Journal of Contemporary Research in the Built Environment ISSN: 2636-4468
Volume 2, Numbers 1&2, 2018

IMPACT OF OIL AND GAS EXPLORATION ON PHASE II OF THE BUILDING LIFE CYCLE

***Cyril J. Effiong*[1] *and Ifiok E. Ekop*[2]**

[1]Department of Urban and Regional Planning, Faculty of Environmental Studies, University of Uyo, Akwa Ibom State, Nigeria

[2]Department of Building, Faculty of Environmental Studies, University of Uyo, Akwa Ibom State, Nigeria

ABSTRACT

Purpose: The study was design to assess impact of oil and gas exploration on phase II of the building cycle with particular reference on the three oil producing communities of Akwa Ibom State- Estern Obolo, Ikot Abasi and Ibeno. The research became necessary because oil and gas exploration has greatly affected buildings and environment in the region. Nigeria as a nation is blessed with abundant natural resources and crude oil contributes about 80% to Nigeria's government revenue. However, oil exploration, despite its contribution to government revenue, has some consequential environmental implications on buildings and environment of the host communities.

Design/methodology/approach: For the purpose of collecting data, a survey research design involving observation and assessment of structures was adopted for the research. A five point Likert scale was used in assessing building conditions using structural and environmental indicators as drawn from literature. A numeric figure of Very Poor =1, Poor =2, Partially Good =3, Good =4 and Very good=5. The assessment was carried out on buildings that are within 1m radius of the oil exploration site which thus constitute the population of the study. The buildings were further categorized into residential and commercial buildings. The sample size was drawn using 50% of the total building within the study area. The relative important index method was used in the study to determine perception of the level of impact of oil exploration on building.

Findings: The study reveals that there is a strong impact between emissions from the flare and buildings. Oil spillage and gas flaring are the causes of attendant problems the people of the area and that the most visible consequences of oil and gas exploration on buildings was corrosion of roof tops which resulted in changes in colour of roof tops and leakage of roof tops. This is caused by emissions of SO_2, NO_2 and PM_{10} during gas flaring and oil spillage.

Originality/value: The findings from the study would serve as a useful tool not only to make informed decision on how to mitigate air pollution levels among the local population, but also justify the need for further research on the growing problem of oil and gas spillage and flaring in the oil and gas producing areas in the Niger Delta Region of Nigeria.

Keywords: Environmental pollution; oil spillage; gas flaring; building life cycle.

[1]cyrileffiong@uniuyo.edu.ng

1. INTRODUCTION

The Niger Delta Region of Nigeria is a resource rich- environment which produces 95% of the GNP of the Nigerian nation. However, the region has witnessed industrial pollution due to oil exploration activities and the inadvertent discharge of petroleum hydrocarbon into the environment has posed threats to buildings in terms of life cycle performance due to concrete loosening its strength as a result of contamination of sand and water used in building production in the oil and gas producing areas (Snowden and Ekweozor, 2002). The discovery and extraction of oil and gas world over has contributed to ecological degradation and environmental pollution, which have adversely affected the quality of life in these regions (UNDP, 2006). These ecological problems range from environmental pollution, gas flaring, competition for space, urbanization, climate and ecological changes. The most worrisome aspect is that constructed buildings which was to serve as a cover against the physical attack from the environment is now a bane as a result of unfriendly exploration of natural resources. Houses with zinc roof that are close to the location of the flare stack do not last for two years compared to houses outside the flared locations. This is why Bassey, (2000) posited that the zinc corrosion has added another dimension to the increasing socio-economic cost to the burden of the Niger-Delta people.

Performance of concrete structural frame building life cycle is classified into three main phases according to BS EN 15804 (2012). Phase 1 takes into account aspects and impacts related to product manufacture and building construction (on-site construction). Phase II includes aspects and impacts arising from the maintenance and repair of the building structure. Phase III of the life cycle encompasses end of life and corresponding destination of disassembled or demolished material. During building construction, the developers take into consideration standards as enshrined in the building code, architectural designs and specifications, environmental and other physical quality in order to maintain quality construction that is sustainable. However, during maintenance and repairs, the developers neglect certain environmental requirement which make the quality of construction below acceptable standard. The most worrisome aspect is that major stakeholders like Architect, planning agency, project managers are sidelined during maintenance and repairs of buildings which the result is poor quality of work. Usually, in such buildings there are applicability mistakes as a result of lack of knowledge, poor quality of construction work due to inexperience labourers. This study, therefore, seeks to investigate the Phase II (aspects and impact arising from the maintenance and repair of the building structure using its indicators and assessing how oil and gas exploration activities have affected the performance of building in the study area. This is sequel to the observation by Abolore (2012) that, unsustainable development has been attributed to poverty, inequalities, discrimination and socio-cultural exclusion, insecurity, human rights, abuse, corruption as well as environmental disaster and inappropriate resource management.

2. REVIEW OF RELATED LITERATURE

The Niger Delta ecosystem is under threat from pollutants generated by a multiplicity of oil and gas related installations, including flow stations, oil well heads loading terminals and tank farms (Egborge et al, 1986; Onwudinjo, 1990). Similarly, Eteng 1997, has argued that, ‘oil exploration/exploitation has over the last forty years (40) impacted negatively on the socio-physical environment of the Niger Delta oil bearing communities, massively threatening the subsistent peasant economy, the environment and hence the entire livelihood and basic survival of the people. Jimoh and Aghalino (2000), concurred to the report of UNDP (2006), which asserts that ‘the Niger Delta is a region suffering from administrative neglect, crumbing social infrastructure and services, high unemployment, social deprivation, abject poverty, filth and squalor and endemic conflict. The most profound and adverse impact of oil pollution in the Niger Delta with far-reaching implications on all other aspects of our traditional lifestyles and livelihoods, had been the total loss of biodiversity and destruction of the Ecosystem and its habitats largely due to soil degradation. The results of the unchecked oil pollution have been the complete destruction of ecosystems. This is why Bisina, (2004) agreed with Idumu, (2008) by asserting that the effects of oil on the Niger Delta community is very detrimental to human life as it has affected their main source of livelihood. It has further corroborated what Essien (2005), said that the oil producing area has largely become a cynosure because of widespread social unrest generated by neglect, environmental degradation and mindless spoliation among others. Moller (2005) also agreed that social unrest and pervasive youth restiveness in the area is the result of soil degradation, environmental pollution, water contamination, inequality in resource allocation and deliberates under development spanning over three decades

The impact of pollution is felt on human health, environment and ecosystem. Studies have shown that the rise of certain ailment that were previously unknown in the area is as a result poorly managed ecosystem. According to the report made by Bassey, (2002) that Multinational Company operating in Niger Delta flare more gas than their counterpart in other climes which has contributed to the several ailments witnessed in the area. This confirms the assertion that many residents within the oil exploration area complain of asthma, breathing difficulties, headaches, nausea, and throat irritation as well as chronic bronchitis (Amaize, 2012).

Another impact of oil pollution is the rapidity of which zinc roofs are easily corroded. This is a common trend that is observed in the parts of the Niger Delta where oil extraction is presently taking place. Houses with zinc roofs that are close to the location of the flare stacks do not last for two years before they become corroded. This is different from other areas where zinc roofs last for at least ten years. This is why Essien, (2002) posited that the corroded Zincs added another dimension to the increasing socio-economic costs to the burden of the people of the area. It is a common knowledge that acid rain oxidizes zinc through the process of oxidation to form zinc oxides. This oxidation process is responsible for the corrosion which has led homeowners to resort to roofing their houses with expensive asbestos as an alternative of abating potential health hazards. Corrugated roofs in the oil and gas producing communities have been corroded by the composition of the rain that falls as a result of oil and gas exploration (Gbadegesin, 2000). The primary causes of acid rain are emissions of (SO2) and (NO) which combined with atmospheric moisture to form sulfuric acid respectively. Size and environmental philosophy in the industry have very strong positive impact on the oil and gas exploration related CO2 emission (Amadi and Tamuno, 2001).

Acid rain acidifies lakes and streams and damages buildings (mostly roofing materials). In addition, acid rain accelerates the decay of building materials and paints. Prior to falling to the earth, SO2 and NO2 gases and their particulate matter derivatives, sulfates and nitrates, contribute to visibility degradation and harm building structures. This will late manifest in corrosion of roofs tops (changes in the colour of roofing materials), leakage of roofs tops, etc. due to toxic properties associated with oil and gas exploration.

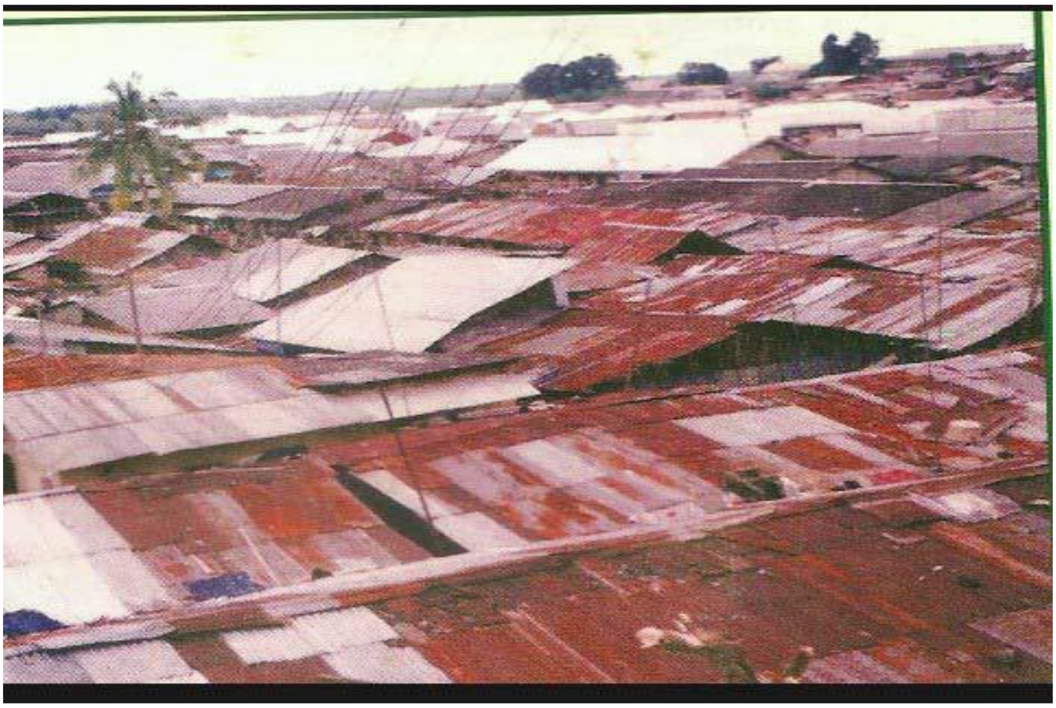

Plate 1: Rusted zinc roofs in atabrikang community in Ibeno local government area of Akwa Ibom State

2.1. The concept of building life cycle

Building life cycle refers to entire course of a building which takes into cognizance the design, construction, operation, demolition and waste treatment (Kotaji, 2003). It is useful to use this concept when attempting to improve operational feature of a building which is related to how a building was designed. The life cycle of a building begins with the Product Phase where raw materials are obtained and transported to factories for manufacturing. Secondly, all construction products (including admixtures, formwork, etc) are transported or distributed and end up at the building site. At the construction phase, all installations are undertaken onsite (Bengt, 2003).

At the third stage, it is known as Use Phase where maintenance, repair, replacement and refurbishment involving periodic site activities and replacement of components are done (these stage usually instigate more extracting, transporting and manufacturing). .

Fourthly, there are the on-site activities to demolish the building, process all waste, and transport them to where it will be reused, incinerated, or disposed into a landfill. This is the 'end of life' phase. All of the waste generated during transporting, manufacturing, constructing and replacing components must also be managed. (Bengt, 2003).

Figure 1 is life cycle assessment and analysis as well as their potential uses help construction professionals make environmentally friendly decisions. The life cycle assessment recognizes that all stages from raw materials extraction to waste management have environmental and economic impacts. It is a tool which assesses the environmental aspects and potential impacts associated with a product or service. Life cycle assessment can be applied to the environmental life cycle of buildings

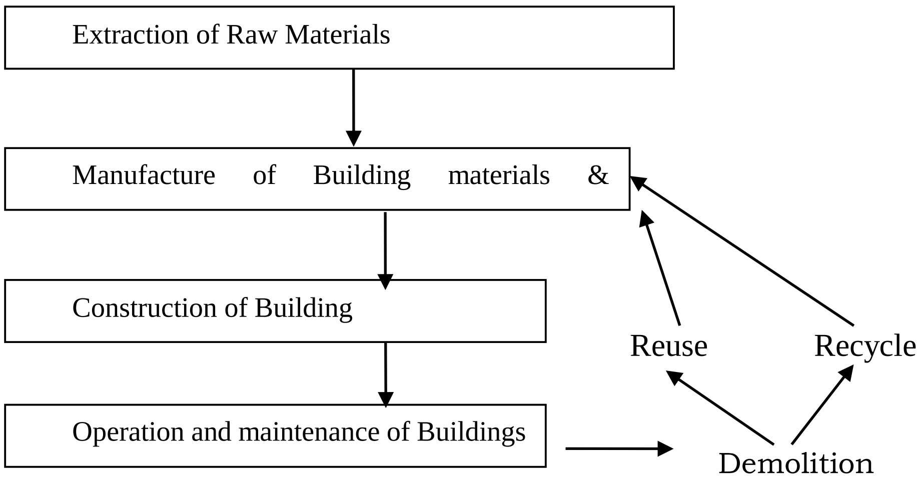

Figure1: Environmental Life Cycle of a Building
Source: www.esru.strath.ac.uk/EandE/web accessed February, 2019

3. RESEARCH METHODOLOGY

To collect data, a survey research design involving observation and assessment of structures was adopted for the research. A five point likert scale was used in assessing building conditions using structural and environmental indicators as drawn from literature. A numeric figure of Very Poor =1, Poor =2, Partially Good =3, Good =4 and Very good=5. In this work, Phase II of the building cycles represents rehabilitation. To investigate the Phase II (aspects and impact arising from the maintenance and repair of the building structure) eight Structural indicators and nine environmental indicators were assessed to ascertain the performance of building in oil and gas environment.

The assessment was carried out on buildings that are within 1m radius of the oil exploration site which thus constitute the population of the study. The buildings were further categorized into residential and commercial buildings. The sample size was drawn using 50% of the total building within the study area. At Eastern Obolo Local Government Area, 43 buildings were identified as residential while 28 were commercial. In Ikot Abasi Local Government 45 buildings were identified and categorized into residential while 15 buildings were categorized into commercial. In Ibeno Local Government Areas 57 buildings were identified and categorized into residential and 18 building was categorized into commercial. The sample size was drawn using 50% from the population of buildings as shown in Table 1.

Table 1: Sample size

Study Area	Sample Size Residential	Commercial	Total
Eastern Obolo	22	14	36
Ikot Abasi	23	8	31
Ibeno	28	9	37
Total	73	31	104

Data on perception of impact of oil exploration on building using structural and environmental indicators were measured on five-point Likert scale namely Very Poor =1, Poor =2, Partially good =3, Good =4 and Very Good =5. The relative important index method was used in the study to determine perception of the level of impact of oil exploration on building in line with the formula used by Ugwu and Haupt, (2007) and Enshassi, Mohamed and Abushaban (2009) as shown in equation 1

$$RII = \frac{\sum W}{\mathrm{A \times N}} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Where W is the weight given to each variable by the respondents and ranges from 1-5; A- the highest weight =5; N – the total number of respondents. The RII were then classified as 0-0.359 Very Strong Impact (VHI); 0.36- 0.529 Strong Impact (HI); 0.53-0.679 Moderate Impact (MI); 0.68-0.839 Low Impact (LI) and 0.84 – 1.0 Very Low Impact (VLI).

4. Data Analysis and Discussion

Table 2 examines the characteristics of buildings assessed which shows that buildings within the 1m radius were identified and categorized into residential and commercial buildings. However, a total of 73 buildings were residential representing a percentage of 70.2 while commercial were 31 representing 29.8% .it can be deduced that there are more residential buildings located within the oil producing site. The increase in residential buildings is predicated on the demand for housing close to production site. It can also be an opportunity for prospective land owners to reap the economics of scale were they build more residential houses as there will be likelihood of oil producing staff living close to the exploration site. Ages of building ranges from less than 5years, 6-15years and more than 16years. The survey indicates that 19 respondents representing 18.3% renovate their building every 5 years, 41 respondents representing 39.4% renovate their buildings every 6-15 years while 44 respondents representing 42.3% renovate their buildings after 16 years. The materials used for roofing as observed indicates that zinc materials were mostly used as roofing materials in the study area. The study indicates that 51 respondents representing 49% used Zinc as roofing materials. Aluminum comes second with 35, representing 33.7%, Asbestos is third with 12, representing 11.5% and Thatch roof came last with only 6, representing 5.8%.

Table 2: Characteristics of buildings assessed

Characteristics of Respondents	Sub Characteristics	Frequency	%
Nature of Building	Residential	73	70.2
	Commercial	31	29.8
	Total	104	100
Age of Building	>5years	19	18.3
	6-15 years	41	39.4
	>16years	44	42.3
	Total	104	100
Material used	Zinc	51	49.0
	Aluminium	35	33.7
	Abestos	12	11.5
	Thatch	6	5.8
	Total	104	100

For the purpose of assessing the impact of oil and gas exploration on building, eight structural indicators and nine environmental indicators were identified from literature and used for assessment to ascertain the conditions of buildings within this locale as shown in Table 3. The result in Table 3breveals that nature of road, drainage, environmental aesthetics and pollution recorded very strong impact which implies that the activities of oil and gas exploration had affected the operation and condition of these facilities. This therefore corroborates what Afinotan & Ojakorotu (2009), rightly asserted that "obtuse neglect by successive governments and massive degradation in the region, occasioned by oil production and export activities contributes to the bane of the oil producing communities. The multinationals companies operating in these regions repatriate natural resources of the region with their allies to the detriment of the environment and its people. This is why Jimoh and Aghalino (2000), concurred to the report of UNDP (2006), that 'the oil producing communities are region suffering from administrative neglect, crumbing social infrastructure and services, high unemployment, social deprivation, abject poverty, filth and squalor and endemic conflict. This development has produced significant and far-reaching consequences in which industrial establishments and their staff has been the target of restive youth. It is therefore pertinent for oil producing companies to reducing gas emission and provides infrastructures that will better the lots of the citizenry.

Table 3: Perceptive assessment of the impact of oil and gas exploration on building

			N = 104					
Indicators	**1**	**2**	**3**	**4**	**5**	**Sum**	**R.I**	**Rank**
Structural								
Roof (leakage, colouring)	37	54	54	48	50	243	0.47	7th
Wall (weathering, cracks, colouring)	34	46	42	72	70	264	0.51	5th
Foundation (exposed)	16	36	69	68	150	339	0.65	4th
Beams	11	54	54	80	140	347	0.67	2nd
Columns	12	56	114	48	120	350	0.67	2nd
Facial board	38	56	33	56	65	248	0.48	6th
Floor finishing	9	36	93	96	110	344	0.66	3rd
Ceiling (caved)	19	52	87	72	60	290	0.56	5th
Environmental								
Nature of road	47	74	48	8	10	187	0.36	10th
Drainage	58	66	24	12	10	170	0.33	11th
Toilet facilities	32	54	48	44	90	268	0.51	5th
Public Sanitation	49	44	24	68	40	225	0.43	8th
Waste disposal	36	44	45	56	85	266	0.51	5th
Environmental aesthetics	53	66	24	20	25	188	0.36	10th
Air quality	47	52	48	32	35	214	0.41	9th
Water quality	12	28	63	96	165	364	0.70	1st
Pollution reduction	79	24	9	20	15	147	0.28	11th

The second indicators had high impact which includes roof, wall, facia board, toilet facilities, public sanitation and waste disposal which suggests that the activities of oil and gas affected the performance and state of these indicators. To a greater extent, the environment of the region is not healthy as emission of flare stack stares residents in the face. However, inhaling these emissions have serious health challenges on the resident of the region which confirms the assertion made by Amazi, (2012) that many residents within the oil exploration area complain of asthma, breathing difficulties, headaches, nausea, and throat irritation as well as chronic bronchitis. As opined by Essien, (2002) that houses with zinc roofs that are close to the location of the flare stacks do not last for two years before they become corroded. The corroded zinc makes the area an eye saw and further increase the socio-economic burdens of the residents. This is the situation of the study area which most houses are mostly corroded due to the exploration

5. CONCLUSION AND RECOMMENDATIONS

This study has assessed the impact of oil and gas exploration on building life-cycle in oil producing areas of Eastern Obolo, Ikot Abasi and Ibeno Local Government Areas. From the study, it is seen that oil and gas exploration has grave effects on the life span of buildings and environment especially in the area of study. The study has also revealed that life cycle assessment recognizes that all stages from raw materials extraction to waste management have environmental and economic impacts.

Results revealed a strong impact between emissions from the flare and buildings. Oil spillage and gas flaring are the causes of attendant problems the people of the area are facing which ranges from environmental degradation, oil conflict. The situation is worsened by the lack of commitment in rectifying the anomaly

The results showed that most houses located within the flare stack do not last for two years before becoming corroded. This is perhaps the most visible consequences of oil and gas exploration on buildings which usually result in changes in colour of roof tops and leakage of roof tops. This is caused by emissions of SO2, NO2 and PM10 during gas flaring and oil spillage.

The result obtained in this study would serve as a useful tool not only to informed decision on how to mitigate air pollution levels among the local population, but also to justify the need for further research on the growing problem of oil and gas spillage and flaring in the oil and gas producing areas in the Niger Delta Region of Nigeria.

Based on the study, it is recommended that:

- Special courts or tribunals should be set up to adjudicate on environmental disputes arising from the activities of oil and gas companies and its effects in the environment (buildings).
- Special attention and special rehabilitation measures should be carried out frequently in the host communities to check the negatives effect.
- The Nigerian Oil and Gas Emergency Response Agency (NOERA) should be empowered by the Federal Government of Nigeria financially so that the core mandate of ensuring pollution free oil producing areas of the Niger Delta can be achieved.
- Promotion of environmental awareness and consciousness not only amongst the oil operators but in the general public through the organization of the Biennial Seminar on the Petroleum Industry and the Nigerian Environment should be encouraged.
- Oil Operators in the region should adopt and promote the use of existing environmentally friendly technologies as recommended by World Environmental Safety Standard.

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