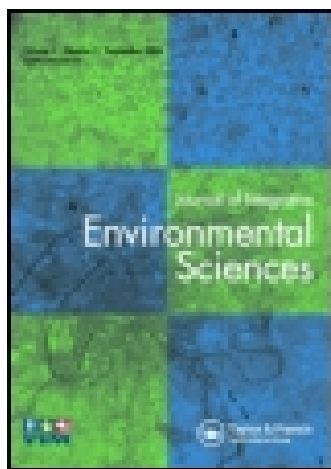


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Socio-economic implications and environmental effects of oil spillage in some communities in the Niger delta

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This study examined the effects of oil spillage on the socio-economic activities of the people and the environment in some communities in the Niger delta. The objectives are to determine the quantity of oil spilled from pipelines, the area of coverage and to assess the effects of oil spillage on the people, soil and water. Data were collected from both primary and secondary sources. The primary data relied on the administration of structured questionnaires; 319 questionnaires were randomly distributed to a sample population (household heads), with 302 retrieved. Secondary data were sourced from published materials. Also, soil samples from four locations and water samples from five locations were collected to determine the pH value of the water, the presence and concentration of heavy metals in the soil and the total hydrocarbon content (THC) of water. Soil and water samples were analysed using the atomic absorption spectrophotometer and gravimetric methods for soil and water, respectively. There was a strong relationship between the volume of oil spilled and the area coverage. Laboratory soil analysis from sampled communities showed a higher concentration of heavy metals (chromium, lead, arsenic, etc.) above the World Health Organization (WHO) permissible levels as well as the figure for controlled site. Similarly, three of the communities studied had THC concentrations of 40,000 ppm exceeding both WHO limit of 1 ppm and controlled site. This has grave implications on the soil, water and socio-economic activities of the people. It is, therefore, important that environmental laws should be strictly adhered to. Compensation should be adequately and promptly paid to the communities, and remedial action should be speedily undertaken whenever there are spills. Finally, the oil companies must involve the communities in the maintenance and monitoring of pipelines with the ultimate goal of improving the quality of life of members of rural communities.

Keywords: environment; oil; spillage; soil; water

1. Introduction

Nigeria is one of the leading oil producers in the world. It is ranked sixth at global level, first in Africa, and exports about 1.8 million barrels per day (NBS 2006). Most of the oil exploration activities are concentrated in the Niger delta, which contains the world's largest wetland, with extensive fresh water swamp, forest and rich biological diversity. Over half of the area is criss-crossed with creeks and dotted with small islands whereas the remaining is a lowland rainforest zone (UNDP 2006).

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The large population of the country, which stood at 140 million in 2006 (NPC 2006), places a great demand on the energy sector. The sector provides employment for the survival of many people and more importantly it serves as a major source of foreign exchange. Oil production generates the greatest proportion of foreign exchange and internal revenue earning for the federal government. For instance, it accounts for more than 90% of foreign exchange earning and about 80% of government internal revenue (NDDC 2006). The overall contribution of the oil sector to the National economy grew from an insignificant 0.1% in 1950 to 87% in 1976 (Achi 2003). Between 2000 and 2004, oil accounted for about 79.5% of the total government revenues and about 97% of foreign exchange earnings (UNDP 2006).

Despite these enormous financial gains, there are problems associated with oil exploration. Adetular (1996) stated that the enormous revenue derived from the oil industry has not been translated to socio-economic development, and that the environmental pollution resulting from oil prospecting, spillage and seepage is increasing. Repeated pollution undermines the ecological basis of a hitherto self-sustaining coherent way of life in oil producing communities.

The coming of the multinational companies to Nigeria for oil exploration has led to unquantifiable environmental pollution, especially oil spillage. For example, since the first oil spillage that took place in Bomu on the 9th July 1970, several other incidents have occurred in different parts of the Niger delta region (Mobil Producing Nigeria 1998). Over 784 oil spillage incidents took place between 1976 and 1980 in which about 1.3 million barrels of oil were spilled (Ogbogbo 2004). Recent available data indicated that between 1976 and 2002 there were about 4625 major oil spillage reported incidents involving release of greater than 3 million barrels of oil (NDDC 2006).

In Burutu, the local government area where the study took place, there are many cases of oil spillage over the years. For example, between 1981 and 2007, there were 14 incidents of oil spillage, whereas between 1996 and 2006, the total volume of oil spills was 124,377 barrels. These spills have affected the livelihood and socio-economic activities as well as the environment of the people. For instance, fishing, which is the predominant occupation and means of livelihood of the people, does not yield much benefit anymore. Similarly, the spills have impacted negatively on both the pH value of soil and the hydrocarbon content of the water. The consequences are that people now migrate to other towns for greener pasture. Also, there is loss of fishing ground and disappearance of livelihoods for the people. To this end, the study therefore examined the socio-economic characteristics of the people, determined the quantity of oil spill and assessed the effect of oil spillage on the people and the environment. The article is divided into four sections including this introduction. Section 2 is on the trend and causes of oil spillage in Nigeria whereas the study area and method of data collection are in Section 3. Results of findings are discussed in Section 4. The way forward is in Section 5 and conclusion in Section 6.

2. Trend, causes and effects of oil spillage in Nigeria

In Nigeria, the amount of oil entering into water bodies has raised concern over the sustainability of coastal and marine life. The trend of oil spillage in the country indicated that the first oil spill occurred in Bomu on the 19th July 1970 during which 150 barrels of oil was spilled (Mobil Producing Nigeria 1998). Other notable incidents include the Funiwa five well blowout in 1980, during which 400,000 barrels

of crude oil were spilled; the Oyakama oil spill in 1980, with an estimated discharge of 30,000 barrels; the Oshika oil spill in 1983, with 10,000 barrels and the Idoho–QIT 24 pipelines oil spill in January 12 1998 resulting in the release of about 40,000 barrels (~6000 tones) of Qua Iboe light crude oil. Another notable spill is the Forcados spill in July 1979, which spilled 600,000 barrels of crude oil.

Table 1 shows the incidents of oil spillage in the eastern operations for 12 years (1989–2000). Within this period, a total of 2252 incidents of oil spills occurred, 536,858.4 barrels were spilled; 23,003.86 barrels were recovered and 513,854.98 barrels were not recovered. From the table, it can be deduced that, whenever there is a spill, it is always difficult to recover most of the spills as only a few barrels were recovered. This may be due to the inability to notice spills in time and act promptly, or the use of inadequate equipment in cleaning up the spills. More spills were recovered in 1997, which had 226 incidents. It was followed by 1996 and 1999, which had 264 and 260 spill incidents, respectively. The least number of incidents occurred in 2000, which recorded 51 incidents.

The highest volume of spill occurred in 1999, with 155,041.33 barrels spilled. It was followed by 74,749.52 barrels spilled in 1997; 69,338.68 barrels were spilled in 1998. The lowest volume of spill (6147.59 barrels) was recorded in 1989. Shell Petroleum Development Company (SPDC) had 1672 spills, followed by Nigeria Agip Oil Company (NAOC).

The immediate causes of oil spillage have been attributed to one or a combination of the following: break-up of pipelines or damage to or leakage of oil pipelines, oil tank overflow; rupture or failure of loading, floating or under-busy hose; broken flange connections or flow lines (Mobil Producing Nigeria 1998). Most spillages occur during the process of transportation of crude through pipelines or tankers from one location to another (Ogbogbo 2004). Frequent spillages involving a few gallons are caused by cleaning operations, malfunction of sea valves, carelessness during connecting and disconnecting of hoses, and sometimes by non-observance of rules. These may happen anywhere within the port and are restricted to operations at terminals or specifically to oil tankers.

Table 1. Incidents of oil spillage in the eastern operations: 1989–2000.

Year	Incidents	Approximate barrels spilled	Approximate barrels recovered	Approximate barrels loss	Percentage of barrels recovered
1989	92	6147.59	1467.25	4680.34	23.8
1990	119	15,2264.50	5172.50	10,091.61	3.4
1991	117	155,041.33	1402.25	153,629.08	0.9
1992	184	27,161.54	721.00	26,440.54	2.6
1993	251	7310.14	1973.50	5336.64	26.9
1994	270	32,259.70	1692.25	30,567.45	5.2
1995	245	67,561.41	8846.39	58,715.02	13.0
1996	264	43,841.35	0.92	43,840.43	0.00004
1997	266	74,749.52	1243.50	73,506.02	1.7
1998	133	69,338.68	383.50	68,955.18	0.6
1998	260	28,013.72	100.80	27,912.92	0.3
2000	51	10,179.75	Nil	10,179.75	0.0
Total	2252	536,858.84	23,003.86	513,854.98	4.3

From the Department of petroleum resources 2004.

Frequent spillages involving up to 5 tonnes of oil also occur. These may result from damage or mechanical failure, and most often take place during loading or discharging operations in the vicinity of terminal. The serious and catastrophic spillages from tankers following collision, grounding or other damage of vessel are rare compared with the above, and may occur anywhere along tanker routes (Baker 1981).

Research findings show that oil spillage has an effect on the environment. In the literature of marine toxicology, there are many studies related to questions on the degree of biological danger from oil spill, ranging from studies which report on the absence of harmful effects (in water with an oil concentration of approximately several ppm or mg/l), to studies which show damage to the vitality of aquatic organisms even in the presence of small amounts of dissolved oil hydrocarbons (in the hundredth and thousands ppm or mg/l) (Isyban and Izrael 1988; GESAMP 1993).

According to Alexander (2007), toxic concentration from spills causes destruction of organisms or irreversible damage to vitally important functions for caviar (embryos), larvae and fingerlings of marine animals, which reaches minimum values of 0.01 to 0.1 mg/l of dissolved oil hydrocarbon and is usually much lower than for adults. He noted that there is a wide range of toxic and threshold concentration. Benthos and demersal forms (including many kinds of fish living in constant contact with polluted sediments) are especially vulnerable. Bottom fish show tumours, mutation and diseases of cancerous character when the concentration of some dissolved aliphatic hydrocarbons (DAH) in sediments is in the range of 3 to 5 mg/l or higher. UNDP (2006) has also documented the toxic and carcinogenic effects of exposures to high concentrations of hydrocarbons.

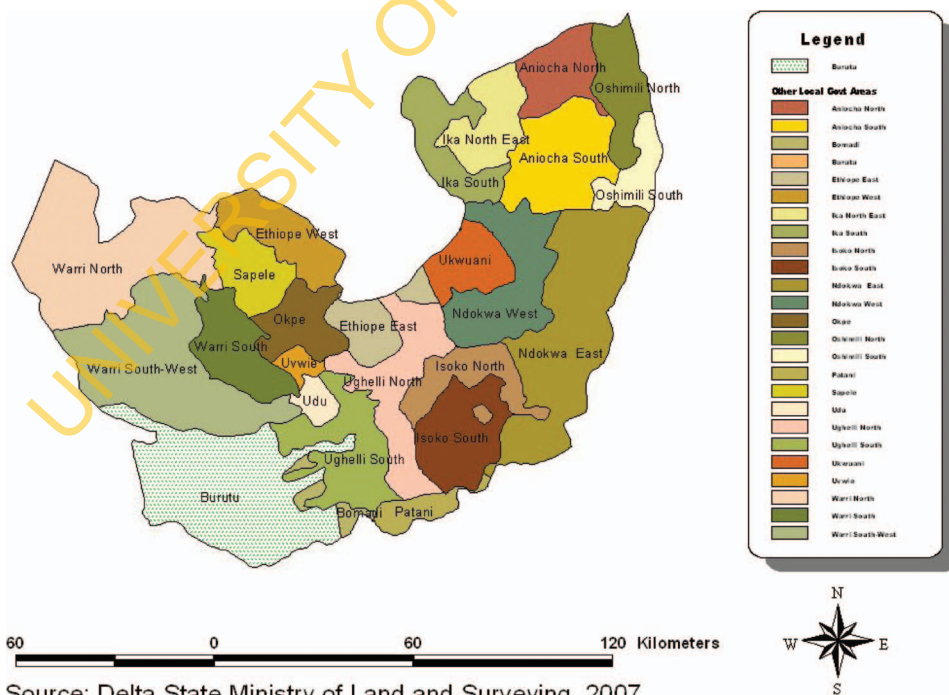
An estimated 5–10% of the Nigeria mangrove ecosystem has been wiped out by oil spillage (Wikipedia 2006). Akankali (1998) stated that the impact of oil spillage on the environment can be highly detrimental with numerous socio-economic impacts, aquatic and terrestrial impact. These impacts include loss of fish, crustaceans, eutrophication of water bodies, abandonment of fishing ground and associated livelihood pursuits, degradation of aquatic resource and ecological damage. In terms of wildlife, oil spills result in the death of a large number of birds and mammals. Similarly, oil coated birds suffer from hypothermia, dehydration, drowning and starvation (Kerley et al. 1987; Etkin 1997).

Ogbogbo (2004) stated that the consequences of oil spillage are massive pollution of land, rivers and streams in the Niger delta. He argued that the aquatic environment and the ecology of the area, which constitute a major resource for the people, are destroyed. The result is that the land becomes unsuitable for agricultural production, and therefore, the livelihood of the inhabitants of the area is jeopardised. Oil pollution has a deleterious effect on living organisms, impairs water quality and creates imbalance in the ecosystem (Biukeme 2001). Most pipelines are laid on the ground, criss-crossing village land used for both agriculture and residential purposes. The implication of the presence of these pipelines in their everyday activities is that spillages, when they occur, tend to paralyse the economic activities of the people. When on land, their crops are destroyed and farmlands rendered desolated, whereas if it is a spill from an oil tanker, the rivers, streams, creeks and waterways are massively polluted and aquatic life endangered if not obliterated (Ogbogbo 2004). He argued that people are dislodged from their traditional economic activity without any alternative. With time hunger, misery, joblessness and a feeling of hopelessness pervades the communities. He further noted that the negative externalities of oil production are borne solely by the oil producing communities without adequate compensation.

3. The study area and the method of data collection

The Burutu local government area is located on the western part of the Niger delta. It is located between latitude 5°05'N and 5°19'N and between longitude 5°17'E and 5°57'E in delta state. It is bounded by Warri South-West local government area to its north, Ughelli South to the east, Bomadi local government area to its south-east, Ekeremor local government area (Bayelsa State) to its south and the Atlantic Ocean (Bight of Benin) to its western flank as shown in Figure 1. The most prominent means of livelihood is fishing, as the majority of the people are mostly fishermen who utilise the rivers and creek. They are also involved in fish processing, fish marketing and other agricultural practices. Palm wine and local gin production and palm oil production is a viable industry here. Boat making is a viable craft of the traditional industry, providing a means of livelihood for relatively few people.

The data collection made use of both primary and secondary sources. Primary data collection relied on the administration of 319 questionnaires to inhabitants of 13 randomly selected localities (communities) in the Buturu local government as shown in Table 2. However, only 302 questionnaires administered were retrieved. Major rivers and creeks were used as a basis for selection. These are the Ramos river, the Forcados river and Forcados creek. For instance, Forcados, Ogulagha, Yeye, Yokri, Sekebolou, Obotobo I are located along the Forcados river; Odimodi (Isiayegbene, Beniboje), are found along the Forcados river and proximate to Forcados creek; Okofagbene and Obotebe are located on the north-eastern part of the study area, close to the Ogbe-Ijoh river, whereas Tuomo, Beneiseide, Bazikumo and Bikorogha are along the Ramos river and its adjoining creeks are shown in Figure 2.



Source: Delta State Ministry of Land and Surveying, 2007

Figure 1. Burutu local government area within delta state.

Table 2. Population projection for 2006.

Localities	Base year (1991) population ^a	2006 Population projected at 3% growth rate ^b	No. of questionnaires to be administered in each locality at 0.01%
1 Forcados	651	1014	10
2 Ogulagha	5949	9268	93
3 Yeye	1964	3060	31
4 Obotebe	3969	6184	62
5 Obotobo I	227	354	4
6 Odimodi	2094	3262	33
7 Okofagbene	317	494	5
8 Sekebolou	1675	2610	26
9 Tuomo	849	1323	13
10 Bikorogha	953	1485	15
11 Yokri	999	1556	16
12 Beneiseide	283	441	4
13 Bazikumou	317	749	7

Sample frame = 31,801 Sample size = 319

^aFrom the National population commission 1991.

^bFrom the Researcher's Projection 2006.

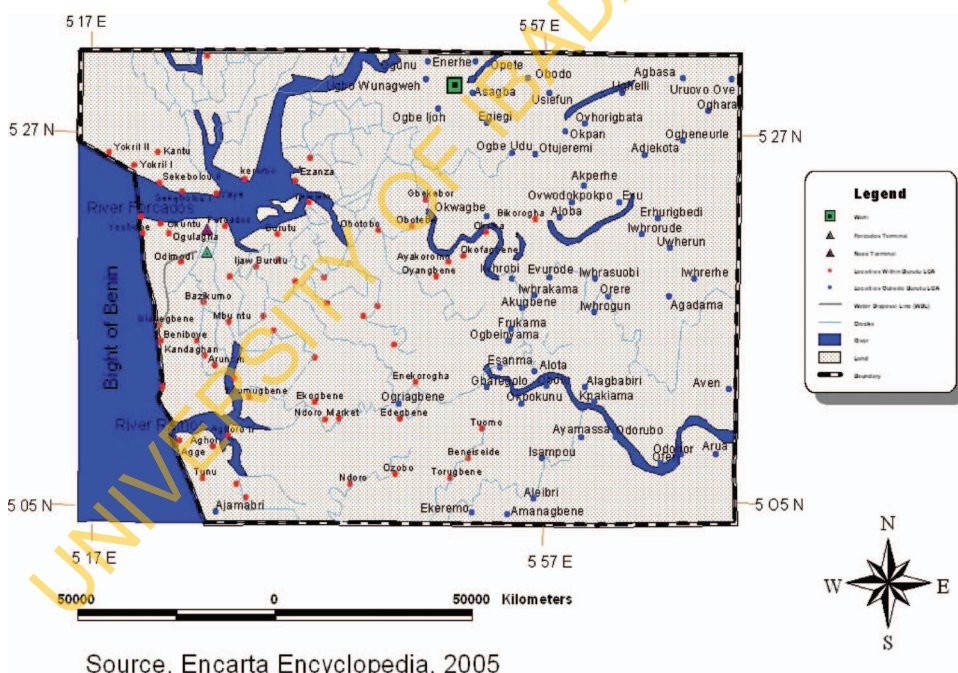


Figure 2. Localities within Burutu local government area.

The questionnaires were then administered using simple random sampling. This was done by first selecting households from each quarter or street as the case may be in the communities visited. The households were then assigned identification numbers. The various identification numbers were written on pieces of paper and put

in a box where they were properly mixed up, after which they were drawn one at a time until the sample size was completed. Households whose identification number was drawn were those where questionnaires were administered. The households were assigned the responsibility of filling in the questionnaire.

Soil samples from four different locations [Isiayegbene/Beniboye (Odimodi), Okuntu, Ogulagha and WDL] and water samples from five different locations [Enekorogha, Okuntu, Ogulagha, Isiayegbene/Beniboye (Odimodi) and WDL] were collected to determine the pH value of the soil, the presence and concentration of heavy metals in soil and the total hydrocarbon content (THC) of water. The water sample from Enekorogha was used as the control; the reason for this is because Enekorogha has not experienced oil spillage. The control site has similar geological characteristics to the other sites because they are not far apart.

To determine the pH values of the soil, the collected soil samples were air dried, crushed with mortar and pestle and sieved with 0.2-ml sieve to get the soil samples in fine texture form. Ten grams of each of the air-dried soil samples were weighed into two different places. Distilled water of 10 ml, ratio 1:1, was added to the first set of four different samples, and 20 ml of calcium chloride was added to the second set of air dried soil samples. A stirring rod was used to stir the samples and left for 30 min to get a homogenous solution. After 30 min, the pH meter was used to take the readings (values) for both sets of soil samples, hence determine the pH value.

To analyse for heavy metals, the soil samples collected from four different locations [Isiayegbene/Beniboye (Odimodi), Okuntu, Ogulagha and WDL] were air dried, crushed with mortar and pestle and sieved with an 0.2-ml sieve to get the sample in a fine texture form; 100 ml of distilled water was added to 0.1 normal of each air-dried soil samples. They were then put on a reciprocal shaker to shake for 30 min, after which they were filtered using filter paper to get the filtrates (extracts) for each samples. The filtrates (extracts) were analysed for heavy metals (chromium, nickel, copper, cadmium, selenium, arsenic, lead and mercury) using the atomic absorption spectrophotometer alpha 4 model. The water samples collected were analysed for THC measured in parts per million (ppm). It was determined by the gravimetric method. This was done to assess the effect of oil spillage on the environment.

4. Data presentation, results and discussion

Findings are discussed under three headings; the socio-economic characteristics of the residents, effect on their livelihoods and impact on physical environment.

4.1. Socio-economic characteristics of the residents

The age structure of the residents indicated that more than 60% of the people are within the productive age group of 20–60 years. Over 60% of the respondents were males and 55% of the people are married. In terms of educational background, 32.1% are without formal education, 25.8% have primary school certificates whereas only about 3% have first degree and above. Further investigations revealed that many of them abandoned their education because they could not pay their school fees because their parents' major source of income (fishing) has been badly affected by oil spillage.

In terms of occupation, the traditional industries in the area include canoe carving, mat making, thatch making (roofing), net making or mending and palm oil

processing. Others are gari or starch processing, fish smoking, local gin (wuru) distillation among others. Presently, fishing is the most dominant occupation in the area. Fishing and farming together with forestry accounted for more than 70% of the total employment in this area. It could be seen that the livelihoods of the people come chiefly from water and land.

With respect to the income as shown in Table 3, about 75% of the respondents earn less than N15,000 per month. A substantial amount of this comes from fishing activities. The marketing structure may partly be responsible for this income pattern. For instance, it is middlemen who buy from the fishermen and sell directly to the consumers in urban areas that make more profit. In most cases, they buy on credit from fishermen and make remittance to them after sales to the urban consumers. Poor storage facilities lead fishermen to accept this kind of marketing structure as they would not want their catch to spoil, thus depreciating in value.

4.2. Incidence and effects of oil spillage on the residents' livelihoods

Incidence of oil spillage in the study area abounds. Table 4 shows that as at 24th July 1981, there was a blow out of tank 5 at the Forcados terminal and the resultant oil spillage affected Forcados, Ogulagha and neighbouring villages. The people complained of polluted air. Oil leakage from a pipeline affected Bikorogha community on the 20th February 1992. The people claimed that the response by the oil company responsible for the pipeline was slow as it took them days to visit the spill site and fix the pipeline. Odimodi, Laboseigha, Barki creek and surrounding forest: Okorobientuaye creek, Westminster canal and shallow wells were affected when there was oil spillage on the 8th October 1994. The general remark by the affected communities was that the natural appearance of the river or water changed to blackish colour whereas the water plants and shrubs withered. Fishing camps were relocated; the crude oil spread more than half a kilometre.

As a response to an incidence of spill which affected Sekebolou, Obotobo I and Yeye communities on 24th August 1995, the oil companies operating there short down North bank and Yokri flow station. Similarly, leakage from the Trans Ramos trunk line affected Tuomo on 5th August 1996. The response was slow, and compensation was done by giving relief materials, N15,000 cash and the following items 18 bags of rice, 18 bags of beans, 18 bags of garri, 12 plastic water tanks and 2 crates of soft drinks for each quarter. The Funiwa 5 oil spill of 12th June 1998 spread through the creeks and affected Idugbene community. The spill of 12th July 1998 affected Bazikumo, Ololugbene, Enebragbene, Chicogbene, Kalaogogbene,

Table 3. Income distribution.

Monthly income	Frequency	Percentage
N5000–N10,000	158	52.3
N11,000–N15,000	47	15.6
N16,000–N20,000	22	7.3
N21,000–N25,000	15	5.0
N26,000–N30,000	4	1.3
No response	56	18.5
Total	302	100.0

From the author's fieldwork 2007.

Table 4. Incidence of oil spillage in the study area.

S/N	Date Year	Affected communities/locations	Causes	Company responsible	Response	Remark by community
1	24th July 1981	Forcados, Ogulagha and Neighbouring villages	Blow out in tank 5, forcados terminal	SPDC		Unconductive air for breathing
2	20th February 1992	Bikorogha	Leakage from a pipe near a valve			Slow Response by oil company responsible for the facility (pipeline)
3	8th October 1994	Odimodi laboseigha Barki Creek and surrounding forest, Okorobientuaye Creek, canal dug by westminster dredging and shallow wells	Leakage of pipeline	NAOC		The natural appearance of water/river changed to a blackish colour Water plants shrubs withered Fishing camps relocated Crude oil estimated to be half a metre thick
4	24th August 1995	Yeye, Sekebolou Obotobo I		SPDC	North Bank and Yokri flow station were shut down	
5	5th August 1996	Tuomo	Leakage from trans Ramos trunk line	SPDC	Slow response to oil spill	Compensation was done by giving relief materials, N15,000 cash and the following items: 18 bags each of rice, beans and garri Plastic water tank-12 and 2 crates of soft drink for each quarter
6	12th June 1998	Idougbene	Funiwa five oil spill spreading through the Creeks			
7	14th June 1998	Izubulobu				

(continued)

Table 4. (Continued).

S/N	Date Year	Affected communities/locations	Causes	Company responsible	Response	Remark by community
8	12th July 1998	Bazikumbe, Oloigbene Enebragbene Chicogbene Kalagobene Yourdebergbene fishing camp Arikpedebo fishing camp Tontimigbene Okofagbene fishing camp Kornigbene Ogbdoojiegbene Boimtagbene Aghoro II (Angoloiba) Ogulagha Odimodi Okibou-zion Agge, Okibon Okingbene Obotobo II Obotebe, Labulo-useigha Kemogbene Obotebe, Tuhome Obotobo I, Yeye, Bazikumbe Yokri, Obotebe, Ogulagha Sekebolou Obotobo I, Yeye, Beniboye Odimodifisiyegbene Ogulagha	Spill from Forcados off-shore loading terminal	Chevron, Texaco Nigeria Limited	SPDC	
9	24th August 1998					
10	3rd January 1999					
11	6th–24th January 1999		Leakage from Odidi II flow station	SPDC		
12	2001					
13	2006					
14	2007					

From the Burutu local government area 2007.

Yourdebergbene fishing camp, Arikpedebo fishing camp, Tontimigbene, Okofagbene fishing camp, Komigbene, Ogbdoijeigbene and Boimagbene. On the 24th August 1998, there was also an oil spillage that affected Aghoro II, Ogulagha, Odimodi, Okibou-zion, Agge and Okibon. Within this period, more spills were experienced and lots of communities were affected compared with other years.

The spill of 3rd January 1999 affected Okingbene and Obotobo II, from 6th to 12th of the same month leakage from Odidi flow station affected Obotebe, Labuloseigha and Kemogbene. The oil spill that occurred in 2001 affected Obotebe and Tomo and that of 2006 affected Yeye, Bazikumo, Obotobo I, Yokri, Ogulagha, Sekebolou and Obotebe.

Furthermore, the volume and the area of coverage of oil spillage in the study area between 1996 and 2006 are presented in Table 5. The year 1998 had the highest volume of oil spills (21,876.6 barrels) with area coverage of 12 km². The year 2002 recorded the second largest volume of spillage (15,296.12) covering 8.1 km², whereas 2000 had 11,023 barrels of oil spilled as the third largest spilled volume covering 5.8 km². The year 2004 had the lowest volume of oil spilled (7271.37 barrels) covering 4.2 km², it is followed by 2001, which had 8086.1 barrels spilled covering 6.3 km² and 1997 had 8607 barrels spilled. It covered 4.9 km². The larger the volume of spills, the wider the area it covers. The total number of spilled volumes over the period is 124,377 barrels. It should be noted that the volume of spills could probably be more because some spills may not have been accounted for because they probably occurred unnoticed in the very difficult terrain of the swampy mangrove forest of the study area.

The impact of oil spills on the socio-economic activities of the people has been tremendous. For instance, 88.4% said that they run at a loss whenever oil spills occur whereas 8.9% of the respondents make less profit from their major means of livelihoods (fishing) in times of oil spills as shown in Table 6. Only 2.7% of the respondents claimed that their business remained profitable.

The impact of oil spill on fishing activities and other economic activities have, therefore, prompted some respondents to give serious thought to changing their means of livelihood; 43.0% of respondents have changed their means of livelihoods whereas 25.5% intend to change theirs. The reasons given include among others; no catch immediately after a major oil spillages, dwindling income over the years and

Table 5. Volume of oil spilled and area coverage.

Year	Volume spilled (barrels)	Area covered (km ²)
1996	10,091.61	5.8
1997	8607.0	4.9
1198	21,876.6	12.0
1999	9351.3	5.4
2000	11,023.0	5.8
2001	8086.1	6.3
2002	15,296.12	8.1
2003	13,402.9	7.1
2004	7271.37	4.2
2005	9656	5.5
2006	10,111.1	5.8
Total	124,377.0	100

From the Burutu local government area 2007.

low demand for products/commodities during and after an oil spillage. For those who are considering a change of their means of livelihood, they cited lack of training/skill as a major factor. Where people are not trained for other means of livelihood, they can hardly change their job, because they are not equipped for such. It could be deduced that those willing to change their jobs are considering such out of frustration.

4.3. Hypothesis testing and laboratory analyses of water and soil samples

4.3.1. Hypothesis testing

Simple correlation analysis was used to determine the relationship between the volume of oil spilled and the area covered by the spillage. The result of the analysis is shown in Table 7.

The result indicates that there is a strong positive relationship between the independent variables (volume of oil spillage) and the dependent variables (area covered by oil spillage). As the volume of oil spill increases, the area covered by the oil spillage increases equally. Further analysis shows that the calculated F -value is 42.615 and the critical p -value is 0.000 at 0.05 α value. Hence, the calculated F -value 42.615 is higher than the critical p -value 0.000, because the critical p -value 0.000 is less than 0.05 α value; the null hypothesis (H_0), which states that there is no significant relationship between the volume of oil spilled and the area covered by the oil spillage is rejected; the alternative hypothesis (H_1), which states that there is significant relationship between volume of oil spilled and the area covered by the oil spillage, is accepted. In other words, the volume of oil spilled dictates or predicts the area coverage of the oil spillage; hence, the area degraded by oil spillage in the study area is dictated by the volume of oil spilled.

4.3.2. Soil pH

Result of the analysis of soil samples for soil pH values in the study area is shown in Table 8. The pH values of the spillage sites are higher than the controlled site. This indicates that oil spillage has increased the acidic level of the soil slightly. However,

Table 6. Impact of oil spills on economic activities.

Response	Frequency	Percentage
Profitable	6	2.7
Less profitable	20	8.9
Not profitable	198	88.4
Total	224	100.0

From the author's fieldwork 2007.

Table 7. Model summary.

Model	R	R^2	Adjusted R^2	SE of the estimate
1	0.965	0.930	0.923	0.59570

the soil pH value is within the World Health Organization's (WHO's) limits of between 6.5 and 8.5.

The implication of these figures is that soils with a pH below 6.0 are more likely to be deficient in calcium, magnesium and potassium. In strongly and very strongly acid soils, iron and manganese may exist in toxic quantities because of their increased solubility. In alkaline soil pH > 7.0, manganese, zinc, iron and copper become unavailable for plant growth. It can be deduced that oil spillage has increased the acidity of soil pH, hence depleting or proliferating some metals. These have a biological and chemical effect on biodiversity (environment) and on man.

4.3.3. Heavy metal analysis

Heavy metal concentration above permissible levels has health implications. Plants can transfer heavy metal pollutants from soils into food chains and this accumulation is one of the most serious environmental concerns of the present day, not only because of the phytotoxicity of many of these metals to the crops themselves, but also because of the potentially harmful effects the toxic metals have on animal and human health (Miroslav and Vladimir 1999). Using an atomic absorption spectrophotometer, the concentration of heavy metals in the different soil samples was determined. Concentration levels in parts per million (ppm) are shown in Table 9 and compared with their permissible levels.

Table 8. Soil pH value analysis result.

Locations	Soil sample (pH value)
Isiayegbene/Beniboye (Odimodi)	6.9
Okuntu	7.1
Ogulagha	7.3
Water disposal line linking Forcados terminal Ogulagha to south point, and finally emptying into River Forcados (controlled site)	6.7

From the author's fieldwork 2007.

Table 9. Heavy metals soil concentration and their permissible levels.

Parameter (heavy metals)	Permissible level by WHO (ppm) ^a	Concentrations in locations ^b			
		Isiayegbene/ Beniboye (Odimodi) (ppm)	Okuntu (ppm)	Ogulagha (ppm)	WDL (ppm)
Chromium	0.05	0.054	0.27	0.98	0.00
Nickel	0.02	0.0	0.0	1.7	0.9
Copper	1.3	0.09	0.07	0.30	0.07
Cadmium	0.005–0.03	0.000	0.004	0.015	0.00
Selenium	0.05	25.288	0.000	21.115	0.00
Arsenic	0.010	1.8	1.4	6.9	0.00
Lead	0.015	0.38	0.04	0.00	0.00
Mercury	0.002	0.000	0.000	2.712	0.00

^aFrom Miroslav and Vladimir 1999.

^bFrom the author's fieldwork 2007.

At Isiyegbene/Beniboye (Odimodi), chromium was found to be 0.054 ppm; this is above the WHO permissible level of 0.05 ppm. Selenium (25.288 ppm), arsenic (1.8 ppm) and lead (0.38 ppm) are all above the WHO permissible levels, whereas others such as nickel (0.0 ppm), copper (0.09 ppm), cadmium (0.000 ppm) and mercury (0.000 ppm) were found to be within their permissible level. At Okuntu, chromium (0.27 ppm) and arsenic (1.4 ppm) were found to be above their permissible levels of 0.05 and 0.010 ppm, respectively.

In Ogulagha community, chromium (0.98 ppm), nickel (1.7 ppm), cadmium (0.015 ppm), selenium (21.115 ppm) and arsenic (6.9 ppm) were found to be above their respective permissible levels. However, other parameters were within the permissible levels. The water disposal line (WDL) that runs from Forcados terminal Ogulagha, through Okuntu, Youbebe, to South point (Isiyegbene) before emptying into River Forcados does not pose much threat, except for the fact that the concentration of nickel (0.9 ppm) that gets into the river and the environment is above the WHO permissible level (0.02 ppm).

Chromium and arsenic are the main contaminants among the heavy metals analysed. Chromium concentration in three locations (Odimodi 0.054 ppm, Okuntu 0.27 ppm and Ogulagha 0.98 ppm) exceeds the permissible level of 0.05 ppm. Arsenic concentration in Odimodi (1.8 ppm), Okuntu (1.4 ppm) and Ogulagha (6.9 ppm) exceeds the permissible level of 0.010 ppm. Nickel concentration exceeded the permissible level of 0.02 in two locations (Ogulagha 1.7 ppm and WDL 0.9 ppm), and selenium concentration also exceeded permissible level of 0.05 in two locations (Odimodi 25.288 ppm and Ogulagha 21.115 ppm). Lead, cadmium and mercury exceeded their permissible level in one location each.

4.3.4. *THC of water*

Table 10 provides the result of water samples analysed for THC. Okuntu, Ogulagha and Isiyegbene/Beniboye (Odimodi): all had 40,000 mg/l of THC. These concentrations are higher than those of the WHO standard. These high levels cannot be divorced from the impact of oil spillage. Enekorogha, which had not experienced any oil spillage, has 0 ppm of THC; the WDL equally had 0.00 ppm of THC. This implies that the effluent from the WDL is well treated before it is disposed into the Forcados river. This excessive hydrocarbon content has unquantifiable effects on aquatic and marine animals. This may also be detrimental to human health because of the food chain process. Furthermore, there is the likelihood for the high hydrocarbon content to aid water-borne diseases.

Table 10. Gravimetric analysis for THC.

Locations	THC ppm ^a	WHO permissible level for THC in ppm ^b
Isiyegbene/Beniboye (Odimodi)	40,000	1
Okuntu	40,000	1
Ogulagha	40,000	1
WDL	0	1
Enekorogha(controlled environment)	0	1

^aFrom the author's fieldwork 2007.

^bFrom NDDC 2006.

5. Way forward in the Niger delta

Because agriculture, forestry and fishing are the main employer in that region, it is essential that they remain viable. This can only be achieved by sustainable exploitation or utilisation or management of oil resources in the Niger delta, especially in the study area. This will promote environmental sustainability, goal number seven of the Millennium Development Goals (MDGs). This is expected to be of benefit to both present and future generations.

With respect to legislation, the major constraint is the lack of enforcement of existing regulation. Most of the laws that regulate the activities of oil companies are poorly enforced. Similarly, some of the environmental laws are uncoordinated and outdated, so that they need to be harmonised and reviewed in line with the reality on ground. A comprehensive inventory of spill sites should be conducted and the characteristics of the sites (soil, vegetation and groundwater) documented. These variables are very important to determine the extent of oil spillage and the impact on soil and water as well as their consequences on farming and fishing activities.

In communities where both soil heavy metals and hydrocarbon water content are greater than the permissible level, it is very urgent that the oil companies embark on remedial action to restore the soil productivity and water quality. This will be of great benefit to the fishing industry, which is the main employer and backbone of the communities in the region. In the same vein, the oil companies must ensure that the communities are adequately compensated whenever there is an oil spill. Also, alternative sources of livelihoods should be identified and strengthened, but this will require capacity building. Furthermore, in this era of participatory development, the oil companies should not single handedly proffer solutions to oil spillage; they need the active participation of the rural communities. Their cooperation is cardinal to the successful implementation of any remedial measures.

Also, the oil companies must ensure regular maintenance and monitoring of their pipelines so as to avoid spills resulting from rupture, whereas pipeline vandalism should be greatly discouraged by imposing stiffer penalties against defaulters.

6. Conclusion

Oil production in the Niger delta is cardinal to the socio-economic development of the country. For instance, the sub sector accounts for over 90% of export revenue and foreign exchange earning for the country. Despite this importance, oil exploration in the region is not without some environmental problems in which oil spillage is paramount. For example, since the first oil spillage that took place in Bomu on the 9th July 1970 through the operations of multinational companies, several other incidents have occurred in various communities in the Niger delta region. In the study area, there were 14 incidents of oil spillage between 1981 and 2007. Similarly, between 1996 and 2006, the total volume of oil spills was 124,377 barrels.

Findings indicated that the age structure of the residents showed that more than 60% of the people are within the productive age group of 20–60 years. With respect to educational background, more than 95% do not have more than secondary education. Investigations revealed that many of them abandoned their education because their parents' major source of income (fishing) has been badly affected by oil spillage. Presently, the dominant occupation in the study area is fishing, which together with farming and forestry accounted for more than 70% of the total

employment in this area. Monthly income distribution indicated that about 75% of the respondents earn less than N15,000 per month.

Analysis of soil samples collected in all the communities showed a high level of heavy metals (chromium, lead, arsenic, etc.) with concentration above the WHO permissible levels. This poses health threats to the people of the study area and those in urban areas who consume fish caught in these rivers and creeks as heavy metals in soil can infiltrate to the rivers and finally get into the fishes. Furthermore, there is a herbicidal effect on the vegetation. In the advent of an oil spillage, after a while plant cover withers as if sprayed with herbicides and they lose their colouration as well as performing poorly. Similarly, the results of water samples analysed for THC in Okuntu, Ogulagha and Isiyegbene/Beniboye (Odimodi) communities had higher concentrations than the WHO standard. This excessive hydrocarbon content has unquantifiable effects on aquatic and marine animals. In the same vein, results of the hypothesis tested showed that oil spillage have significant adverse impact on the environment and also on the socio-economic activities of the people. In a nutshell, the oil spills have impacted negatively on soil, water and biodiversity with grave consequences for socio-economic activities and the welfare of the people.

It is very imperative, therefore, to enforce existing regulations on oil exploration, and where necessary such laws should be reviewed in line with the present reality. Also, sustainable remedial action should be undertaken in the communities where spills have occurred and this must be accompanied with adequate compensation. Oil companies must ensure that oil pipes are adequately maintained to avoid leakage and be properly monitored to guide against vandalisation. This can be done through participatory development, that is, by actively involving communities in the security of the pipelines.

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References

- Achi C. 2003. Hydrocarbon exploitation, environmental degradation and poverty: the Niger delta experience. Paper presented at: The diffuse pollution conference. Dublin. Ireland.
- Adetular VAO. 1996. Oil and the people of Niger delta: a case study of economic, social and cultural impacts of oil pollution. Research Report. Jos, Nigeria: Centre for Development Studies.
- Akankali JA. 1998. Impact of oil pollution on fishery and environment. Paper presented at: The workshop on determining compensatory indices based on destroyed fishing gears in oil polluted brackish water environment, 23–24 July, Effurun. Nigeria.
- Alexander L. 2007. Oil and gas development on the Sakhalin Island: an assessment of changes in the Okhostsk sea ecosystem [Internet]. Available from: <http://www.src-h.slav.hokudai.ac.jp/sakhalin/eng/71/leonov.html>.
- Baker JM. 1981. The investigation of oil industry influence on tropical marine ecosystems. *Mar Pollut Bull.* 12(1):6–10.
- Biukeme EA. 2001. Oil spills and other environmental factors affecting fisheries productivity and fisher folk loan repayment capabilities in Rivers state [M. Phil. Geosciences Dissertation]. Nigeria: River State University of Science and Technology.
- Department of Petroleum Resources (DPR). 2004. Oil spillage in the Niger delta (Eastern operations). Port Harcourt: DPR.
- Etkin DS. 1997. The impact of oil spills on marine mammals. OSIR Report March 1997. Washington DC, USA: US Marine Agency.

- GESAMP. 1993. Impact of oil and related chemicals and wastes on marine environment. GESAMP Reports and studies. London, United Kingdom: IMO.
- Isyban AV, Izrael JA. 1988. Anthropogenic ecology of the ocean. Leningrad, Russia: Hydrometeoizdat.
- Kerley GIH, Bowen L, Erasmus T. 1987. 'Fish behaviour – a possible role in the oiling of seabirds'. *S Afr J Wildl Res.* 17:128–130.
- Miroslav R, Vladimir NB. 1999. Practical environmental analysis. Cornwall, UK: MPG Books.
- Mobil Producing Nigeria. 1998. January 1998 Idoho – QIT 24 pipeline oil spill. Short term environmental impact assessment report. Nigeria: Mobil Producing Nigeria.
- National Population Commission (NPC). 2006. Nigeria provisional population. Abuja: NPC.
- NDDC (Niger Delta Development Commission). 2006. Niger delta regional development master plan. Port Harcourt, Nigeria: NDDC.
- Nigerian Bureau of Statistics (NBS). 2006. Annual abstract of statistics. Abuja: NBS.
- Ogbogbo CBN. 2004. The Niger delta and the resource control conflict since 1960–1995 [Ph.D. Institute of African studies dissertation]. Nigeria: University of Ibadan.
- United Nations Development Programme. 2006. Niger delta human development report. Abuja: UNDP.
- Wikipedia. 2006. Oil spill. Wikipedia Website [Internet]. Available from: <http://en.wikipedia.org/wiki/oil/spill>.