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An Assessment of the Physical Impact of Oil Spillage Using GIS and Remote Sensing Technologies: Empirical Evidence from Jesse Town, Delta State, Nigeria.

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Abstract

Over 6000 spills had been recorded in the 50 years of oil exploitation in Nigeria, with an average of 150 spills per annum. In the period 1976 – 1996, 647 incidents occurred resulting in the spillage of 2,369,407.04 barrels of crude oil. With only 549,060.38 barrels recovered, 1,820,410.50 barrels of oil were lost to the ecosystem. The environmental consequences of oil pollution on the inhabitants of Delta State and Jesse community in particular are enormous. Oil spills have degraded most agricultural lands in the State and have turned hitherto productive areas into waste lands. This study relied majorly on secondary data sources from supervised image classification method. ILWIS 3.2 GIS software was employed to classify ground cover into oil spill area, bare land/ cultivation, built up areas and vegetation. The findings reveal that oil spillage is increasing unabated in the study area. This paper recommends qualitative employee training and preventive maintenance culture as remedy to continuous oil spillage since the principal cause of spills was attributed to human errors and equipment failure.

Keywords: Oil Spillage, Environmental Pollution, Land use/Land cover, GIS, Remote Sensing, Jesse.

1 Introduction

This study presents a synthesis of the problems regarding the impacts of oil spillage that dates back to crude exploration in the Niger Delta which started over 50 years ago. The exploration and exploitation of crude oil has brought with it several cases of oil pollution leading to depletion of natural resources. Nigeria, the most populous country in Africa, is also one of the best endowed in terms of natural resources. Since 1974, only 14 years after her independence, oil production for export has been by far the main source of revenue for the government. Today, oil sales account for more than 40percent of GDP, 80 percent of the government's budgetary revenue, and more than 95 percent of exports. With an average production of approximately 2 million barrels per day, Nigeria is one of the world's largest oil producers.

The Niger Delta Region belongs to the South-South geo-political zone of Nigeria. It is the most endowed delta in the world in terms of both human and material resources. Before the discovery of crude oil, agriculture was the dominant occupation of the people. Crude oil was discovered in commercial quantity in the region specifically in the present Bayelsa State in 1956. Since then oil exploration has continued resulting into what is termed environmental destruction due to neglect and negative attitude of the multinational companies in environmental management in the area. The world today recognizes the significance of environmental sustainability to the development of the nations. In fact, one of the cardinal objectives of the Millennium Development Goals is to ensure environmental sustainability. It then implies that there should be reduction in environmental pollution (Eregha and Irughe, 2009).

The Niger Delta region is Nigeria's only productive region for petroleum. The region consists entirely of nine states of Rivers, Bayelsa, Cross Rivers, Akwa Ibom, Delta, Edo, Ondo, Abia, and Imo. As is the case with many oil-rich developing countries, oil reserves have proved a mixed blessing for Nigeria. This is so because of the environmental and social impacts exploration and exploitation of this important natural resource (Amu, 2006).

The Niger Delta region is dominated by rural communities that depend solely on the natural environment for sustenance living and non-living livelihood (UNDP Report, 2006). Environmental degradation issues are of topical concern to communities in the Niger Delta as it is a major cause of productivity losses (Opukri and Ibaba, 2008). This is the main reason why oil and gas extraction impact on the Niger-Delta has consequences for the declining productivity of the region which is predominantly based on fisheries and other agricultural activities as farming, and timber businesses. Oil production has definitely worsened environmental disaster in the region (Worgu, 2000).

Delta State is the largest crude oil producing state in Nigeria located in the Niger delta region, the base of the Nigerian oil and gas industry which generates over 90 percent of the nation's foreign exchange earnings. Paradoxically, in spite of the increasing revenue from crude oil exploitation, the communities from which this resource flows in the Niger Delta continue to live in conditions of social deprivation and abject poverty. All stages of oil exploitation impact negatively on the environment, and the greatest single intractable environmental problem caused by crude oil exploration in the Niger Delta region is oil spillage (Worgu, 2000).

Oil is a general term used to denote liquid petroleum products which mainly consists of hydrocarbons. The release of oil into the natural environment is termed oil spill. The extraction, refining, transportation and storage of oil are accompanied by seepages and spills by operations or accidents. Deliberate act such as sabotage, oil bunkering, lack of maintenance of engineering equipment, tanker accidents causes oil spill. Oil spill can also occur through natural disasters like hurricane and earthquake, movement of tectonic plate and inadequate trap system (NNPC, 2009).

The GIS model provides an efficient planning tool for urban oil spill management. Additionally, the graphical capability of GIS allows users to integrate environmental features and spill characteristics in the management analysis. This project sets out to investigate the physical impacts or effects of oil production in the Niger Delta (http/ science.Irank.org)

One of the most common impacts of oil exploitation is oil spill, which is defined as a flow from a container, especially accidentally and usually with resulting loss or waste. Oil spills constitute a menace in any place where they occur and have been a source of serious concern for people and governments. This phenomenon occurs regularly in the Niger Delta and generates a lot of environmental issues that call for meticulous study to ameliorate.

The aim of this study is to carry out an assessment of the physical impacts of oil spillage on Jesse community, Ethiope West Local Government Area of Delta State, Nigeria using GIS and Remote Sensing technologies. The objectives of the study are to: identify the sources of oil spillage in the study area; examine the impact of oil spillage on the socio-economic life of the people; assess the impact of oil spillage on agricultural production; and evaluate Land use/ Land cover change of the study area using Remote Sensing and GIS technologies.

2 The Study Area

Jesse, the study area is the principal town in *Idjerhe* clan within the heartland of the Niger Delta. It is situated in Ethiope West Local Government Area of Delta state. The town is about 55kms from Warri the capital city of Delta State. The estimated population of Jesse is about 7000 persons (NPC, 2006).

Jesse is located in the western part of the Niger Delta, south of latitude 6^0N. It occupies an area of about 500 square kilometres in the southern part of Delta State. It is bounded by latitudes $5^0$15’N and 6^0 00’N and longitudes $5^0$40’E and $6^0$25’E. It is low lying plain consisting mainly of recent unconsolidated sediments of quaternary age. These sediments are partly of marine and partly of fluvial origin. Land elevation is generally less than 50 metres above mean sea level and there is a marked absence of imposing hills that rise above the general land surface. The most important river in Jesse is river Ethiope and it is prone to flooding during the wet season mainly because of the heavy rainfall, high ground water table and the flat-floored valleys (UNDP Report, 2006).

The climate of Jesse is humid sub-equatorial with a long wet season lasting from March to October that alternates with a short dry season that lasts from November to February. The climate is influenced by two prevailing air masses namely South West Monsoon Wind and the North East Trade Wind. The former prevails during the wet season and the latter during the dry season. Annual rainfall is high throughout Jesse; being usually up to 2500mm. Annual temperature average in Jesse is about 27^0C with no marked seasonal departure from the average temperature as the annual range of temperature is quite small, rarely exceeding 3^0C (UNDP Report, 2006).

The major occupation in Jesse community includes farming, fishing, trading, lumbering, mining, palm wine tapping and manufacturing. Farming is the mainstay of the people which is mainly subsistence and commercial in nature. The farmers usually grow tree crops, especially rubber purely in order to generate income. The main food crops grown in Jesse include cassava, water yam, plantains, cocoyam and groundnuts. The two most important cash crops produced in Jesse are rubber and oil palm, both of which are tolerant of the acidic sandy soils. Fishing is important occupation in the main streams and river especially in the Ethiope River (Egbe and Thompson, 2010).

Jesse is rich in human, mineral and forestry resources. The community is situated on huge commercial deposit of crude oil. The soil is acidic clay, harbouring fresh water swamp forest. The vegetation is diverse and economic plants like raffia and rubber thrive in commercial quantity (Egbe and Thompson, 2010).

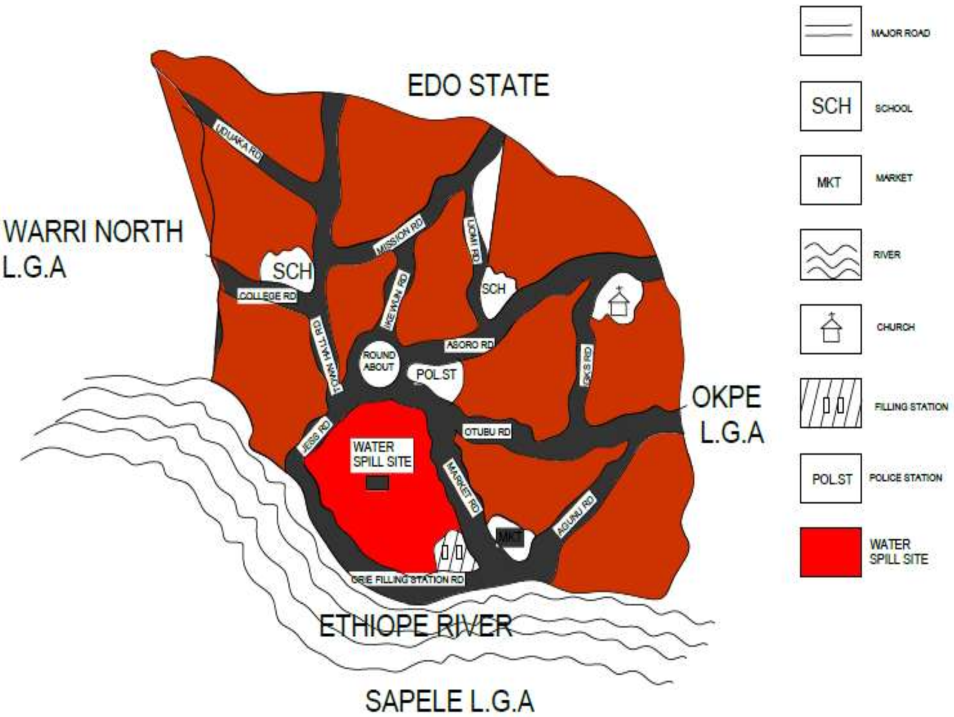


Fig1: Map of Jesse Community
Source: Ethiope West Local Government Area Council, Oghara.

3 Summary of Literature

Notoma (2010) defines pollution as the contamination of Earth's environment with materials that interfere with human hearth, the quality of life, or the natural functioning of the ecosystem (living organisms and their physical surroundings).He said pollution is the introduction of any substance or stressor, in such quantity and characteristics for such duration that a deleterious effect is produced on the biota in terms of their viability, relative abundance, health, mortality, etc.

Kerambrun and Parker (1998) dealt with shorelines inundated with thick black oil pollutants. Results of the study focus on the society to accept responsibility for repair of damage to environment through human intervention and carefully targeted clean-up activities. Moller, Dicks, White &Girin (1999) explored approaches for managing activity bans in fisheries and aquaculture sectors following oil spills. They stated that considerable improvement is desired in spill response technology, highlighting technical and organizational problems associated with major marine oil spills. This author further opines that the cost of incidence in coastal waters, shorelines and seas depends on factors like type of oil coupled with physical, biological and economic characteristics of spill locations, other factors being rate of spillage, weather, time of year and effectiveness of clean-up.

The oil industry has an enormous physical presence in the environmentally sensitive, highly populated Niger Delta Region of Nigeria. Throughout 50 years of oil production, this ecologically productive region has suffered extensive habitat degradation, forest clearing, toxic discharges, dredging and filling, and significant alteration by extensive road and pipeline construction from the petroleum industry. Of particular concern in the Niger Delta are the frequent and extensive oil spills that have occurred. Spills are under-reported, but independent estimates are that at least 115,000 barrels (15,000 tons) of oil are spilled into the Delta each year, making the Niger Delta one of the most oil-impacted ecosystems in the world (Ndifon, 1998)

The Niger Delta can be regarded as a high consequence area for oil spills, requiring additional risk-reduction measures from oil companies. Oil spills have a significant impact on the natural resources upon which many poor Niger Delta communities depend. Drinking water is polluted, fishing and farming are significantly impacted, and ecosystems are degraded. Oil spills significantly affect the health and food security of rural people living near oil facilities. Additionally, oil spills and associated impacts of oil and gas operations have seriously impacted the biodiversity and environmental integrity of the Niger Delta (Nwilo and Badejo, 2005b)

There has been a significantly higher rate (spills per length of pipeline) of serious pipeline spills in the Niger Delta than in developed countries such as the U.S., beyond that accounted for by sabotage. This, and other evidence, suggests that oil companies operating in the Niger Delta are not employing internationally recognized standards to prevent and control pipeline oil spills (Ndubuisi and Asia, 2007). According to Opukri and Ibaba (2008), environmental degradation issues are of tropical concern to communities in the Niger Delta as it is a major cause of productivity losses. The dominant view blames oil production and its attendant consequences for the declining productivity of local economies that are mainly based on fisheries and agriculture (Aaron, 2006). The literature on the Niger Delta highlights poverty, unemployment, underemployment, proletarianisation, and rural urban migration as the consequences (Opukri and Ibaba, 2008). The collapse of the local economies, induced by oil spillages, gas flaring and other activities of the oil industry had displaced many from their occupations, without providing viable alternatives.

Oil spillage has a major impact on the ecosystem into which it is released. Immense tracts of the mangrove forests, which are especially susceptible to oil spillage, have been destroyed. An estimated 5 to 10% of Nigerian mangrove eco systems have been wiped out either by settlement or oil. The rain forest which previously occupied some 7,400km/square of land has disappeared as well (ANEEJ, 2004). Spills in populated areas often spread out over a wide area, destroying crops and aquacultures through contamination of the underground water and soils. The consumption of dissolved oxygen by bacteria feeding on the spilled hydrocarbons contributes to the death of fish. In agricultural communities, often a year’s supply of food can be destroyed instantaneously. Because of the careless nature of oil operations in the Delta, the environment is growing increasingly uninhabitable (ANEEJ, 2004).

Wadsworth, Dicks & Lavigne (1999) opine that oil spills contaminate both agricultural facilities and livestock, which can be prevented by innumerable self-help response options like relocation of cages, transfer of stock and early harvest. He elucidated cooperation between ship owners, government and private bodies involved in addressing hassles due to oil spillage. Moller, Dicks, Whittle &Girin (1999) explored approaches for managing activity bans in fisheries and aquaculture sectors following oil spills. According to (Celestine, 1997) oil spills can affect the environment in three different ways, by poisoning after ingestion of affected agricultural yields, by direct contact and by destroying habitats. One of the critical problems facing the oil industry today is that of oil spillage. It is of particular concern because of the emphasis on land, deep water and general human habitation. The first oil spillage was that of Exxon Brooklyn which occurred in 1940 at Newton creek Brooklyn USA, where about 97,400 tonnes of oil was spilled. Since the discovery of oil in Nigeria in1956, the country has been suffering the negative environmental consequences of oil development. Oil spill incidents have occurred in various parts of the world, it could be caused by natural and man-made reasons. Oil spill occur naturally by natural disaster, movement of tectonic plate, and also as a result of inadequate trap system (Akpofure, 2006). Oil spills have caused a lot of environmental problems in the Niger Delta; it has degraded most agricultural lands in the area and has turned hitherto productive areas into wastelands. With increasing soil infertility due to the destruction of soil micro-organisms, and dwindling agricultural productivity, farmers have been forced to abandon their land, to seek non-existent alternative means of livelihood. Aquatic life has also been destroyed with the pollution of traditional fishing grounds, exacerbating hunger and poverty in fishing communities (Gbadegesin, 1997).

In a study of the socio-economic impact of oil pollution, Omofonmwan and Odia (2009) state that crude oil exploitation has had adverse environmental effect on soils, forests and water bodies in host communities in the Niger Delta. Farmers have lost their lands, and are consequently forced to emigrate to other communities in search of livelihood exerting additional pressures on natural resources in such areas. It is noteworthy that, the devastating consequences of oil spill in Niger Delta region with its eventual hazards on both aerial and terrestrial environs tantamount to an irreversible chain effect on both the bio-diversity and safety spills in populated areas affect crops and agriculture through contamination of the ground water and soils. Spills also contribute to the contamination and death of fishes which affects the economy and human health adversely.

Oil spill incidents have occurred in various parts and at different times along Nigerian coast. Some major spills in the coastal zone are the GOCON’s Escravos spill in 1978 of about 300,000 barrels, SPDC’s Forcados Terminal tank failure in 1978 of about 580,000 barrels and Texaco Funiwa-5 blowout in 1980 of about 400,000 barrels. Other oil spill incidents are those of the Abudu pipe line in 1982 of about 18,818 barrels, The Jesse Fire Incident which claimed about a thousand lives and the Idoho Oil Spill of January 1998, of about 40,000 barrels. The most publicized of all oil spills in Nigeria occurred on January 17 1980when a total of 37.0 million litres of crude oil got spilled into the environment. This spill occurred as a result of a blow out at Funiwa 5 offshore station. Nigeria's largest spill was an offshore well blow out in January 1980 when an estimated 200,000 barrels of oil (8.4million US gallons) spilled into the Atlantic Ocean from an oil industry facility and that damaged 340 hectares of mangrove (Nwilo and Badejo, 2005).

Table 1: Showing the Number of Spills in the Niger Delta between 1979 and 2005.

Episode	Year	State	Quantity Spilt in Barrels
Forcados terminal oil spills	1979	Delta	570,000
Funiwa no.5 well blow out	1980	Rivers	400,000
Oyakama oil spillage	1980	Rivers	10,000
System 2c Warri, Kaduna pipe line rupture at Abudu	1982	Edo	18,000
Sohika oil spill	1983	Rivers	10,000
Idoho oil spill	1983	Akwa Ibom	40,000
Jones creek oil spill	1998	Delta	21,000
Jesse oil spill	1998	Delta	10,000
Etiama oil spill	2000	Bayelsa	11,000
Ughelli oil spill	2005	Delta	10,000
Total	**-**	**-**	**700,000**

Source: United Nations Development Programme (UNDP) (2006)

From the table it is evident that over 87% (611, 000 barrels) of total oil spill in the period under review occurred in Delta state which is the state where the study area, Jesse is situated, this phenomenon is indicative of the fact that the study area is in no doubt under perpetual threat of oil spill.

4 Data and Methods

This study is a case study research designed to explore the physical impact of oil spillage in Jesse community, Delta State, Nigeria. It evaluates the impact of oil spillage on: crop production, fishing activities, air quality and land use/land cover change. To achieve this, data was collected majorly from secondary sources, as data were extracted from books, seminar papers, journals, and other relevant literature. The internet was also a veritable source of data in this study. Maps of the study area showing its national, regional and local setting were also sourced. Photographs of sites damaged by oil spillage were also taken during site visitation. Direct observation of spillage sites was also carried out. The LandSat Imagery of the study area at 28.5meter resolution was acquired. The imagery showed the land use, land cover map of the study area from which the physical implications of oil spills were derived. The raw spatial images used in the research were acquired from the United States National Aeronautical and Space Administration (NASA). The topographical map of the study area was also acquired. All maps and imageries were processed using ILWIS 3.2 software.

The topographical maps of Warri North West and North East were acquired as the study area falls within this region. Both maps were glued since the study area falls within the area covered by the two topographical map sheets. Figure 2 shows the glued map of the study area.

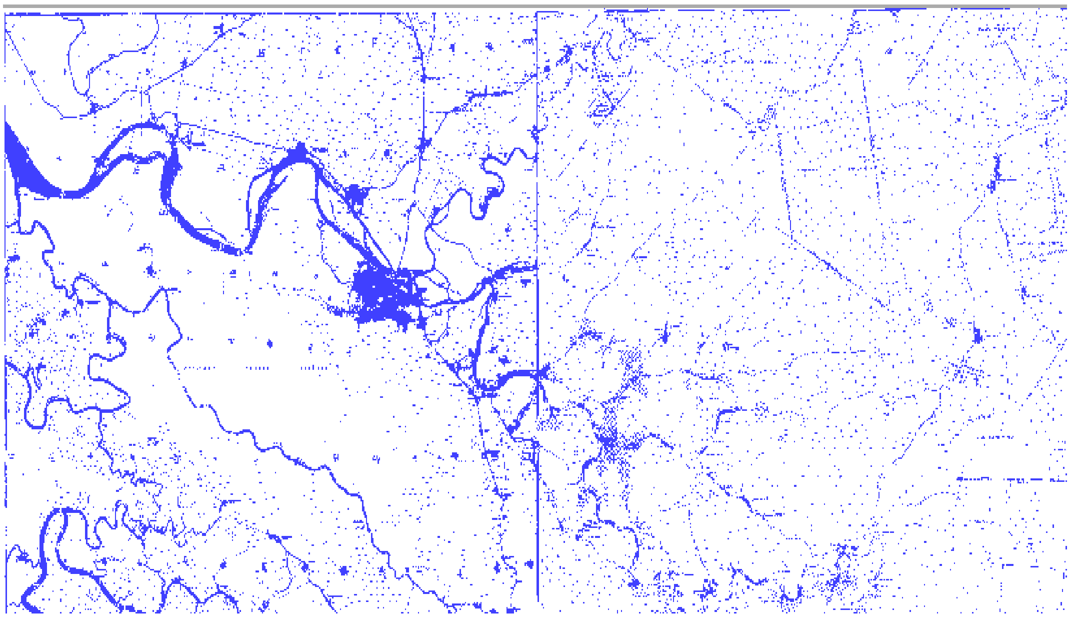


Figure 2: Glued Topographical maps of Warri North West and North East.

The second stage used in acquiring data for this study is the digital image processing and analysis. This stage involves: importing the different bands of the Land Sat images into ILWIS environment. Since the images are in separate bands, colour composite is carried to merge the bands together in order to form a floating scene (see Figures. 3 and 4). Band 3 is sometimes referred to as the chlorophyll band. It is used to monitor vegetation of an environment. Band 4 is used to monitor water bodies surface while band 5 monitors vegetation and soil mixture and differentiates between clouds and snow.

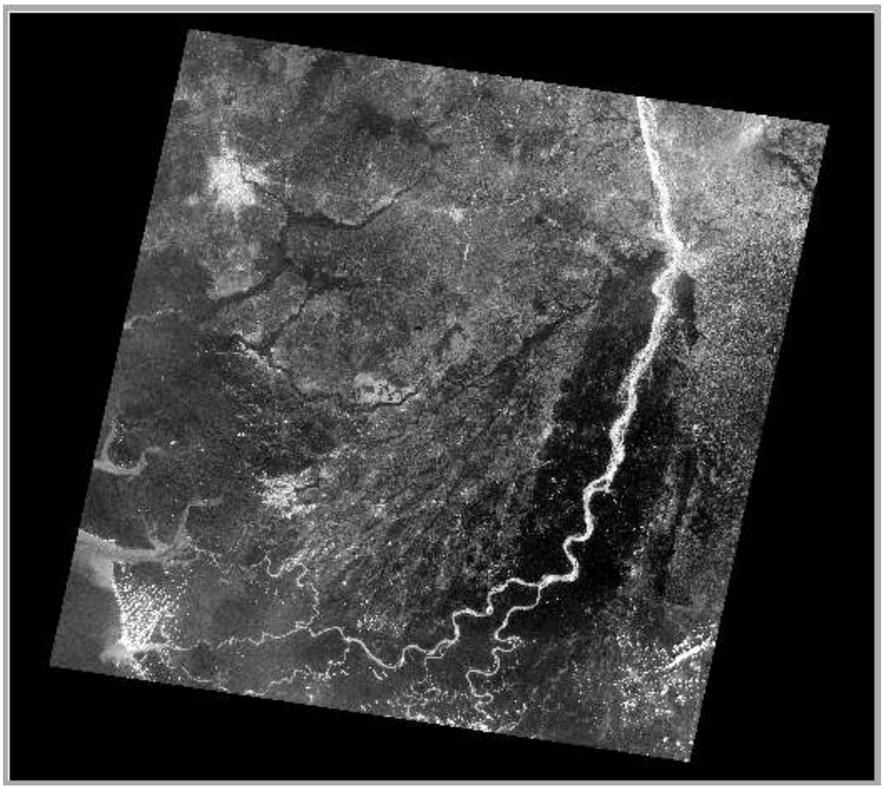


Figure 3: Band 3 map of LandSat TM Dec 21, 1987.

Source: United States National Aeronautical and Space Administration (NASA, 2012)

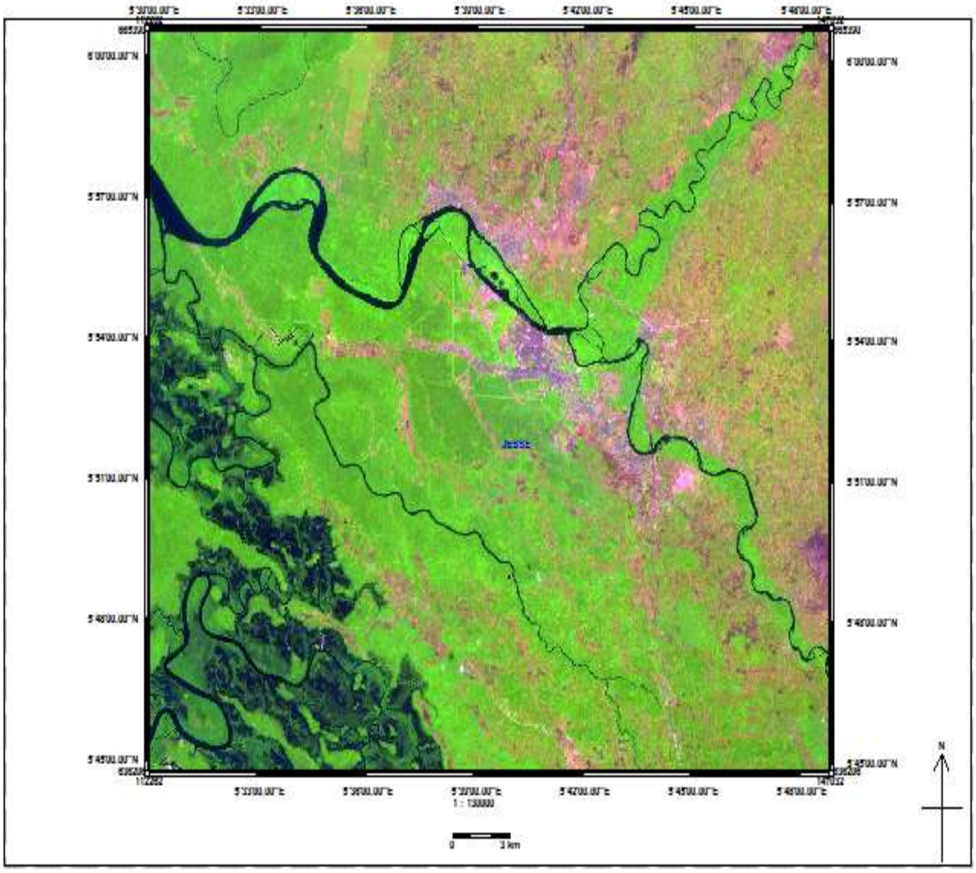


Figure 4: Composite band 3, 4, and 5 map of LandSat TM Dec 21, 2002.

Source: Authors, 2012

The next stage is the combination of the various bands to make a composite band. Bands 3, 4 and 5 for three consecutive years were employed in this study. The ground cover classes are; oil spill areas, water body and aquatic lives, gallery forest, light forest, dense forest, built up areas, and bare-land. The bands were then filtered to remove all known image noise using linear filters such as average 3 x 3 filters (see Figure 5).

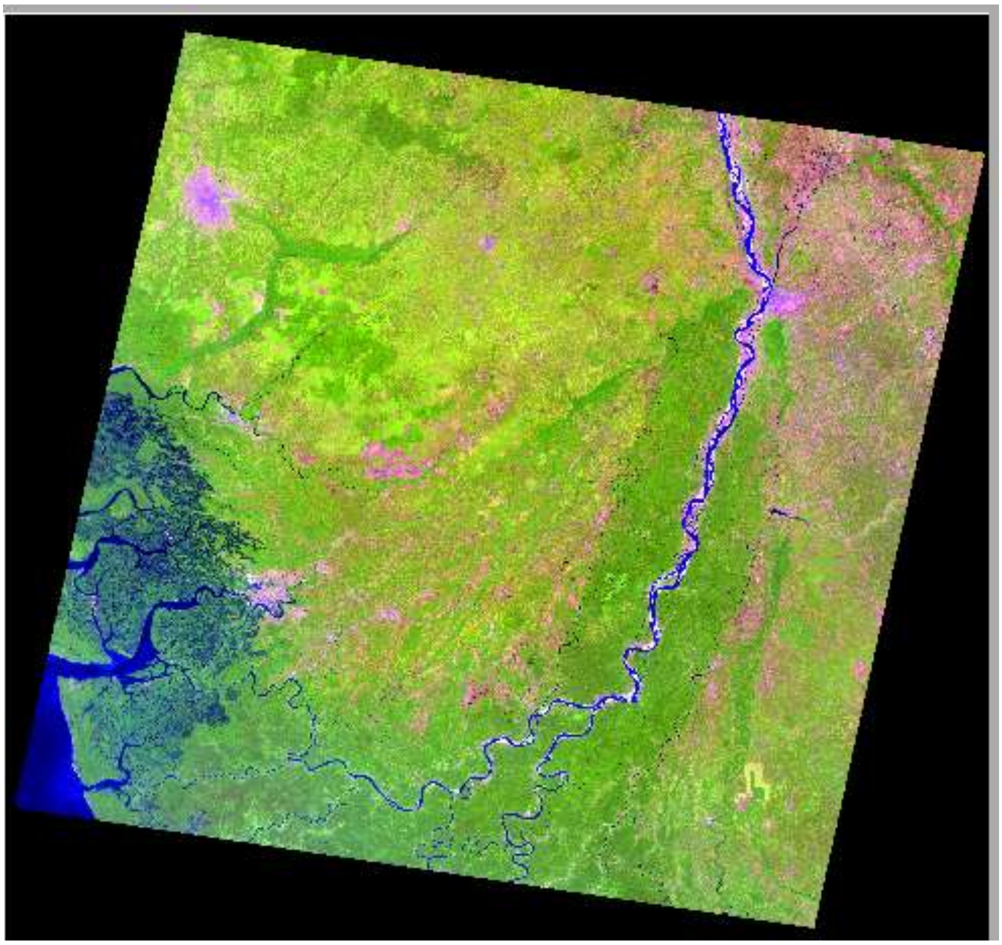


Figure 5: Filtered Band 3, 4 and 5 map of LandSat TM Dec 21, 1987.

Source: Authors, 2012

The next stage is the cutting out the study area from the LandSat image by using the coordinates derived from the topographical map. This step also entails creating a domain name for the image and entering the variables stated afore. The resultant map of the study area is referred to as the sub map, see figure 6.

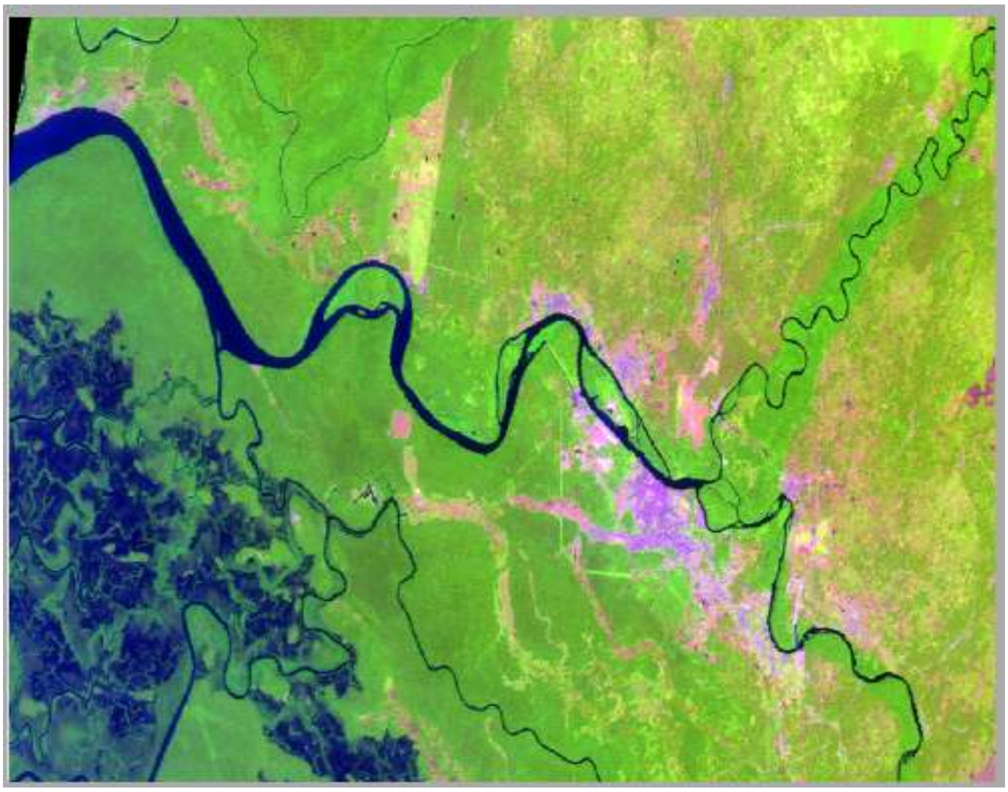


Figure 6: Sub-map of LandSat TM December 21, 1987 Showing Jesse (The study area)

Source: Authors, 2012

Finally, classification of the various ground covers was carried out. This is done to review the dynamics of the land use and land cover changes and also to know the area covered in each year. For the purpose of this paper, oil spill area was digitized for 1987, 2002 and 2007 respectively. Figures 7, 8 and 9 show the classified map of the study area for 1987, 2002 and 2007 respectively.

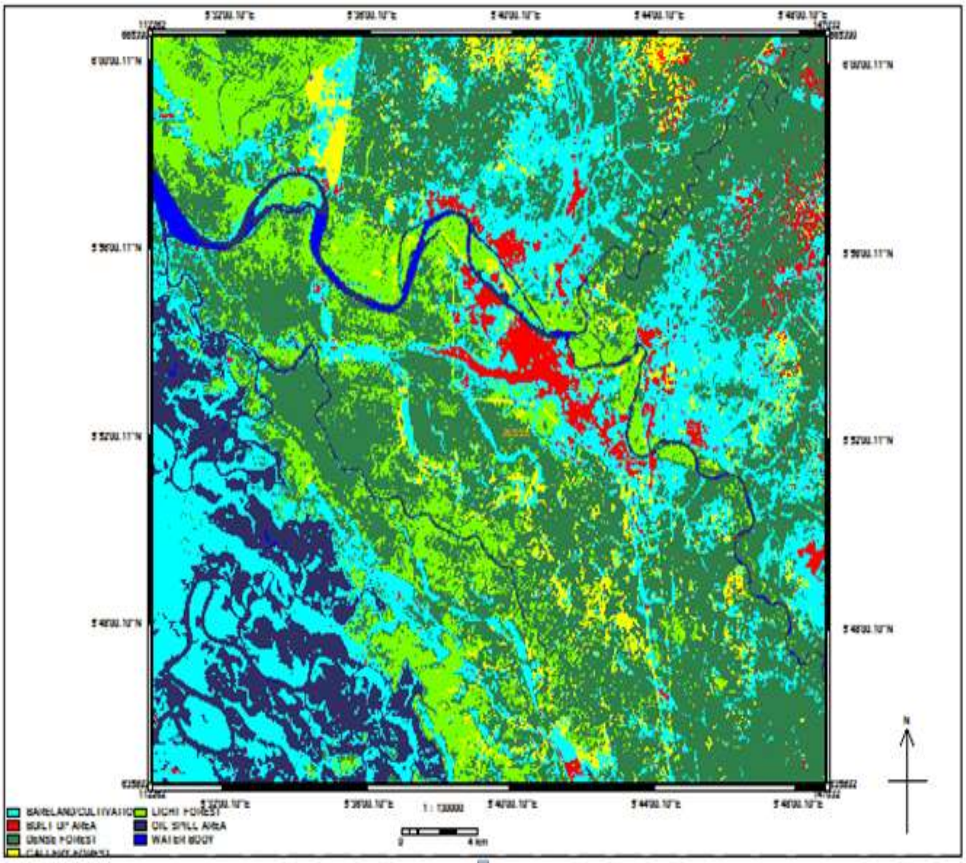


Figure 7: Classified Map of LandSat TM, December 21, 1987 Showing the Various Land Covers.

Source: Authors, 2012.

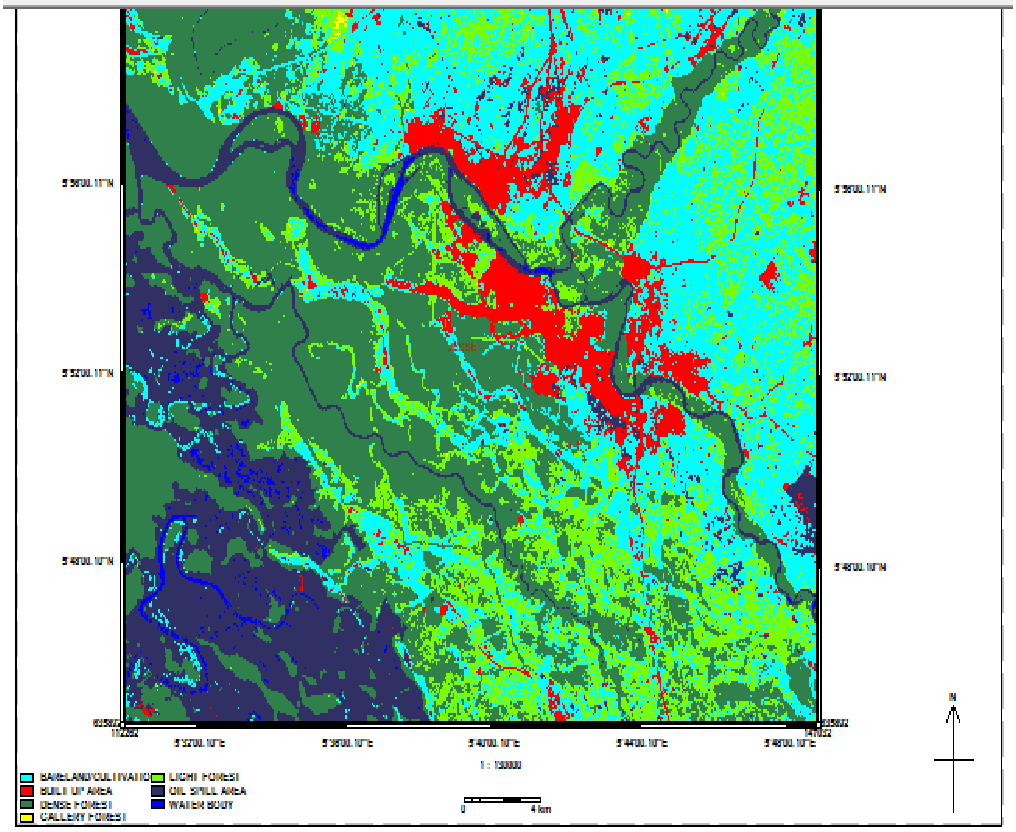
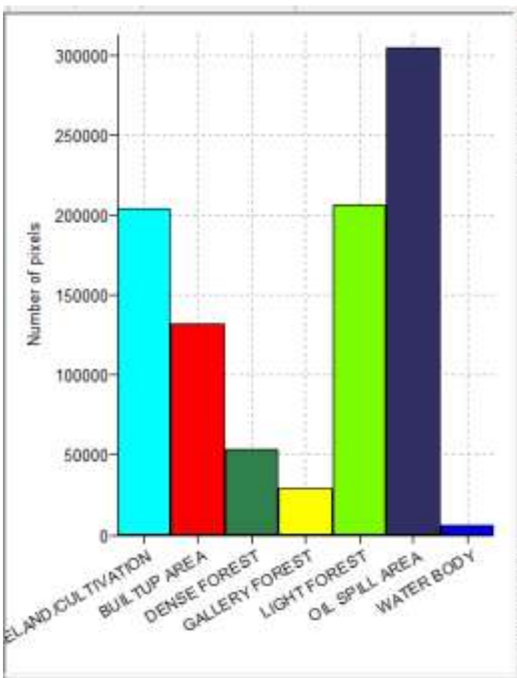


Figure 8: Classified Map of LandSat TM, December 21, 2002.
Source: Authors' Field Work, 2012.



	npix	npixpct	pctnotund	Area
BARELAND/CULTIVI	203974	17.89	21.78	183576600
BUILTUP AREA	131925	11.57	14.09	118732500
DENSE FOREST	53794	4.72	5.74	48414600
GALLERY FOREST	29247	2.56	3.12	26322300
LIGHT FOREST	206692	18.12	22.07	186022800
OIL SPILL AREA	305136	26.76	32.59	274622400
WATER BODY	5659	0.50	0.60	5093100
Min	5659	0.50	0.60	5093100
Max	305136	26.76	32.59	274622400
Avg	133775	11.73	14.28	120397757
StD	110566	9.70	11.81	99509762
Sum	936427	82.12	99.99	842784300

Pred=OIL SPILL AREA (305136)
Number of Undef pixels = 204029 (17.89%)

Figure 9: Histogram of Classified LandSat ETM, December 21, 2004.
Source: Authors, 2012.

The results from these maps and histogram are summarized in Table 2.

Table 2: Summary of Land Use/ Land Cover for Jesse in 1987, 2002 and 2004

Land Cover	Year					
	1987		2002		2004	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Bare land/ cultivation	27119.4	26.44	27912.0	27.21	18327.7	21.78
Built up Area	3666.1	3.75	6671.4	6.50	11873.3	14.09
Dense forest	43103.3	42.03	33997.9	33.15	4841.5	5.74
Gallery forest	4479.9	4.86	124.4	0.12	2632.2	3.12
Light forest	13017.4	12.69	17700.8	17.26	18602.3	22.07
Oil spill area	10065.6	9.81	15334.0	14.95	27462.2	32.59
Water bodies	611.1	0.60	822.3	0.80	509.3	0.60
Total	**102,062.2**	**100.**	**102,562.8**	**100.00**	**84,248.5**	**100.00**

Source: Fieldwork, 2012.

5 Findings and Discussion

The classified LandSat images for 1987 and 2002 are presented as Figures 7 and 8, while the histogram of the classified image for 2004 is shown in figure 9.

In figure 7, the red colour represents the built up area, midnight blue shows the oil spill area, the blue represents water body, and cyan represents bare land/ cultivation. Also, yellow represents gallery forests, lawn green shows the light forest and forest green represents the dense forest. As revealed in Table 2 in the year 1987, bare land covered an area of 27119.4 ha which is 26.2% of the total land area, built up area occupied 3666.1ha which is 3.5% of the study area. Also, dense forest covered an area of43103.4 ha constituting 42% of the forest reserve, light forest occupied 13017.4 ha constituting12.69% and the gallery forest has an area of 4979.9 ha which is 4.86% of the forest region. Furthermore, the classification revealed that oil spillage occupied an area of 10065.6 ha constituting 9.81%, water body covered an area of 611.1ha which constitutes 0.605% of the area.

In Figure 8 the red colour represents the built up area, midnight blue shows the oil spill area, the blue represents water body, and cyan represents bare land. Also, yellow represents gallery forests, lawn green shows the light forest and forest green represents the dense forest. As revealed in Table 2 in the year 2002, bare land covered an area of 2791.20 ha which is 27.21% of the total land area, built up area occupied 6671.4 ha which is 6.5% of the study area. Also, dense forest covered an area of 33997.9 ha constituting 33.15% of the forest reserve while light forest occupied 1770.08 ha accounting for 17.26% and the gallery forest has an area of 124.4 ha which is 0.12% of the forest region.

Furthermore, the classification revealed that oil spillage occupied an area of 15334.0 ha constituting 14.95%, water body covered an area of 822.3ha which constitutes 0.80% of the total land area (see Figure 9).

As revealed in Table 2 in the year 2004, bare land covered an area of 18357.7 ha which is 21.78% of the total land area, built up area occupied 11873.3ha which is 14.09% of the study area. Also, dense forest covered an area of 4841.5 ha constituting 5.74% of the forest reserve, light forest occupied 18602.3 ha constituting 22.07% and the gallery forest has an area of 2632.2 ha which is 3.12% of the forest region. Furthermore, the classification revealed that oil spillage occupied an area of 27462.2 ha constituting 32.59%, water body covered an area of 509.3ha which constitutes 0.60% of the area.

Figures 7, 8 and 9 show that the area affected by oil spillage in 1987, 2002 and 2004 are 10065.6 ha, which is 9.81% of the study area; 15334.0 ha which is 14.95% of the area, and 272462.2 ha which is 32.59% of the study area respectively. It is therefore evident that oil spillage has been spreading to larger area from 1987 to 2004. The spread is shown by an increase of 5.14% from 1987 to 2002 and 17.64% from 2002 to 2004 indicating a total spread of 22.78% from 1987 to 2004. The built-up area covered 3666.1ha that occupied 3.57% of the study area in1987; 6671.4 ha which also constitute 6.50% of the land area in 2002; and 11873.3 ha, 14.09% in 2004. There is a general expansion of the built up area from 1987 to 2004. An expansion of 2.93% was observed between 1987 and 2002, and 8.4% from 2002 to 2004 indicating a total expansion of 11.33% from 1987 to 2004.

In the study area, there has been a general decrease in the dense forest region (Table 2). In 1987, dense forest covered 43103.4 ha constituting 42% of the forest reserve. By 2002 and 2004 dense forest had shrank to 33997.9 ha about 33.1% of forest reserve and 4841.5 ha which is 5.74% of forest reserve. The enormous decrease in dense forest reserve cannot entirely be ascribed to oil spillage. It probably could be as a result of deforestation for the purpose of energy generation and wood production.

The light forest experienced increase as a result of the logging activities on the dense forest. In 1987 it occupies an area of 13017.4 ha covering 12.69% of the forest reserve and increased to 17700.8 ha 17.26%) in 2002 with a higher increment of 18602.3 ha (22.07%) in the 2004. There was also a noticeable change in the gallery forest with 4979.9 ha (4.86%) in 1987, 124.4 ha (0.12%) in 2002 which later increased to 2632.2 ha (3.12%) in 2004.

Water bodies are well discernible in 1987 with an area of 611.1 ha occupying about 0.605% of the study area, to an increment of 822.3 ha which is 0.80% of the town due to exposure of some vegetations cover and probably high rainfall for that year but later decreased to 509.3 ha constituting 0.60% of the area due to spillage occurrence in the land channelled to the tributaries through surface run off then into the large sea.

As revealed in figures 7,8 and 9, the bare land/ cultivation as a result of farming activities, encroachment and deforestation, light forest vegetation has also increased from 14953.40 hectares which constitutes 15.25% of the area in 1972 to17741.30 ha that covers 17.98% of the study area in 1986 and further increased to 37277.20 ha covering about 37.78% in 2002.

6 Recommendations

Multinational oil companies operating in the Niger Delta must immediately cease all harmful and wasteful practices, and engage in immediate clean-up of affected areas. They must compensate communities for the resources lost as a consequence of oil exploration and production activities, as well as for any other social and economic damages.

The Nigeria Sat-1 would help in monitoring oil spill by providing the spill position which would serve as input data into the oil spill model. It would also give the extent of coastal water and coastal areas polluted. These information are vital for quick clean up of oil impacted areas. In order to reduce the response time and qualify the decision-making process, application of Geographic Information Systems (GIS) as an operational tool has been suggested. Information on the exact position and size of the oil spill can be plotted on maps in GIS and a priority of the combat efforts and means according to the identified coastal sensitive areas can be carried out.

The creation of Regional Spill Response Centres along coastlines would help in managing oil spill problems. The centres will use oil spill models for combating oil spill problems. Data collected with an airborne system could serve as inputs in the model. The petroleum industry should work closely with government agencies, universities and research centers to combat the menace of oil spill incidents in the study area.

7 Conclusion

The impact of oil spill on the degradation of the environment of the Niger Delta region of Nigeria has raised questions of great concern to stakeholders, particularly oil producing communities who have suffered polluted air, water resources, degraded forests and farm lands, and very high atmospheric temperatures all over the years.

The study revealed that oil spill has a negative and statistically significant impact on crop yield, health of the dwellers, land productivity and farm income in a manner consistent with economic expectation. Therefore, in order to halt the continual degradation of the Niger Delta environment, the Federal Government must play a leading role by enacting and enforcing stringent environmental laws that will protect the oil producing areas, as well as guarantee the people a better livelihood. Deliberate intervention policies must be implemented speedily to embark on massive infrastructural development of the region, as well as address the crushing level of poverty among the peoples of the Niger Delta especially Jesse community.

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