.552	-	

Author's computation *Means significant at $\alpha = 0.05$ level of significance

per cell. The data for this study is from a secondary source, it is sourced from shell Nigeria (oil spill incident) ranging from January 2015 to September 2018. The data included date of the oil spill incident, oil spill site, estimated oil spill volume (bbl), the joint investigation findings and dates of remediation and finally pictures of affected areas.

The two way ANOVA model is given as:

$$X_{ijk} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + \varepsilon_{ijk} \quad (1)$$

Where *i* measures the observation per row

j measures the observation per column and *k* measures how many observations per cell

X_{ijk} means the observation *jth* level of factor A and *ith* level of factor B.

μ is the universal constant or observations when the factors are absent or treatments not applied.

α_i is the average effect of *ith* level of factor A

β_j is the average effect of *jth* level of factor B

$(\alpha\beta)_{ij}$ is the interaction effect of ith level of factor A and jth level of factor B

ε_{ijk} is the error term associated with the observation X_{ijk}.

Thus, from our study, the factors A and B are Causes and Terrain respectively while the *kth* observation measures the number of times of oil spillage (estimated oil spill volume) associated with the *jth* terrain and the *ith* causes. Here, *ith* causes runs from one to four, where respectively they are sabotage as 1, operational as 2, mystery spill as three and others (i.e. other causes) as 4. The jth terrain also runs from one to three and thus respectively they are; swamp as 1, water as 2 and land as 3. Finally, the interaction effect is the interaction of the two factors, that is, causes and terrain respectively. The layout of the study is seen below:

Causes 1 2 3 4

$$\begin{matrix} \\ terrain \end{matrix} \begin{matrix} 1 \\ 2 \\ 3 \end{matrix} \begin{bmatrix} (1,2,\ldots kth) & ( ) & ( ) \\ & & \\ & & \end{bmatrix}$$

From the layout, the entry (1,2,…*kth*) are just positions for the estimated spill volume and not necessary data.

Assumptions of analysis of variance:

1. Normality assumption
2. Constant variance (homoscedasticity)
3. Independence.

Table 3: Multiple comparisons of the causes of oil spillage

(i) Causes (j) causes	Mean difference	Significant
Sabotage		
Operational	9.47090*	0.026
Mystery spill	25.27447*	0.016
Others	17.27447	0.310
Operational		
Sabotage	−9.47090*	0.026
Mystery spill	15.80357	0.155
Others	7.80357	0.654
Mystery spill		
Sabotage	−25.27447*	0.016
Operational	−15.80357	0.155
Others	−8.00000	0.687
Others		
Sabotage	−17.27447	0.310
Operational	−7.80357	0.654
Mystery spill	8.00000	0.687

Author's computation. *The mean difference is significant at the α=0.05 level of significance

4. ANALYSIS AND INTERPRETATION OF RESULTS

The stated hypothesis for the study is given as:

H_0: There is no significant difference amongst the causes of oil spillage in the Niger delta versus

H_1: There is more spillage due to some causes more than others.

From the null hypothesis, it means that the causes of oil spillage are all equal.

Table 2 shows the ANOVA table and the associated results. From the table below, it can be seen that the causes are significant with the value 0.047, that is, there is significant difference at an $\alpha = 0.05$ level of significance, thus, the causes of oil spillage in Nigerai are not equal. our concern is on which of the causes actually have more impact than the others. Is it sabotage, operational, mystery spill or others? To achieve this, a multiple pairwise comparison would be done and thus the cause that is more significant would be seen. From the table above, with 0.830 and 0.837, it can be seen that the terrain isn't significant and has nothing to do with the oil spillage and the interaction, i.e. causes and terrain isn't significant either at an $\alpha = 0.05$ level of significance.

Table 3 shows the multiple pairwise comparisons, from the table, one can see that the mean differences amongst some of the causes are significant. For instance, the mean difference between sabotage and operational causes are significant with the values 0.026 and the mean difference of 9.47090, likewise sabotage and mystery spill but for sabotage and others, there is no significant difference. This implies that the major causes of oil spill incident are sabotage,

Table 4: Frequency table on the most affected terrain in the Niger Delta

Terrain	Frequency (%)
Swamp	328 (82.0)
Water	46 (11.5)
Land	26 (6.5)
Total	400 (100)

operational and mystery spill to some extent because the mean differences between sabotage and operational, operational and sabotage, sabotage and mystery spill and finally mystery spill and sabotage shows that the sabotage causes are more pronounced than the operational and finally the mystery spill.

Table 4 shows the terrain that is most affected and from the table, it can be seen that Swamp is the most affected, thus, the swamp terrain is the incident site with the highest frequency of 328 and percentage of 82 followed by water with 46 as its frequency and 11.5% and lastly land with 26 and 6.5% respectively. This implies that most of the spillages that occurred in the Niger Delta were majorly on swampy areas.

5. CONCLUSION AND RECOMMENDATION

It is pertinent to note that oil spillage in Nigeria has created and caused a lot of environmental and health problems and from the two-way ANOVA, it can be seen that sabotage majorly is the cause of oil spillage in the Niger Delta irrespective of the terrain or incident site. Sabotage can be in form of vandalization of oil pipes, siphoning and so on. The issue of oil spillage isn't a current case since as far back as the eighties, oil spill incident had been on the news and headlines of prominent newspapers.

Niger Delta residents can testify that they don't have access to clean water and thus, it isn't drinkable either because their streams or rivers are polluted. The chemicals released into the environments are slowly killing the occupants and indigenes of the Niger Delta. Thus, the federal government of Nigeria and federal environmental agencies should enforce the already existing laws as regards oil spill management and thus bring to book all the perpetrators of these criminal act except this is done and some persons are used as scape goats for others to learn. The criminal act may not stop.

REFERENCES

Al-mawali, N., Hasim, H.M., Al-busaidi, K. (2016), Modeling the impact of the oil sector on the economy of sultanate of Oman. International Journal of Energy Economics and Policy, 6(1), 120-127.

Bioucas-Dias, M.J., Pelizzari, S. (2010), Bayesian Segmentation of Oceanic SAR Images: Application to Oil Spill Detection. Conference.

CAB. (2005). US Energy Information Administration. Nigeria: Country Analysis Brief.

Chandrasekar, S., Sorial, G.A., Weaver, J.W. (2006), Dispersant effectiveness on oil spills e impact of salinity. ICES Journal of Marine Sciences, 63, 1418-1431.

Gambardella, A., De Grandi, G., Ainsworth, T., Migliaccio, M. (2008), Sea Oil Spill Observation by Means of Analysis of Spatial Statistics in Polarimetric Sar Data Using Wavelet Signatures. In the 2nd International workshop on Advances in Sar oceanography from envisat and Ers mission 21-25. p1-21.

Gingerich, E. (2018), Generation and storage of renewable energy: Rising parity of emerging economies. International Journal of Energy Economics and Policy, 8(1), 17-26.

Moreira, S.M., Moreira-Santos, R., Ribeiro, R., Guilhermino, L. (2004). The "coral bulker" fuel oil spill on the north coast of portugal: Spatial and temporal biomarker responses in mytilus galloprovincialis. Ecotoxicology, 13, 619-630.

Ndeh, E.S., Okafor, J.O., Akpan, G.U., Olutoye, M.A. (2017), Environmental impacts of crude oil spillages on water in ibeno local government area of Akwa Ibom state, Nigeria. Bayero Journal of Pure and Applied Sciences, 10(1), 315-319.

NDES. (1997), Niger Delta Environmental Survey Final Report Phase I; Vol I Environmental and Socio Economic Characteristics. Lagos: Environmental Resources Mangers Ltd., Niger Delta Environmental Survey.

Nwilo, P.C., Badejo, O.T. (2005), Oil spill problems and management in the Niger delta. In: International oil Spill Conference Proceedings. Vol 2005. Mexico: IOSC. p567-570.

Ohanmu, E.O., Igiebor, F.A., Bako, S.P., Danazumi, I.B. (2018), Impact of crude oil on physicochemical properties and trace metals of soil before and after planting of two pepper species (*Capsicum annum* L and *C. frutescens* L). Journal of Applied Sciences and Environmental Management, 22(5), 765-768.

Olujobi, O.J., Oyewunmi, O.A., Oyewunmi, A.E. (2018), Oil spillage in Nigeria s upstream petroleum sector: Beyond the legal frameworks. International Journal of Energy Economics and Policy, 8(1), 220-226.

Sexton, W.J., Murday, M. (1994), The morphology and sediment character of the coastline of Nigeria-the Niger delta. Journal of Coastal Research, 10(4), 959-977.

Smith, R.A., Slack, R.J., Wyant, T., Lanfear, K.J. (1982), The Oilspill Risk Analysis Model of the U.S. Geological Survey. Geological Survey Professional Paper.

UNDP. (2006), United Nations Development Programme: Niger Delta Human Development Report Abuja Nigeria.

Vogt, N.B., Sjoegren, C.E. (1989), Investigation of chemical and statistical for oil-spill classification methods. Analytica Chimica Acta, 222, 135-150.

Wang, Z., Fingas, M., Sigouin, L. (2001), Characteristics and identification of a "mystery oil spill" from Quebec (1999). Journal of Chromatograghy A, 909, 155-169.

Wegeberg, S., Fritt-Rasmussen, J., Baertmann, D. (2017), Oil Spill Response in Greenland: Net Environmental Benefit Analysis, Neba, and Environmental Monitoring. Scientific Report from DCE-Danish Centre for Environment and Energy, No. 221.