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EVALUATION OF THE IMPACTS OF OIL SPILLAGE ON SOIL FERTILITY AND SUSTAINABLE LIVELIHOODS IN OIL-BEARING COMMUNITIES OF ABIA STATE, NIGERIA.

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Abia State, Nigeria, Oil-bearing communities, Oil spillage, Soil fertility, Sustainable livelihoods.

ABSTRACT

Oil spillage is a major environmental challenge in the oil- and gas-bearing communities of Abia State, Nigeria. Despite the huge revenues that have accrued to the Nigerian state and oil companies operating in these communities, the communities have not fared well in terms of socio-economic development and the sustainability of the livelihoods of households. They have seen a steady decline in agricultural productivity and fish catch over time, resulting to lowered household incomes and the aggravation of poverty levels. The decline in farm yield and household incomes has been linked to the repeated oil spill impact in the area which has, in turn, led to the loss in soil fertility. The aim of this study therefore, is the evaluation of the impacts of oil spillage on soil fertility and sustainable livelihoods of houselds in the oil-bearing communities of Abia State, Nigeria. A combination of the participatory research appraisal and the survey methods was used to collect the primary data used for the study. A questionnaire, which was designed and instrumented to elicit information on the socio-demographic features of households, was administered to respondents in the area. Data on farm crop yield and its measurement were obtained through the participatory research appraisal method. In addition, samples of oil-impacted and control (not oil-impacted) soils were tested for major indices of soil fertility, namely, pH, Available Phosphorous, Total Nitrogen, Total Organic Carbon and Total Organic Matter given the prevailing physico-chemical conditions of temperature, moisture content and electrical conductivity. All the indicators from the results of the tests of the oil-impacted soil samples from the oil-bearing communities of Umuorie, Owaza and Uzuaku/Imo River confirmed enormous reduction in soil fertility especially when compared with the control soil samples from the communities. It is recommended, among others, that a quick and timely recovery process must be initiated each time there is oil spill since the seriousness of oil spill impact is directly related to the speed of recovery of impacted habitats and species.

INTRODUCTION

OIL spillage, which refers to the accidental or unintentional discharge of crude oil and or its products into the ecosystem – rivers, seas, oceans and on land – is one of the most serious environmental challenges confronting the contemporary world. This phenomenon has adversely affected terrestrial and aquatic biota often bringing with it the destruction of the environment and the various lives supported by such an environment. Thus, it affects both land and water resources on which man and other organisms, both plant and animals, depend for sustenance and livelihood, particularly, in developing countries of the world where a greater number of the people depend on the land and its resources and on water for livelihood. However, oil spill impact is usually more expansive and widespread on water than on land since the spilled oil or its products are easily dispersed by water. Furthermore, oil spillage may be caused by intentional and deliberate anthropogenic action such as crude oil theft, terrorism and sabotage, among others. For example, the Gulf War oil spill, 1991, which was among the largest oil spills in history, had as its probable strategic goal the prevention of a possible landing by US Marines; and, made the takeover of oil reserves by US forces difficult as visibility and mobility were enormously hampered (Australian Broadcasting Service, 2010).

The risk of oil spillage increases with the increased transportation of crude petroleum and products from points of production/exploitation to places of refining and consumption. For instance, the international community recorded a spill of 287,000 metric tonnes of oil into the Caribbean Sea in 1979 when the vessel *SS Atlantic Empress* collided with another vessel, the *Aegean Captain* (Soter, 1979). Again, on 24 March, 1989, the *Exxon Valdez,* an oil tanker operated by Exxon Shipping Company and bound for Long Beach, California, struck Prince William Sound Reef, Alaska, spilling about 41,000 metric tonnes of oil in the process. However, there has been a reversed trend as the rate and volumes of oil spillage from ocean-going vessels have drastically reduced in the last 15 – 20 years (International Tanker Owners Pollution Federation, ITOPF, 2017). Empirical evidence from the ITOPF (2017) for the period 1970 – 2016 have confirmed that the average number of oil spills in the waters per year has fallen from about 24.5 large spills (> 700 tonnes each) in the 1970s to about 1.7 large spills each year in the 2010s. Similarly, the quantity and volume of oil spills have decreased drastically in the same period with the lowest volume of about 1,000 metric tonnes recorded in 2012. These reductions have occurred despite the gigantic increases in global trade and transportation including of oil and gas products in the same period; and, may be accounted for by the enormous deveopments in technological advancements and innovations in this area of human activity.

In Nigeria however, the issue of oil spillage – particularly, on land – remains a serious challenge and consequently, has continued to attract scholarly and policy-making attention due to its devastating effects on, not just the health conditions of the people and the environment but also on the sustainability of the livelihoods of households in the oil-bearing communities. This is because the chemicals in the spilled oil reduce soil fertility, contaminate sources of surface and underground water, destroy micro-organisms in the soil (which aid aerobic and carry out microbial actions), destroy vegetative cover of the soil as well as the breeding places for fishes. In addition to the chemical effects of oil spills, there may be physical effects also where the spilled oil blankets the affected area and destroys plants and animals through physical smothering. This is usually the case with oil and oil products with heavy viscosity. Consequently, oil production operations have exerted tremendous negative impact on the sustainability of the livelihoods of households in these communities.

This study therefore, focuses on the evaluation of the impact of oil spillage on soil fertility and livelihoods of households in the oil- and gas-bearing communities of Ukwa West Local Government of Abia State, Nigeria. These communities include: Owaza, Umuorie, Umuokwor, Obiga, Uzoaku and Imo River. The main livelihood sources of these communities are farming, fishing, and, to a lesser extent, petty-trading, boat carving and traditional cloth-weaving. The study examines the changes, if any, which have taken place in the income levels, employment opportunities, farm crop yield, health conditions and educational levels of the households in these communities as a result of oil spillage due to oil exploration and production activities in their domains during the period 1970 – 2015. Furthermore, the study also examines the strategies adopted by households in these communities to cope and adapt to the changes that have occurred in their livelihood systems due to the shocks and stresses resulting from the operations of oil and gas companies.

Geographical Scope

Location and Size

The geographical scope of this study covers oil- and gas-bearing communities in Ukwa West LGA of Abia State, including: Owaza, Umuorie, Ozar, Umunteke, Umuokwor and Uzuaku/Imo River communities. The Ukwa West LGA with headquarters at Okeikpe is one of the 17 local government areas in Abia State, and, the only one where oil and gas hydrocarbons are found and exploited in the State presently. The local government area lies approximately within Longitudes 7^0 11′ 0″ and 7^0 22′ 0″ East of the Greenwich meridian and Latitudes 4^0 52′ 30″ and 5^0 9′ 0″ North of the Equator. It has a total area of about 271 km^2 and is bounded to the east by Ugwunagbo LGA and by Ukwa East LGA to the south-east. It is also bounded to the north and north east by Aba North and Aba South LGAs respectively. To the south and south west of the local government is Rivers State.

Physiography, Rainfall and Climate

Ukwa West LGA is situated in the wet equatorial climatic zone with high cloud cover. There is limited sunshine, low sunshine hours, extended high cloud cover and relatively high humidity of about 96 percent most part of the year (NDES, 1999). The area is also characterized by a mean daily temperature of 26^0C with the feature of incessant rains every month of the year except for a brief dry spell between the months of January and March (NDES, 1999). The area is characterized by flat, low-lying land and falls within the riverine region of Nigeria with heavy rain of about 2,400 millimeters per year. There are two climatic seasons in the area, namely: rainy season and dry season. The rainy season is usually long and takes place between the months of March and October with a short spell of dryness in August referred to as 'August Break'. The dry season begins in November and ends in February. The soil types found in the area includes the ferralitic soils of the coastal plain and alluvial soils. The vegetation of the area is typically tropical rain forest.

People, Population and Settlements

The people of Ukwa West LGA are mainly of the Igbo ethnic origin with projected populations, based on the 2006 Nigerian census figures, of about 101, 619 persons in 2010 and 116, 610 in 2014 respectively. This is made up of about 52, 334 females (or 51.5 percent) and 49, 285 males (or 48.5 percent) in 2010; and about 60, 054 females and 56, 556 males in 2014 respectively. The people live in clustered communities of about 5,000 inhabitants for the biggest communities and much less for the small communities. The household size is relatively small with about 34 percent of the people belonging to households with 4 – 5 members including father and mother. This is followed by households with 2 – 3 members at 27 percent. It is also important to note that while 3 percent of the people of the area possess higher academic qualifications (for example, M.Sc., MA, Ph.D), 33 percent hold the West African School Certificate (WASC), about 9 percent never sat in a classroom at all (Ibekwe, 2016).

They are mostly farmers and fishermen, and, depend hugely on natural resources – land, forests, and rivers, among others, for livelihood. Thus, the mainstay of the economy of the area is farming and fishing which together employ about 66 percent of the people across the four communities, though there are more fishermen than farmers in the riverine communities of Uzuaku/Imo River communities where 46 percent are fishermen and 34 percent are farmers (Ibekwe, 2016). The reverse is the case in Owaza and Umuorie where 42 percent and 18 percent are farmers and 34 percent and 14 percent are fishermen respectively. A few of them are artisans (for example, carpenters, boat-carvers, traditional cloth-weavers and so on) and petty-traders, and, yet others engage in sand-mining, dredging and in various agri-business ventures such as piggery, poultry, among others. The people of the riverine areas of Imo River community and its environs are mostly fishermen, boat carvers and sand miners and dredgers (Ibekwe, 2016).

The implication of this pattern of occupational distribution is that farming and fishing together with resources connected to them (including rivers, streams and land) are critical for the sustainability of the livelihoods of a greater number of households in these communities. The level of vulnerability and, by extension, poverty in these communities is increased if adequate measures are not taken to protect these resources.

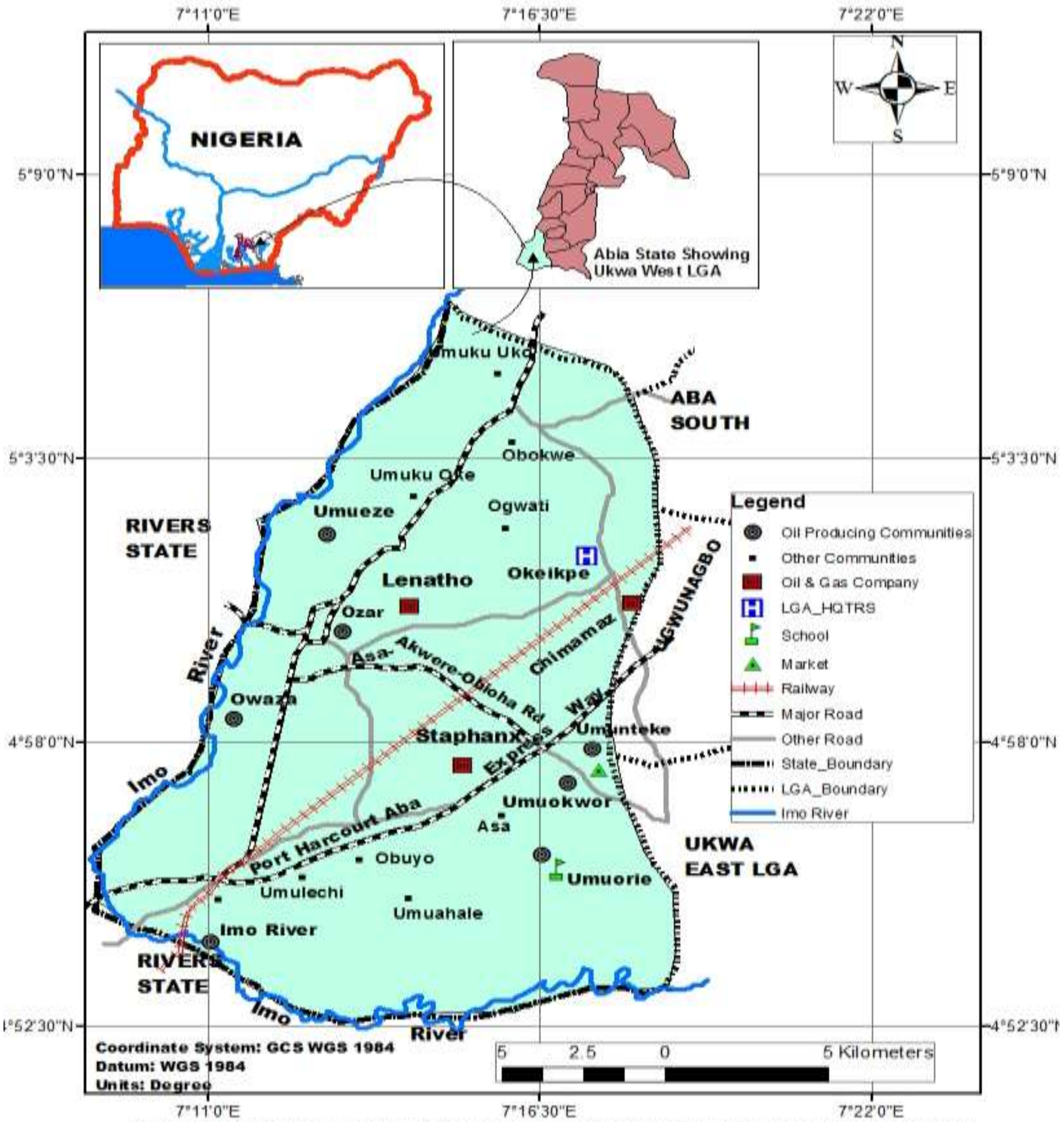
Economy

The major agricultural crops in the local government area are oil palms, cassava, yam, corn and plantain. Farming and fishing are the main occupations of the people, which together employ about 66 percent of the people though on a subsistence basis. The Ukwa West LGA is the major income earner for the Abia State government since the local government area is the only crude oil-bearing area in the State presently. It is noted that oil and gas produced in this area contributes about 39 percent of the gross domestic product (GDP) of the State (ZODML, 2013). The economy is also characterized by a high incidence of poverty as about 15 percent of the people in the area earn N5, 000 or less per month. This translates to about N167 or US $0.48 per day in a 30-day month given the prevailing (as at December, 2016) exchange rate of N350/dollar (Ibekwe, 2016). Furthermore, 46 percent of them earn N10, 000 or less which means a daily income of about N333 or US $0.95 per day. Similarly, 35 percent of the residents earn between N11, 000 and N25, 000 or N367 and N833 per day translating to between US $1.04 and N2.40 per day. The implication of these figures is that about 68 percent of the respondents live below the poverty line of US $1.90 (World Bank, 2015) per day (Ibekwe, 2016).

Administration and Governance

The major autonomous communities in Ukwa West LGA include Igiriukwu Autonmous Community, Ipu West Autonomous Community, Etitioha and Isi-Etitioha Autonomous Communities – these 4 autonomous communities collectively make up Owaza. Other autonomous communities are: Isimanu Autonomous Community, Isimiri Autonomous Community and Ipu South Autonomous Community. Owaza is particularly, of great importance to the discourse in this study because the area hosts more than 90 percent of oil and gas installations in the local government area as well as in the State.

Fig. 1 shows the map of Ukwa West LGA with the oil- and gas-bearing communities of Owaza, Umuorie, Umuokwor, Ozar and Imo River/Uzuaku, among others, clearly delineated. Inset is the map of Abia State showing Ukwa West LGA and that of Nigeria respectively.



Source: Adapted from Nigeria Census Shapefile (2006) & Google Earth Pro (2014)

FIG. 1: Map of Ukwa West Local Government Area, Abia State, showing the study area.

Review of Literature

It has been pointed out severally in the literature that oil and gas production operations are the major culprits for the livelihood challenges faced by communities and households in the oil- and gas-bearing communities. For example, Osuji and Nwoye (2007), while appraising the impact of petroleum hydrocarbons on soil fertility in Owaza community in the study area, argued that oil exploration and production activities have "decimated terrestrial and aquatic biota, which constitute the people's major source of livelihood". The result of this appraisal is a confirmation of the evidence of severe hydrocarbon contamination resulting in high soil acidity, low electrical conductivity and high temperature and moisture content. The consequences of these are greatly reduced soil fertility, low yield and decline in farm income leading to higher levels of poverty and impoverishment for households.

Ndubuisi and Asia (2007) in a study of environmental pollution in the oil-producing areas of the Niger Delta agreed with the above assertions and averred that oil spills have destroyed farmlands and polluted surface and underground water. These researchers contended that oil spill incidents have caused serious problems on fishing activities and even led to the death of human beings through fire outbreaks and explosions as well as blow-outs. Thus, households in the oil-bearing communities of Ukwa West LGA of Abia State have become impoverished by oil and gas production operations as a result of declining farm crop yield and low fish catch. Basically, these challenges result from the impacts of repeated oil spills and non-stop gas flaring in the area.

In a similar study of oil spillage and management problems in the Niger Delta, Udoudoh (2011) argued that oil spillage "constitutes the greatest threat to the region, making livelihood in the region very difficult". The study concluded that oil exploration and production operations in the Niger Delta region of Nigeria have rendered households homeless and jobless. Thus, the environmental degradation occasioned by oil production has culminated in poverty, restiveness and militancy as well as insecurity of the lives of the people of the local communities.

Furthermore, oil spills impact soil fertility negatively and result in the massive decline of agricultural productivity and, by extension, the incomes of rural households. In a study of the effect of oil spillage on crop yield and farm income in Delta State, Nigeria, Inoni, Omotor and Adun (2006) using a sample of 262 farmers drawn from 10 communities and 5 local government areas in Delta State, found that oil spills reduced crop yield, land productivity and depressed farm income. According to them, a 10 percent increase in oil spill reduced crop yield and farm income by 1.3 percent and 5 percent respectively. This finding is similar to the results of UNEP (2011) which assessed the impact of environmental pollution in Ogoniland, Niger Delta, on the people's livelihood, health, water sources, among others. This result also agrees with the findings of other empirical studies, including UNDP (2006), Osuji, Egbuson and Ojinaka (2005) and NDDC (2006), among others, on the subject-matter.

Emphasizing, Adelana, Adeosun, Adesina and Ojuroye (2011) in a study of environmental pollution and remediation in the coastal areas of Nigeria, have argued that oil spillage is one of the most troublesome environmental challenges confronting Nigeria at this time. One of their findings is that oil and gas companies in Nigeria still operate with old, out-dated and pollution-intensive technology which account for the high frequency and volume of oil spills in the country. These equipments have been described as "very old and lack regular inspection and maintenance" (quoted in Adelana, et al. 2011 pp. 835). According to these scholars, most of the pipelines in the Nigerian oil and gas industry have exceeded their estimated life span of about fifteen years having been laid in the 1960s and 1980s. These pipelines, which are too narrow in diameter and the flow-lines, are laid on the earth surface making them vulnerable to rupture as they come in contact with anthropogenic agents. Admitting this fact, Shell Petroleum Development Company, SPDC, (the major international oil company in operation in the study area) stated that "most of the facilities were constructed between the 1960s and early-1980s to the then prevailing standards. SPDC would not build them that way today" (quoted in Adelana, et al. 2011 pp.836). They also found corrosion of pipes and tanks and the frequent rupturing of production infrastructure to be the largest contributor to oil spill incidents in the area.

Thus, several factors have been identified as being responsible for oil spillage in the oil- and gas-bearing communities. These include: human error during operations, sabotage, corrosion of pipes and storage tanks, equipment failures and natural disasters (Anderson & LaBelle, 2000). However, there is no consensus as to the degree to which each of these factors is responsible for the frequency and volume of oil spill in the oil- and gas-bearing communities of study. For example, Nwilo and Badejo (2002) in their study of the impacts and management of oil spill pollution along the Nigerian coastal areas, have argued that 50 percent of oil spills are as a result of the corrosion of pipelines and storage facilities, 21 percent due to oil production operational issues, 28 percent due to sabotage and 1 percent due to engineering faults.

Adelana, et al. (2011), on the other hand, confirm this but assign 50 percent of all oil spills in Nigeria to corrosion of pipelines and tankers, 36 percent to sabotage, 6.5 percent to oil production operations and 1 percent due to equipment faults. The authors here focused on the causes, consequences and management of oil spill incidents in the coastal areas of Nigeria. And for SPDC (2002), 57 percent of the spills are attributed to corrosion and 20 percent to operational equipment failure and human error. While SPDC (1996) attributed 43 percent of oil spills to sabotage, SPDC (2002) revised this figure down to 1 percent while Bob-Manuel and Johnson (2001) gave 33 percent to sabotage.

Despite the lack of consensus and the absence of reliable data regarding the exact proportions of the total oil spills that are attributable to each factor, it can be argued that one of the largest single causes of oil spills in Nigeria is the corrosion of pipelines and tankers as well as leakages due to rupture of production facilities. It is also not deniable that oil and gas companies in Nigeria still operate with old, out-dated and pollution-intensive technology which account for the high frequency and volume of oil spills in the country. Moreover, most of the pipelines in the Nigerian oil and gas industry have exceeded their estimated life span of about fifteen years having been laid in the 1960s and 1980s (Adelana, et al. 2011). These pipelines, which are too narrow in diameter and the flow-lines, are often laid on the earth surface making them vulnerable to rupture as they come in contact with human agents.

More importantly, the present state of oil exploration and production technology in Nigeria is a contradiction of the Petroleum (Drilling and Production) regulations which provide that it is mandatory for all oil companies granted license to operate in the country to adopt all measures necessary as precautions. The oil companies are expected to provide up-to-date and modern equipments capable of pro-actively preventing oil pollution of any sort and volume. The companies are also required to adopt measures, whenever and wherever oil pollution occurs, to stop and control the pollution. Moreover, these companies must maintain their equipments and facilities in good operational state to prevent the spill of crude oil and to cause as little damage as possible to the environment including the trees and crops, buildings, structures and other property (Petroleum-Drilling and Production-(Amendment)-Regulations, 2006).

Despite the provisions of the law, oil spill incidents have continued to be a regular occurrence in the study area. A study of the genesis of this situation confirms that it is not a recent phenomenon but is as old as the oil industry in Nigeria itself. In-fact, the Department of Petroleum Resources (DPR) reported a total of 6,744 oil spills between 1976 and 2001 which resulted in approximately 2.4 million barrels of oil being spilled into the environment (cited in Udoudoh, 2011). The National Oil Spill Detection and Response Agency (NOSDRA) confirms that oil companies operating in the country reported 2, 054 cases of oil spill incidents with spill volumes greater than one barrel each in the 4-year period from June 2006 to June 2010 (Milieudefensie-FoE, 2011).

In some cases, the delay in responding to oil spill impacts in the oil-bearing communities of Abia State, aggravates the negative consequences of oil spills and, in so doing, worsens the plight of houeholds in the area. For example, an oil spill incident of 16 November, 2012 (recorded as Spill Incident number 894753) of the Imo River Well 64 S/L Flowline in Owaza was not responded to until 22 November, 2012. The procedural delay whereby recovery is not initiated until a report of the incident is made by the community or other interested stakeholders followed by the constitution of the Joint Investigation Team (JIT) increases the seriousness of the impact. The constitution of the JIT, which is made up of representatives of the host community, Department of Petroleum Resources (DPR), National Oil Spill Detection and Response Agency (NOSDRA), State Ministry of Environment (MoE), Nigeria Police Force (NPF), and the oil company, often takes days to happen. Delays or time losses such as this heighten the negative impacts of oil spills on soil fertility, crop yield and the sustainable livelihoods of households in these communities. Accordingly, Dicks (1998, pp.2), contends that the "seriousness of oil spill is primarily related to the speed of recovery of the damaged habitats and species".

However, the oil and gas companies in the country have attempted to defend the incessant oil spill incidents in the study area by putting the blame on militancy and community restiveness in the area. While agreeing that there are some elements of sabotage involved, it should be noted that the history of oil spillage in Nigeria goes back in time before youth restiveness and militancy, in the form known today, began. While oil theft, pipeline vandalism, hostage-taking and such other crimes are recent developments in the Nigerian oil and gas industry relative to oil spill incidents, the occurrence of oil spill incidents in Nigeria is as old as the industry itself. This fact has been confirmed by Kadafa (2012) in a study of oil exploration and spillage in the Niger Delta of Nigeria. The scholar contended that oil spillage is as old as the industry itself with the first reported oil spill having occurred in Araromi in western Nigeria in 1908. The study averred that oil exploration and production in Nigeria have exerted tremendous environmental and human consequences for the oil-bearing communities of the Niger Delta region. The social and environmental costs include extensive destruction of wild-life and biodiversity, loss of soil fertility, air and water pollution, among others. The study recommended more government investments in the sustainable development of the region.

The literature reviewed in this section has confirmed that there is a paucity of empirical studies on Abia State as a constituent member of the oil-producing Niger Delta region of Nigeria. Particularly, there is a dearth of empirical research linking oil and gas production activities with livelihood challenges of households in Abia State, Nigeria. This is surprising given the fact that a lot of work has been done on oil TNCs and the environmental impacts of their activities on the Niger Delta region generally (Adekola & Mitchell, 2011; UNEP, 2011; Joab-Peterside, 2007; UNDP, 2006 and Onwuka, 2005). Moreover, oil and gas exploration and production operations have taken place in such communities as Owaza for more than five decades now. In fact, it was not until the establishment of the NDDC in 2000 that Abia State became recognized as a constituent state of the Niger Delta region (FGN, 2000).

Indeed, the literature on Abia State as an oil and gas-bearing state is scanty. The reasons for this neglect, until recently, may not be far-fetched given the low intensity of operations in the communities in terms of the absolute number of oil fields and wells, flow stations, gas fields, pipelines and other facilities. However, for the oil-bearing communities in Abia State, these oil production activities represent a significant factor in their daily attempts to achieve sustainable livelihood and deal with their poverty challenges. This study therefore, fills the gap in the literature by evaluating the impact of oil spillage on soil fertility and sustainable livelihoods of households in the oil- and gas-bearing communities of Abia State, Nigeria.

Methodology

The ex-poste facto research design is considered appropriate and adopted for this study because it is impossible to apply the entire protocol of pure experimental research design in investigating the impact of oil spillage on soil fertility and livelihoods of households in the study area. The primary sources of data consisted mainly of data acquired through field survey using the questionnaire designed and administered to elicit information on, among others, socio-demographic characteristics of households in the study area. These include: data on family size, educational levels of household members, income, age, gender and occupation.

The purposive sampling technique was adopted to select four oil- and gas-bearing communities in Ukwa West LGA of Abia State. These communities have also been affected, at varying times and degrees, by oil spillage. The purposive sampling technique is a non-probability sampling technique adopted when the elements or members to be included as samples possess a unique characteristic(s) which distinguishes them from other members of the population. The researcher, thus, selects the items 'purposely' because they possess this unique characteristic thereby avoiding the probability of not selecting them if a probabilistic sampling technique was to be adopted. Thereafter, a simple random sampling technique was used to select respondents from each of these communities to include in the sample population for the purpose of the questionnaire administration.

In addition, the data on soil fertility were obtained solely through the collection and analyses of soil samples from the study area. In total, 12 soil samples were collected comprising 4 samples from each of the 3 communities of Umuorie, Owaza and Uzuaku/Imo River. The modality for the sample collection consisted of the collection of crude oil-impacted soils at two depths of 0-15 centimeters and 15-30 centimeters respectively. Control samples (that is, soil not impacted by oil spills) were also collected at these two depth levels for comparison. The soil samples were examined for the major indices of soil fertility, namely: pH, Available Phosphorus, Total Nitrogen (TN), Total Organic Carbon (TOC) and Total Organic Matter (TOM). This examination was conducted on the soil samples given the prevailing physico-chemical conditions of temperature, moisture content and electrical conductivity of crude oil-impacted soils at Umuorie, Owaza and Uzuaku/Imo River communities in the study area. Tests were also conducted on samples of soil not affected by oil spill as the control samples in the study area.

The participatory research approach, involving interviews (based on semi-structured questionnaire), individual (one-on-one) discussions and focused group discussions (FGD), was used to elicit information on crop yield and its measurement for the period from 1970 to 2014. For the FGD, a total of 24 participants were drawn from among notable farmers in the four study communities with 75 percent of the target population comprising farmers who were more than 50 years of age and the remaining 25 percent made up of farmers of between the ages of 25 and 50 years. There were 4 groups of 6 members each consisting of 3 female and 3 male members with the male members meeting separately from the female members. The FGD took place in a total of 4 sessions and each session had 12 members drawn from the 4 communities in the study area. That is, three male farmers participated from each of the four communities and three female participants were drawn from each of the four communities. Two of the sessions were for male participants and the other 2 sessions for female participants. The principal issues discussed focused on such topics as: the main crop cultivated by farmers in the communities, the yield from a plot of farm land in the 1990s and the yield in recent times. Also, information was elicited from the farmers on measurement modalities and prices of farm produce in the area.

Data Presentation, Analysis and Discussion of Findings

The empirical evidence from this study confirm that soil fertility in the oil- and gas-bearing communities of Abia State has been negatively impacted by oil spillage. This has resulted to the decline in crop yield and concomitant fall in household incomes, thus, exacerbating the level of impoverishment in these communities. In otherwords, oil spill incidents in the study area have exerted deleterious effects on the land and its resources on which the people of the oil-bearing communities depend for livelihood. This is made worse when considered against the fact that more than 66 percent of the people of this area are farmers and fishermen who live off the land and or its resources (Ibekwe, 2016).

Moreover, oil spills are still occurring despite efforts by the oil and gas companies, the government and its agencies to bring this phenomenon to a halt or, at least, reduce it to its barest minimum. For example, Table 1 confirms that a total of about 5,425 barrels of crude oil were spilled in the study area between 2011 and 2015 in about 64 reported and investigated oil spill incidents. The investigation of such spills is usually carried out by the Joint Investigation Team (JIT) comprising of the representatives of the host community, Department of Petroleum Resources (DPR), National Oil Spill Detection and Response Agency (NOSDRA), State Ministry of Environment (SMoE), Nigeria Police Force (NPF) and Oil company (in this case, SPDC). The highest number of spills occurred in 2012 with a total of about 2,073 barrels of crude oil spilled into the environment with serious adverse ad damaging impacts on the ecosystem.

Table 1: Recent annual oil spill incidents in the study area, 2011-2015

Year	Qty Spilled 0 - 20 bbl	Qty Spilled 21-100 bbl	Qty Spilled > 100 bbl	Number of Spills	Total Spill Qty (bbl)
2011	13	1	4	18	1,454
2012	16	5	4	25	2,073
2013	9	2	5	16	1,538
2014	2	0	1	3	354
2015	2	0	0	2	6
Total	42	8	14	64	5,425

Source: Author's Computation, 2016 from: SPDC (2015).

Similarly, Table 2 shows the distribution of oil spill incidents among the oil-bearing communities in the study area. It is shown that of the 64 oil spill incidents, about 69 percent or 44 of these spills occurred in the four autonomous communities of Owaza – Etitioha, Isi-Etitioha, Igiriukwu and Ipu West. In the same vein, 17 percent or 11 spills, 11 percent or 7 spills and 3 percent or 2 of the spills occurred in Uzuaku/Imo River, Umuorie and Umuokwor/Obiga communities respectively. Likewise, about 66 percent of the spills were of volumes ranging from 0.1 to 35 barrels of crude oil each while spills with volumes greater than 200 barrels of crude oil each were about 15 percent though in total the volume of this range constituted more than 83 percent of the total volume of oil spilled in the five-year period.

Table 2: Distribution of oil spill incidents among communities in the study area, January 2011- June 2015

Estimated spill volume (bbl)	≤1 - 35		36 - 70		71 - 100		101 - 199		≥200		Total	
Community	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
Umuorie	2	5	2	33	0	0	1	20	2	20	7	11
Owaza	33	79	3	50	1	10	3	60	4	40	44	69
Umuokwor/Obiga	1	2	0	0	0	0	0	0	1	10	2	3
Uzuaku/Imo River	6	14	1	17	0	0	1	20	3	30	11	17
Total	42	100	6	100	1	100	5	100	10	100	64	100
As perc.of the total	42	66	6	9	1	2	5	8	10	15	64	100

Source: Author's computations from: SPDC. (2015).

The findings of this study have also confirmed that oil spills, resulting from the operations of oil and gas companies in the study area, have impacted greatly on the sustainable livelihoods of households in the host-communities. For instance, there has been a gradual but steady decline in farm crop yield, resulting to a 38-percent decline in crop yield between 1970 and 2014. Consequently, household incomes have plummeted, thus, intensifying poverty levels in these communities. This fall in crop yield is attributed to the loss of soil fertility resulting from the frequent oil spills and incessant gas flaring that have continued to take place in the oil-bearing communities of Abia State.

Tables 4 and 5 amplify this assertion. However, Table 3 describes the texture of the soil samples collected from the study area. Essentially, the texture is of sand, loamy sand and sandy clay loam. The particle sizes are dominated by sand fractions ranging from 741.00 g kg^{-1} to 861.00 g kg^{-1} especially when compared with the silt and clay fractions in the ranges of 37.00 g kg^{-1} to 87.00 g kg^{-1} and 82.00 g kg^{-1} to 212.00 g kg^{-1} respectively. It is important to note that soil texture has a profound impact on the cation exchange capacity of the soil.

Table 4, on the other hand, shows the pH, available phosphorus, total nitrogen, organic matter and total organic carbon concentration of the soil samples collected from three of the four communities in the study area. It shows that the pH of the soils is low at between 4.20 and 4.80. The pH, which is a measure of the acidity or alkalinity of a soil, should be maintained at above 5.5 in the top soil. A low pH value, as in the case of the study area, is indicative of high acidity content which points towards low soil fertility. In other-words, the low pH in the soil samples is not good for plant growth due to the imbalances in nutrient levels. The samples also show a high extractable organic carbon content of 5.20 g kg^{-1} to 25.80 g kg^{-1}, high total organic matter in the range of 8.90 g kg^{-1} to 44.40 g kg^{-1} and low total nitrogen content. The available phosphorus is in the moderate to high rating. The damage to the biomass by chemicals contained in the crude oil spill has resulted in the high build up of organic matter in the soil (micro and macro fauna and organisms). Put together, these indices are indicative of low soil fertility especially when compared with the control (unaffected) soil samples.

Similarly, Table 5 shows the total exchangeable bases (Ca, Mg, K and Na), total exchangeable acidity (TEA), effective cation exchange capacity (ECEC) and the percent base saturations (BS) of the soil samples. It can be seen that the exchangeable bases (Ca, Mg, K and Na) are low which have affected the effective cation exchange capability (ECEC) of the soils. The ECEC is a measure of the soils potential in trapping and or holding nutrients in the soil. A high ECEC value means a greater ability of the soil to retain soil nutrients necessary for plant growth. The analyses in this study confirm lowered ECEC values for the oil-inundated soils in the study area, thus, confirming the destructive effects of hydrocarbon presence in the soils. The total exchangeable acidity is also low indicating poor soil fertility.

Table 3: Particle size distributions of the soil samples from the study area (g/kg^{-1}).

Community	Position	Sand	Silt	Clay	Texture
Umuorie	Control	861.00	57.00	82.00	Sand
	(0-15 cm)				
Umuorie	Control	861.00	57.00	82.00	Sand
	(15-30 cm)				
Umuorie	Surface	821.00	77.00	102.00	Loamy Sand
	(0-15 cm)				
Umuorie	Subsurface	821.00	66.00	112.00	Loamy Sand
	(15-30 cm)				
Owaza	Control	821.00	77.00	102.00	Loamy Sand
	(0-15 cm)				
Owaza	Control	821.00	57.00	122.00	Loamy Sand
	(15-30 cm)				
Owaza	Surface	841.00	77.00	82.00	Loamy Sand
	(0-15 cm)				
Owaza	Subsurface	841.00	37.00	122.00	Loamy Sand
	(15-30 cm)				
Uzuaku/Imo River	Control	841.00	57.00	102.00	Loamy Sand
	(0-15 cm)				
Uzuaku/Imo River	Control	781.00	67.00	152.00	Sandy Loam
	(15-30 cm)				
Uzuaku/Imo River	Surface	761.00	87.00	152.00	Sandy Loam
	(0-15 cm)				
Uzuaku/Imo River	Subsurface	741.00	47.00	212.00	Sandy Clay Loam
	(15-30 cm)				

Source: Author's Fieldwork, 2016

Table 4: Available Phosphorus, pH, Total Nitrogen (TN), Total Organic Matter (TOM) and Total Carbon concentration of the samples from the study area.

Community	Position	pH (H_2O) (1:2.50)	Available Phosphor. Mg kg^{-1}	Total Nitrog. g kg^{u}	Organic Carbon g kg^{-1}	Organic Matter g kg^{-1}
Umuorie	Control	4.50	54.30	0.70	14.50	8.40
	(0-15 cm)					
Umuorie	Control	4.80	45.10	0.14	8.90	5.20
	(15-30 cm)					
Umuorie	Surface	4.40	59.10	0.70	39.00	22.60
	(0-15 cm)					
Umuorie	Subsurface	4.60	61.80	0.42	26.40	15.30
	(15-30 cm)					
Owaza	Control	4.70	26.30	0.56	15.00	8.70
	(0-15 cm)					
Owaza	Control	4.70	58.60	0.28	26.03	15.10
	(15-30 cm)					
Owaza	Surface	4.20	43.50	0.70	42.60	24.70
	(0-15 cm)					
Owaza	Subsurface	4.40	47.30	0.42	11.40	6.60
	(15-30 cm)					
Uzuaku/Imo River	Control	4.50	32.20	0.56	19.10	11.10
	(0-15 cm)					
Uzuaku/Imo River	Control	4.60	16.60	0.42	11.40	6.60
	(15-30 cm)					
Uzuaku/Imo River	Surface	4.70	37.10	0.56	44.40	25.80
	(0-15 cm)					
Uzuaku/Imo River	Subsurface	4.30	45.70	0.28	33.60	19.50

Source: Author's Fieldwork, 2016.

Table 5: Total Exchangeable Bases (Ca, Mg, K and Na), Total Exchangeable Acidity (TEA), Effective Cation Exchange Capacity (ECEC) and Base Saturation (Percent).

Community	Position	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	TEA	ECEC	BS
		Cmol kg^{-1}						(%)
Umuorie	Control (0-15 cm)	4.00	2.00	0.18	0.21	0.32	6.71	95.23
Umuorie	Control (15-30 cm)	7.20	3.20	0.22	0.20	0.40	11.22	96.43
Umuorie	Surface (0-15 cm)	2.00	0.40	0.19	0.17	0.56	3.32	83.13
Umuorie	Subsurface (15-30 cm)	3.20	0.80	0.19	0.20	0.32	4.71	93.21
Owaza	Control (0-15 cm)	4.00	1.20	0.31	0.19	0.32	6.02	94.68
Owaza	Control (15-30 cm)	4.00	2.00	0.28	0.34	0.48	7.10	93.34
Owaza	Surface (0-15 cm)	6.00	1.60	0.22	0.28	0.40	8.50	95.29
Owaza	Subsurface (15-30 cm)	2.40	0.80	0.12	0.22	0.48	4.02	88.06
Uzuaku/Imo River	Control (0-15 cm)	2.00	0.80	0.24	0.18	1.20	4.42	72.85
Uzuaku/Imo River	Control (15-30 cm)	1.60	1.20	0.14	0.21	1.20	4.35	75.41
Uzuaku/Imo River	Surface (0-15 cm)	1.60	0.80	0.20	0.20	0.88	3.68	76.09
Uzuaku/Imo River	Subsurface (15-30 cm)	1.60	1.20	0.17	0.15	1.68	4.80	65.00

Ca^{++} = Calcium, Mg^{++} = Magnessium, K^{+} = Potassium, Na^{+} = Sodium.
Source: Author's Fieldwork, 2016.

In Table 6 are found the major food and cash crops cultivated by households in the study area. It shows that 44 percent of the total of these crops are Cassava, followed by Palm fruits (cultivated in palm plantations) to the range of 21 percent, yam 19 percent, among others. These crops are also the most adversely affected by oil and gas exploration and production operations in the area. Furthermore, these crops represent the main sources of income to households in these communities. Therefore, the destruction of these crops through frequent oil spills amounts to the impoverishment of the people.

Table 6: Major cultivated food crops affected by oil spillage in the study area

S/N	Crop Type	Precentage Share of Total
1	Cassava	44
2	Palm Fruit	21
3	Yam	19
4	Coco-yam	3
5	Fluted Pumpkin/Water Leaf	5
6	Others	9

Source: Author's Field Work, 2016.

In Table 7 is shown the estimated crop yield, using cassava (the most cultivated crop) as example, by notable farmers in the study area. A plot of farm land measuring 650 m^2 was estimated to yield about 24 traditional baskets of an average weight of 15 kilograms each basket in Umuorie and Umuokwor/Obiga respectively per cropping season. In the same vein, a similar portion of land in Owaza and Uzuaku/Imo River was estimated to yield an average of 25 baskets of 15 kilograms each. This means that there are no significant differences between communities on crop yield. In total, an average yield of about 1,470 kilograms of cassava was expected, all things being equal, per plot of farm land of size 650 m^2 in 1970 for a cropping season in the study area.

Table 7: Estimated average annual crop yield (cassava) per plot in the study area, 1970

(1 Plot=650m2) Community	Yield (Baskets)	Weight per Basket (kg)	Total Weight (kg)
Umuorie	24	15	360
Owaza	25	15	275
Umuokwor/Obiga	24	15	360
Uzuaku/Imo River	25	15	375
Total	98	15	1,470

Source: Author's Field Work, 2016.

In the same manner, Table 8 shows the estimated cassava yield, per cropping season, in 2014. It shows yields of 17 15-kilogram baskets in Umuorie per plot of 650 m^2; 16 baskets in Owaza, 14 and 15 baskets in Umuokwor/Obiga and Uzuaku/Imo River communities respectively for similar plots of farmland. This gives a total of 62 baskets of 15 kilograms each or 930 kilograms in total.

Table 9 compares the crop yield for 1970 with that for 2014. It shows that there was a 38 percent fall in crop yield per plot of farm land of 650 m^2 across the communities of the study area. Specifically, in Umuorie, the decrease in yield is about 29 percent while it is 36 percent, 42 percent and 40 percent in Owaza, Umuokwor/Obiga and Uzuaku/Imo River communities respectively. This finding confirms that the fall in crop yield is traceable to the loss of available farm land to oil installations and right of way (RoW) as well as to the effects of oil spillage and gas flare on soil fertility.

Table 8: Estimated average annual crop yield (Cassava) per plot in the study area, 2014

(1 Plot=650m2) Community	Yield (Baskets)	Weight per Basket (kg)	Total Weight (kg)
Umuorie	17	15	255
Owaza	16	15	240
Umuokwor/Obiga	14	15	210
Uzuaku/Imo River	15	15	225
Total	62	15	930

Source: Author's Field Work, 2016.

Table 9: Decline in estimated average annual crop yield (cassava) per plot in the study area 1970-2014

(1Plot = 650m2) Community	Average Total Yield (1970) (kg)	Average Total Yield (2014) (kg)	Difference in Yield (kg)	Percentage Decline in Yield (Percent)
Umuorie	360	255	-105	-29
Owaza	375	240	-135	-36
Umuokwor/Obiga	360	210	-150	-42
Uzuaku/Imo River	375	225	-150	-40
Total	1,470	930	-540	-38

Source: Author’s Field Work, 2016.

Recommenations

Based on the findings of this study and to achieve the sustainability of the livelihoods of households in the oil-bearing communites of Abia State, in particular, and, of Nigeria, in general, the researcher recommends a participatory and sustainable approach to poverty alleviation and socio-economic development. This approach involves concerted efforts of various stakeholders including State and Federal governments, host-communities, oil companies, NGOs and development partners. Specifically, the following recommendations which, if adopted and effectively implemented, would have profound implications for poverty reduction and the amelioration of the livelihood challenges that confront households in the oil- and gas-bearing communities of Abia State, are now put forward:

i. The government, through her agencies (NOSDRA, NESREA, among others) should ensure that environmental sensitivity index (ESI) mapping is prepared proactively wherever the oil companies are in operation. More importantly, an ESI mapping should be timely and regularly prepared by oil companies operating in the study area whenever there is an oil spill incident. The ESI is simply a base map which shows the sensitivity of an area or areas to certain stress factor(s) such as oil spillage on a scale of 1 to 10, with 10 being the most sensitive. The standards for the ESI maps in Nigeria have been developed by the Environmental Systems Research Institute (ESRI) with the initial impetus provided by the Oil Producers Trade Section (OPTS) of the Lagos Chamber of Commerce and Industry (LCCI).

ii. The oil companies should each be required to establish observation and monitoring centres for monitoring, on a real-time basis, their production facilities and other installations; and, to receive alerts of breakdowns, oil spills, and so forth. The use of remote sensing facilities, geographic information systems (GIS) and other modern information and communication equipments are recommended for this purpose to enable early detection of and response to oil spill impacts.

iii. There should be quick and timely intervention in terms of recovery and remediation after an oil spill. This is because the “seriousness of oil spill impact is primarily related to the speed of recovery of the damaged habitats and species” (Dicks, 1998 pp.2), be they animals or plants, aquatic or terrestrial. Recovery involves both the clean up of the environment, as a first step, and the remediation of the ecosystem. While clean up involves the removal of oil or the physical smothering, remediation involves biological processes aimed at restoring the damaged environment (habitats and species) to a healthy state, for example, the growth of seedlings, introduction of composts, special and effective protection of specie survivors, among others. Recovery has been defined as “the re-establishment of a healthy biological community in which the plants and animals characteristic of that community are present and functioning normally” (quoted in Dicks, 1998, pp.2) and will continue to show further normal development and change. The re-established community does not necessarily need to have the same composition or age structure as the community before the oil spill impact. It is also not necessary that there be total or one hundred percent removal of oil and or its products from such an impacted environment. The most important indicator of recovery is that the organisms normally found in such environments are present again and functioning in a healthy manner.

iv. There should be an implementation of a water-sanitation-hygiene programme in the study area by relevant stakeholders including the oil companies operating in the area, the NDDC, State and Federal governments, among others. Such a programme should be patterned after the World Health Organization/United Nations International Children Emergency Fund (WHO/UNICEF) Water-Sanitation-Hygiene (WASH) programme and intended to reduce, if not eliminate, the challenges associated with the contamination of surface and underground water.

v. The government of Nigeria should establish operational standards in the oil and gas industry regarding the type of oil and gas exploration and production equipments to be used by operators in the country. The technologies to be used in the industry should be clean technology – low-carbon and environmentally-friendly technologies.

Conclusion

The evidence presented in this study has confirmed that oil spillage has negatively impacted soil fertility in the oil-bearing communities of Abia State. This is because the biological impacts of an oil spill have been found to be deleterious not only to the soil but also to the plants and animals that depend on it for survival and growth. These impacts as outlined in Dicks (1998) include: the physical and chemical changes and or alterations of natural habitats of plants and animals in the oil-inundated environment; the physical smothering of flora and fauna – this involves the blanketing of an area (including plants and animals found in such an area) by oil slick especially in the case of oils with heavy viscosity; the toxic effects – lethal or sub-lethal, on flora and fauna and, changes in the composition of the biological communities in the environment resulting from effects oil spill impacts on, especially, prominent plants and animals in the environment.

The sum-total of these in terms of the sustainability of livelihood options for households in the oil-bearing communities of Abia State, Nigeria, is the gradual but persistent decline in agricultural productivity resulting from loss of soil fertility in the area. The decline in farm yield has led to the plummeting of household incomes and, finally, to the exacerbation of poverty levels in these communities. However, it must be hastily mentioned that, though, the evidence presented in this study is not robust enough to establish a direct causal relationship between oil spill impact and soil fertility, the use of control soil samples (that is, soil not impacted by oil spill) for comparism purposes with oil-impacted soil samples, has exerted a profound mitigating effect on this shortcoming. It is therefore surmisable that oil spill impact is the culprit, majorly, for the decline in agricultural productivity and for the unsustainability of farming and fishing as livelihold options for households in the oil- and gas-bearing communities of Abia State, Nigeria.

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