

# Oil Spills, Health Risks and Environmental Degradation in Ozoro Community, Niger Delta, Nigeria

Peter M. Eguvbe<sup>1</sup>, Samson O. Akpodarie<sup>1</sup>, and Joy O. Obielumani<sup>3</sup>

<sup>1</sup>Department of Environmental Science and Resource Management, National Open University of Nigeria, 14-16 Ahmadu Bello Way, Victoria Island, Lagos, Nigeria (Emevor Study Centre)

Live DNA: 234.17895

<sup>2</sup>Department of Chemistry, Federal College of Education (Technical), Asaba, Nigeria.

**Abstract:- Oil spillage has devastating effect on health of human's, crop productivity and livestock, therefore, the strategies for coping with the negative impact of oil spillage on humans and the environment were investigated in Ozoro Community, Niger Delta, Nigeria. The population of the sample size is 480. In carrying out the investigation, three hypotheses were formulated and tested at 0.05 level of noteworthy degrees of freedom. A questionnaire was used to collect data for the study. Additionally, simple percentage and weighted mean statistics were employed to analyze the data collected, while chi-square was used for testing the hypotheses. Oil spillage have significant effect on degradation of the environment, there are negative effects of oil spillage on health of humans, government played significant roles in implementation of environmental laws to combat oil spillage, oil spillage have negative impact on health of aquatic animals and crop production and there are possible solution to oil spillage. This research provided information on individual, community, government, and organization affected by crude oil spillage and oil production activities, to be enlightened with regards to environmental protection, sustainable development, health care delivery and standard of living of people of affected communities.**

**Keywords:- Oil Spillage, Health Risks, Aquatic Lives, Ozoro Community, Environmental Degradation**

## I. INTRODUCTION

Ozoro community is among the indigenes of the Niger Delta region which consist of nine states with over 37 million inhabitants which constitute 22% of Nigeria's population, within these are over 1,500 communities who act as host to the oil Industry, and the inhabitants in the region generally dwell below the poverty level and rely on fishing and agriculture to survive. The Niger Delta region is home to the oil wealth that has made Nigeria the biggest producer of petroleum in Africa and the sixth largest oil producer in the world<sup>1</sup>.

Oil has brought much wealth to Nigeria and it can be used to promote development. One disadvantage of the production of oil is the possible pollution of water<sup>2</sup>. In

1981, it was estimated that 6 million tons of oil polluted Nigerian water yearly. One tenth of this amount occurs through accidental spillage while most of the remaining 5.4 million tones is as a result of constant dripping of petroleum products from ordinary activities in all phases of the oil Industry<sup>3</sup>. Additional pollutants enter the water body through fallouts from gas flaring, used lubricating oils, oil tanks washing, emptying of water used to balance empty oil tankers when they are moving in the ocean and leakages from marine vessels<sup>4</sup>.

An accidental spillage can be devastating. In January 1980, an offshore oil rig exploded within two weeks i.e equivalent of over 280,000 barrels of oil spilt into the sea<sup>5</sup>. This oil with the aid of the waves and wind was spread along kilometers of coastland and 30 kilometers inland along the Delta. Most of the inhabitants who lived in this area were frustrated.

Oil spillage has since become a constant occurrence to the extent that the whole Niger Delta area has been devastated and has almost become a waste land<sup>6</sup>. Places like Uzere, Jesse and Ozoro are only but a few examples of such devastated lands in the Niger Delta. Most often, the oil spillage are due to sabotage by people, who damage the oil pipelines to collect oil from them which is the major causes of oil spillage in the Ozoro Community<sup>6</sup>. This is commonly known as bunkering. Oil spillage is a major environmental threat because it leads to; loss of farm land, degradation of the environment, loss of fishing ponds and ground water pollution, air pollution, acid rain, global warming, damage to beaches and sea shores, loss of jobs, health risks and loss of mangrove swamps<sup>7</sup>.

In the Niger Delta, oil spills are a regular occurrence and has been connected to corrosion of pipelines, poor maintenance of infrastructures, spills during processing at refineries, human errors and intentional acts of vandalism or oil theft especially in the Ozoro Community<sup>8</sup>.

A survey of the literature showed that limited data are currently available on the management of oil spillage in aquatic environment of the Niger Delta. The objectives of this study were: to determine the effect of oil spillage on health of humans, crop production, aquatic organisms and

degradation of the environment, with a view to providing information on the possible solution to oil spillage in the environment.

**II. MATERIALS AND METHODS**

*Study Location*

The study was carried out in Ozoro Community, Niger Delta, Nigeria, from January to June 2020. The Delta State map below shows where Ozoro is located.



Figure 1: Map of Delta State showing Ozoro community.

Source: www.google.com/maps/place/ozoro

The area is located approximately between Longitudes 5°00 and 6°.45' East and Latitudes 5°00 and 6°.30' North of the equator. Ozoro community is home to several oil producing communities, it is a source of on-shore crude oil production in Delta State. The main economic activities is food crops, farming accompanied by some hunting activities which are dramatically influenced by oil spillage.

*Sampling Technique*

Stratified sampling techniques was used after which random sampling was taken. However, in the case of stratified sampling techniques, Ozoro community was grouped into four quarters (See Table 1). After the researcher had divided the population in strata, the researcher then used simple random sampling method to select required sample size from each stratum in which 120 people were selected from each stratum for the study. Then a total sample size of 480 person was selected for the study to represent the entire population.

Table 1: Distribution of target population

S/N	Target Ozoro Community	Population	Sample	Percentage %
1	Uruto Quarter		120	25.0 (i.e 120 x100 divide by 480 = 25.0
2	Urude Quarter		120	25.0
3	Erovie Quarter		120	25.0
4	Etevie Quarter		120	25.0
	TOTAL		480	250

Source: Field Survey, 2020

*Research Instrument*

The major instruments used for the data collection, are questionnaires and oral interview. The questionnaire was developed by the researcher to gather information from the indigenes of the community and environmental health officers in the community. However, in order to determine the degree of agreement or disagreement in each of the scaling statement in the questionnaires, values were distributed to different scaling as follows:

Strongly agreed (SA) = 5

- Agreed (A) = 4
- Disagreed (D) = 3
- Strongly disagreed = 2
- Undecided (UD) = 1

The cut off point was calculated as follows  $(5+4+3+2+1) = 15 = 3.0$

5 5

The response whose mean score is below 3.0 is not accepted as agreed and the responses whose mean score is 3.0 and above are accepted as agreed.

*Validity of the Instrument*

The copies of the instruments were given to experts in the field of environmental science, community health workers and environmental health workers, for critical appraisal. Through this process, the face validity content and construct validity of the instrument was enhanced. Their suggestions were incorporated into the final draft of the instrument, before the administration of the questionnaires on the respondents and this helped to enhance the quality of the instrument.

*Reliability of the Instrument*

To ensure that the instrument that was developed will be reliable, a smaller sample of the same respondents was selected using the test retest method. The questionnaires were administered on the respondents and after 3 weeks, the same was re administered and the outcome of the two administration were calculated using simple percentage.

*Data Analysis Techniques*

The data were presented in a tabular form. The statistical tool used in testing and analyzing the data in order to arrive at valid conclusion is the Chi-square ( $X^2$ ). This can be used to test more than two population proportions. The

chi square ( $X^2$ ) provides means of comparing a set of observed frequencies with a set of expected frequencies.

The formular is as follows:

$$\text{Chi-square, } x^2 = \frac{\sum (O-E)^2}{E} \text{ (Cochran}^9)$$

Where:

- $X^2$  = chi-square
- $\sum$  = summation
- O = Observed frequency
- E = Expected frequency

Simple Percentage

$$\% = \frac{F}{N} \times 100$$

Where:

- F = Frequency
- N = Numbers of respondents
- % = Percentage

Weighted Mean

$$X = \frac{E_x}{E_f}$$

Where:

- $E_x$  = Total Scores
- $E_f$  = Total Frequencies
- X = Mean Scores

**III. RESULTS AND DISCUSSION**

**Effects of Environmental Degradation from Oil Spillage**

*Table 1:* The effect of environmental degradation from oil spillage

S/N	Responses	SA	A	D	SD	UD	No. Of Resp.	Mean Score	Remarks
1	It leads to loss of farmlands	270	160	0	0	0	480	3.4	Accepted
2.	It leads to degradation of the environment	380	112	0	0	0	480	3.6	Accepted
3.	It leads to water pollution and deforestation	190	200		0	0	480	3.0	Accepted
4.	It poisons various habitats for years	314	119	0	0	0	480	3.5	Accepted
5.	It devastate the ecosystem	270	111	0	0	0	480	3.3	Accepted
6.	It causes desertification and slow growth of valuable trees	250	150	0	0	2	480	3.8	Accepted
7	It gives room to global warming	300	180	0	2	0	480	3.1	Accepted

Source: Field Survey, 2020

The study found an Table 1 shows that seven items were effects of environmental degradation from oil spillage on the environment. The findings on effects of environmental degradation from oil spillage are as follows: loss of farmlands, degradation of the environment, water pollution and deforestation, habitat destruction, devastation of the ecosystem, desertification and slow growth of valuable trees and global warming. This is in line with the findings of Ivshina et al.<sup>10</sup>, who reported that oil spillage

have negative effects on the environment. According to Bayode and Adewunmi<sup>11</sup>, oil spillage on the land could lead to environmental degradation. Supporting this view, Ekperusi et al.<sup>12</sup> stated that oil spillage acts as hindrance to soil aeration which can lead to poor farmlands and desertification. The comments and opinion of the authors above helped to justify the findings of the study on the effect of environmental degradation from oil spillage.

**The Effects of Oil Spillage on Health of Humans in the Environment**

*Table 2: The effects of oil spillage on health of humans in the environment.*

S/N	Responses	SA	A	D	SD	UD	No. Of Resp.	Mean Score	Remarks
1.	Memory loss	300	116	0	0	0	40	3.0	Accepted
2.	Dizziness and irritability	200	226	0	0	0	480	3.9	Accepted
3.	Headache	312	116	2	0	0	480	3.4	Accepted
4.	Nausea and vomiting	314	117	0	0	0	480	3.6	Accepted
5.	Chest pain	278	111	0	0	0	480	3.3	Accepted
6.	Coughing and lung problem	250	180	0	0	0	480	3.0	Accepted
7.	Fatigue	367	76	0	0	0	480	3.9	Accepted
8.	Skin injuries, rash and blisters	200	280	0	0	0	480	3.7	Accepted
9.	Eye sores	345	105	0	0	0	480	3.5	Accepted
10.	Easily kill infant	330	120	0	0	0	480	3.3	Accepted
11.	DNA alteration	335	105	0	0	0	480	3.2	Accepted
12.	Heart problems	314	278	0	0	0	480	3.0	Accepted
13.	Post-traumatic stress disorders	111	275	0	0	0	480	3.9	Accepted
14.	Stomach illness	150	250	0	0	0	480	3.8	accepted
15.	Geno toxicity	86	360	0	0	0	480	3.7	Accepted
16.	Endo crine toxicity	90	300	0	0	0	480	3.6	Accepted
17.	Skin cancer, melanoma, lung cancer and leukemia	112 102	301 280	0 0	0 0	0 0	480 480	3.1 3.3	Accepted Accepted

Source: Field Survey, 2020

From Table 2 above, it can be concluded that the above listed options in the table are the effects of oil spillage on health of humans in the environment. The findings on effects of oil spillage on health of humans in the environment are as follows: memory loss, dizziness, and irritability, headaches, nausea and vomiting, chest pain, coughing and lung problems, fatigue, skin injuries, rash and blisters, eye sores, easily kill infant, DNA alteration, heart problems, post-traumatic stress disorders, stomach illness, geno toxicity, endocrine toxicity, skin cancer, melanoma,

long and leukemia. These findings is in line with Adekola et al.<sup>13</sup> who reported that oil spillage have negative effects on health of humans. According to Oshienemen et al.<sup>1</sup>, most of the human diseases are as a result of oil spillage. Ojimba<sup>14</sup>, agreed that oil spillage is a threat to health of humans in the society. The comments and opinions of the authors above helped to justify the findings of the study on the effects of oil spillage on health of humans in the environment.

**Roles of Various Environmental Laws**

*Table 3: The roles of various environmental laws.*

S/N	Responses	SA	A	D	SD	UD	No. Of Resp.	Mean Score	Remarks
1.	To combat oil spillage	-	-	9	0	3	480	3.3	Accepted
2.	To monitor pollution of marine water, fresh water and ground water	-	-	0	0	0	480	3.4	Accepted
3.	To regulate oil producing company activities	-	-	0	6	0	480	3.7	Accepted
4.	Receiving reports of oil spillage response activities throughout Nigeria.	-	-	0	0	0	480	3.3	Accepted
5.	To prohibit processes and use of equipment or technology that undermine environmental quality.	247	179	9	0	1	480	3.3	Accepted
6.	To establish mobile courts to expeditiously dispense cases of violation of environmental regulations.	300	112	0	0	0	480	3.7	Accepted
7.	To apply enforcement measures to combat environmental degradations in manufacturing premises and government operation.	314	160	1	0	1	480	3.6	Accepted
8.	To prohibit the discharge of oil into designated sea areas.	217	270	0	0	0	480	3.0	Accepted
9.	To reduce the rate of oil incident along the Nigerian coast.	340	112	1	0	1	480	3.2	Accepted
10.	To tackle ecological and environmental problems that arises from exploration of oil in the Niger Delta Area.	280	200	0	0	0	480	3.3	Accepted

Source: Field Survey, 2020

From the Table 3 above, it shows that various environmental laws played important roles to control oil spillage. The study found on Table 3, shows that there are ten roles of various environmental laws. The findings on roles of various environmental laws are as follows: combat oil spillage, monitor pollution of marine and fresh water and ground water, regulate oil producing company activities, receiving reports on oil spillage, prohibits processes and use of equipment or technology that undermine environmental quality, establish mobile courts to expeditiously dispense cases of violation of environmental regulation, apply enforcement measures to combat environmental degradation, prohibits the discharge of oil into sea water, reduce the rate of oil incident and tackle ecological and

environmental problems that arise from oil exploration. This finding is in line with Ogbonnaya<sup>15</sup>, who reported that environmental laws played significant roles to eradicate and mitigate the incident of oil spillage. According to Ugochukwu and Ertel<sup>16</sup>, various environmental laws contribute enormously to combat oil spillage saga. Supporting this view, Omofonmwan and Osa-Edoh<sup>17</sup> stipulated that environmental laws such as FEPA (Federal Environmental Protection Agency) have important roles to control oil spillage. The comments and opinions of the authors above helped to justify the findings of the study on the roles of various environmental laws to combat oil spillage.

**Effects of Oil Spillage on Aquatic Animals and Crops**

*Table 4:* The effects of oil spillage on aquatic animals and crops.

S/N	Responses	SA	A	D	SD	UD	No. Of Resp.	Mean Score	Remarks
1.	Absence of freshwater for aquatic animal to breed.	207	218	1	0	0	480	3.5	Accepted
2.	In fertile land for crop production	200	150	0	0	7	480	3.0	Accepted
3.	Reduction of aquatic animal population.	350	110	0	0	0	480	3.2	Accepted
4.	Reduction of crops production	400	80	0	0	0	480	3.4	Accepted
5.	Loss of job/means of living (farmers and commercial fishermen and fisherwomen)	405	160	0	8	0	480	3.3	Accepted
6.	Retarded growth of crops	150	350	0	1	0	480	3.5	Accepted
7.	Loss of life of aquatic animals	350	160	0	0	0	480	3.9	Accepted
8.	Loss of fishing ponds and grounds	355	60	0	0	0	480	3.0	Accepted
9.	High cost of food crops	367	100	0	0	0	480	3.3	Accepted
10.	Destruction of fish eggs	400	80	0	0	0	480	3.4	Accepted
11.	Cultivable farm plots are reduced	360	116	0	0	0	480	3.6	Accepted
12.	Some aquatic animals and crops species are already extinct	167	300	5	0	1	480	3.2	Accepted

*Source: Field survey, 2020*

The study found on Table 4., shows that there are twelve effects of oil spillage on aquatic animals and crops. The findings on effect of oil spillage on aquatic animals and crops are as follows: absence of fresh water for aquatic animal to breed, infertile bud for crop production, reduction of aquatic animal population, reduction of crops production, loss of job, retarded growth of crops, loss of life of aquatic animals, loss of fishing ponds and grounds, high cost of food crops, destruction of fish egg, cultivable farm plots are reduced and extinct of some aquatic animals. This is in agreement with the reports of Inoni et al.<sup>7</sup>, who observed that germination, growth performance and yield of crops are stifled by oil spillage. They also found out that oil spills reduce crop yield greatly and depress farm incomes. A 10% increase in oil spill reduces crop yield by 1.3% while farm income plummets by 5% and above. Bayode et al.<sup>11</sup>

lamented that oil spill on the land could lead to refutation of vegetation growth for a period of time and in extreme cases, to destruction of vegetation. According to Omofoumwan and Odia<sup>18</sup>, lots of aquatic animals (e.g. Crocodiles, turtle, hippo, fish e.t.c), die prematurely when their residential water is polluted with oil. The opinion of Chukwuka et al.<sup>19</sup> also supported the findings of this study, who lamented on the frequent and premature death of animals especially those communities that are very close to oil station. The view of Osuagwu and Olaifa<sup>20</sup> also agree to the finding where they highlighted the difficulty in raising aquatic animals and cultivation of crops in an area close to oil station. The comments and opinion of the authors above helped to justify the findings of this study on the effect of oil spillage on aquatic animals and crops.

**The possible solution to oil spillage****Table 5:** Possible solution to oil spillage.

S/N	Responses	SA	A	D	SD	UD	No. Of Resp.	Mean Score	Remarks
1.	Vandalism of oil infrastructure and oil theft should be highly prohibited.	100	200	100	50	1	480	3.5	Accepted
2.	Oil pipelines should be periodically maintained to avoid corrosion and leakage.	300	180	0	0	0	480	3.7	Accepted
3.	Clean up team should be set up immediately after oil spillage.	290	118	0	0	1	480	3.3	Accepted
4.	NGO's should work with the government to combat oil spillage	300	180	0	0	0	480	3.3	Accepted
5.	Illegal oil refining should be prohibited	50	400	10	0	0	480	3.8	Accepted
6.	Human errors during crude oil process should be avoided	318	111	0	0	0	480	3.5	Accepted
7.	Oil flow lines should be periodically maintained and inspected.	280	260	0	0	0	480	3.0	Accepted
8.	Damaged pipelines and flow lines should be replaced immediately.	200	200	160	0	40	480	3.1	Accepted
9.	Proper security service should be provided at the site of oil well and pipelines against crude oil sabotage.	250	200	0	10	0	480	3.2	Accepted
10.	SPDC should endeavour to follow environmental laws and policies in relation to oil pollution.	360	100	0	10	0	480	3.4	Accepted

Source: Field Survey, 2020. SPDC= Shell Petroleum Development Company.

The study found on Table 5 shows that there are ten possible solution to oil spillage. The findings on possible solution to oil spillage are as follows: vandalisms of oil infrastructure and oil theft should be prohibited, oil pipeline should be maintained periodically, clean-up team should be set up immediately after oil spills, NGO's should support the government to fight oil spillage, illegal oil refining should be banned, human errors during oil processes should be avoided, oil flow lines should be inspected periodically, damaged pipelines and flow lines should be replaced immediately, proper security service should be provided at the side of oil well and SPDC should follow environmental laws and policies in relation to oil pollution. These findings are in line with Ojukwu-Ogba<sup>21</sup>, who reported that oil spillage can be eradicated if the laws governing the oil spillage are strictly followed and human errors are mitigated in the site of processes. According to Igbal et al.<sup>22</sup>, periodic inspection and maintenance of oil infrastructure can solve the problems of oil spillage. The view of Obi<sup>23</sup>, also agree with the findings, as he highlighted the importance of replacing damaged pipelines and prohibitions of illegal oil refining. The opinion of Ahmed and Mohd<sup>24</sup> also supported the findings of the study who lamented on crude oil vandalism which is the major causes of oil spillage in Niger Delta. The comments and opinions of the authors above helped to justify the findings on the possible solution to oil spillage.

Findings of the study in hypothesis one revealed that oil spillage has a significant effect on the environment; hypothesis two indicated that oil spillage has a significant effect on the health of aquatic animals and crop productivity; and hypothesis three, showed that the Government play significant role in implementing environmental laws to combat oil spillage.

#### IV. CONCLUSION

In view of the study, it can be concluded that oil spillage has a negative and statistically significant effect in Ozoro community in the Niger Delta, thereby leading to a high rate of environmental degradation and negative impact on health of humans. There is a significant relationship between oil spillage and low productivity of animals and crops. Finally, there are negative impacts of oil spillage on aquatic lives. The study, therefore, pointed out that the indigenes have suffered a lot of impact on crop yield, farm income and land productivity.

#### ACKNOWLEDGEMENT

The study team wishes to acknowledge the useful information provided by residents and other key informants at all the study locations in Ozoro Community, their special input and their cordial and hospitable nature during the field work of this study are very much appreciated.

## SIGNIFICANCE STATEMENT

This study will help to reduce the rate of environmental health impact created by oil spillage in the study Area. The findings will be of great importance to the Federal and State ministry of environment as it seeks to address the effect of oil spillage on the environment and environmental degradation caused by oil spillage. Finally the findings of this study will also be of immense benefit to government, students, scholars, researchers and the general public.

## REFERENCES

- [1]. Oshienemen, N. A.; Dilanthi, A. and Richard, P. H. 2018. Evaluation of the impacts of oil spill disaster on communities and its influence on restiveness in Niger Delta, Nigeria. *Procedia Engineering*. 212: 1054-1061. <https://doi.org/10.1016/j.proeng.2018.01.136>
- [2]. Mendelsohn, I.A., Anderson, G.L., Baltz, D.M., Caffey, R.H., Carman, K.R., Fleeger, J.W., Joye, S.B., Lin, Q., Maltby, E., Overton, E.B. and Rozas, L.P. 2012. Oil impacts on coastal wetlands: Implications for the Mississippi River Delta ecosystem after the deepwater horizon: Oil spill. *Bioscience*. 62(6): 562-574. <https://doi.org/10.1525/6.0.2012.62.6.7>
- [3]. Babatunde, A.O. 2020. Oil pollution and water conflicts in the riverine communities in Nigeria's Niger Delta region: Challenges for and elements of problem-solving strategies. *J. Contemporary. African. Studies*. 38(2): 274-293. <https://doi.org/10.1080/02589001.2020.1730310>
- [4]. Adewale, O.O. and Mustapha, U. 2015. The impact of gas flaring in Nigeria. *International Journal of Science, Technology and Society*. 3(2): 40-50. <https://doi.org/10.11648/j.ijsts.20150302.12>
- [5]. Dung, E. J., Bombom, L. S. and Agusomu, T. D. 2008. The Effects of Gas Flaring on Crops in the Niger Delta, Nigeria. *Geo Journal*. 73:297-305. <https://doi.org/10.1007/s10708-008-9207-2>.
- [6]. Onuoha, F. 2007. Poverty, pipeline vandalization/explosion and human security: Integrating disaster management into poverty reduction in Nigeria. *African Security Review*. 16(2):94-108. <https://doi.org/10.1080/10246029.2007.9627420>.
- [7]. Inoni, E.O., Omotor, D.G. and Adun, F.N. 2006. The effect of oil spillage on crop yield and farm income in Delta State, Nigeria. *Journal of central European Agriculture*. 1:41-48. DOI: <https://doi.org/10.5513/jcea.v7i1.353>.
- [8]. Ordiniola, B. and Brisibe, S. 2013. The human health implications of crude oil spills in the Niger Delta, Nigeria: An interpretation of published studies. *Niger. Med. J.*. 54(1):10-16. Doi.10.4103/0300-1652.108887.
- [9]. Cochran, W.G. (1952). The  $\chi^2$  Test of Goodness of Fit. *The Annals of Mathematical Statistics*. 23(3):315-345. Doi: 10.1214/aoms/1177729380.
- [10]. Ivshina, I.B., Kuyukina, M.S., Krivoruchko, A.V., Elkin, A.A., Makarov, S.O., Cunningham, C.J., Peshkur, T.A., Atlas, R.M. and Philip, J. 2015. Oil spill problems and sustainable response strategies through new technologies. *Environ. Sci. Processes. Impact*. 1201-1219. <https://doi.org/10.1039/C5EM00070>
- [11]. Bayode, O.J and Adewunmi, E. A. 2011. Environmental Implications of Oil Exploration and Exploitation in the Coastal Region of Ondo State Nigeria: A Regional Planning School of Environmental Technology, Federal University Of Technology Akure, Ondo State Nigeria. *Journal of Geography and Regional Planning*. 4 (3): 110-121. DOI: <https://doi.org/10.1.1.918.9529>.
- [12]. Ekperusi, A.O., Imiuwa, M.E. and David, A.O. 2020. Towards transparency in oil spill management in Nigeria. *Society of Petroleum Engineers*. 2(6): 834-845. <https://doi.org/10.2118/203761-MS>.
- [13]. Adekola, J., Fischbacher-Smith, M., Fischbacher-Smith, D. and Adekola, O. 2017. Health risks from environmental degradation in the Niger Delta, Nigeria. *Environment and Planning, Politics and Space*. 35(2): 334-354. DOI: 10.1177/0263774x16661720
- [14]. Ojimba, T.P. (2012). Determining the effects of crude oil pollution on crop production using stochastic translog-production function in River State Nigeria. *Journal of Development and Agricultural Economics* 4(13):346-360. DOI: 10.5897/JDAE12.082
- [15]. Ogbonnaya, U.M. 2011. Environmental laws and underdevelopment in the Niger Delta region of Nigeria. *African Research Review*. 5(5): 68-82. DOI: <https://dx.doi-org/10.4314/afrr.v5i5.7>
- [16]. Ugochukwu, C.N.C. and Ertel, J. 2008. Negative impacts of oil exploration on biodiversity management in the Niger Delta area of Nigeria. *Impact Assessment and Project Appraisal*. 26(2): 139-147. <https://doi.org/10.3152/146155108x316397A>
- [17]. Omofonmwan, S.I. and Osa-Edoh, G.I. 2008. The challenges of environmental problems in Nigeria. *J. Human. Ecology (Delhi, India)*. 23(1). DOI: 10.1080/09709274.2008.11906054
- [18]. Omofonmwan, S.I. and Odia, L.O. (2009). Oil exploitation and conflict in the Niger Delta Region of Nigeria. *Journal of Human Ecology*. 26(1) 25-30. <https://doi.org/10.1080/09709274.2009.11906161>
- [19]. Chukwuka, K.S., Alimba, C.G., Ataguba, G.A. and Adeyemi, J.W. 2018. The impact of petroleum production on terrestrial fauna and flora in the oil producing region of Nigeria. *The Political Ecology of oil and gas activities in the Nigerian aquatic ecosystem*. 125-142. DOI: 10.1016/B978-0-12-809399-3.00009-4
- [20]. Osuagwu, E.S. and Olaifa, E. 2018. Effects of oil spills on fish production in the Niger Delta. *Plos ONE*. 13(10): e0205114. <https://doi.org/10.1371/journal.pone.0205114>
- [21]. Ojukwu-Ogba, N.E. 2009. Legislating development in Nigeria's oil-producing region: The N.D.D.C Act seven years on. *African Journal of International and comparative law*. 17(1): 136-149. DOI: 10.3366/E0954889009000322

- [22]. Igbal, H., Testamariam, S., Haider, H. and Sadiq, R. 2016. Inspection and maintenance of oil and gas pipelines: A review of policies. *J. Structure and Infrastructure Engineering*. 13(6): 794-815. <https://doi.org/10.1080/15732479.2016.1187632>
- [23]. Obi, C.I. (2010). Oil as the “curse” of conflict in Africa: Peering through the smoke and mirrors. *Review of African Political Economy*. 37(126):483-495. DOI: 10.1080/03056244.2010.530947
- [24]. Ahmed, T.U. and Mohd, S.H.O. 2017. Causes and consequences of crude oil pipeline vandalism in the Niger Delta region of Nigeria: A confirmatory factor analysis approach. *Cogent Economics and Finance*. 5(1). DOI: 10.1080/23322039.2017.1353199.