

Hydrocarbon Oil Spill Cleanup and Remediation in the Niger Delta

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

The paper examines hydrocarbon oil spill Cleanup and Remediation from four perspectives namely historical, regulatory, scientific, and socioeconomic considerations. The historical perspectives show a gap of 12 years between oil production and environmental policies that would guide and enforce Cleanup and Remediation. Historically, official records indicate between 3000-5000 major spillage sites from over 9000 spills, with many undocumented ones waiting to be detected. The Regulatory aspects are evaluated at marginal performance with respect to Cleanup and Remediation. The lack of any publicly accessible documented evidence of Cleanup and Remediation certificates for any site indicates failure in the enforcement of regulatory best practices despite the expectations from the reforms in developing a separate institution such as NOSDRA. This is supported strongly by the inaction to start cleanup of the Ogoni sites nearly four years since the UNEP report was concluded. The Science of Cleanup and Remediation is shown not to have kept pace with the rate at which contaminated sites are being generated. Only in less than 0.2% of sites (10 sites out of over 5000 sites) are records of attempts at Cleanup and Remediation. Many of the scientific best practices have never been tested in the different ecosystems and habitat types including groundwater. This could have driven innovation in the discovery of new technologies that would make remediation indigenous and cost effective especially as Nigeria ranks as the inland polluted capital of the world. The socioeconomic aspects are analyzed as a complex interplay of

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interest between the local population, NGOs, the IOCs and the government agencies responsible for Cleanup and Remediation. A strong arbitration component is suggested where reforms in policy should include enforceable incentives and penalties designed into existing and new commercial transactions.

Keywords: Oil spill; cleanup; remediation; Niger Delta.

1. BACKGROUND

Oil Spill Cleanup and Remediation, like most environmental issues in the Niger Delta have many dimensions which include Historical, Regulatory, Scientific, Socioeconomic and Political considerations. The complications arise from many questions that form the debate of any spill. Typical questions such as Who should pay for the cleanup; How should the spill be cleaned up; Should the least expensive clean-up option be used; or the method that works the best — no matter the cost?

The subject and activity of Cleanup and Remediation when viewed from a historical perspective shows clearly a practice that came into effect as a result of regulatory enforcement and not as that of good corporate behavior by the spill agents. In Nigeria oil exploration and production which provided the platform for spills has been on-going since the first commercial oil discovery in the Tertiary delta was confirmed at Oloibiri field in January 1956 by Shell D'Arcy (later Shell–British Petroleum) and a second oil field later discovered at Afam.

Shell British Petroleum (now Royal Dutch Shell) in February 1958, started exporting crude oil produced from Oloibiri and Afam oil fields at Port Harcourt. Further discoveries such as in the southeast of Port Harcourt, Rivers State in 1958 was the giant Bomu oil field, which had been estimated to have an ultimate recovery (EUR) of 0.311 billion of barrels (BB) of oil and a total of 0.608 billion of barrels of oil equivalent (BBOE) including gas. Between 1958 and 1970 many multinational oil companies joined oil and gas exploration in Nigeria and these included Texaco Overseas, Nigeria Petroleum Company Unlimited in 1961, Amoseas in 1961, Gulf Oil Company in 1961 (now Chevron), Société Africaine des Pétroles (SAFRAP) in 1962 (which later became Elf Nigeria Limited in 1974), Tennessee Nigeria Limited (Tenneco) in 1962, Azienda Generale Italiana Petroli (AGIP) in 1962, ENI in 1964, Philips Oil Company in 1964 and Pan Ocean Oil Corporation in 1972. Most of these multinational oil companies recorded considerable successes

in oil and gas exploration and production in both onshore and offshore fields in the Niger Delta.

It was not until 1970, twelve years after, that Nigeria created the Department of Petroleum Resources (DPR) Inspectorate to take control of the country's petroleum industry. Between 1958 and 1970, no documented spill register existed, neither were there any records of the observance of cleanup activity or attempt at remediation activity. Therefore this paper is based on many secondary sources that derive from authenticated information from regulatory agencies such as DPR and National oil Spill Detection and Response Agency (NOSDRA) whose efforts since 1970 have provided some information on the many aspects of Hydrocarbon Spill Cleanup and Remediation.

2. GENESIS OF CLEANUP AND REMEDIATION

The contextual framework to examine this topic derives from the extent of the volume of spills and the number of sites qualified for Cleanup and Remediation. By current accounts as documented in Adati Ayuba [1], the first oil spill in Nigeria was at Araromi in the present Ondo state in 1908 [2]. In July 1979 the Forcados tank 6 Terminal in Delta state incident spilled 570,000 barrels of oil into the Forcados estuary polluting the aquatic environment and surrounding swamp forest [3,2].

The Funiwa No.5 Well in Funiwa Field blew out an estimated 421,000 barrels of oil into the ocean from January 17th to January 30th 1980 when the oil flow ceased [3,4,2], 836 acres of mangrove forest within six miles off the shore was destroyed. The Oyakama oil spillage of 10th may 1980 with a spill of approximately 30,000 barrels [3]. In August 1983 Oshika village in Rivers State witnessed a spill of 5,000 barrels of oil from Ebocha-Brass (Ogada-Brass 24) pipeline which flooded the lake and swamp forest. The area had previously experienced an oil spill of smaller quantity; 500 barrels in September 1979 with mortality in crab, fish and shrimp. Eight months after the occurrence of the spill there was

high mortality in embryonic shrimp and reduced reproduction due to oil in the lake sediments [4]. The Ogada-Brass pipeline oil spillage near Etiama Nembe in February 1995 spilled approximately 24,000 barrels of oil which spread over freshwater swamp forest and into the brackish water mangrove swamp. The Shell Petroleum Development Company (SPDC) since 1989 recorded an average of 221 spills per year in its operational area involving 7,350 barrels annually [5]. From 1976-1996 a total of 4,647 oil spill incidences spilling approximately 2,369,470 barrels of oil into the environment of which 1,820,410.5 (77%) were not recovered. Most of these oil spill incidences in the Niger Delta occur on land, swamp and the offshore environment [6, 7, 8, 9, 10]. NNPC estimates 2,300 cubic meters of oil has spilled in 300 separate incidences annually between 1976-1996 [9]. The Punch Newspaper on February 20, 1991 reported a total of 2,796 oil spill incidences recorded between the periods of 1976-1990 leading to 2,105,393 barrels of oil spilled.

The UNDP [11] also reported that between the periods of 1976-2001, three (3) million barrels of oil were lost in 6,817 oil spill incidences of which over 70% of the spilled oil were not recovered. In 2001 the western operations of the Shell

Petroleum Development Company (SPDC) recorded a total of 115 incidences of oil spill in which 5,187.14 barrels of oil were spilled and 734,053 barrels of the spilled oil representing 14.2% were recovered [5]. In January 1998, 40,000 barrels of crude oil was spilled by Mobil in Eket but the largest spill in Nigeria was the offshore well blowout in January 1980 with a spill of approximately 200,000 barrels of oil into the Atlantic Ocean from an oil facility which damaged 340 hectares of mangrove forest [7].

The charts (Figs. 1-20) below show the progression in number of sites requiring Cleanup and Remediation from the NOSRDA portal [12]. The data show progression of sites for Cleanup and Remediation increasing from 2006 to 2013 on a national scale. In the Niger Delta, few sites were identified in only two states of Delta and Bayelsa. From 2007 -2011 more sites were located in more states such as Delta, Bayelsa, Rivers Imo and Akwa-Ibom. Increased sites for Cleanup and Remediation were recorded from 2012 to 2015 to include Edo and Abia states among the others earlier mentioned. Altogether no sites were listed for Cross River and Ondo states. The NOSDRA portal however show absence of information on cleanup or remediation of the 5874 sites listed in the portal.

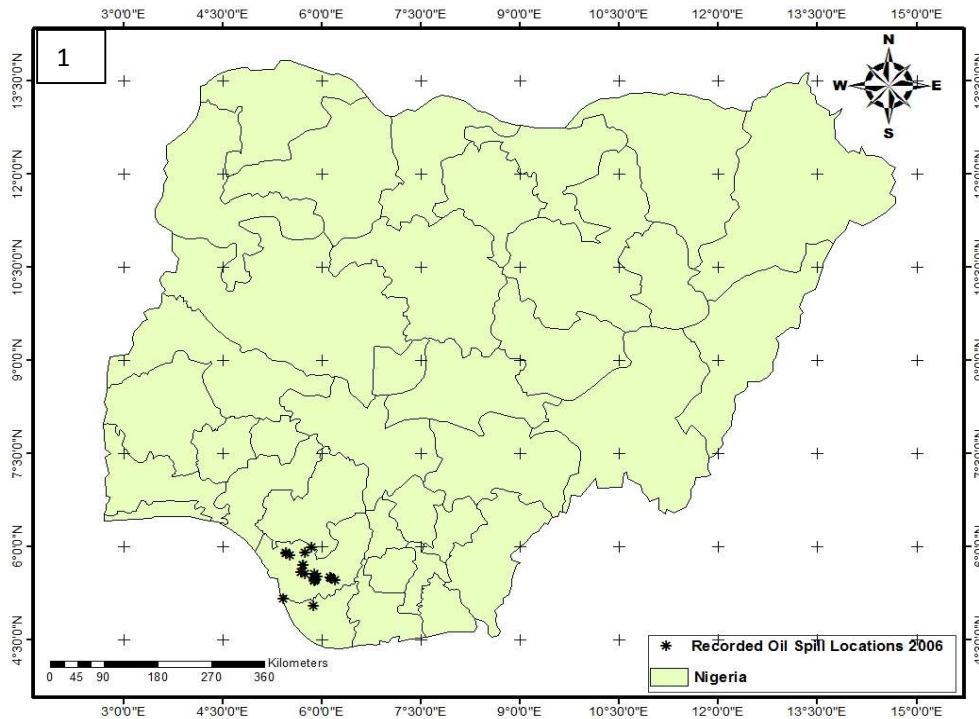
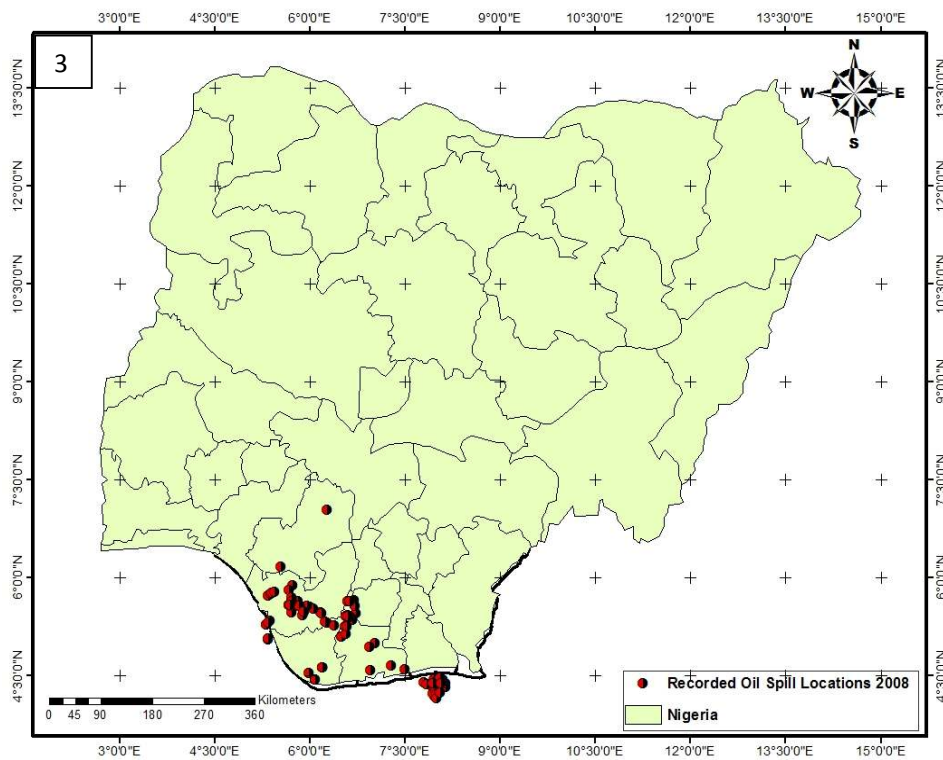
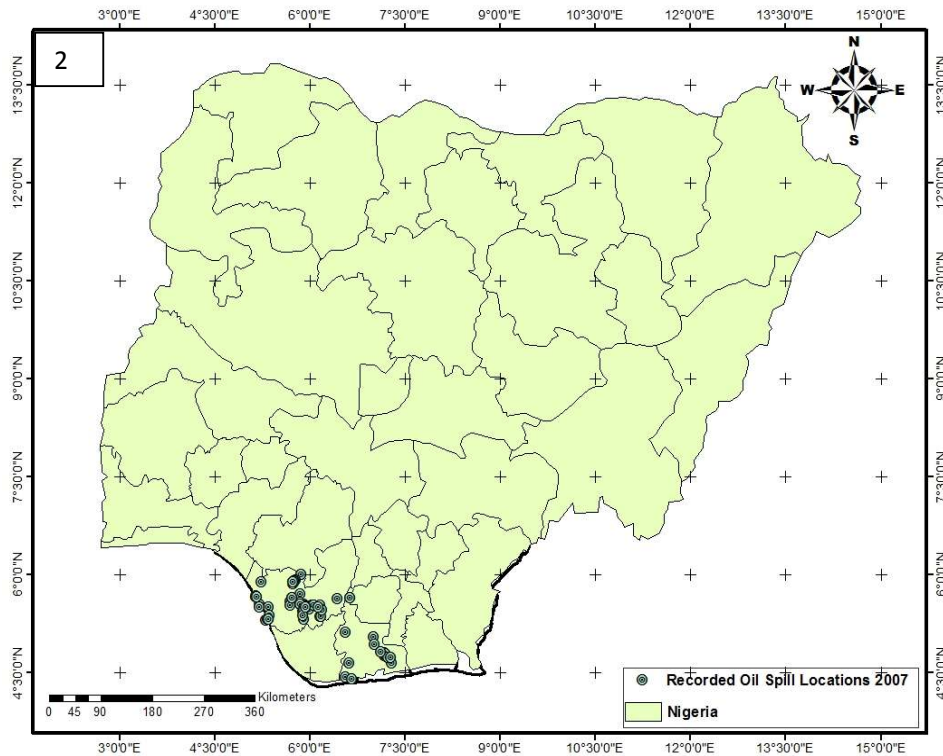
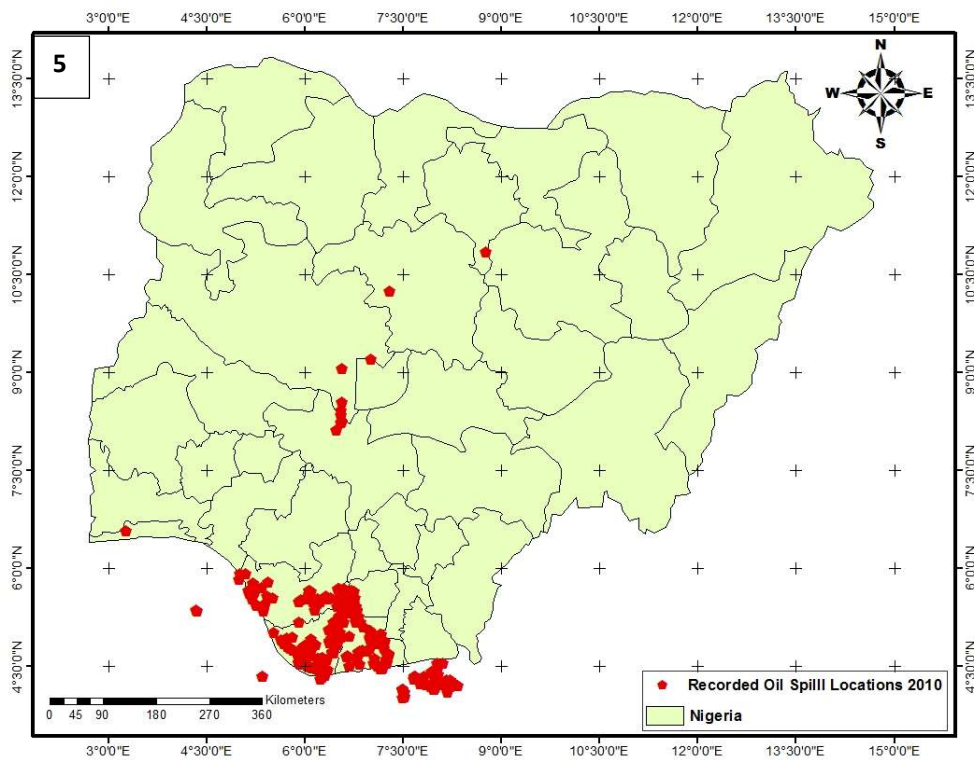
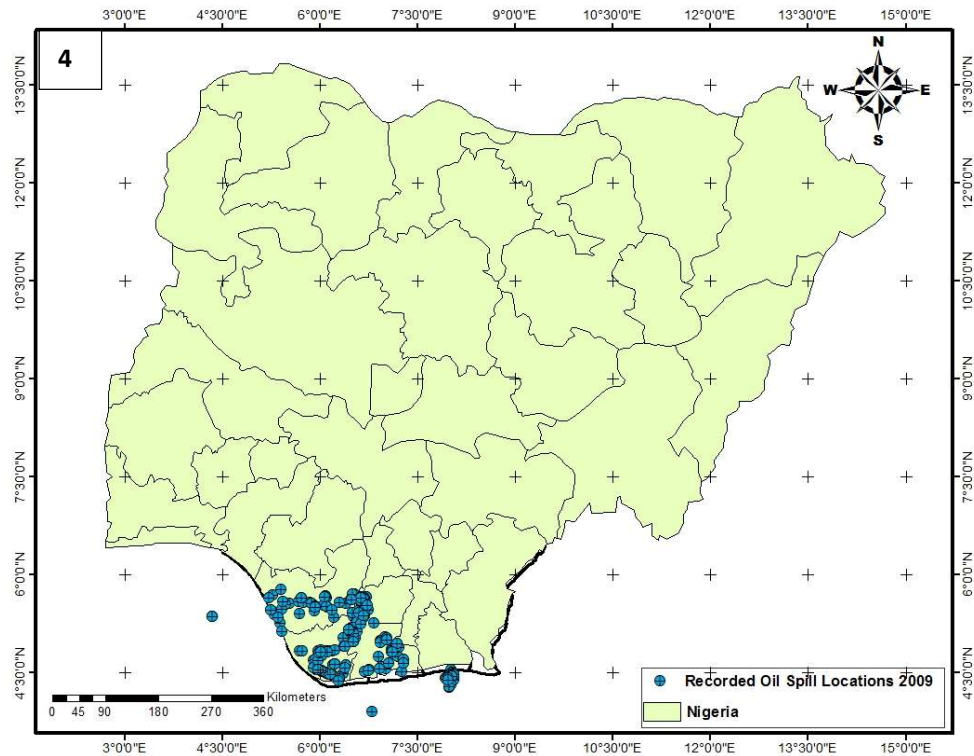


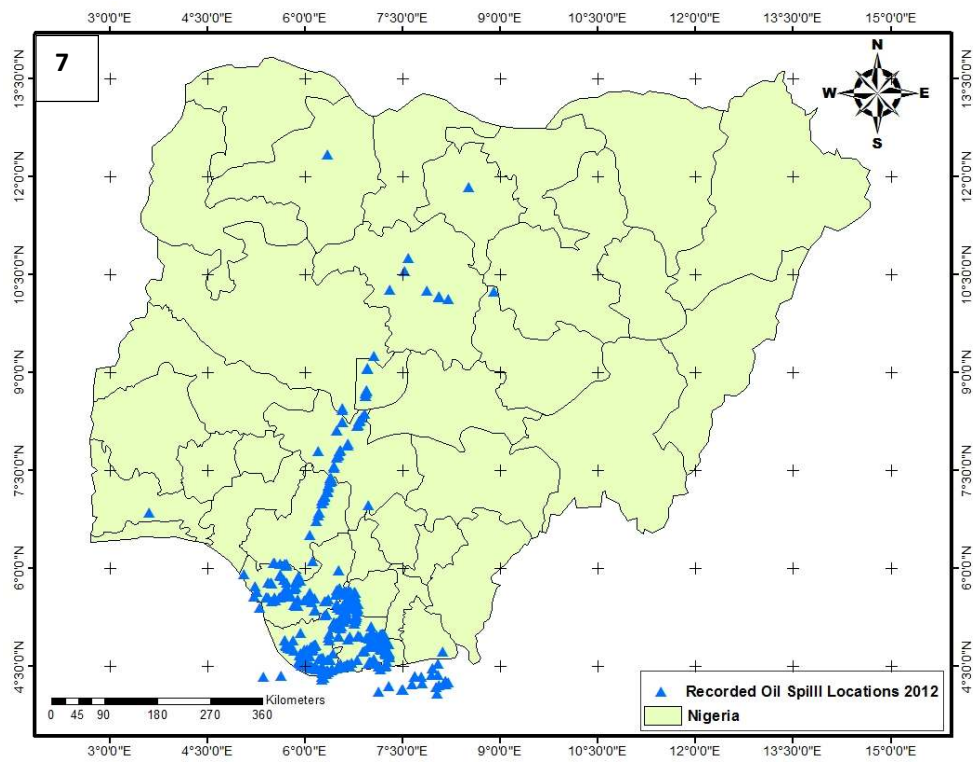
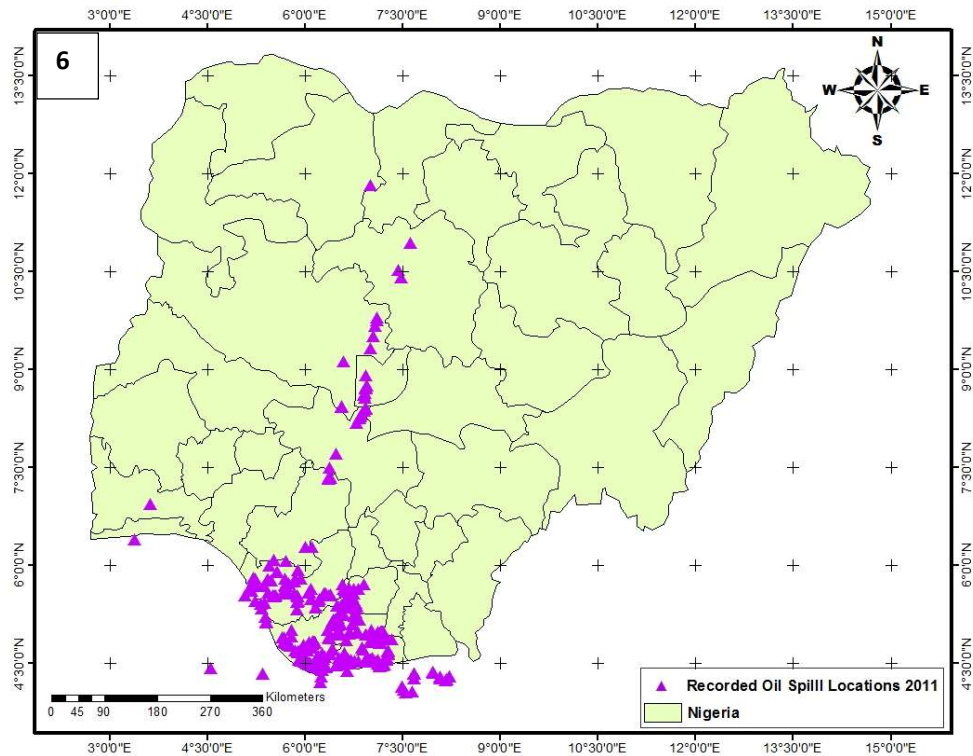
Fig. 1. Oil spill sites in Nigeria in 2006
(Source: Oil spill monitor – NOSDRA)



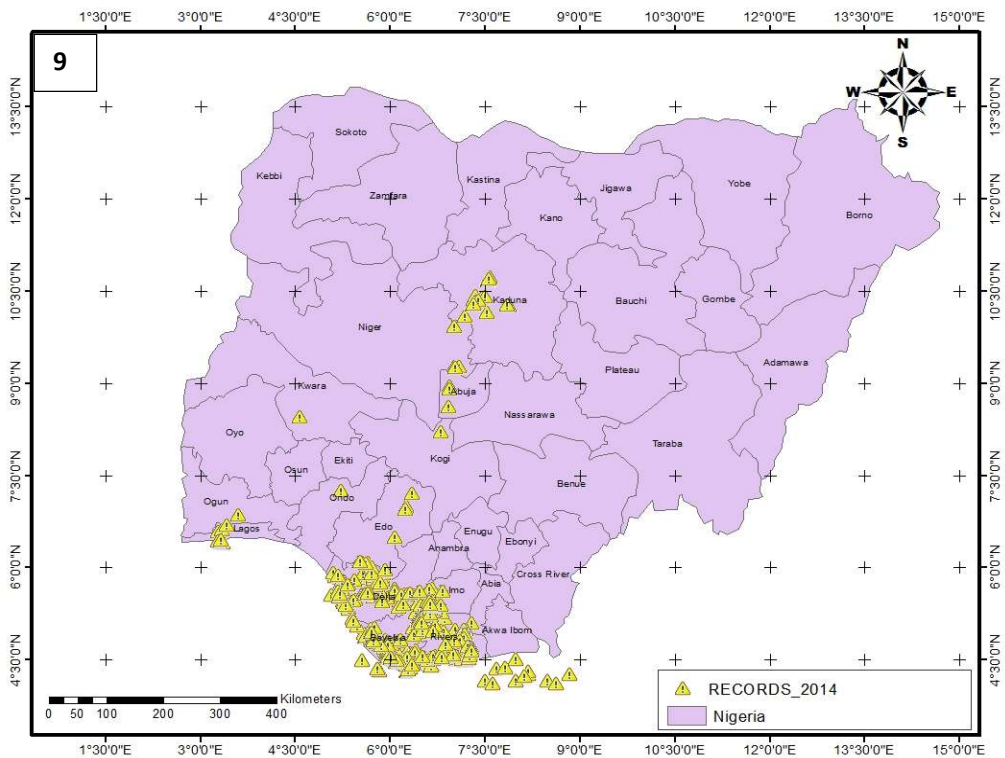
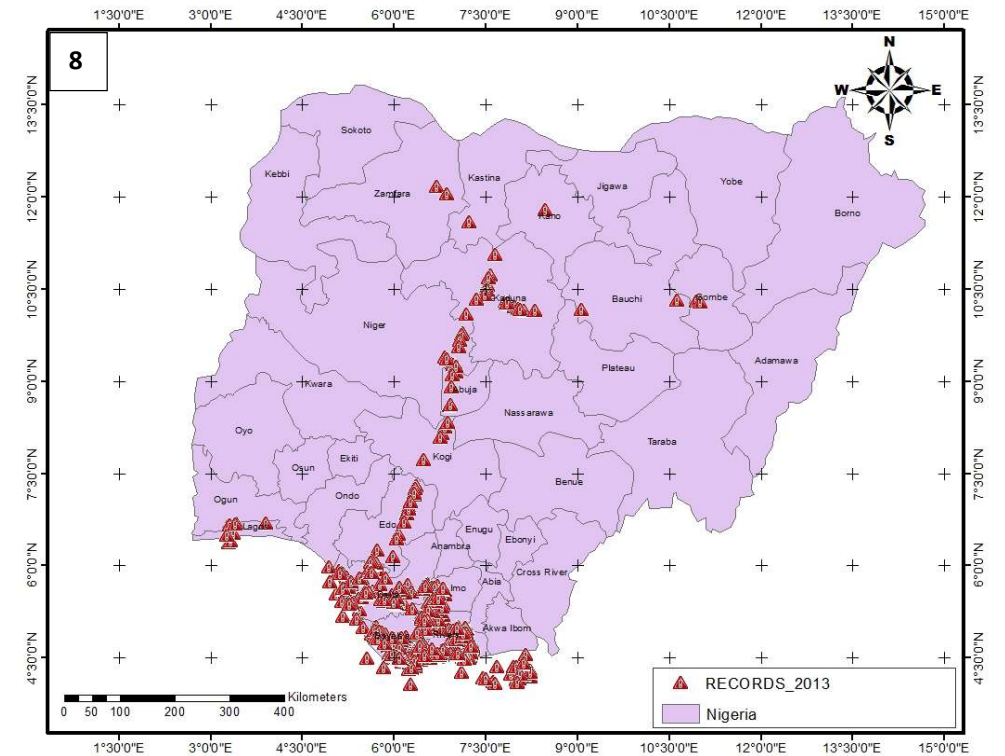
Figs. 2-3. Oil spill sites in Nigeria from 2007 -2008
(Source: Oil spill monitor – NOSDRA)



Figs. 4-5. Oil spill sites in Nigeria from 2009 -2010
(Source: Oil spill monitor – NOSDRA)



Figs. 6-7. Oil spill sites in Nigeria from 2011 -2012
(Source: Oil spill monitor – NOSDRA)



Figs. 8-9. Oil spill sites in Nigeria from 2013 -2014
(Source: Oil spill monitor – NOSDRA)

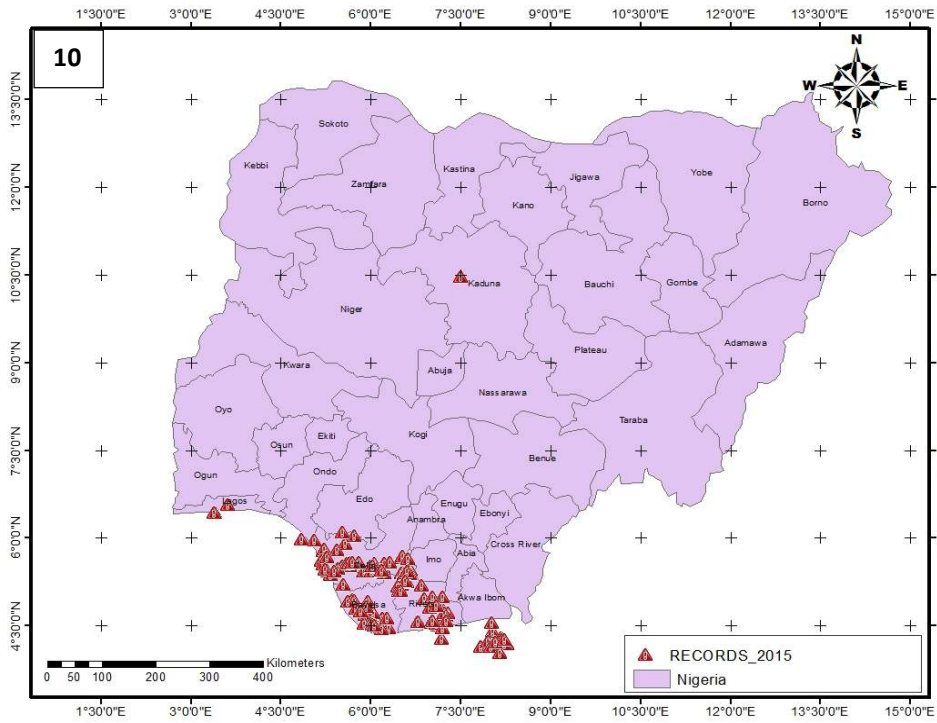


Fig. 10. Oil spill sites in Nigeria in 2015
(Source: Oil spill monitor – NOSDRA)

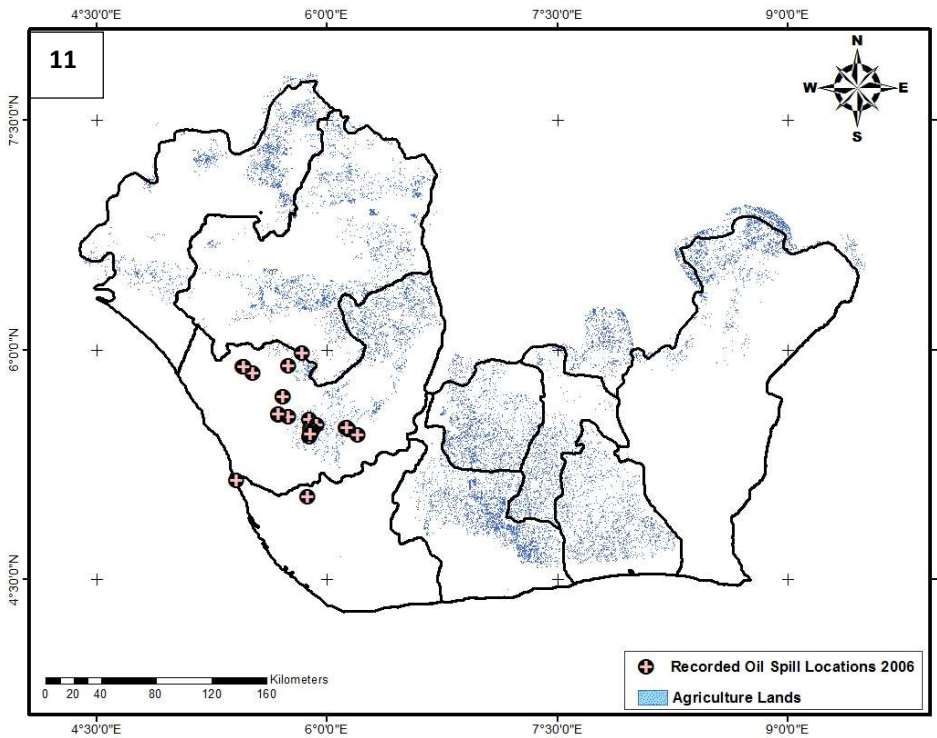
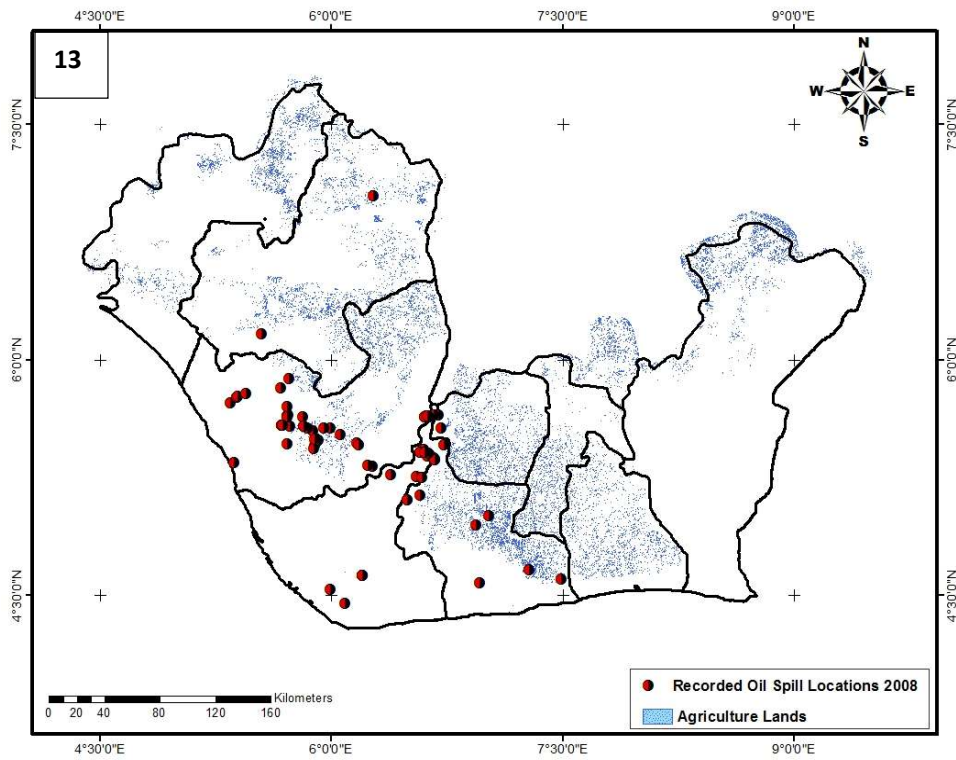
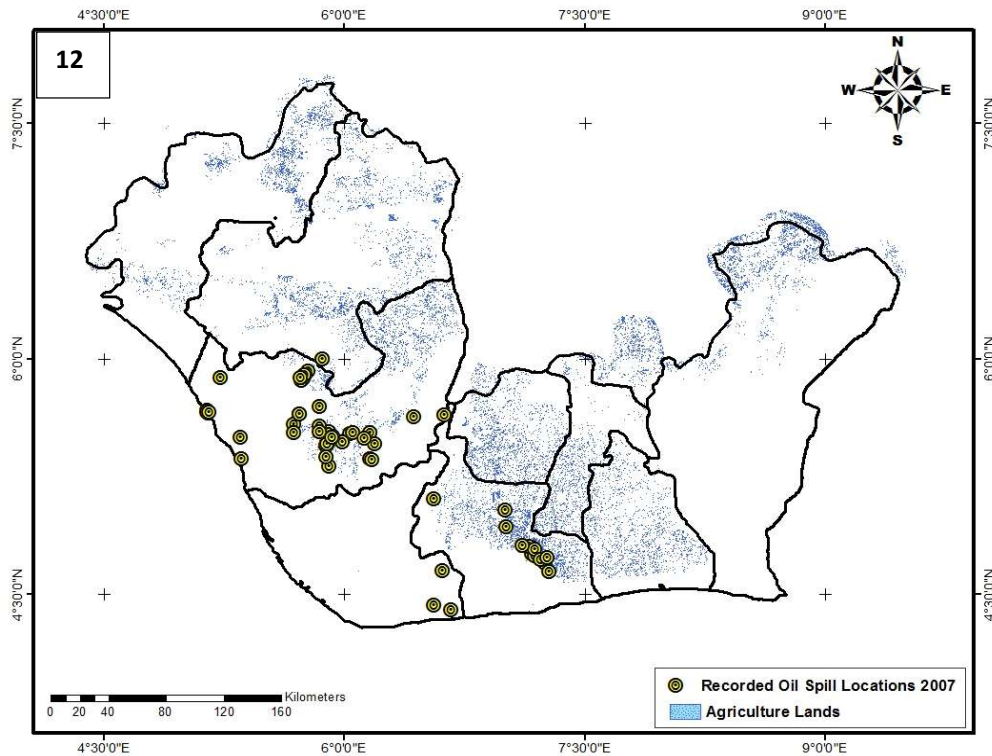
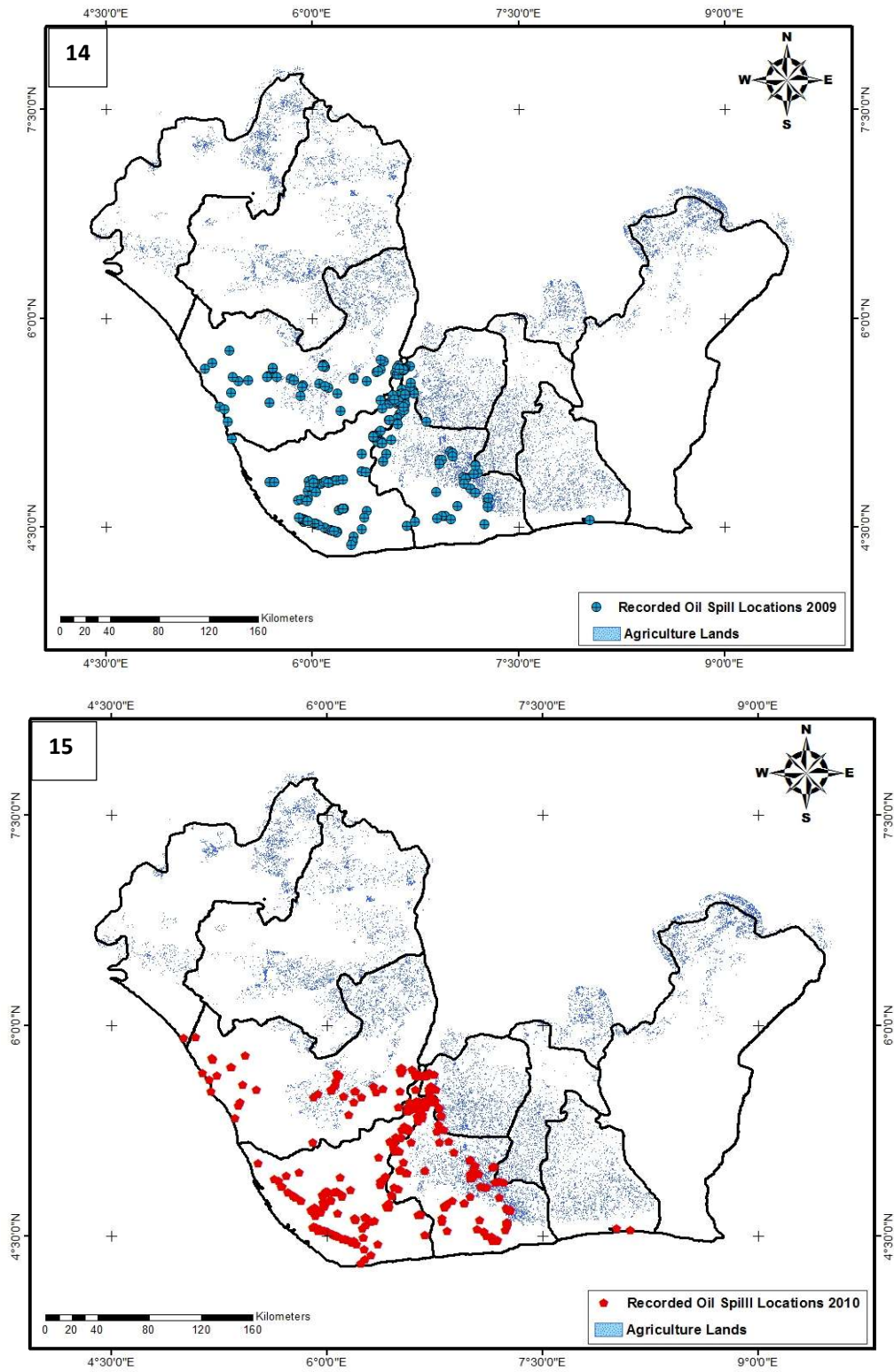


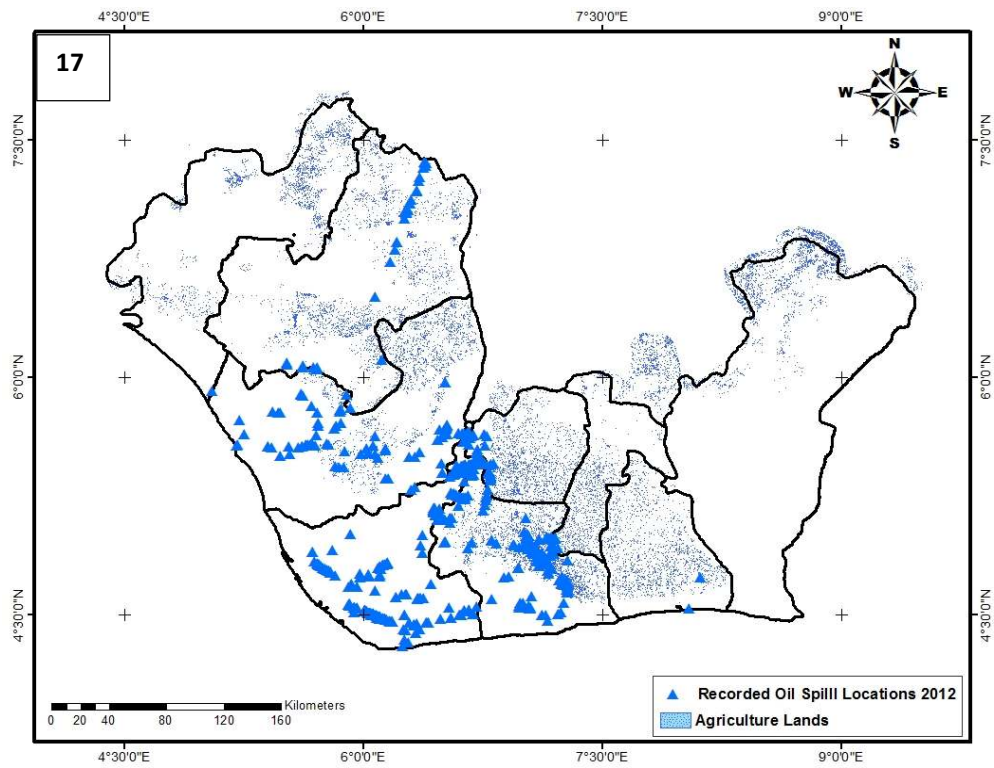
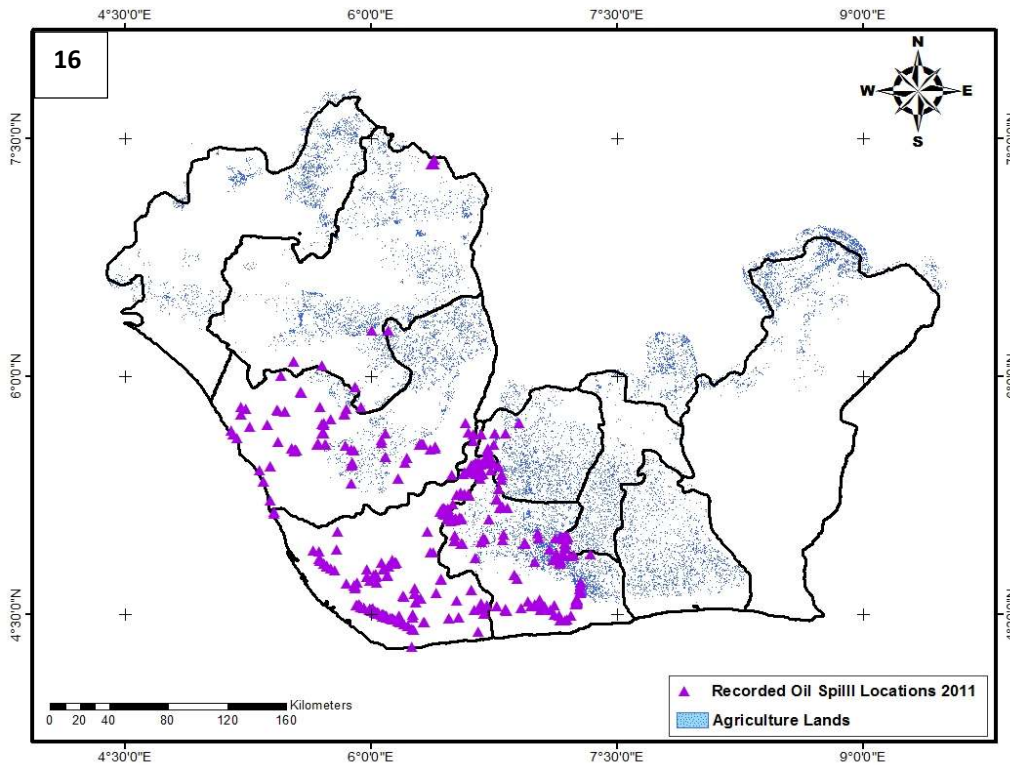
Fig. 11. Oil spill sites in Niger Delta in 2006
(Source: Oil spill monitor – NOSDRA)



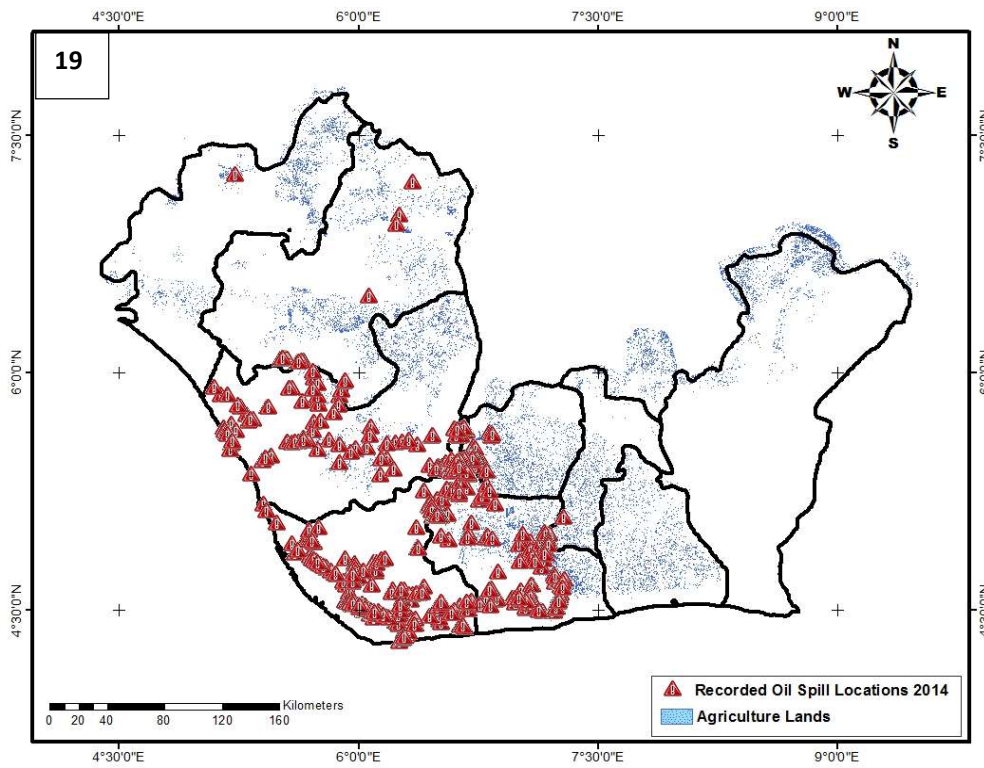
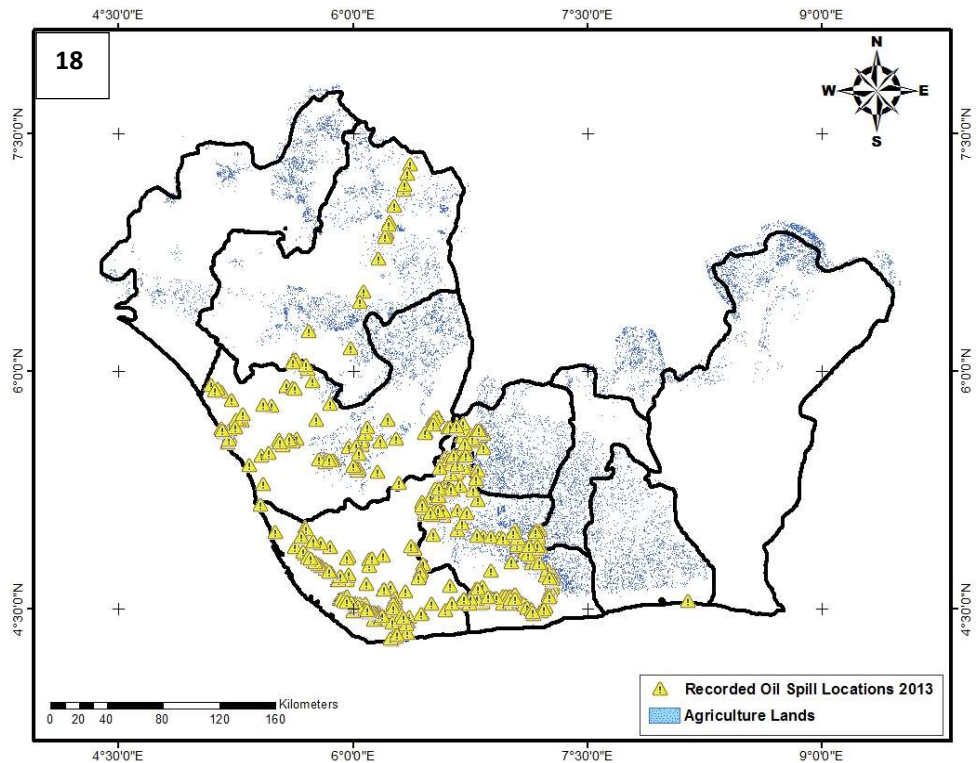
Figs. 12-13. Oil spill sites in Niger Delta States from 2007 to 2008
(Source: Oil spill monitor – NOSDRA)



Figs. 14-15. Oil spill sites in Niger Delta States from 2009 to 2010
(Source: Oil spill monitor – NOSDRA)



Figs. 16-17. Oil spill sites in Niger Delta States from 2011 to 2012
(Source: Oil spill monitor – NOSDRA)



Figs. 18-19. Oil spill sites in Niger Delta States from 2013 to 2014
(Source: Oil spill monitor – NOSDRA)

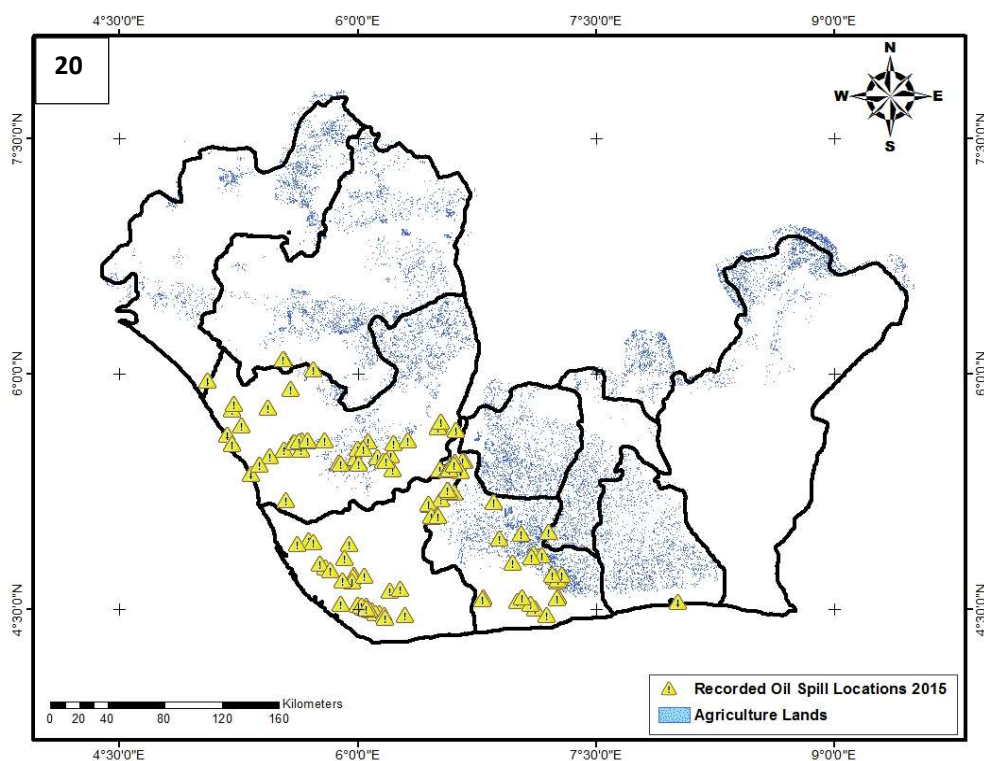


Fig. 20. Oil spill sites in Niger Delta States in 2015
(Source: Oil spill monitor – NOSDRA)

3. REGULATORY ASPECTS

The oil industry is subject to a number of specific federal laws in Nigeria, including the Oil Pipelines Act [13], the Petroleum (drilling and production) Regulations [14], and the Petroleum Act [15]. There are several additional regulations, such as EGASPIN [16], issued by the DPR. The DPR supervises all petroleum industry operations while NOSDRA is responsible for compliance with environmental legislation in the petroleum sector. The duty of NOSDRA is to “undertake surveillance, reporting, alerting and other response activities as they relate to oil spillages”. The agency is supposed to ensure that Nigeria’s national oil spill contingency plan is implemented in line with the International Convention on Oil Pollution preparedness, Response and Co-operation. When a major oil spill occurs, NOSDRA should assess the damage to the environment and undertake a post-spill impact assessment. It should also advise the authorities on possible health impacts to ensure remediation and help to mediate between the affected community and the company.

EGASPIN is very specific about oil companies’ obligations. It requires them to inspect pipelines

monthly to prevent equipment failure. They must take practical precautions to prevent pollution and prepare an oil spill contingency plan. This should include the operator’s policy on pollution, prevention and management. The aims of the contingency plan include protecting the environment, ensuring all measures are in place for containing and cleaning up spills, and that accurate information is made available to the public and the authorities. After a spill occurs, oil companies must commence clean-up within 24 hours of a spill occurring and ensure no additional damage is caused and keep a daily log of events until the clean-up is concluded. They are expected to apply to carry out remediation of contaminated sites.

The considerable limitations to these regulations lie in the fact that in the Niger Delta, oil companies frequently take the lead in the process, rather than the regulators. The Nigerian environmental regulatory agencies have no independent means to initiate oil spill investigations. They are usually dependent on the company to take regulators to the site and to supply much of the data about cleanup of spills. The dominant role of the companies in the Clean up and Remediation process creates a

worrying conflict of interest. Effectively, the company as the potentially liable party has substantial control over a process that sets many of the parameters for compliance. This substantial control is also not countered by the very low financial penalties that can initiate meaningful sanction or deterrent. Nigerian law and regulations allow the authorities to apply specific measures to ensure that oil companies comply with regulations, including by imposing penalties. The fine for failing to report an oil spill to NOSDRA is 500,000 Naira (US\$2,350) “for each day of failure to report the occurrence”. The fine for failing to clean up an affected site “to all practical extent, including remediation”, incurs a fine of 1 million Naira (US\$4,700).

The lack of strong regulatory enforcement perhaps lies in the fact that the promotion of maximization of revenue by increasing production is causing a conflict of interest with the requirement to ensure environmental compliance. For instance EGASPIN stipulates that “any person, body corporate or operator of a vessel or facility, who persistently violates the provisions of the guidelines and standards, shall have his lease, license and/or permit revoked. This provision has not been enforced on any oil company to date despite the large number of sites that have not been given a clean bill of health either for cleanup or remediation. Evidence from the UNEP report [17] shows lengthy delays in addressing oil spills in Ogoni land in terms of Cleanup and Remediation. It exposed serious and systemic problems with the clean-up processes as post-oil spill clean-up of contamination did not achieve environmental standards according with Nigerian legislation. Neither was the primary method of oil remediation on affected sites, proven to be effective as they failed to achieve either clean-up or legislative compliance. The report further demonstrated that in ten out of fifteen investigated sites which records showed as having completed remediation, still have pollution exceeding the government remediation closure values while in eight of these sites the contamination had migrated to ground water.

In general the development of environmental standards through legislation has been quite slow and has brought some marginal progress but has not succeeded in improving significantly practices in Cleanup and Remediation of hydrocarbon contaminated sites. The situation is changing with the setting up of NOSDRA whose effectiveness can be significantly improved if

there is an adoption of a coherent philosophy on jurisdiction, administration and enforcement policies and regulatory instruments regarding Cleanup and Remediation of hydrocarbon contaminated sites.

4. SCIENTIFIC ASPECTS

The science of hydrocarbon Cleanup and Remediation is well documented. However the applications of the scientific principles that are guided by international best practices are fraught with complications that are peculiar to the Niger Delta. First unlike in many parts of the world crude oil spillages are more inland than in coastal areas in the Niger Delta due to the fact that pipeline density as shown in Fig 21. are a significant source of oil storage/transportation in comparison to storage tanks, trucks or vessels. Secondly the distribution of hydrocarbon contamination between free, adsorbed, and dissolved phases in both the vadose and saturated zones interact with a complex terrain of the inland areas which include rivers, creeks, creeklets, freshwater swamps, mangrove swamps, agriculture, groundwater etc. These produce conditions that dictate different set of requirements in the use and application of acceptable Cleanup and Remediation methods either in a single or combination mode.

The broader challenges in combination with site specific characteristics in addressing hydrocarbon contamination include clean-up goals, technology feasibility, cost, regulatory and time requirements. Support for the last component is indicative from the UNEP study which reported that it will take 30 years to cleanup and remediate the spill sites in Ogoni land which perhaps constitute a about 50% of the spills in the Niger Delta using the oil spill monitor dashboard statistics from NOSDRA.

Furthermore an IUCN – NDP study of 2013 [18] noted that the methodologies currently being used for the remediation and rehabilitation of oil spill-impacted sites in the Niger Delta do not fully address the need for rehabilitation of biodiversity. The report also noted that they do not meet Nigerian standards or international industry best practices. The report which was based on visits to ten sites in Ogoni land provided an in-depth review of potential remediation methods such as Land Farming, Hydrogen Peroxide Treatment, Solidification and Stabilization; Soil vapour extraction, Soil washing, Air-sparging, Phyto remediation, Rhizoremediation,

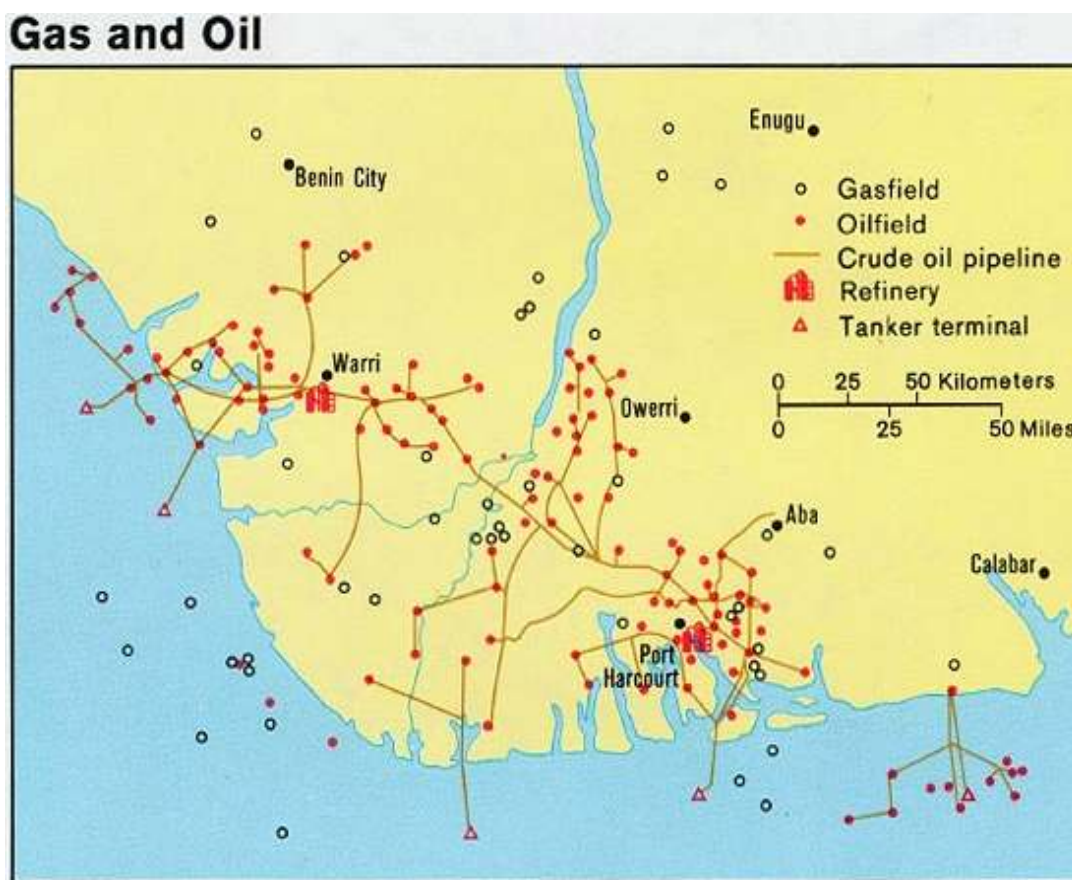


Fig. 21. Pipeline density showing potential sources of oil spill sites in the Niger Delta

Phycoremediation, and Bioaugmentation. On a global scale the most promising is Bioremediation technologies which are growing into a green, attractive and promising alternative to traditional physico-chemical techniques for the remediation of hydrocarbons at a contaminated site. This is due to its cost-effectiveness and its selective capacity to degrade the pollutants without damaging the site or its indigenous flora and fauna. However, bioremediation technologies have had limited applications due to the constraints imposed by substrate and environmental variability, and the limited biodegradative potential and viability of naturally occurring microorganisms. For the development of remediation processes to succeed commercially, it is essential to link different disciplines such as microbial ecology, biochemistry and microbial physiology, together with biochemical and bioprocess engineering.

The Challenge for the Niger Delta is that despite the available technologies and vast number of sites there are no repository of a tried and tested

metadata on application of these technologies on cleanup and bioremediation at the various representative habitat types in the Niger Delta. Such a development would provide empirical meta dataset that have the capacity to document and describe indigenous guidance/standard documents for regulatory oversight functions. A validation of the above statement is seen in the lack of any publicly documented certification of cleanup and or remediated sites despite the massive number of documented spills recorded from 2006 on NOSDRA oilspill monitor site. Also in the three years since UNEP's study was published, no open access documentation of actions have been taken by the Hydrocarbon Pollution Restoration Project (HYPREP) created in 2012 to implement its recommendations.

5. SOCIAL, ECONOMIC AND POLITICAL ASPECTS OF CLEANUP AND REMEDIATION

The search for stewardship of hydrocarbon contaminated sites that require Cleanup and

Remediation is a difficult task because it means an understanding of the history of the “most contaminated sites in the Niger Delta which are many and varied. The difficulty also includes the interpretation of the complex and often contradictory government practices and policies that are in place to remediate the enormous wastes from the oil and gas economy. Furthermore there are no coherent datasets that can provide scientific help in recognizing the effects on the ecosystem and people where the sites are located. Many of these places have become “sacrifice zones” – land and communities sacrificed for economic progress.

The problem of long term stewardship for cleanup and full remediation of hydrocarbon contaminated sites as opposed to compensation is a relatively modern problem, so there is no real experience to draw on compared to when oil was first discovered in the Niger Delta. In Nigeria, Cleanup and Remediation of contaminated sites are the legal responsibility of a number of different government bureaucracies with their own structures, cultures and idiosyncrasies. The organizations that are charged with care of these sites tend to be complex and politically vulnerable with respect to implementation of the policy of the Polluter-pay-Principle. Many of the information necessary to facilitate action are managed in a secretive manner, handled selectively and released slowly. Some of are detailed as follows:

1. There is tension exacerbated by government and industry interests for economic development and the environmental stigma of contaminated sites. There is an emerging realization that the current effective advocacy for cleanup/remediation will likely result in increased clean-up costs, which have to be borne by the oil and gas companies with the current dwindling profits.
2. There are challenges which include the continuous atrophy of vigilance in an environment where the need to act is intermittent as is the case with the UNEP study of Cleanup and Remediation of Ogoni land. The study which started in 2006 and ended in 2011 has remained in 2015 without any real action at either cleanup or remediation. The challenges stem from the splintering of responsibility amongst different actors where institutional silo mentality, jurisdictional differences and structural secrecy to protect institutional

reputation and the fear of producing panic generate and maintain inertia.

3. There is the difficulty of maintaining adequate funding for Cleanup and Remediation as is evident from the rapid increase in the number of contaminated sites. This is because most budgets in the oil and gas industry and government agencies in charge renew their funding through annual appropriations which have to compete with politically more attractive projects.
4. The current advocacy for a massive Cleanup and Remediation in the Niger Delta is the result of the calculation based on net present value and discounting calculations which assume very long-term endless economic growth. They neither have taken notice of the emerging national economic downturn nor the continuous growing ecological degradation which unfairly minimize the costs to future generations of today's pollution.
5. The apparent rational and technical choice of Cleanup and Remediation frequently involve choices of a Political nature about how laws and policies should be implemented to reach the level of environmental protection that is construed as desirable.
6. The Political feature of the conversation involves on one hand NGOs and the local population which are the main users of the areas requiring Cleanup and Remediation and the oil and gas companies who assume costs of the remediation process. These two groups are likely to have strongly diverging interests in terms of the environmental ambition of the remediation. The current overwhelming inaction for Cleanup and Remediation and the numerous cleanup sites is evidence that government is not yet playing its role as the strong arbitrator. There is an unspoken conflict about cost minimizing solution of IOCs and the high cost of optimal remediation mostly demanded by NGOs and the local population that can only be resolved through strong arbitration backed by policy.
7. Therefore strong arbitration can only be effective where deficits in the design of government agencies which have loopholes in the regulatory framework are rectified. The deficits can be improved through policies such as Incentives for Voluntary Remediation (Liability

Exemptions, Tax Benefits, and Grants), Designation of a Single Agency with Jurisdiction over the Remediation Process, Mechanisms for Public Review and Comment, Environmental Insurance as a Mechanism to Prevent Abandoned Contaminated Sites and Clear Definition based on Specific Contaminant Levels.

6. CONCLUSION

1. Many sites in the Niger Delta are currently documented as requiring Cleanup and Remediation without a clear plan on remediation timeframes backed by enforcement penalties.
2. The unavailable records of sites contaminated from 1957 before NOSDRA oil spill monitor was setup in 2006 provides a huge deficit of understanding the extent of sites for Cleanup and Remediation.
3. There is inaction between spills and successful Cleanup and Remediation.
4. There are no open accesses to information on successful Cleanup and Remediation campaigns.
5. However the basic building blocks for successful Cleanup and Remediation of contaminated sites are already in place as documented in the standard and guidance documents of DPR and NOSDRA. The long term Cleanup and Remediation plan must be designed to drive innovation in discovery of new technologies for the future to have local content value and cost effectiveness.

DISCLAIMER

A paper presented at the 4th Oil Spill Conference, Holding at Colonades Hotels Conference Center, 21 Alfred Rewane Road, Ikoyi Lagos, 25th to 26th August 2015.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Adati Ayuba K. Oil exploration and spillage in the Niger Delta of Nigeria Civil and Environmental Research. 2012;2(3). ISSN 2222-1719 (Paper) ISSN 2222-2863. Available:www.iiste.org
2. Tolulope AO. Oil exploration and environmental degradation: The Nigerian experience. International Information Archives, International Society for Environmental Information Science. EIA04-039. 2004;2:387-393.
3. Ukoli MK. Environmental factors in the management of the oil and gas industry in Nigeria; 2005. Available:www.cenbank.org
4. Gabriel AO. Women in the Niger Delta: Environmental issues and challenges in the third millennium; 2004. Available:www.jsd_africa.com
5. Shell Petroleum Development Company (SPDC). People and the Environment. Annual Report; 1995.
6. Nwilo CP, Badejo TO. Impacts and management of oil spill pollution along the Nigerian coastal areas. Department of Survey and Geoinformatics, University of Lagos, Lagos, Nigeria; 2005a. Available:www.fig.net/pub.figpub36/chapters/chapter_8.pdf
7. Nwilo CP, Badejo TO. Oil spill problems and management in the niger delta. International Oil Spill Conference, Miami, Florida, USA; 2005b.
8. Nwilo CP, Badejo TO. Management of oil dispersal along the Nigerian coastal areas. Department of Survey and Geoinformatics, University of Lagos, Lagos, Nigeria; 2004. Available:www.oceandocs.org/handle/1834/267
9. Twumasi Y, Merem E. GIS and remote sensing applications in the assessment of change within a coastal environment in the Niger Delta Region of Nigeria. International Journal of Environmental Research and Public Health. 2006;3(1):98-106. Available:www.ijerph.org
10. Uyigüe E, Agho M. Coping with climate change and environmental degradation in the Niger Delta of Southern Nigeria. Community Research and Development Centre Nigeria (CREDC); 2007.
11. United Nations Development Programme. Niger Delta Human Development Report. Abuja, Nigeria, 2006:185 and 186.
12. National Oil Spill Detection and Response Agency (No 15 of 2006), Oil Spill Recovery, Clean-up, Remediation And Damage Assessment Regulations, 2011, Section 17, p6. Available:www.oilspillmonitor.ng/
13. Oil Pipelines Act 1956 No. 31 (Laws of the Federation of Nigeria 1990, Cap. 338)

14. Petroleum (Drilling and Production) Regulation 1969 with amendments in 1973, 1979, 1995 and 1996. First published in 2011 by the United Nations Environment Programme. 2011, United Nations Environment Programme.
15. Nigeria Petroleum Act 1969.CAP 120, 140, 286, 364
16. Department of Petroleum Resources (DPR). Environment Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN) Revised Edition. 2002;135-140.
17. United Nations Environmental Programme. Environmental Assessment of Ogoniland.
18. International Union for Conservation of Nature–Niger Delta Panel (IUCN–NDP). Sustainable Remediation and Rehabilitation of Biodiversity and Habitats of Oil Spill Sites in the Niger Delta. A report by the independent IUCN–Niger Delta Panel (IUCN–NDP) to the Shell Petroleum Development Company Ltd of Nigeria (SPDC); 2013.

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