

1 **Management of petroleum hydrocarbon contaminated sites in Nigeria: Current**  
2 **challenges and future direction**

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4 **Abstract**

5 Sites affected by petroleum hydrocarbons from oil exploitation activities have been  
6 identified as a major environmental and socio-economic problem in the Niger Delta  
7 region of Nigeria. The current Nigerian regulatory instruments to manage these  
8 contaminated sites are fragmented and the roles and responsibilities of government  
9 agencies, such as the Department for Petroleum Resources (DPR), and the National Oil  
10 Spill Detection and Response Agency (NOSDRA), are not well defined. This lack of  
11 coordination has led to ineffective land contamination policy and poor enforcement  
12 more generally. Appropriate, risk-based policy instruments are needed to improve  
13 regulatory capacity, and to enhance the regulator's ability to manage new and existing  
14 petroleum hydrocarbons contaminated sites. Lessons can be learned from countries like  
15 the United Kingdom (UK) and the United States America (USA) that have experience  
16 with the management and clean up of historically contaminated land. In this paper, we  
17 review the status of petroleum hydrocarbon contaminated sites management in Nigeria  
18 and identify the gaps in existing policy and regulation. We review the contaminated  
19 land policies and regulation from the UK and the USA, and identify lessons that could  
20 be transferred to the Nigerian system. Finally, we provide a series of recommendations  
21 (e.g. source – pathway-receptor approach, soil screening criteria, clean-up funding,  
22 liability) that could enhance contaminated land legislation in Nigeria.

- 1 Keywords: Contaminated-land, risk management, Niger Delta, environmental policy,
- 2 oil spill
- 3

## 1 **1 Introduction**

2 The Federal Republic of Nigeria, commonly referred to as Nigeria, is located in West  
3 Africa, covering an area of 923,773km<sup>2</sup> (Nwilo and Badejo, 2006), and is comprised of  
4 4 regions, 36 states, and 774 Local Government areas (Adeyemi, 2013). Nigeria has a  
5 diversity of natural resources, such as bitumen, coal, iron ore and crude oil. Nigeria is  
6 the 12<sup>th</sup> largest producer of petroleum hydrocarbons in the world and its main oil  
7 producing region is the Niger Delta. The Niger Delta is located at the apex of the Gulf  
8 of Guinea on the west coast of Africa and within Nigeria's southern geopolitical zone  
9 (Figure 1). Approximately 31 million people live within the Niger Delta (NDDC, 2014).  
10 Geographically, the Niger Delta (Figure 2) covers an area of 112,000 km<sup>2</sup> and  
11 encompasses one of the most bio-diverse ecosystems on the planet (Ugochukwu and  
12 Ertel, 2008). Ecologically sensitive regions include, for example, coastal barrier islands,  
13 mangrove swamps, and freshwater swamps (NDDC, 2014).

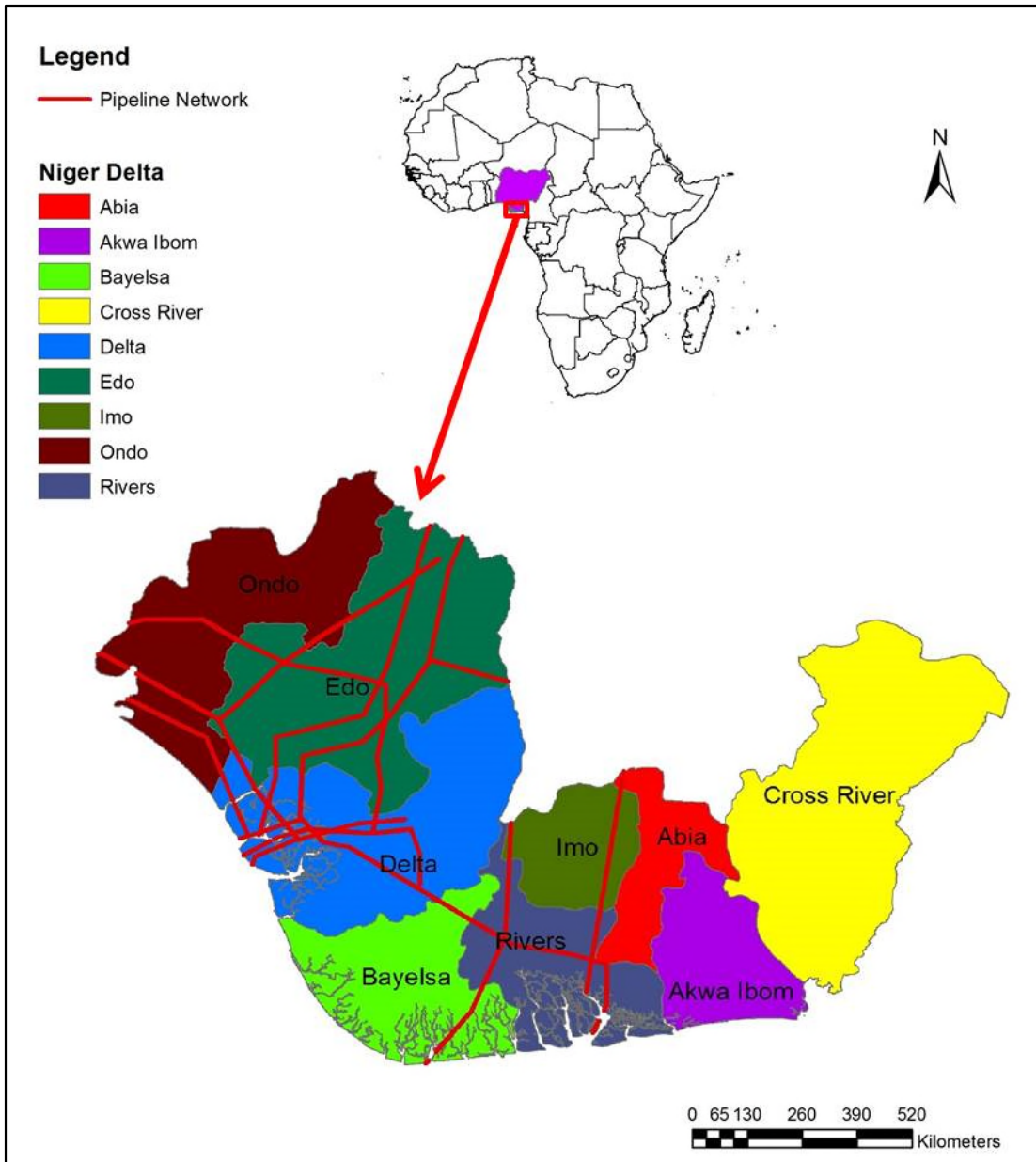
14 In the late 1950s, Britain (British Petroleum) discovered crude oil in the region and in  
15 1958 the country started commercial production at Oloibiri – a village in the Niger  
16 Delta – producing 6000 barrels per day (Kadafa et al., 2012). Today, about 606 oil  
17 fields (355 situated onshore and 251 offshore), 5,284 oil wells, and 7,000 km of oil and  
18 gas pipelines are operated by 13 multi-national companies in the region (Nwilo and  
19 Badejo 2006; Kadafa 2012). The region prides itself as the hub of oil exploration and  
20 production infrastructure in Nigeria (Eke, 2016), and currently produces on average 1.7  
21 million barrels per day as of 2015 (OPEC, 2015).

22 The oil sector has become vital to the Nigerian economy. Reports estimate the export  
23 value of oil from the region to be \$89b USD per annum (OPEC, 2015), or in excess of

1 \$600b USD since 1960 (Ite et al., 2013). This translates into a contribution of up to 35%  
2 of Nigeria's gross domestic product (GDP), and over 90% of its foreign exchange  
3 wealth (Akpabio and Akpan, 2010; OPEC, 2015). Despite the country's oil wealth, the  
4 majority of the population, including the oil producing communities in the Niger Delta,  
5 remain relatively poor (Eke, 2016). The common employment is agriculture, food  
6 production, and fisheries (NDDC, 2014).

7 The Niger Delta has been reported as one of the most heavily oil-impacted regions in  
8 the world due to over five decades of oil exploitation activities (Zabbey and Uyi, 2014),  
9 coupled with poor management practices that have led to the contamination of soil and  
10 groundwater resources. Since the inception of the Nigerian oil sector, 13 million tonnes  
11 of hydrocarbons have been reported as spilled in the Niger Delta (Nwilo and Badejo,  
12 2006; Kadafa, 2012) as a result of sabotage, pipeline vandalism (individuals that break  
13 pipeline during oil theft), well blowout, and engineering failure (e.g. pipeline rupture)  
14 (Nwilo and Badejo, 2006; Ambituuni et al., 2014; Könnet, 2014). Considerable oil  
15 contamination of the land has been reported (Ite et al., 2013; Linden and Palsson, 2013)  
16 and recent estimates suggest that over 2000 land-based oil-contaminated sites exist(Ite  
17 et al., 2013).

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3 **Figure 1:** Map of Africa showing the Niger Delta region (red box) and oil pipeline  
 4 network (red lines).

5 Nigeria has made few attempts to clean-up oil-related contaminated land and the most  
 6 common approach used is remediation by enhanced natural attenuation (RENA)

1 (UNEP, 2011; Orji et al., 2012). RENA is a farming treatment bioremediation method  
2 whereby contaminated media (e.g. soil and sediments) are periodically tilled to provide  
3 aeration (Ebuehi et al., 2005). This approach differs from monitored natural attenuation  
4 (MNA) that relies on natural processes for remediation without human intervention  
5 (Jørgensen et al., 2010). RENA is often used in Nigeria and has been reported as  
6 ineffective as concentrations of contaminants in soil remain significantly high, even  
7 after sites have been certified remediated (UNEP, 2011). RENA is an inappropriate  
8 approach because of the extent and scale of the spills with oil penetrating soil to depths  
9 of over 5 m and leaching into groundwater aquifers (Ebuehi et al., 2005; Orji et al.,  
10 2012). In addition, RENA is ineffective for the treatment of contaminated aquifers, as  
11 this preferred approach to remediation has led to some communities no longer having  
12 access to safe drinking water (UNEP, 2011), due to hydrocarbon contamination of  
13 aquifers that are sources of potable and non-potable water in communities. Of the few  
14 attempts made to remediate contaminated land, none have involved stakeholder inputs  
15 (Rim-rukeh, 2015), and this has led to conflict and protest against the government and  
16 industry operators (UNEP, 2011).

17 The United Nations Environment Program (UNEP) report (Environmental Assessment  
18 of Ogoniland) is the most influential account to document the scale of pollution in the  
19 region (UNEP, 2011). A major recommendation from this report highlighted the need  
20 for development and adoption of oil pollution mitigation strategies. In general, Nigeria  
21 lacks the policies necessary to manage pollution, and this has been attributed to a  
22 number of different factors, e.g. a fragmented governance structure, a lack of decision  
23 transparency, and poor implementation (Ajayi and Ikporukpo, 2005; Ite et al., 2013).

1 Examples of countries with effective policies to manage pollution and contaminated  
2 land exist. Two such examples include the United States of America (USA) and the  
3 United Kingdom (UK). These countries have spent considerable time and effort to  
4 develop governance structures and strategies that provide effective management of  
5 contaminated land (Hird, 1993; Luo et al., 2009; Rodrigues et al., 2009; Swartjes et al.,  
6 2012; Kiel, 2013). Though the drivers (or conditions) that led to these developments  
7 will differ from that of Nigeria, the overarching principles should remain the same, i.e.  
8 environmental mitigation and reduction of human health impacts (Ferguson, 1999;  
9 Rodrigues et al., 2009a; Swartjes, 2011).

10 Therefore, Nigeria could benefit from the lessons learned in the USA and UK as they  
11 seek to improve their contaminated land management policy. In this study, we focus on  
12 petroleum hydrocarbon contaminated sites in the Niger Delta region. Using this region  
13 as a case study, we review the current contaminated land management situation in  
14 Nigeria to identify the gaps in policy and regulation. We also review the UK and USA  
15 experiences to identify the elements of those policies that could support progress in  
16 Nigeria. Finally, we propose recommendations for Nigeria that could support further  
17 development and implementation of a more effective contaminated land management  
18 regime.

19

1 **2 Contaminated land management in Nigeria**

2 **2.1 Regulatory history of contaminated land in Nigeria**

3 Contaminated land management regulation in Nigeria can be classified as three distinct  
4 periods (Figure 2), which include:

- 5 1) no legislation;
- 6 2) non-specific legislation; and
- 7 3) specific legislation.

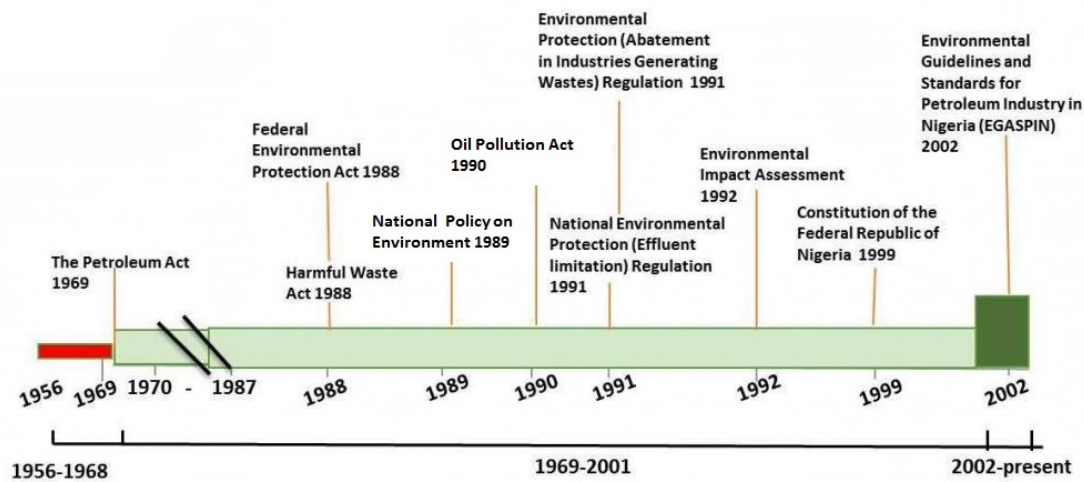
8 Between 1956 – 1968 (during the period of no legislation) oil exploration and production  
9 was in its infancy, with oil exploitation initiated in 1956 and commercial production at  
10 Oloibiri starting in 1958. During the period between 1956-1960 (Nigeria achieved  
11 independence in 1960) regional management policies for oil exploitation and production  
12 were being developed. No specific regulations to manage contaminated land were in place  
13 at this time, nor were there any legal instruments available to discourage contamination  
14 (Ite et al., 2013). However, it is worth mentioning that pieces of regulation related to  
15 granting of licenses for the establishment of pipelines (i.e. the Oil and Pipeline Act 1956),  
16 safety of oil drilling operations (the Mineral oils (safety) regulation 1963), importation,  
17 exportation, loading and landing of petroleum (i.e. the Petroleum regulations 1967), and  
18 the Oil in navigable waters Decree 1968 which led to the Petroleum Act 1969 were  
19 enacted (DPR, 2002).

20 At the end of this period (1956—1968) oil contamination incidents were on the rise and  
21 this elicited a response from the Nigerian authorities and marked the beginning of the



1 period of non-specific legislation (1969-2001) (Anago, 2002; Ogbodo, 2009). During this  
 2 period the Petroleum Act (1969) was developed to provide an overarching legislation for  
 3 the prevention of environmental pollution in different environmental media, e.g. water,  
 4 air and soil. Other notable legislations, such as the Harmful Waste Act 1988 and the  
 5 Environmental Impact Assessment Act 1992, were established but were not designed  
 6 specifically to address contaminated land management (Ajayi and Ikporukpo, 2005;  
 7 UNEP, 2011).

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11 **Figure 2:** Timeline presenting the development of contaminated land management policy  
 12 in Nigeria from 1956 to present. Red – period of no legislation; Light green - period of  
 13 non-specific legislation; Green – period of specific legislation.

14 Increases in oil production, incidents of oil pollution (Badejo and Nwilo, 2004; Nwilo  
 15 and Badejo, 2005), and community protests specifically in Ogoniland (Osaghae, 1995),  
 16 led to a response from Government in the form of the Environmental Guidelines and

1 Standards for the Petroleum Industry (EGASPIN), which was published in 1991 and  
2 enacted in 2002. The EGASPIN 2002 regulations represented the first time in Nigeria  
3 where regulations specifically related to the management of contaminated land were  
4 enacted. To date, EGASPIN 2002 forms the regulatory basis of the current environmental  
5 mandate related to oil contamination in Nigeria. Since 2002, no other regulations related  
6 to contaminated land management have been enacted.

7 Many of the guidelines for environmental quality standards described within the  
8 EGASPIN have been adopted from other countries (mainly from the USA). This has been  
9 attributed to Nigeria's lack of technical capabilities and expertise to develop such  
10 guidelines (Ajayi and Ikporukpo, 2005). There are concerns that the guidance within  
11 EGASPIN 2002 lacks contextualisation; particularly that the conditions in the USA for  
12 land use, soil type, and soil total organic carbon differ from those in Nigeria. This  
13 difference could have an impact on the appropriateness and efficacy of the guidelines to  
14 assess and thus risk management (Ajayi and Ikporukpo, 2005, UNEP, 2011).

## 15 **2.2 EGAPSIN - Current approach to contaminated land management**

16 The EGASPIN describes environmental quality control guidelines that cover oil  
17 exploration, production operations, hydrocarbon processing, transportation, permits,  
18 sanctions, and pollution abatement technologies (DPR, 2002). Specific to contaminated  
19 land, the EGASPIN provides a set of guidance to mitigate the risks of contaminated  
20 land to human health and ecological systems. This is a risk-based framework that uses a  
21 multi-tiered contaminated land risk management approach. In the event of a new spill,  
22 the EGASPIN requires the operator to report it to the Department of Petroleum  
23 Resources (DPR), however, in practice operators report to both the National Oil Spill

1 Detection and Response Agency (NOSDRA) and DPR. Next, a risk assessment is  
2 conducted at the discretion of the operator and the director of DPR. The risk assessment  
3 process requires the development of a conceptual site model (CSM) to identify all  
4 potential pollution linkages. Finally, a risk ranking exercise is performed (DPR, 2002)  
5 to identify priority sites requiring attention.

6 In Nigeria, risks are assessed using soil screening values (SSVs) that are predicated on  
7 contaminant concentrations for which soil functionality, plant life, animal, and human  
8 health are deemed to be threatened or could be seriously impaired. Management actions  
9 are triggered when certain contaminant threshold levels are exceeded (DPR, 2002).  
10 These values were directly adopted from the American Society for Testing and  
11 Materials (ASTM), a standards organisation that develops and publishes voluntary  
12 technical standards for materials and products testing (ASTM, 1995), as developed by  
13 the ASTM Committee E-50 on Environmental Assessment as part of Data Series 64 on  
14 Clean up Criteria for Contaminated Soil and Groundwater. Developed for specific  
15 conditions in the USA, it is unclear how appropriate these are for assessing risk under  
16 Nigerian conditions.

### 17 **2.3 Governance and regulatory organisational structure**

18 Environmental management falls under the responsibility of numerous governmental  
19 departments and agencies at the federal, state, and local levels (Figure 3). Only two  
20 agencies have the responsibility to manage contaminated land, and these are the DPR  
21 and the National Oil Spill Detection and Response Agency (NOSDRA). DPR is  
22 responsible for managing legacy sites (i.e. spill sites that have existed over a long period

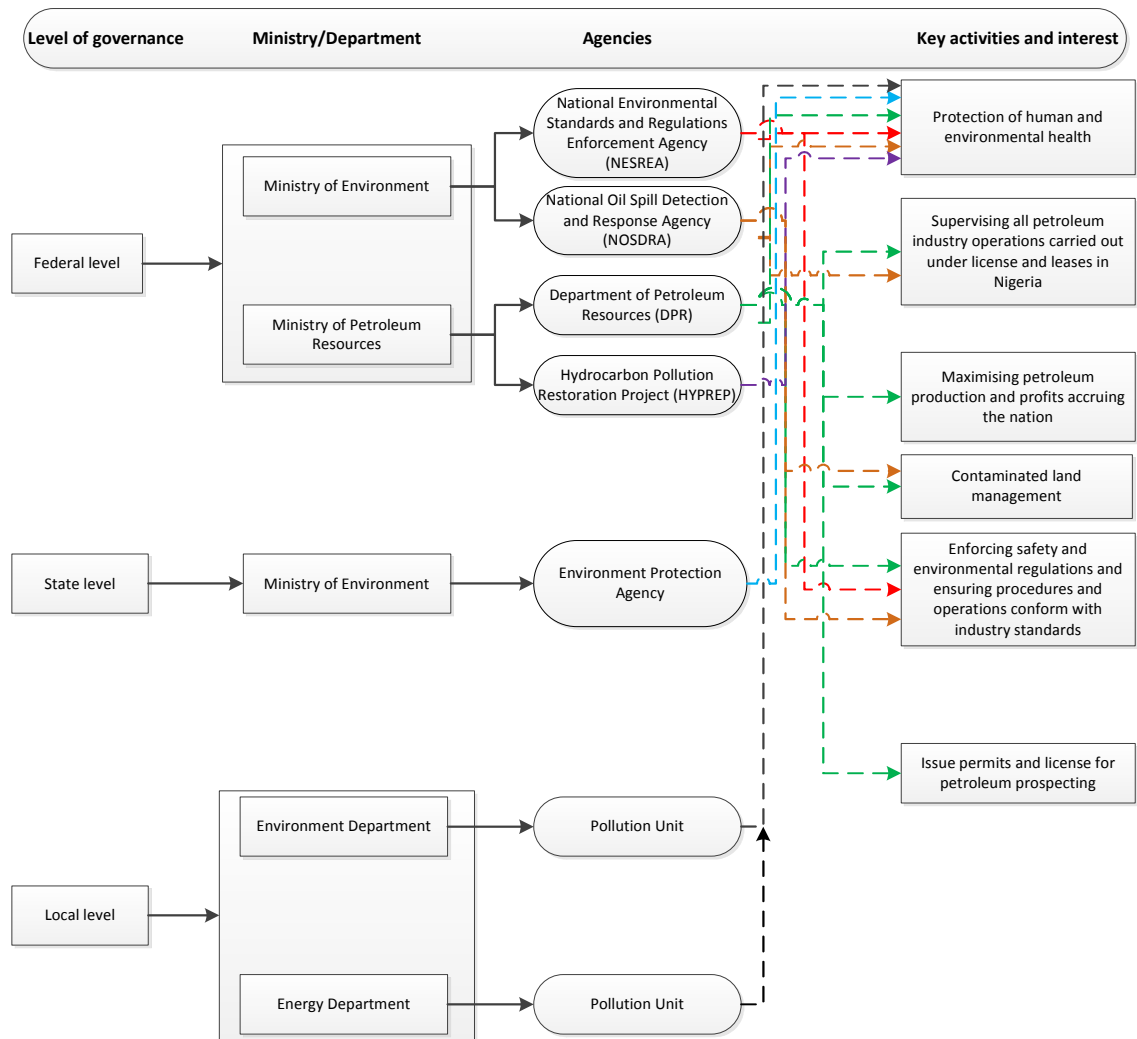
1 of time and no polluter has taken responsibility) and NOSDRA is responsible for the  
2 detection and management of emergency oil spills (Oyefusi, 2007; Ambituuni et al.,  
3 2014; Rim-rukeh, 2015).

4 Despite this difference, agency (NOSDRA and DPR) roles often conflict. For example,  
5 when an oil spill occurs the operator must notify both agencies, each of which will then  
6 initiate an independent risk assessment of the site. Conflict might thus arise from  
7 different assessments (e.g. the assessment of the Bonga oil spill in 2011), which could  
8 impact the legitimacy of the management recommendations provided by NOSDRA who  
9 has the mandate to address new spills. Duplication of responsibility exists elsewhere,  
10 for example, pollution prevention and management of the oil sector falls under  
11 jurisdiction of two different federal agencies sitting across two different ministries  
12 (Figure 3) (Eneh, 2011). Overlap will ultimately lead to inefficiencies in the governance  
13 process, such as the double budgeting for management of contaminated sites, and  
14 conflicting recommendations from regulators (Ajai, 2010; Eneh, 2011; Ambituuni et al.,  
15 2014).

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2 **Figure 3:** Map of the Government departments and agencies that are responsible for  
 3 environmental management in Nigeria. This map shows the overlap of activities  
 4 between different departments and agencies. Functions performed by each agency are  
 5 represented in colour: NESREA (red), DPR (green), NOSDRA (orange), HYPREP  
 6 (purple), Environment Protection Agency (blue), Pollution Unit (black).

7

8 Concerns about conflict of interest exist in DPR’s dual role for contaminated land  
 9 management (limited legacy sites) and responsibility to maximise oil production and

1 collect oil related revenues (Okotoni, 2004). This arrangement has led to reports of  
2 unethical behaviour, i.e. corruption (Eneh, 2011; UNEP, 2011). Countries such as the  
3 USA and UK specifically separate these two roles to avoid such occurrences (Ramseur  
4 and Hagerty, 2013).

#### 5 2.3.1 Shortcoming in governance

6 Nigeria suffers from a number of operational shortcomings that have an impact on the  
7 development of effective governance. One shortcoming is a lack of adequately trained  
8 and experienced personnel who understand the technical aspects of contaminated land  
9 risk assessment and management (Ajayi and Ikporukpo, 2005; Eneh, 2011; UNEP,  
10 2011). Another shortcoming is a weak and ambiguous definition for contaminated land  
11 (Table 1), which is crucial for identifying contaminated land and subsequently  
12 developing and implementing suitable risk management measures (Walton, 1997).

13

14

1 **Table 1:** Statutory definitions for contaminated land in the UK, USA and Nigeria

Country	Definition	Reference
<b>UK</b>	“any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land that – (a) significant harm is being caused or there is a significant possibility of such harm being caused; or (b) significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused”	(DEFRA, 2012)
<b>United States</b>	”a real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant or contaminant. The term “pollutant or contaminant” shall include, but not be limited to, any element, substance, compound, or mixture, including disease-causing agents, which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction) or physical deformations...”	(CERCLA, 2002)
<b>Nigeria</b>	“The presence in the environment of an alien substance or agent or energy, with a potential to cause harm”	(DPR, 2002)

2

3 Other shortcomings include insufficient funding to support the assessment and  
 4 management of contamination, as well as enforcement of regulations. For example, the  
 5 national government has started the implementation of the UNEP recommendations on  
 6 oil contaminated sites in Ogoniland (UNEP, 2016). However, the project is  
 7 experiencing funding challenges due to lack of a funding structure. Lack of funding  
 8 manifests in areas such as training, logistics, and facilities (Eneh, 2011), and it has been  
 9 observed that operators, with sufficient resources, are often willing to assist regulators

1 during their assessments and investigations (Oyefusi, 2007). For example, most spills in  
2 the Niger Delta occur in remote locations where transportation is limited (e.g.  
3 helicopters and boats used to access spill sites). Under these circumstances, regulators  
4 will depend on operators to provide access to spill sites. Experts suggest that this type of  
5 engagement might interfere with the completion of a risk assessment leading to biased  
6 reporting of the cause, volume, and extent of an oil spill (Eneh, 2011; UNEP, 2011;  
7 Könnert, 2014). At a higher level, this type of engagement could potentially present  
8 opportunities for corruption or abuse of the regulatory process.

9 Fragmented legislation, insufficient funding, and a lack of expertise pose a significant  
10 challenge to contaminated land management in Nigeria. In addition, the regulation does  
11 not effectively assign liability. Rather than outlining a process to identify and apportion  
12 liability, the EGASPIN states that the operator is liable for all oil spills (DPR, 2002).  
13 While this ensures the operators take responsibility for security and integrity of oil  
14 extraction and exploration infrastructures such as pipelines, it does not achieve the  
15 principle of polluter pays because there is no action or mechanism in place to identify  
16 and ensure that the operator pays for land contamination (Könnert, 2014). To understand  
17 how Nigeria might address these challenges, we review the UK and the USA  
18 contaminated land management regimes to identify lessons that could be learned and  
19 transferred to a Nigerian context.

20



### 1 **3 Contaminated land management in the UK**

2 In the UK, contaminated land is defined as outlined in Table 1. The UK definition is  
3 specific and reflects the source-pathway-receptor model, which makes it easier for a  
4 regulator to identify contaminated land and determine the level of contamination.

5 The onset of urban land contamination in the UK can be traced back to over 200 years  
6 (Kossoff et al., 2016; Pizzol et al., 2016; Swartjes, 2011). There had been concerted  
7 efforts from the Government, regulators, the regulated and policy makers to ensure that  
8 the legacy of contaminated land and associated risks is addressed (Forton et al., 2012).

9 Today, the UK contaminated land management regime is a reference point for many  
10 countries such as China (Brombal et al., 2015), Cameroon (Forton et al., 2012) and  
11 European countries (Rodrigues et al., 2009b). Different approaches for decision making  
12 on contaminated land have been developed and evolved over the past few decades  
13 through extensive scientific investigation from being cost-centric in the 1970s, techno-  
14 centric in the 1980s and risk-based in the 1990s (Pollard et al., 2004a) to a much more  
15 integrated and sustainable technique (Bardos et al., 2016).

16 Initial attempts to regulate land contamination in the UK were introduced in the Town  
17 and Country Planning Act of 1947. In 1974, the Control of Pollution Act was  
18 introduced, and this Act specified the different types of pollutions (e.g. waste on land,  
19 pollution of water, noise, and air pollution) that might be encountered in the planning  
20 process. A contaminated land management strategy was initiated in the UK in 1976  
21 with the development of the Inter-departmental Committee on the Redevelopment of  
22 Contaminated Land (ICRCL) (Rodrigues et al., 2009a). The mandate of the ICRCL was  
23 to provide experts with the necessary tools to assess and manage the risks associated

1 with contaminated land. In particular, the ICRCL published a set of guidance for the  
2 management of human health hazards that might result from exposure to contaminated  
3 land (Guidance Note 59/83, 1987). The ICRCL also developed trigger values for three  
4 groups of pollutants (i.e. toxic metals, aggressive substances, and phenols) and assigned  
5 land use categories to support risk assessment and management decisions (Rodrigues et  
6 al., 2009a).

7 As time passed, concerned stakeholders like landowners and developers, regulators, and  
8 local authorities, demanded more specific contaminated land regulation. As a response,  
9 the UK Government developed two principal regulations: the Town and Country  
10 Planning Act 1990 and Part 2A of the Environmental Protection Act 1990 (Catney et  
11 al., 2006). The main purpose of these regulations was to improve the identification of  
12 contaminated land that posed an unacceptable risk to human health and environmental  
13 receptors (EA, 2002). Additionally, Part 2A was intended to prevent new  
14 contamination, promote remediation and redevelopment of legacy sites, and to intervene  
15 where development might not be feasible because a site could pose risks to receptors  
16 (Brombal et al., 2015; Luo et al., 2009). Founded on risk-based principles, Part 2A was  
17 intended to promote voluntary clean-up on about 10% of sites in the UK, while the  
18 majority of sites were remediated as part of normal land development processes under  
19 the Town the Country Planning Act 1990 (Luo et al., 2009). Stakeholder consultations  
20 are a central tenet of the redevelopment process, and are used to create awareness,  
21 harness contributions to new policies, and educate the public about changes or updates  
22 to contaminated land management policy. The precautionary and polluter pays  
23 principles are also significant components of UK contaminated land management. The

1 precautionary principle promotes discretion in the presence of uncertainty, seeking to  
2 protect the public from exposure to harm (Reinikainen and Sorvari, 2016), while the  
3 polluter pays principles assigns liability for clean-up on the person or persons  
4 responsible for the release of a polluting substance (Catney et al., 2006; EA, 2009a).  
5 Appropriate persons are classified further: Class A persons are those who knowingly, or  
6 unknowingly, permitted polluting substances in, on, or under land while Class B  
7 persons are the owners or occupiers of a site who may be liable if the actual polluter is  
8 not found (DEFRA, 2012). If neither a Class A nor B person is found, the site is  
9 classified as an ‘orphan site’ and becomes the responsibility of the local council  
10 (DEFRA, 2012). The UK’s polluter pays principle has been adapted by other countries,  
11 including the Netherlands, and Finland (Rodrigues et al., 2009a; Sorvari et al., 2009).

12 Pragmatically, Part 2A provides practitioners with a series of steps to assess the risk  
13 associated with contaminated land. These steps include: identification, determination,  
14 liability, appeals against remediation notice, and offences of non-compliance, among  
15 others (UK Government, 1990). Statutory Guidance (SG) to aid implementation has  
16 also been refined over the years to clarify the objectives of legislation and thus support  
17 its implementation. Also, as new scientific knowledge becomes available it is integrated  
18 into the SG documents, thus providing a routine update that demonstrates a desire for  
19 continuous improvement of legislation. For example, to achieve a more targeted  
20 approach to identifying and managing contaminated land in relation to the risk (or  
21 possibility) of harm to human health, the revised SG presented in 2012 established a  
22 new four category system for considering land under Part 2A. Categories range from  
23 Category 4, where the likelihood that land poses a significant possibility of significant

1 harm is low, to Category 1, where the likelihood that land poses a significant possibility  
2 of significant harm is unacceptably high (CL:AIRE, 2014). The Impact Assessment  
3 (IA) that accompanies the revised SG explains this system in more detail and identifies  
4 a potential role for Category 4 Screening Levels (C4SLs) to provide a simple test for  
5 deciding whether land is suitable for use and thus not contaminated.

6 Overall, the UK's contaminated land legislation uses a risk-based, tiered approach to  
7 support decision making as outlined in CLR 11 (DEFRA, 2012; DEFRA and EA,  
8 2004). Tier 1 requires that a potential connection be identified between a hazard and a  
9 receptor, and this is done using the source, pathway and receptor S-P-R model (EA,  
10 2004). The S-P-R model is a critical component for determining a potential pollutant  
11 linkage, which indicates the potential presence of risk (EA, 2004; Rodrigues et al.,  
12 2009; Nathanail et al., 2013). If a pollutant linkage is established, the process moves to  
13 Tier 2, which requires the completion of a generic quantitative risk assessment. This  
14 assessment is supported by soil guideline values (SGVs). SGVs are scientifically  
15 derived contaminant thresholds designed to protect human health from exposure to  
16 long-term contamination in soil (EA, 2009b). SGVs are based on specific land use,  
17 assumptions about contaminant behaviour, and the sources, pathways, and receptors  
18 (Cheng and Nathanail, 2009). If guidance values are unavailable, professional bodies  
19 (e.g. Land Quality Management) might provide generic assessment criteria (GACs) to  
20 simplify the risk assessment process and provide a benchmark for decision-making  
21 (DEFRA and EA, 2004; Forton et al., 2012). At a high level, SGVs serve as screening  
22 tools to determine whether or not a site requires further assessment, based on the effects  
23 to human health. If SGVs are exceeded, the process moves to Tier 3, which requires the

1 completion of a detailed quantitative risk assessment (Carlon et al., 2007). In such  
2 instances, there is need to develop and use site specific information to inform the risk  
3 assessment process. This will necessarily require the development of Site Specific  
4 Assessment Criteria to enable informed decision-making in the risk assessment process.  
5 Overarching this process is the consideration of sustainability, whereby risk assessors  
6 and policy makers ensure that the decision-making process integrates stakeholders, and  
7 that the final decision returns environmental, economic, and societal benefit to the  
8 public (Bardos et al., 2016; Hou et al., 2014).

9 Funding to manage contaminated land is provided through the land capital grant  
10 scheme. Local authorities can use the fund to clean-up historic sites, however this  
11 funding has been reduced over time and is expected to end in April 2017 (Mills and  
12 Reeve, 2015).

13 Responsibilities within government to manage contaminated land are divided between  
14 departments. Local Authorities are responsible for delivery, and focus on the protection  
15 of human health, inspection, identification, and maintenance of a contaminated site  
16 registry. They also play a role in the management and monitoring of clean-up actions,  
17 and the facilitation of public consultations. The Environment Agency (EA) provides  
18 support to Local Authorities and is responsible for managing Special Sites, which are  
19 those where soil is contaminated by explosives or radioactive substances, are owned by  
20 the Ministry of Defence, or directly impacts on controlled waters (EA, 2009a, Catney et  
21 al., 2006; Defra, 2012). The EA, together with Defra develop policies and supervise  
22 implementation.

23

#### 1 4 Contaminated land management in the US

2 The statutory definition for contaminated land in the USA is outlined in Table 1. Similar  
3 to the UK definition, it identifies what constitutes a hazard, and specifies the need to  
4 protect human and environmental receptors. This provides regulators with direction to  
5 identify and quantify contaminated land.

6 Contaminated land regulation in the USA originated from concerns about the effects of  
7 contaminated soil and water on human health and the environment (Bearden, 2012). The  
8 first legislation for contaminated land management was part of the National Oil and  
9 Hazardous Substances Pollution Contingency Plan (NCP), which was developed in  
10 response to the *SS Torrey Canyon* oil tanker spill off the South West coast of the UK in  
11 1968 (USEPA, 2016). This strategy was developed to help officials cope with similar  
12 types of spills in the USA, and served as a blueprint for response to land contamination  
13 from oil spills and hazardous substances in the USA. In 1976, the Resource  
14 Conservation and Recovery Act (RCRA) was developed to manage contaminated land.  
15 Briefly, the RCRA addressed the management and disposal of hazardous wastes and  
16 was the basis of contaminated land management up until 1980 (CERCLA, 2002;  
17 Nathanail et al., 2013). Incidents such as the Santa Barbara oil spill of 1969 (Hendy et  
18 al., 2015), and the hazardous waste deposited at the Love Canal, NY in 1978 (Austin et  
19 al., 2011) further raised the profile of contaminated land in the USA, and in 1980 the  
20 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)  
21 was developed. Commonly referred to as the Superfund programme, this act was used  
22 to designate funding (generated from taxation of the chemical and petroleum industries)  
23 to the remediation of historically contaminated sites (Rodrigues et al., 2009a). In 1986

1 the Superfund programme was updated (i.e. Superfund Amendments and  
2 Reauthorisation Act) (Nathanail et al., 2013) to include the introduction of community  
3 awareness initiatives, and to broadened the public's access to information about the  
4 potential threats posed by contaminants. The Superfund program has been very effective  
5 with remediation action taken on 2436 sites, of which 428 sites have been completely  
6 remediated (USEPA, 2012). In addition, 1,361 sites have been listed on the National  
7 Priority List (NPL), which is a list of national priority sites based on the type of  
8 contamination and the threat it poses to public health.

9 Similar to the processes of the UK, the Superfund process comprises a series of steps  
10 that support the decisions that lead to the remediation of contaminated lands. These  
11 steps include definition of contaminated land, prescription on how to issue abatement  
12 notice, financial liability, clean up (including removal and remedial measures), and  
13 litigation procedures, among others. Risk Assessment Guidance for Superfund (RAGS)  
14 was developed to clarify the procedures and aid practitioners' implementation of the  
15 CERCLA (USEPA, 1997; Kowalski et al., 2002).

16 The USA approach is risk-based, similar to the UK, but the two systems differ in how  
17 they score and assess priorities to human health and ecological receptors. To assess the  
18 risk to public health and the environment the USA uses a Hazard Ranking System  
19 (HRS) that comprises a score based on the assessment of likelihood to cause harm, the  
20 behaviour of a substance, and the proximity of receptors in the area. These scores are  
21 used to determine the status of a site and if a site scores sufficiently high, it is listed on  
22 the USEPA's NPL, thus classifying it as requiring long-term clean-up (DeLong, 1995;  
23 Rahm, 1998). The USA also enforces the polluter pays principle once a potential

1 responsible party (PRP) has been identified. Where no PRP is identified, the regulator  
2 takes up remedial action and ‘apportions liability’ to a PRP when one is identified  
3 (CERCLA, 2002). Regarding sustainably, the USA also ensures that final decisions on  
4 contaminated land management will provide benefits to society, will reduce  
5 environmental footprints, and will lessen economic impacts (Hou and Al-Tabbaa, 2014;  
6 Hou et al., 2014).

7 Guidance documents are available to support practitioners and these include ASTM  
8 International’s health-based site clean-up criteria (Rodrigues et al., 2009a), the Regional  
9 Screening Levels (RSLs) for human health and different land use (USEPA, 2015), and  
10 the contaminated sediment remediation guidance for hazardous waste sites (USEPA,  
11 2005). Programmes have also been initiated to support remediation work on superfund  
12 sites and these include the site-specific risk based corrective action programme, and  
13 voluntary clean-up programmes (De Sousa, 2001; Rodrigues et al., 2009).

14 Responsibility to regulate contaminated sites falls within the jurisdiction of the USEPA.  
15 Oversight of risk assessments and remediation activities is the responsibility of the  
16 State, except in the instances of contaminated land emergencies (e.g. spills) and  
17 hotspots (sites that require urgent attention) where regional teams take the lead and  
18 report to the USEPA (CERCLA, 2002).

19



1 **5 Lessons learned: recommendations that could benefit contaminated land**  
2 **management in Nigeria**

3 The Nigerian contaminated land management system lags behind those in the UK and  
4 the USA in terms of its effectiveness to identify relevant sites, conduct appropriate  
5 detailed risk assessments, and to initiate remediation activities. Nigeria lacks a  
6 comprehensive regulatory framework for contaminated land management that integrates  
7 sustainability appraisal. More specifically, Nigeria requires a more effective statutory  
8 definition for contaminated land, better regulatory coordination, mechanisms to  
9 apportion liability, soil screening values, training, proportionate fund, and technical  
10 expertise. In the following section we will discuss how lessons from the UK and the  
11 USA might be used to address these gaps (Table 2).

12

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**Table 2:** Lessons based on the UK and USA experiences that might benefit contaminated land management in Nigeria

	<b>UK</b>	<b>USA</b>	<b>Current practice in Nigeria</b>	<b>Recommendations for Nigeria</b>
<b>Statutory definition</b>	Clear statutory definition for contaminated land that makes reference to the S-P-R and pollutant linkage methodology.	Clear definition for contaminated land that makes, and identifies the significance of the S-P-R relationship.	The current definition is ambiguous and does not make reference to source of hazard, pathways and receptor	Revise existing guidance to provide a statutory definition for contaminated land that refers to the S-P-R model.
<b>Regulator structure and capacity</b>	The local authorities and the EA are well coordinated with clarity of roles and standards. Both authorities are equipped with technical personnel.	The USEPA is well coordinated and understands its roles. It is adequately equipped with appropriate training, technical, and human resources.	Multiple and overlapping regulatory agencies exist. Lack of periodic training and capacity building and development platforms.	Revise existing guidance to clearly define roles and responsibilities of agencies. Provide regular training to improve capacity for contaminated land identification and remediation techniques.
<b>Funding contaminated land</b>	Government funding has been reduced. Policy encourages voluntary remediation by private land owners.	Government funds contaminated land clean-up via the Trust Fund. Voluntary remediation is encouraged.	There is no funding mechanism or structure for oil contaminated land management.	Adequate legislation including the polluter pays principle should be enforced for pollution events and approaches to deal with ‘orphan sites’ outlined. In the short term, a Trust Fund should be established with contributions from crude oil sales to fund contaminated land clean up. This has started in Ogoniland although the

<b>Technical approach</b>	Land use is considered in the assessment. Scientifically derived values such as GACs and SSTLs are used for screening contaminants.	Land use is considered in the assessment. Scientifically derived endpoints and the HRS method are used to screen sites (CERCLA, 2002)	Generic soil screening values which might be inappropriate for the Nigerian environment are used for contaminant screening.	source of funding is not sustainable. Produce nationally consistent methods for deriving human health and ecologically appropriate screening values that consider land use (i.e. fit for purpose).
<b>Liability</b>	Appropriate Person (AP) is identified through a structured process. AP could be Class A or B (EA, 2009a).	Potential Responsible Party (PRP) is identified through a structured process. The regime practice both strict and joint liability (CERCLA, 2002).	There is no structure for identifying or allocating liability to a polluter.	Stringently implement the polluter pays principle. Implement means to identify a polluter and apportion liability
<b>Sustainability appraisal</b>	Contaminated land management decisions are based on maximising societal benefits, while reducing costs, and environmental damage.	Sustainability is geared towards reducing the environmental footprint of contaminated land management decisions.	The current approach to contaminated land management does not integrate sustainability principles and thus maximising societal benefits is challenging.	Develop a policy to integrate sustainability indicators that maximise societal benefits, reduce cost, and environmental footprint into management decisions.
<b>Public awareness</b>	Extensive consultations are held to educate the public and create awareness of new policies and changes to contaminated land management policies.	Public awareness programmes are undertaken to educate stakeholders and members of the public of changes to policy and identified contaminated sites	Low public awareness and participation in contaminated land management.	Increase public awareness via different media such as symposia and workshops in rural and urban areas to inform the public about contaminated land policies and impacts.

1 **5.1 Statutory definition for contaminated land**

2 To distinguish between lands that are deemed contaminated and those that are not  
3 requires a clear statutory definition (Catney et al., 2006). The provision of a definition  
4 sets the basis for quantifying the extent and scale of contamination (Walton, 1997), and  
5 informs the risk management approach used to contain and treat contamination. For  
6 example, the UK statutory definition (Table 1) identifies receptors (i.e. human health,  
7 land and controlled waters) that must be protected (Luo et al., 2009), as well as the  
8 authority responsible for management. Definitions from the USA provide details about  
9 what constitutes a release, or a hazard, which can guide management activities.  
10 Elements of the source—pathway—receptor model are present in both definitions. The  
11 statutory definitions in the UK and USA reflect the risk-based model, reduce ambiguity,  
12 and identify receptors that could be impacted.

13 Definitions for contaminated land management in the EGASPIN are broad and generic  
14 (see DPR, 2002), which could lead to ambiguity about the risks presented by  
15 contaminated land (e.g. hazards, receptors, exposure). The current definition (see Table  
16 1) might benefit from more information about the environment (e.g. land and water), the  
17 hazard, and the harm. For example, the UK the definition includes harm to ecological as  
18 well as human receptors. Subtle changes in language are needed to improve the  
19 specificity of the definition, to differentiate land use and to reduce ambiguity.

20

## 1 **5.2 Regulatory coordination**

2 Effective implementation of regulation requires a coordinated regulatory system across  
3 government. Nigerian regulatory coordination for contaminated land management is  
4 flawed, evidenced by fragmented responsibility across Government (e.g. federal, state,  
5 and local) and between agencies (e.g. DPR and NOSDRA) (Figure 3). Poor  
6 coordination could lead to a duplication of efforts, discordant environmental  
7 governance, and unethical behaviour, such as corruption (Ajayi and Ikporukpo, 2005;  
8 Ajai, 2010; Eneh, 2011; Ambituuni, Amezaga and Emeseh, 2014).

9 Both the UK and USA contaminated land regulatory regimes are decentralised, and  
10 their functions are facilitated by clear roles and responsibilities spread across different  
11 stakeholders so as to avoid duplication of effort (Catney et al., 2006). For example, UK  
12 responsibilities are shared between the Environment Agency and local authorities, with  
13 each actor responsible for a specific activity so as to minimise duplication and the  
14 chance of conflicting reports (DEFRA, 2012). Similar structures are present in the USA  
15 where the roles of the USEPA and the Regional Decision Teams are clearly defined and  
16 separated (CERCLA, 2002). Learning from the UK and USA, the roles and  
17 responsibilities between DPR and NOSDRA need to be redefined and where possible, a  
18 system should be developed to coordinate actions for human health, water,  
19 environmental management, as well as emergency response (EA, 2009; Luo et al.,  
20 2009).

21 When redefining roles and responsibilities, Nigeria must separate responsibility for  
22 environmental enforcement and revenue collection to avoid opportunities for corruption.  
23 Lessons can be learned from the USA where the potential for conflict of interest within

1 the USA Department of Interior (responsible for the collection of oil royalties and  
2 environmental pollution management) became apparent during the Deep Water Horizon  
3 oil spill in 2010. In response, the USA divided responsibility between the USA Bureau  
4 of Safety and Environmental Enforcement (inspection and environmental management)  
5 and the Office of Natural Resources Revenue (revenue collection) (Ramseur and  
6 Hagerty, 2013). Similar examples for redefining roles exist elsewhere that relate more  
7 closely to developing economies (e.g. Thailand) (Singkran, 2014).

8 Coordination can also be used to improve the promptness of reporting and response  
9 time by locating teams near to communities that are prone to contamination (e.g. oil  
10 spills), or home to legacy sites (i.e. past spill sites). The USEPA uses this approach to  
11 locate regional teams across the county; a process that expedites the identification and  
12 reporting of spills and contamination. In Nigeria, this mechanism could be used to  
13 involve local committees to monitor pipelines and report spill incidences to the central  
14 regulator. This small-scale approach might also address issues about pipeline vandals or  
15 spontaneous pipeline cracks (Orubu et al., 2004).

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### 1 **5.3 Risk-based decisions**

2 Governments must prioritise the allocation of limited resources to clean-up  
3 contaminated sites. Decisions to prioritise sites are often risk-based, and frameworks to  
4 assess risk adopt the source-pathway-receptor (SPR) model (Luo et al., 2009;  
5 Reinikainen and Sorvari, 2016). The SPR model determines whether there is a linkage  
6 between pollutant and receptor (Rodrigues et al., 2009b; Swartjes, 2011; Defra, 2012).  
7 If no pollutant linkage is identified then there is no risk, but if risk exists, an assessment  
8 of severity can be used to identify those sites that pose a significant risk to receptors  
9 (Nathanail et al., 2013). Importantly, this process promotes the use of evidence to justify  
10 decisions (Reinikainen and Sorvari, 2016).

11 Both the UK and USA use risk-based models to identify and manage contaminated sites  
12 (CERCLA, 2002; Defra, 2012; Kiel, 2013). Nigeria, on the other hand, lacks a  
13 comparable risk-based framework despite reference to the establishment of pollutant  
14 linkages in the EGASPIN (DPR, 2002). Opportunity exists for Nigeria to directly adopt  
15 risk-based best practices from either the UK or USA. By adopting these practices,  
16 Nigeria can avoid unnecessary assessments and the associated economic burden. For  
17 example, in the absence of risk (where no pollutant linkage exist), the requirement for a  
18 detailed site assessment should be negated (see DPR, 2002). The most profound  
19 benefits that Nigeria could realise by adopting a risk-based approach would be the  
20 increased transparency, logic, and evidence-base for decision-making about  
21 contaminated land.

22

## 1 **5.4 Soil screening values**

2 Soil screening values (SSVs) are pre-determined contaminant concentrations found in  
3 soil or groundwater that represent a threshold concentration, above which further risk  
4 assessment might be necessary (EA, 2004b; Cheng and Nathanail, 2009). SSVs focus  
5 on harm to human health and ecological receptors (MfE, 2006). The UK has developed  
6 soil guideline values (SGVs) that are specific to human health protection (CL:AIRE,  
7 2010), but exceedance of SGVs does not expressly indicate the existence of risk,  
8 because other factors like pollutant linkages must also be considered (DEFRA, 2012).  
9 The USA has developed soil-screening levels (SSL) that protect both human and  
10 ecological receptors from exposure to harm and are also used as target levels for clean  
11 up. These values are dependent upon soil type and land use classifications, so they will  
12 vary from site to site and might not be transferable to different countries (Rodrigues et  
13 al., 2009; Defra, 2012).

14

15 Nigeria uses generic SSVs to assess contaminants in soil. These values were taken from  
16 different international guidelines, which has led to conflicts in terminology (e.g.  
17 acceptance criteria, trigger values, maximum acceptable values, environmental quality  
18 guidelines, intervention levels), receptors, and methodologies and assumptions.  
19 Concerns about the appropriateness of SSVs used in Nigeria (derived from ASTM for  
20 the USA) have been raised, along with their presumed fitness for purpose (Cheng and  
21 Nathanail, 2009), which has contributed to the uncertainty experienced by practitioners  
22 and regulators when investigating contaminated sites (UNEP, 2011; Ambituuni,  
23 Amezaga and Emeseh, 2014). Nigeria needs an overarching national guideline that sets



1 out a method to derive contextually relevant SSVs that protect human and ecological  
2 receptors.

### 3 **5.5 Liability and funding**

4 Clean-up of contaminated sites can be prohibitively expensive and funding is arguably  
5 the most important challenge facing contaminated land management. Funding  
6 availability is an on-going concern in Nigeria, despite the one-off investment of 1  
7 billion USD provided by the Nigerian Government and liable operators to clean-up  
8 contamination in Ogoniland (Orubu, Odusola and Ehwarieme, 2004; Steiner, 2010;  
9 Anyanwu, 2012). The effectiveness and sustainability of this type of fund is unknown  
10 (Könnet, 2014). The USA addresses funding challenges through their Superfund  
11 mechanism, which transfers funds from the chemical and petroleum industries (as a tax)  
12 to clean-up activities. UNEP (2011) suggested a similar approach for Nigeria whereby a  
13 percentage of the Excess Crude Account (petroleum royalty scheme) could be assigned  
14 to a contaminated land management fund.

15 In the UK and USA, funding is a function of liability (the process of identifying the  
16 person or group of persons that have unknowingly or deliberately contaminated land)  
17 (Alberini et al., 2005; Catney et al., 2006; Larson, 2005; Luo et al., 2009; Zhao, 2013).

18 In the UK, the polluter pays principle ensures that the liable parties pay for the damage  
19 done to the natural environment, (Luppi et al., 2012; Zhu and Zhao, 2015). Nigeria  
20 could adopt the polluter pays principle, or assign responsibility to the operator, or the  
21 owner of an exploratory license (EA, 2009a). Regardless, Nigeria could benefit from the  
22 adoption of structured approaches for assigning legal responsibilities similar to those  
23 used in the UK and USA (Nathanail et al., 2013). These responsibilities, used in

1 conjunction with insurance mechanisms, could be used to manage contamination due to  
2 pipeline sabotage or vandalism. While we recommend an effective policy detailing the  
3 different elements of a contaminated land policy, Nigeria's structure should also include  
4 a protocol for polluter identification, evidence to determine liability, site investigation,  
5 nature of polluter's involvement and polluter's potential defence.

## 6 **5.6 Training and expertise**

7 The practice of contaminated land management continues to evolve (Brombal et al.,  
8 2015) and in order to remain current, practitioners must receive regular training and  
9 retraining (Bardos et al., 2016). Skills acquisition is a means to build and maintain  
10 expertise and many countries integrate regular training into their contaminated land  
11 management policy frameworks (Luo et al., 2009; Brombal et al., 2015).

12 Agencies for managing contaminated land in the UK and USA continually train and  
13 educate their personnel to keep up with innovation and change (Luo et al., 2009). In the  
14 UK, practitioners have access to numerous training platforms e.g. Sustainable  
15 Remediation Forum (SuRF) UK (Bardos et al., 2016), Network for Industrially  
16 Contaminated Land in Europe (NICOLE) (Bardos, 2010), and the Contaminated Land  
17 Rehabilitation Network For Environmental Technologies in Europe (CLARINET)  
18 (Vegter, Lowe and Kasamas, 2002).

19 The level of contaminated land management expertise in Nigeria is low, and training  
20 networks like those in the UK are not readily available. In the absence of technical  
21 expertise, agencies like DPR and NOSDRA depend on the knowledge of operators to  
22 conduct site investigation (Ambituuni et al., 2014), which might influence the assessment  
23 about the volume of a spill or its perceived level of impact (Eneh, 2011). We believe that

1 Nigeria has two options to improve the technical expertise levels. The first is to develop  
2 training platforms like those in the UK, to provide a mechanism for regulators and other  
3 practitioners to exchange knowledge and develop skills. Development of such networks  
4 requires time and effort, and therefore a more immediate solution might see Nigeria  
5 develop strategic partnerships with organisations like SuRF and NICOLE to provide  
6 training. Advantages of this approach would include a rapid up-skilling of the workforce  
7 and an immediate introduction of global best practice into Nigeria.

### 8 **5.7 Public awareness**

9 Public awareness comprises elements of education, communication, and understanding,  
10 and the facilitation of awareness requires mechanisms that enable the public to actively  
11 participate in the management of contaminated land (Sorvari et al., 2009; Erdem and  
12 Nassauer, 2013). These mechanisms include seminars, workshops, exhibitions,  
13 conferences, or websites, which are used to initiate open dialogues between different  
14 contaminated land stakeholder groups.

15 Public awareness about contaminated land, spills, and regulations in Nigeria is low  
16 (Ugochukwu and Ertel, 2008) and one might argue that this has led to the deliberate  
17 release of crude oil into the environment (e.g. pipeline vandalism) or restrained urgency  
18 in dealing with contamination (Nwilo and Badejo, 2005). By contrast, public awareness  
19 in the UK is high, due to media coverage and the use of public consultations. This is  
20 usually done in to form of extensive stakeholder consultation and is used to raise  
21 awareness, and educate residents, land developers, and the public about the issues  
22 associated with land contamination. Prior to publishing Statutory Guidance in the UK,  
23 stakeholder consultations were held to ensure that the public and interested parties could

1 contribute to the guidance and be made aware of the issues (DEFRA, 2012). The use of  
2 public consultation is ingrained in UK governance, whereas it would be a new concept  
3 for Nigeria. To initiate public awareness Nigeria could use local mechanisms (e.g.  
4 town-crier) to reach out to the local population to make them aware of the impact of  
5 spills on, for example, soil fertility or fishing waters. Education might discourage acts  
6 of deliberate contamination (Ukeje, 2001; Ugochukwu and Ertel, 2008), and would  
7 improve awareness of environmental issues and their governance.

## 8 **5.8 Sustainability appraisal**

9 The trend in contaminated land management is towards sustainability, whereby  
10 decisions about contaminated land management integrate socio-economic and  
11 environmental concerns (Bardos et al., 2016; Sam et al., 2016). Sustainable approaches  
12 are intended to ensure long-term benefits and to avoid unsustainable clean-up decisions  
13 (Kiel, 2013; Kapp, 2014). Both UK and USA regimes have developed initiatives that  
14 integrate sustainability principles into their contaminated land management decision-  
15 making processes (Bardos, 2009; P. Bardos et al., 2011; R. P. Bardos et al., 2011;  
16 CL:AIRE, 2015). For example, the USA encourages operators to reduce the  
17 environmental footprint of remediation strategies (Hou et al., 2014; Hou and Al-Tabbaa,  
18 2014).

19 With the benefit of time, the UK and USA have been able to incrementally improve  
20 their contaminated land management programs, but Nigeria has the opportunity to  
21 rapidly advance their program by integrating sustainability principles from the  
22 beginning. Introducing frameworks like the UK's protocol for sustainability appraisal,  
23 or the USA's approach for minimising the environmental footprint of remediation

1 practice (Bardos et al., 2012; Hou et al., 2014), would provide a step-change  
2 advancement that would benefit Nigeria by ensuring that solutions consider social,  
3 economic, and environmental factors fairly (UNEP, 2011). Implementation will require  
4 education, for example, communication amongst stakeholder groups affected by  
5 contaminated land (Booth, 2015). Sustainability forums that encourage the exchange of  
6 innovative ideas might also be considered, for example, the Sustainable Remediation  
7 Forum US (SuRF US), SuRF UK, and SuRF Australia (Bardos et al., 2016).

8

## 9 **6 Conclusions**

10 Contaminated land management in Nigeria suffers from a number of gaps, or  
11 limitations: lack of a clear statutory definition for contaminated land, poor coordination  
12 of governance, lack of a risk-based approach, inexperience, weak policy frameworks,  
13 and limited funding, yet there is opportunity for Nigeria to learn lessons from other  
14 countries (e.g. UK, and USA) to improve their system. In this paper, we reported on a  
15 number of recommendations that Nigeria could adopt from the UK and the USA  
16 regimes. Specifically, Nigeria could benefit from an improved definition of  
17 contaminated land, better regulatory coordination, adoption of risk-based decision tools,  
18 development of soil screening values, improved determination of liability, a means to  
19 generate additional funding, and the integration of a sustainability assessment. Progress  
20 to develop and implement contaminated land management regulation in Nigeria has  
21 been slow, yet despite Nigeria's urgent need for clear regulatory policy we do not  
22 believe it should rush into the transfer of policy from elsewhere. This is because success  
23 will depend on how well Nigeria is able to contextualise policy to meet their unique

1 environmental, economic, cultural, and political needs. We suggest that further research  
2 is needed to understand these contextual needs, how they might affect policy transfer,  
3 and how knowledge about these needs can be used to improve contaminated land  
4 management in Nigeria.

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