Global Journal of human-social science: B
Geography, Geo-Sciences, Environmental Science & Disaster Management
Volume 22 Issue 3 Version 1.0 Year 2022
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-460X & Print ISSN: 0975-587X

Oil Spills Cleanup Operations on Land and Inland Waters – The Mangroves Cleanup Philosophy

By Etuk Etiese Akpan

Abstract- The Niger Delta region has witnessed several environmental pollutions arising from oil exploration and production activities Though crude oil production has its attendant high risks, it is one of the largest and most profitable businesses in the world, and in fact the main economic sustenance for Nigeria (Onayemi 2004,). From its development phase to production phase, many disasters are bound to occur in the industries. Oil spill is the most important type of environmental disaster, which usually occurs. It has impact on humans as wells as on plants and wild life, including birds, fish and mammals.

Sources of spill ranges from equipment failures, human errors, accidents, sabotage and illegal bunkering activities on the production facilities. (Oil theft, sabotage and spills).

Good Industry operating and maintenance procedures is key to reducing incidents of oil spills in the environment.

Prompt spill response management is a key success factor in reducing escalation of the attendant negative impacts on the environment by deploying a workable contingency plan suitable to the specific environment of importance.

Keywords: oil spills; sources; impacts; niger delta region, mangroves, cleanup, land, water.

GJHSS-B Classification: DDC Code: 363.7382 LCC Code: KF27

OILSPILLSCLEANUPOPERATIONSONLANDANDINLANDWATERSTHEMANGROVESCLEANUPPHILOSOPHY

Strictly as per the compliance and regulations of:

Oil Spills Cleanup Operations on Land and Inland Waters – The Mangroves Cleanup Philosophy

Etuk Etiese Akpan

Abstract- The Niger Delta region has witnessed several environmental pollutions arising from oil exploration and production activities Though crude oil production has its attendant high risks, it is one of the largest and most profitable businesses in the world, and in fact the main economic sustenance for Nigeria (Onayemi 2004,).. From its development phase to production phase, many disasters are bound to occur in the industries. Oil spill is the most important type of environmental disaster, which usually occurs. It has impact on humans as wells as on plants and wild life, including birds, fish and mammals.

Sources of spill ranges from equipment failures, human errors, accidents, sabotage and illegal bunkering activities on the production facilities. (Oil theft, sabotage and spills.

Good Industry operating and maintenance procedures is key to reducing incidents of oil spills in the environment.

Prompt spill response management is a key success factor in reducing escalation of the attendant negative impacts on the environment by deploying a workable contingency plan suitable to the specific environment of importance.

Keywords: oil spills; sources; impacts; niger delta region, mangroves, cleanup, land, water.

I. Introduction

Oil spill cleanup generally refers to the removal of spilled oil from the environment to protect and preserve the ecosystem where the incident had occurred. These may include containment, recovery, evacuation and remediation of the polluted area. Oil spill cleanup helps in facilitating speedy recovery and resuscitation of the polluted environment.

Oil spill incidents are inevitable events in the areas where oil is explored, drilled and produced. These could occur either by willful damage by hoodlums, human errors, equipment failure and by an act of nature.

The incidence of oil spillage constitutes serious economic and soil degradation in the Niger Delta. The area currently faces series of ecosystem depletion as most soil flora and fauna are destroyed. Oil spills from the activities in the oil industry in the region affect the environment in the operational areas, right of ways (ROW) and third party areas. These result from equipment failures, leaks from corroded equipment and vandalisation (sabotage). The spilled crude oil from the source, through a plausible transport mechanism and exposure pathway, gets to the receptors - soil, vegetation, surface and ground water, marine environment, animals and humans - and pollute the environmental media. Soil fertility, measured by physical, chemical and biological parameters, is adversely affected. Also the livelihood of the inhabitant of the area

What ever the cause is, it is the corporate social responsibilities of the government and the oil operating companies to cleanup the areas impacted by crude oil as a result of their production activities.

a) Statement of Problem

Oil spills from several different sources are stigma to the environment and cause of concerns to all. The impact on the environment is massive with great degradation in the past decades. Areas of such impacts include contamination of water bodies, danger to aquatic life, destruction of flora and farmlands which includes resort centers, destruction of properties, loss of lives and many more.

b) Objectives

To maintain a better sustainable and viable environment through timely, effective and systematic cleanup operations when spills occur.

c) The Scope

The scope covers cleanup operations generally with emphasis on land spill cleanup, inland water spill cleanup and mangroves spill cleanup options.

II. Literature Review

Oil, as a significant factor affecting economic development and human life of most countries in the world. (Prendergast & Gschwend, 2014) has increased attendant risks associated with its production, however with significant benefits also for diverse locales, regions, and nations.

Transportation, equipment failures, willful damages, aged equipment amongst others have been the major sources of oil spill into the environment. According to ITOPF (2021) statistical data report, statistics on tanker spills more than 7 tones have showed a substantial decline over the last half-century. However, tanker collisions resulted in roughly 10,000 tons of oil being lost to the environment in 2021. This is a significant increase over the prior two years, owing mostly to the one large occurrence oil spill accident reported. Nonetheless, despite significant technological

Author: Ph.D, Clean Nigeria Associates Limited/Gte, 18 Ken Wiwa Road (Stadium Road), Port Harcourt, Rivers State, Nigeria.
e-mail: etukcom@yahoo.com

advancements aimed at ensuring the safety of navigation in order to minimize the likelihood of oil leakage (Bucelli et al., 2018), the possibility and severity of oil spills on land and water body cannot be completely ruled out, as evidenced by several recent severe accidents (Bonvicini et al., 2022; Wang et al., 2022). To mitigate these consequences, preparedness and response to any oil spill are always necessary and important for sensitive resources, including observation, detection, mitigation, response, and remediation of oil pollution (Li et al., 2016; Hung et al., 2018). Despite the devastating effects of oil spills on the ecosystems, social and economic life, and worldwide policies encouraging scientific research on the subject, the peer reviewed literature on oil spill response systems is expected to widen in the future years (Neves et al., 2015; Murphy et al., 2016). Although many studies and equipment exist that support oil spill response planning, because of this issue there remains a need for a comprehensive uderstanding and review of oil spills and their consequences.

Figure 1: Leaking Pipeline

Oil spills change the dynamic of the ecosystems and therefore emphasize the importance of rapid response technology capable of mitigating potential damage (Prendergast & Gschwend, 2014; Chen et al., 2020). To mitigate the negative consequences of an oil spill, it is also vital to manage spilled oil in an orderly and timely manner (Mohammadiun et al., 2021; Yang et al., 2021). This requires the development of both short and long-term contingency strategies (Chang et al., 2014; Wang et al., 2022). A range of response methods are included in the oil spill control strategy/contingency, with the purpose of limiting possible damage to human health and the environment by maintaining a timely and coordinated response (Li et al., 2016). Effective monitoring techniques can help with spill cleanup by detecting slicks early and specifying oil characteristics, estimating spill volume, and predicting oil movement (Robbe & Hengstermann, 2006).

III. Methodology

Removal of spilled oil on land, inland water and the coast could be achieved with combination of options with the use of selected response equipment and manually, which requires the involvement of a large labour force over an extended period. Although its chemical composition changes over time, residual oil remnants still contain various toxic chemicals, which must be dealt with caution for the sake of the health of the clean-up workers.

a) *On Land Spills Cleanup*

These operations involve the containment, recovery, evacuation and remediation of the impacted soil to resuscitate the impacted soil. Spilled oil on land prevents water absorption by the soil, spills on agricultural locations or grasslands have the effect of choking off plant life. There is also high probability of soil infiltration of the oil with the attendant risks of ground water contamination or entering waterways as run-off.

Lined Berms and trenches are some of the best ways to contain the spill on the land, as long as their use does not allow the oil to leach into the soil. Where there is no danger to the water table, the contaminated area can be flooded, which “floats” the oil or moves it to the water’s surface, as it is typically lighter than water. This technique allows for recovery via mechanical means such as vacuums and skimmers. Other possible techniques include mechanical removal of contaminated soil, in-situ burning, sorbents, and bioremediation.

Figure 2: Linned Trench for Containment

Figure 3: Temporary Storage Facilities for Recovered Spilled Oil

Additional strategies may include:

a. *Removal of gross contamination including removal of surface and subsurface pollution (beached oil)*
b. *Manual and Mechanical removal of spilled oil*
c. *Removal of debris*
d. *Segregation of generated waste*
e. *Low pressure flushing*
f. *Final Polish*
g. *Shoreline walk*
h. *Grading*
i. *Cleaning*
j. *Replanting*
k. *Replacement materials if required*
l. *Removal of equipment*

Figure 4: Right of Way Spill Clean up

Spill on Land Cleanup Options:

Table 1: Best Cleanup Option for On Land Spill

Preferred Method	Avoid
Co-ordinated manual recovery	Removing clean sediment
Mechanical transfer of oiled sand	Vehicles mixing oil with clean sand
Water flushing stranded oil	Removal of any vegetation bordering the beach
Consider restricting public access if possible	Use of chemical dispersants
	High Pressure washing

Figure 5: On land Spill Cleanup Operations

b) Inland Water Spills Cleanup

This operations involve the containment, recovery, evacuation of spilled oil on the surface of impacted in land water body.

In managing inland water spill incident and for effective clean-up of inland oil spills the knowledge of the probable sources, volume, flow direction, current, sensitive habitats, weather conditions, accessibility of spills are key delivery factors. Prior planning and preparation for adequate resources and coordinated approach are drivers for effective cleanup operations.

The widespread use of oil for industrial, commercial, and domestic purposes results in frequent small inland oil spills particularly as a result of incidents during delivery to and storage at user premises. Less frequent accidents involving large quantities of oil have occurred at oil storage installations or during bulk movements of oil but there are few reported incidents of significant pollution damage to ground or surface water. Oil companies, local and national government agencies, by developing elaborate emergency plans and providing equipment and training to ensure that the plans can be effectively carried out, have done much to minimise the damage caused by inland oil spills. Close cooperation between industry and government has also helped to make these plans particularly effective.

Figure 6: In land Spill Cleanup Operations

In most cases, oil released in inland waters is subject to the natural hydrologic flow as well as any man-made changes, of which there are many, to the hydrologic system. For example, the banks can be armored, stream flow is directed through culvert systems, or dams of all sizes and uses turn riverine systems into lakes. Another confounding and risky issue is flooding upon oil spills, where waterways leave their banks and/or change courses. The potential for surface water, vegetation and groundwater contamination is often a primary public health concern.

The goal of any spill response be it coastal or inland, should be to select the response methods and endpoints that will result in the most rapid recovery of the environment (Michel and Benggio, 1999). For inland spill response, there are often two perspectives that have to be resolved: 1) Remove all of the spilled oil from the environment versus; 2) Remove as much oil as possible without damaging or slowing the overall habitat/resource recovery. Cleanup endpoints for spills in coastal and marine settings seldom have endpoints as rigorous as "No oil observed" though these can be used for amenity beaches. Most of the time, cleanup endpoints in coastal and marine settings are based on acknowledgement that any residual oil will weather or degrade over time, sped by natural removal processes in areas exposed to waves and currents.

Removing oil to the extent that soil, sediment, and water meet state regulatory limits agreed as the cleanup endpoint could require additional extensive efforts.

Consequently, cleanup endpoints are needed to:

- Define the conditions beyond which further active treatment is likely to provide no net environmental benefit and may delay, rather than accelerate, recovery of impacted habitats and natural resources;
- Define the target conditions that must be achieved before active treatment may cease. As such, these criteria signal the transition from active response-related cleanup to passive, maintenance and monitoring, or final sign-off;
- Provide Operations with clear targets for when treatment activities are done;
- Provide Shoreline Cleanup Assessment Technique (SCAT) Teams with criteria with which to inform their recommendations of the most appropriate treatment options and evaluate results of treatment activities; and
- Provide those responsible for the follow-up remediation with guidelines that are consistent with those provided to emergency responders.

There are generally four types of cleanup endpoints (Sergy and Owens, 2007, 2008; NOAA 2013): 1) Quantitative endpoints that build on the terminology of the SCAT process and use metrics related to the percent oil distribution, the oil thicknesses, the oil type, etc. (e.g., no more than 10% Stain); 2) Qualitative endpoints that describe the presence and character of oil (e.g., does not rub off on contact); 3) Analytical criteria for sediment and water quality and 4) Interpretive impact endpoints (e.g., removal to the point when further treatment will result in excessive habitat disruption). At this point, no further treatment (NFT) is recommended due to a net environmental benefit consideration. This last endpoint is applied mostly to sensitive habitats when meeting one of the first three endpoints would cause greater harm than leaving the oil to attenuate naturally.

Global Journal of Human-Social Science (B) Volume XXII Issue III Version I Year 2022

Figure 7: Inland Water Spill Due Cut Pipeline by Sabotage

Figure 8: Recovery Progress in Inland Water Spill

Figure 9: Oil Containment and Recovery in Progress

c) Oiled Mangroves Spills Cleanup

Several studies frown against aggressive removal of oil from sensitive habitats such as marshes and mangroves because the action can slow the overall recovery of the habitat. (Hoff, 2010). Therefore, in mangrove cleanup response, evaluating the relative environmental risks, using the concept of net environmental benefit analysis is key to safe management of the mangrove ecosystem and to establish the safe cleanup endpoints for the mangrove ecosystem.

In cleaning oiled mangrove forest shoreline, extreme caution must be exercised in selecting cleanup activities. Potential benefits of oil removal must be weighed against the risks of potential additional harmful impacts from the cleanup technique on the mangroves habitat. This is because the mangrove ecosystem are:

- *High degree bio-diversity & ecological sensitivity to hydrocarbons.*
- *Easily damaged by physical presence of shoreline clean-up teams.*
- *Priority sites for protection booming*
- *Requires expert advice & guidance if clean-up is to be attempted.*

Cleanup options are best selected from the list of available techniques taking into consideration the above highlighted points.

- No Action/Natural Recovery

When it is appropriate to do nothing. When cleanup would cause more harm than benefit to mangroves or other associated habitats, or when shorelines are inaccessible

- Barrier Methods

Several forms of barriers can deflect or contain oil, including booms, sediment berms, dams, and filter fences. Barriers can be used along mangrove shorelines and inlets to prevent oil entry. Proper strategic boom deployment is highly effective in trapping large quantities of mobile oil and reducing oil impact to interior mangroves.

- Manual Oil Removal

Manual removal, using hand tools and manual labor, is often conducted to remove bulk oiling by heavier oils, such as crude oil or Bunker oil, stranded in mangroves. Manual removal can help prevent other mangroves from contamination.

- Passive Collection with Sorbents

Sorbent boom or other sorbent materials can be placed at the fringe of oiled mangrove forests to passively recover any mobile oil, including sheens. Sorbents are oleophilic and either absorb or adsorb oil.

- Vacuuming

Vacuuming can remove pooled oil or thick oil accumulations from the sediment surface, depressions, and channels. Vacuum equipment ranges from small units to large suction devices mounted on dredges, usually used outside vegetated areas.

- Ambient Water Flooding (Deluge) and Low-Pressure High Volume Ambient Water Flushing

Low-pressure flushing with ambient seawater can wash fluid, loosely adhered oil from the sediment surface and mangrove vegetation into areas where it can be collected, as long as it can be done without resulting in significant physical disturbance of the sediment.

- Nutrient Addition/Bioremediation

Microbes and essential nutrients for oil degradation generally are not limited in mangrove habitats, but nutrient enrichment may not offer much benefit.

- NO NO Response Techniques for Mangroves Cleanup,

Under no circumstances should live mangrove vegetation be cut or burned. Both techniques will destroy trees and mangrove habitat. Mangrove trees are slow growing and take decades to be replaced by mature vegetation.

Figure 10: The Mangrove Ecosystem Impacted with Spilled Oil

Figure 11: The Mangrove Ecosystem

Figure 12: Low Pressure – High Volume Flushing of the Mangrove Ecosystem

Mangroves Spill Cleanup Options:

Table 2: Best Cleanup Option for Mangroves Spill

Preferred Method	Avoid
If possible leave to degrade naturally (NEBA)	Driving oil further down in to sub-strate
Closely controlled manual recovery (LP flushing & sorbents)	Use of heavy plant & machinery
Pruning of heavily contaminated vegetation	Completely removing oiled vegetation
Priority case for protection booming	Cosmetic clean-up

General Spills Clean-Up Methods

a. Using Oil Booms.
b. Using Skimmers.
c. Using Sorbents.
d. Burning In-situ.

Figure 13: In Situ Burning of Spilled Oil

e. Using Dispersants.
f. Hot Water and High-Pressure Washing.
g. Using Manual Labour.
h. Bioremediation.

IV. Conclusion

Recalling that mangroves are important players in some of the greatest challenges facing the world today. They provide a defense between land and sea, absorb carbon, contribute to economic and food security, and are home to some of the most rare and colorful species.

However, mangroves are disappearing at an accelerating rate consequent on many factors including oil pollution of the marine ecosystem.

Only with healthy ecosystems can we enhance people's livelihoods, counteract climate change, and stop the collapse of biodiversity.

UNEP research shows that mangrove ecosystems underpin global and local economies, by supporting fisheries, providing other food sources and protecting coastlines.

They are also important protectors – sheltering land and coastal communities from storms, tsunamis, rising sea levels and erosion. In addition, with the world at risk of a temperature rise of over 3°C this century, mangroves are an invaluable ally in the race to adapt. They extract up to five times more carbon from the atmosphere than forests on land, and protecting mangroves is 1000 times less expensive, per kilometer, than building seawalls.

Clearing mangrove forests to create space for buildings, and to farm fish and shrimp – is the main driver of mangrove loss. Worldwide, this has caused the loss of 20 per cent of mangrove ecosystems.

Before planting new mangroves, it is important to understand the cause of forest degradation or disappearance. In the case of pollution, over-harvesting or other causes that can be eliminated, mangroves can recover naturally.

When recovery requires human intervention, it is important to follow key steps, like involving local communities, selecting native seedlings and establishing a functioning nursery

Contingency planning and readiness for the management of oil spill incidents as they occur is very important to effectively protect the environment from extensive damages consequent on the spills. It is strongly recommended that prompt cleanup be effected upon any spill incident using the most appropriate selected techniques to protect and preserve sensitive habitats such as the mangrove habitat.

While there is no 100% assurances of complete resuscitation of the ecosystem after effective cleanup, proactive measures to ensure preparedness must be put in place for prompt response in an emergency situation.

Timely response to cleaning up the spill will not only reduce the negative impact on sensitive habitats in the ecosystem, but will guarantee sustainable co-existence in the ecosystem.

Continuous monitoring and evaluation is required after the cleanup to assure quick recovery of the impacted ecosystem.

References Références Referencias

1. Hoff, R. (ed.), 2010. *Oil Spills in Mangroves: Planning & Response Considerations* Office of Response and Restoration, National Oceanic and Atmospheric Administration, Seattle, WA 70pp
2. Michel, J. and B. Benggio, 1999. Guidelines for selecting appropriate cleanup endpoints. *In: International Oil Spill Conference Proceedings,* 1999 (1): 591–595
3. Sergy, G. A. and E.H. Owens, 2008. Selection and use of shoreline treatment endpoints for oil spill

response *In: International Oil Spill Conference Proceedings*: 2008 (1): 435–440.

4. Onayemi, Tim. Nigeria Oil: Prices, Politics, and People, Nigeriatoday.com.23. Feb. 2004 12. Suarez, Yolanda. Economy of Nigeria. 27 February 2004
5. Bonvicini, S., Bernardini, G., Scarponi, G. E., Cassina, L., Collina, A., & Cozzani, V. (2022). A methodology for response gap analysis in offshore oil spill emergency management. Marine Pollution Bulletin, 174, 113272. https://doi.org/10.1016/j.marpolbul.2021.113272
6. Bucelli, M., Landucci, G., Haugen, S., Paltrinieri, N., & Cozzani, V. (2018). Assessment of safety barriers for the prevention of cascading events in oil and gas offshore installations operating in harsh environment. Ocean
7. Chang, S. E., Stone, J., Demes, K., & Piscitelli, M. (2014). Consequences of oil spills: a review and framework for informing planning. Ecology and Society, 19(2), 26. https://doi.org/10.5751/ES-06406-190226
8. Chen, D., Liu, Z., Luo, Z., Webber, M., & Chen, J. (2016). Bibliometric and visualized analysis of emergy research. Ecological Engineering, 90, 285-293. https://doi.org/10.1016/j.ecoleng.2016.01.026
9. Hung, P. V., Kim, K. S., Tien, L. Q., & Cuong, N. M. (2018). Distribution of oil spill response capability through considering probable incident, environmental sensitivity, and geographical weather in Vietnamese waters. Journal of International Maritime Safety, Environmental Affairs, and Shipping, 2(1), 31-41. https://doi.org/10.1080/25725084.2018.1511240
10. ITOPF (The International Tanker Owners Pollution Federation Limited). (2021). Oil tanker spill statistics 2021. Retrieved on February 11, 2022, from https://www.itopf.org/knowledge-resources/datastatistics/statistics/
11. Mohammadiun, S., Hu, G., Gharahbagh, A. A., Li, J., Hewage, K., & Sadiq, R. (2021). Intelligent computational techniques in marine oil spill management: A critical review. Journal of Hazardous Materials, 419, 126425. https://doi.org/10.1016/j.jhazmat.2021.126425
12. Murphy, D., Gemmell, B., Vaccari, L., Li, C., Bacosa, H., Evans, M., Gemmell, C., Harvey, T., Jalali, M., & Niepa, T. H. (2016). An in-depth survey of the oil spill literature since 1968: Long term trends and changes since Deepwater Horizon. Marine Pollution Bulletin, 113(1-2), 371-379. https://doi.org/10.1016/j.marpolbul.2016.10.028
13. Neves, A. A. S., Pinardi, N., Martins, F., Janeiro, J., Samaras, A., Zodiatis, G., & De Dominicis, M. (2015). Towards a common oil spill risk assessment framework–adapting ISO 31000 and addressing uncertainties. Journal of Environmental Management, 159, 158-168. http://dx.doi.org/10.1016/j.jenvman.2015.04.044
14. Prendergast, D. P., & Gschwend, P. M. (2014). Assessing the performance and cost of oil spill remediation technologies. Journal of Cleaner Production, 78, 233-242. https://doi.org/10.1016/j.jclepro.2014.04.054
15. Robbe, N., & Hengstermann, T. (2006). Remote sensing of marine oil spills from airborne platforms using multisensor systems. Water Pollution VIII: Modelling,
16. Wang, J., Zhou, Y., Zhuang, L., Shi, L., & Zhang, S. (2022). Study on the critical factors and hot spots of crude oil tanker accidents. Ocean & Coastal Management, 217, 106010. https://doi.org/10.1016/j.ocecoaman.2021.106010
17. Yang, Z., Chen, Z., Lee, K., Owens, E., Boufadel, M. C., An, C., & Taylor, E. (2021). Decision support tools for oil spill response (OSR-DSTs): Approaches, challenges, and future research perspectives. Marine Pollution Bulletin, 167, 112313. https://doi.org/10.1016/j.marpolbul.2021.112313

Global Journal of Human-Social Science (B) Volume XXII Issue III Version I Year 2022 36