Nigerian Journal of Fisheries and Aquaculture 5(1): 87 – 94, May 2017

Department of Fisheries, Faculty of Agriculture, University of Maiduguri, Nigeria
Available on line: http://www.unimaid.edu.ng
ISSN-2350-1537

An Assessment of the Socioeconomic Impact of Crude Oil Pollution on Aquaculture in Gokana Local Government Area Rivers State, Nigeria

Akankali, J. A. and Nwafili, S. A.
Department of Animal Science and Fisheries, Faculty of Agriculture, University of Port Harcourt
P.M.B. 5323, Port Harcourt, Nigeria

Received: March 21, 2017 Accepted: April 23, 2017

ABSTRACT
This study evaluates the impact of crude oil pollution on aquaculture, with the objective of assessing its impacts and the extent of the identified impacts socioeconomically. Data were obtained from a total of 150 fish farmers in five communities of Gokana LGA of Rivers State, Nigeria using structured questionnaires. The study established that crude oil pollution has adverse and severe socio-economic impacts on fish farming. The results of the study also showed that, crude oil pollution led to increased fish mortality rates, reduced yield and general poor quality of cultured fishes. The Kendall's coefficient of concordance, W was 0.97, indicating high degree of agreement among respondents. Recommendations based on the findings include the provision of more accessible means of information about the adverse consequences of oil pollution to the local communities in particular, educating the people on the socio-economic impact of crude oil pollution and the effects of consuming aquatic resources from polluted waters on the health of humans. Best practices for spill and pollution abatement/prevention including quick response to spill site and mobilizing communities through Global Memorandum of Understanding (GMoU) model to take more direct responsibility for monitoring oil theft and sabotage were recommended to be implemented by the crude oil producing companies within the Niger Delta region, as a means of abating the negative effects of crude oil pollutants adversely impacting aquaculture.

Key words: Socioeconomic, Crude Oil, Pollution, Aquaculture, Gokana Rivers State, Nigeria

INTRODUCTION

Aquaculture and fishing are major sources of food, employment and economic benefits to human populations around coastal and inland water areas. Increasing population around aquatic resources has been associated with urbanisation, tourism and intense agricultural and industrial activities with accompanying competition for utilization of the resources. Competing claims and diverse economic interests have threatened and impacted negatively these aquatic resources. Agriculture and industries discharge pollutants with potential harmful consequences into the environment. In response, many political and legislative authorities all over the world are introducing measures to protect aquatic resources from pollutants due to better understanding, knowledge and awareness of their harmful impacts on living aquatic resources (Biney *et al*., 1994).

The Nigerian inland and marine waters are seriously polluted through lack of proper management (Adeyemo, 2003). The Niger Delta is one the most severely oil spill impacted areas of the world (Zabbey, 2009; Olsson, 2012) from oil exploration and production. Hundreds of oil spills occur annually in the Delta of Nigeria Amnesty International (2013) and Odiete (1999), resulting from leaks during processing, corrosion of oil pipes, poor maintenance of infrastructure and equipment failure, crude oil theft, sabotage and illegal refining (Olsson, 2012; Agbonifo, 2016).

Oil spills cause significant social and economic damage. It can cause ecosystem imbalance through impacts on food chains, interference with fishing and aquaculture resources by physical contamination, toxic effects and by disrupting of business activity (IPIECA, 2000; ITOPF, 2004). For example, between 2008 and 2009 two major oil spills along Bodo creek which was spread by tidal

*Corresponding Author email: sylvanus.nwafili@uniport.edu.ng

waves to neighbouring communities disrupted economic by damaging the environment and livelihood sources of the people (Olsson, 2012). Where feasibility studies reveal the presence of pollutants in waters, due to environmental degradation or discharge of toxic effluents, such resources may not be utilized for aquaculture. On the other hand, where the aquaculture facility is already in place, before a hazardous environmental impact affects it, it may not only lead to the abrupt termination of aquaculture ventures, but also to loss of large investments. Taken together, oil spill halts and leads to declined aquaculture growth, while discouraging any form of expansion via future investments in aquaculture.

Fisheries resources constitute both the traditional and primary source of the enterprise and livelihood of most communities within the Niger Delta region of Nigeria (UNDP, 2006; Worgu, 2000; Opukri and Ibaba, 2008; Baumuller *et al.*, 2011). According to UNDP (2006), the environment is very important for the Niger Delta people and 60% of the population depends on the natural environment for their livelihoods. The oil spills in Ogoni and ensuing protests in the 1990's attracted the attention of governments and environmental rights' activists. According to Tanee and Albert (2011), Ogoni land is richly endowed with massive crude oil reserve which was first discovered at Bomu in Gokana Local Government Area in 1958 by Shell Petroleum Development Company (SPDC). Since the discovery of oil cases of crude oil spills into farm and forest lands, rivers, creeks and other water bodies in Ogoni land have become frequent and rampant.

Most aquaculture facilities within the Niger Delta operate on earthen or concrete ponds with water impounded in a closed culture system (PIND, 2011). Since aquaculture is a major aspect of the local economy of the people of Gokana local government area, like most wetland riverine areas of the Niger Delta region, oil spills may have very far reaching implications for aquaculture in the coastal and inland water areas than generally thought. Massive oil spill in Bodo community was estimated to have covered a total area of 8,106 hectares of mangrove swampland and waterways belonging to the Community, leaving ecological footprint. The effects of oil spill on aquaculture facilities in Ogoniland have not been reported. Therefore, the objective of this study was to investigate and assess the social and economic consequences of oil spill on the fish farmers in Gokana Local Government Area of Rivers State, Nigeria. This study will provide information on the extent and nature of impact of oil spills in the Niger Delta, thereby providing scientific basis for recommending abetment and compensation measures.

MATERIALS AND METHODS

Study area*

The study was carried out in Gokana Local Government Area of Rivers State, Nigeria. Gokana LGA comprises about 19 communities covering an area of 126 km² and a population of 228,828. The area covered by the study include five predominantly fish farming communities within Gokana Local government area, Bomuu, Bodo, Mogho, K-Dere and B-Dere.

Sampling frame and technique

A multi-stage random sampling technique was used to select respondents. Five communities were selected based on incidences of oil spillage and 30 fish farmers based on their involvement in fish culture after a preliminary survey. Therefore, a total of 150 fish farmers were interviewed using structured questionnaires. To ensure that the sample was an unbiased representation of the populations targeted, the cluster/random sampling technique was applied in choosing the respondents (Akankali and Abowei, 2010).

Data analysis

The data was analysed using descriptive and inferential statistics. Kendall Rank Coefficient of Concordance was used to measure differences in the ranking of variables and the degree of

concordance among the respondents. The test statistics for Kendall coefficient of concordance applied is:

$W = \frac{12\sum D^2}{M^2(N)N^2-1)}$ (Akankali and Abowei, 2010),

Where M= Number of identified socio-economic parameters that crude oil pollution impact has on aquaculture, N = Number of respondents, S = Sum of squares of the Rank from the mean of the sum of ranks. The size of W indicates the level of agreement among the respondents about the socio-economic impact of crude oil pollution on aquaculture. When W=1, there is perfect accord among the various respondents on their opinion concerning the socio-economic impact of crude oil pollution on aquaculture in the study area and the value is zero, there is poor or zero accord.

A five point Likert scale ranging from 1 = strongly disagree, 2 = disagree, 3 = not sure, 4 = agree and 5 = strongly agree was adopted to determine the most agreeable opinion of the respondents according to (McLeod, 2008). Since the mean response value for each opinion is 3.0, where response mean is up to and above 3.0, it is considered as the most generally accepted opinion or otherwise if less than 3.0. Any item that has a mean response value of 3.0 and above, will therefore be considered to be the most prevalent or dominant perspective of the respondents on specified variables on the socio-economic impact of crude oil pollution on aquaculture within the study area. Responses by individual respondents were therefore interpreted based on the Likert mean which indicates respondent's level of agreement to each variable being assessed. The mean is computed by taking the average of the product of responses from all the respondents and the scale point probability (1, 2, 3, 4 and 5). The mean is then interpreted based on the ranges shown (Table 1).

Table 1: Likert mean range

Scale point	Range	Interpretation
1	0.1 – 0.99	Strongly Disagree
2	1.0 - 1.99	Disagree
3	2.0 – 2.99	Undecided
4	3.0 – 3.99	Agree
5	4.0 – 5.0	Strongly Agree

The severity of the economic impact of oil spill on aquaculture was further determined by the Kendall coefficient. It ranks economic impact based on respondents rating of the factors. Scores are the horizontal summation of the product of response and the corresponding rank.

RESULTS

Impact of oil pollution

Certain economic parameters identified as possible impact indicators of crude oil pollution on aquaculture activities within the areas of the study were used as the parameters in assessing the opinion of the respondents. Applying Kendall's coefficient of concordance,

W = 12 □□ D□2□□□ M□2□ N□(N□ $W = \frac{12\sum D^2}{M^2(N)N^2-1)}$

Where $M = 7$, $N = 135$, and

$D = 4044 - 577.1$ or 3466.29 (Difference of the sum of ranking from the mean of the sum of ranks).

$$W = \frac{12(3466.29)^2}{7^2(145)(145^2-1)}$$

$= 0.97 \pm 1$

The agreement among the respondents is high (W=0.97). The results of the analysis using Likert mean scale are presented in Table 2.

Table 2: Impact of crude oil pollution on aquaculture activities

Issue	Response (%)						
	SA	Ag	Un	SD	D	Total	MLS
Retardation in growth rate of cultured fish during/post oil spill							
1.0-1.5 kg	0.00	10.67	28.00	44.00	17.33	100.00	2.32
1-0.7kg	44.67	20.67	12.67	18.00	4.00	100.00	3.67
0.7-0.5kg	34.67	32.00	10.67	19.33	3.33	100.00	3.75
Below 0.5kg	5.33	11.33	22.67	40.67	20.00	100.00	2.41
Time taken before aquaculture activities return to normal post oil spill							
Less than a month	0.00	0.00	18.67	32.00	49.33	100.00	1.69
Between 1-4 months	0.00	0.00	10.67	54.67	34.00	99.40	1.75
Between 4-8months	0.00	1.33	30.67	47.33	20.00	99.33	2.12
Between 8-12 months	24.67	63.33	1.33	10.67	0.00	100.00	4.02
Above 12 months	65.33	30.00	4.67	0.00	0.00	100.00	4.63
Mortality rate of fish during and post oil spill							
High mortality rate	62.67	27.33	6.67	3.33	0.00	100.00	4.90
Average mortality rate	18.00	60.67	5.33	10.66	3.33	97.99	3.73
Low mortality rate	0.00	8.00	1.33	60.00	30.67	100.00	1.87
Zero mortality	0.00	4.00	10.00	24.67	61.33	100.00	1.57
Reduced average profit post oil spill	51.33	40.67	4.67	5.33	0.00	100.00	4.00
Extended culture period due to oil pollution							
4-6 months	1.33	5.33	14.00	28.67	50.67	100.00	1.78
6-8 months	29.33	47.33	10.67	5.33	7.33	100.00	3.86
8-12 months	41.33	8.67	24.67	10.67	14.67	100.00	3.51
Above 12months	5.33	13.33	10.00	54.00	17.33	100.00	2.35
Depreciated quality of cultured fish due to oil pollution	24.00	54.00	7.33	8.67	5.33	99.33	3.8
Reduced quantity of harvested fish post oil spill	52.67	37.33	6.67	3.33	0.00	100.00	4.39
Increased cost of production	60.00	38.00	2.00	0.00	0,00	100.00	4.39

The result show agreement among respondents on retarded growth rate of cultured fish post oil spill, increased cost of production per cropping season, increased use of chemicals in farms in order to stabilise culture activities, reduced quantity of harvested fish per cropping season, reduced average income /profit post oil spill and depreciated quality of cultured fish post oil spill. The responses are in agreement with expected effects of oil spill on fisheries in general. The result shows that it took aquaculture activities between 8-12 months and above to return to normal after an oil spill. This represents the commonest opinion among the fish farmers with mean range of 4.02-4.63. While 62.67% of fish farmers strongly agree that the toxic effect of oil pollution resulted in high mortality rate of cultured fish during and after the oil spill with Likert mean of 4.9, only 60.67% agreed that mortality due the effects of oil pollutants was moderate, representing an equivalent of 3.73 on the Likert Scale. In concordance, 61.33% of respondents were in disagreement that pollutants from oil resulted in zero mortality.

In this study oil spill affected the quality and quantity of harvested fish with Likert mean of 3.80 and 4.39, respectively. The quality and quantity fish were negatively affected and this may be linked to reduced profit in aquaculture business as strongly agreed by 51.33% of the respondents. Oil spill also resulted in increased cost of production as 60% of fish farmers were in strong agreement.

Crude oil contact of aquaculture facilities negatively affected fish growth. The dominant perspective on this variable was 44.67% who were of the opinion that pollution from crude oil corresponded to growth retardation in the magnitude of between 1.0-0.7kg followed by 44% who strongly disagreed that pollution did not result to between 1.0-1.5kg retardation in growth. Other most prevalent or dominant perspective of the respondents on specified variables on the socio-economic impact of crude oil pollution on aquaculture are shown in Table 2.

Severity of Impact of Crude Oil Pollution

Kendall rank was used to establish the degree of agreement among the respondents on their rating of severity of the impact of oil pollution on aquaculture. The results are shown in Table 3. The individual scores of each factor is a summation of the product of the responses to each item and the respective ranks. The impact of crude oil pollution is more severe on reduction in average profit generated after an oil spill, followed

Table 3: Ranking of severity of the impact of oil spill on aquaculture

Parameters	1	2	3	4	5	6	7	Score	Rank
Reduction in average profit generated post oil spill	43	24	66	0	17	0	0	374	1
Retarded growth rate of cultured fishes during/post oil spill period	52	16	37	24	20	0	0	391	2
Reduction in quantity of harvested fish post oil spill	10	39	45	12	44	0	0	491	3
Reduction in quality of harvested fish post oil spill	0	36	0	33	41	38	0	637	4
Increased in cost of production post oil spill	19	20	0	35	28	21	26	647	5
Increased use of chemicals to stabilize culture activities	20	16	9	14	0	38	53	734	6
Increased mortality rate during and post oil spill	11	0	13	34	0	40	51	773	7

DISCUSSION

The communities covered by this research engaged in aquaculture, consisting of fish farming in small ponds for sustenance and sale. With W= 0.97, there was perfect accord among the various respondents on their opinion concerning the socio economic impact of crude oil pollution on aquaculture in Gokana LGA. Without exception, the fish ponds within the communities were severely affected by pollution and were not put to use for long period. In fact, many farmers never recovered from the devastating effects of oil spill into their fish culture facilities.

Impact on aquaculture activities

Responses from aquaculturists also showed strong agreement about high mortality rate of cultured fish during and after the oil spill with Likert mean of 4.9. This may be likely due to the toxic effect of oil polluted water on aquatic organisms. The Centre for Biological Diversity (2011) reports that oil and dispersed oil are toxic to fishes of all life stages. Commercially important plants and fishes are harmed by oil toxicity especially if exposure is not contained quickly. The effects of oil on cultured fish depend on oil type, life stage of the species, and species of fish. The early stages of growth have

been reported to be most susceptible to damage by oil products with mortality unlikely in adult life stage (NRC, 2003). This is because adults will normally swim away from crude oil pollution sites but again not in closed aquaculture systems. The main concern during pollution incidents would be sublethal effects. Some sublethal effects are decreased or abnormal growth, increased mucous production, damage to soft tissues, and decreased respiration rates (Hicken *et al.,* 2011; Heintz, 2007).

Another impact of crude oil on aquaculture was the extended culture period. The culture period according to respondents extended from 6 to 8 months, which may come in the form of disruption of operation cycles and retarded growth. Our findings agree with (ITOPF, 2004) which reported that interruption caused by oil spills on fish cultivation cycles can have important economic consequences. The disruption of operation cycle and growth retardation imply increased cost of production due to money spent on feed, chemicals and drugs during the extension period, thereby leading to reduced income generated from aquaculture. Reduced income generated per cropping season is considered the most severe impact of crude oil spill on aquaculture in the communities covered by this study.

The loss of profit, reduction in quantity and quality of harvest from fish ponds observed in this study is consistent with high rate of mortality which accompanies oil spill (ITOPF, 2004). Oil spills therefore pose significant threat to aquaculture resources. The main oil pollution effects are physical contamination of equipment, tainting and contamination of cultured products, and economic loss from business interruption (ITOPF, 2004). Further, by reducing quality and causing high rate of mortality, crude oil spill into fish ponds affect fish farmers and consumers by disrupting operations, and cause scarcities and higher prices for consumers.

Most aquaculture facilities within the Niger Delta region are earthen ponds with water impounded in a closed culture system (PIND, 2011). Therefore, any oil spill will affect the growth and abundance of natural food in the ponds. This may account for the poor growth and high mortality of fish during and after an oil spill into an aquaculture facility. For example, Zabbey and Uyi (2014) found severe reduction in abundance of surface and in the fauna communities of macrobenthos after two major oil spills in Bodo creek. Other factors that could account for retarded growth and mortality is the toxicity of the crude oil and associated components. Because of this effect of crude oil on availability of natural food and disequilibrium in the food chain, it is reasonable to expect retardation in growth of cultured fish and reduced quantity of harvested fish per cropping season as indicated by this study (Table 2). Crude oil spill have profound effects on the availability of natural food in the culture environment. In the aquatic environment, oil kill planktonic organisms exposed to them and prevent photosynthesis since oil does not permit light penetration. As would be expected, since aquaculture in these communities was more or less extensive, growth of fish in culture medium would be impacted negatively.

In conclusion, crude oil pollution seriously diminished the aquaculture potential of the affected areas within Gokana L.G.A. of Rivers state, Nigeria. All the parameters implicated to be negatively affected by the impact of crude oil pollution cumulatively contribute to a drastic reduction in aquaculture productivity of the communities. Consequently, the local aquaculture practitioners and their dependents within the area have been deprived of a critical means of livelihood by this phenomenon over the years. In order to revive aquaculture practices in areas of the Niger Delta region with similar incidents of crude oil pollution and Gokana Local Government Area in particular, measures must be taken to reverse the adverse impacts of crude oil pollution on her fisheries resources and the environment in general.

Based on the above findings, we recommend as follows:

i. That crude oil pollution be given top priority in the management of the negative effect of environmental pollutants adversely impacting fisheries resources in the entire NDR (Niger Delta region).
ii. As a short term measure, concrete tanks, plastic tanks and other forms of fish culture

facilities, (in place of earthen ponds) that can be sited in locations where the impacts of crude oil pollution are quite unlikely to affect them

iii. For the long term, targeted efforts aimed at eliminating the causes of crude pollution into the environment as identified by this study should be implemented.

iv. Mobilizing communities through Global Memorandum of Understanding (GMoU) model to take more direct responsibility for monitoring oil theft and sabotage.

v. Oil companies should be more transparent in dealing with oil spill cases and disclose facts which are germane to the right remedy.

vi. Avenues for increasing awareness on the adverse impacts of crude oil pollution to aquaculture should be fully utilized to educate the local people, as a means of reducing crude oil spillages due to sabotage.

vii. Environmental studies that will identify and delineate areas with potential for aquaculture should be carried out, so that proactive protective measures be instituted to safeguard them in the event of an oil spill.

REFERENCES

Adeyemo, O.K. (2003). Consequences of pollution and degradation of Nigerian Aquatic Environment on fisheries resources. *The Environmentalist* 23(4):297-306.

Agbonifo, P. (2016). Oil spills injustices in the Niger Delta region: reflections on oil industry failure In relation to the United Nations Environment Programme (UNEP) Report. *International Journal of Petroleum and Gas Exploration Management*, 2 (1):26-37.

Akankali, J.A. and Abowei, J.F.N. (2010). The Intuitional Perspective of environment pollutant impact severity on artisanal fisheries resources in Niger Delta. Current *Research Journal of Economic Theory* 2(2):76-81.

Amnesty International (2013). *Bad information: oil spill investigations in the Niger Delta*. Amnesty International Publications, International Secretariat Peter Benenson House 1 Easton Street London, 80Pp.

Baumüller, H., Donnelly, E., Vines, A. and Weimer, M. (2011). *The effects of oil companies' activities on the environment, health and development in Africa*. Chatham House, United Kingdom, 61Pp.

Biney, C., Calamari, D., Naeve, H., Maembe, T.W., Nyakagaeni, B., Saad, M.A.H. (1994). Scientific bases for pollution control. IN Calamari, D and Naeve, H. (Eds.) Review of pollution in the African Aquatic environment. *CIFA Technical Paper, No.25. Rome*, 118p.

Centre for Biological Diversity (2011). A deadly toll: The Gulf oil spill and the unfolding wildlife disaster. http://www.biologicaldiversity.org/programs/public_lands/energy/dirty_energy_development/oil_a nd_gas/gulf_oil_spill/a_ deadly_toll.html. Accessed April 23, 2017.

Heintz, R.A. (2007). Chronic exposure to polynuclear aromatic hydrocarbons in natal habitats leads to decreased equilibrium size, growth, and stability of pink salmon populations. *Integrated Environment Assessment and Management*, 3:351–363.

Hicken, C.E, Linbo, T.L, Baldwin, D.H., Willis, M.L., Myers, M.S., Holland, L., Larsen, M., Stekoll, M.S., Rice, S.D., Collier, T.K., Scholz, N.L. and Incardona, J.P. (2011). Sublethal exposure to crude oil during embryonic development alters cardiac morphology and reduces aerobic capacity in adult fish. *Proceedings National Academy of Sciences, USA*, 108: 7086-7090.

IPIECA (2000). Guidelines on biological impacts of oil pollution. International Petroleum Industry Environmental Conservation Association, *Report Series* 1:20Pp.

ITOPF (2004). Oil spill effects on fisheries. The International Tanker Owners Pollution Federation Limited. *Technical Paper No.* 3**,** 8Pp.

McLeod, S.A. (2008) Likert scale - simply psychology. http://www.simplypsychology.org/likert-scale.html. (Accessed 14th May, 2014).

NRC (2003). National Research Council (US) Committee on Oil in the Sea: Inputs, Fates, and

effects. Oil in the Sea III: Inputs, Fates, and Effects. Washington (DC): National Academies Press (US) 2003. 5, Biological Effects of Oil Releases. Available from: https://www.ncbi.nlm.nih.gov/books/NBK220710/. Accessed April 23, 2017.

Odiete, W.O. (1999). Environmental Physiology of Animals and Pollution. Diversified Resources Limited, Lagos. 171-185.

Olsson, G. (2012). *Water and energy: threats and opportunities*. United Kingdom: IWA Publishing, 294Pp.

Opukri, C.O. and Ibaba, S.I. (2008). Oil induced environmental degradation and internal population displacement in Nigeria's Niger Delta. *Journal of Sustainable Development in Africa* 10(1):173- 193.

PIND (2011). *A report on aquaculture value chain analysis in the Niger Delta*. A Publication of Foundation for Partnership Initiatives in the Niger Delta. 60Pp.

Tanee, F.B.G., and Albert, E. (2011). Post-Remediation Assessment of Crude Oil polluted site at Kegbara-Dere Community, Gokana L.G.A. of Rivers State, *Nigeria. Journal of Bioremediation and Biodegradation*, 2:122Pp. doi:10.4172/2155-6199.1000122

UNDP (2006). Niger-Delta Human Development Report; Available:http://hdr.undp.org/en/reports/national/Africa/Nigeria/name,3368,en.html. Accessed March 10, 2017.

Worgu, S.O. (2000). *Hydrocarbon Exploitation, Environmental degradation and poverty in the Niger Delta region of Nigeria*. Lund University Lumes Programmes, Lund, Sweden, 2-11.

Zabbey, N. (2009). Pollution and Poverty in the Niger Delta Region – What is the Responsibility of Oil Companies in Nigeria. Paper delivered at the University of Stavanger, 29th October, 2009, Stavanger, Norway (www.cehrd.org).

Zabbey, N. and Uyi, H. (2014). Community responses of intertidal soft-bottom macrozoobenthos to oil pollution in a tropical mangrove ecosystem, Niger Delta, Nigeria. *Marine Pollution Bulletin,* 82 (2014):167-174