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"Paradigm on sustainable human health, environment and petroleum-contamination: Constraints and Challenges"

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Abstract

Human-generated, natural occurrences and other actions connected with the petroleum industry have contributed expansively to the contamination of numerous areas of human habitant, thus effecting overwhelming challenges and constraints to sustainable human health, development and the biosphere. The sites commonly associated include derelict pits, hydrocarbon onshore release sites, and places to where oil slicks exuding from offshore releases are blown onshore. In diverse cases, remediation is pertinent to restore the affected ambient. This is required despite the complexity and intricate pore structure and fluid trafficking trajectories of soil which are not easily amenable to remediation. Due to the complex assemblage of contaminated soil, it is necessary to conduct an encompassing site assessment by considering the potential impact of the environment and human health prior to proper selecting and implementing of a desirable remediation process. There are extant remediation methodologies which are effective and efficient for the clean up of contaminated shorelines and other petroleum-contaminated sites involving inter alia agricultural activities. There are salient variations in the techniques to expunge contaminants regarding spatiotemporal and pecuniary costs or considerations due to the gross environmental hazards entailed. This study provides for the opportunity to harness and sustain the capacity for the mitigation of untoward impacts, and induce the latitude for an enabling condition in sustainable human health, environment and development in the petroleum industry and other anthropogenic activities.

Key words: environmental impact assessment, remediation, petroleum-contaminated sites, environment, health, capacity building

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Introduction

This study considers the challenges and constraints as they fit into the local, ecological, sociological and economic environment of oil producing areas and storage sites of the petroleum industry. Environmental petroleum hydrocarbon exposure is a frequent occurrence either as a result of anthropogenic activities or accident with resultant site derangement or contamination, and deranging effects on human health and other biota. Petroleum and its products as evidenced by the global petrochemical industry constitute an integral part of modern developed society. Petroleum is located in several sedimentary rocks. It is the by-product of organic matter decomposition at high temperatures spanning millions of years culminating in a complex mixture of solid, liquid and gaseous hydrocarbons. A vast majority of the world's energy, transportation, electrical utility, heating requirements, lubricants, solvents, highway surfacing, waterproofing, manufacturing of feed stocks, etc are derived from petroleum [1]. Petroleum hydrocarbons generate numerous toxic compounds which are potent immunotoxicants and carcinogens to humans. Remedial technologies to treat petroleum-contaminated environments involve diverse physicochemical and biological tools [2, 3].

Governments and institutions in developing countries have become increasingly aware of the deranging impacts of environmental, natural resources and human health as related to short-term and long-term development potentials. Thus, there is greater inclination for the implementation of veritable measures whereby human health, environment and natural resources are considered in the petroleum exploitative industry. Available land is the veritable source of livelihood in developing countries, as the people are directly dependent on land for the natural resources which provide their employment, food and shelter. Invariably, their welfare and well-being are inextricably linked to the productivity of natural systems. On that score, the socioeconomic repercussions of environmental degradation are more debilitating on the vulnerable population. It is axiomatic that beneficial economic development is proportionally related to the prudent application of environmental resources and on the abatement of the untoward impact of the exploitative petroleum industry. This is derivable by improved project selection, planning, design and implementation. The indirect and direct benefits and costs of the projected exercise must be assessed via economic analyses of alternative development operations. A broader perspective that considers an expansive spectrum of benefits and costs [4] must be included in the proposed project as in petroleum extraction. It is currently globally acknowledged that an ecological and environmental perturbation of potentially catastrophic dimension is imminent. In the pursuit of economic growth buttressed by gross investment solely in the petroleum industry are likely to propound devastating impacts of depletion, destruction and pollution on naturally available veritable resources, such as air, forests, fuels, land, minerals and water. These present a critical situation of much concern and challenges regarding the survival capability of humanity and the biosphere on the on-going production, exploitation and consumption of petroleum resources. The resultant impacts of the petroleum industry are extant pollution and

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environmental deterioration which culminate in the decline in quality of life of a myriad of habitats, acute excruciating deficits accompanied by increasing costs of diverse essential goods, such as fish, forests, fuels and their related products [4].

Components and distribution of petroleum

Petroleum consists of aliphatic and aromatic hydrocarbons, paraffins (aliphatic alkanes) and naphthalenes (cycloalkanes). The physicochemical properties of the chemical compounds are hydrophilic and amphipathic which make them readi;y dissolvable in water, whereas the lipophilic components bind to soil, aquatic sediments and edible crops. Petroleum contaminates soil and water with deleterious effects on vegetables [5]. Thus, petroleum hydrocarbons releases are likely to permeate and contaminate environmental compartments. Due to the complex nature of petroleum releases and the potential impact of severe public health derangement by inhalation, ingestion and dermal contact grave risks are presented to society [1]. Also, Heavy metals are major ubiquitous pollutants in the worldwide soil environment. In oilfields, the crude oil extraction process result in the concomitant contamination of the soil with petroleum and heavy metals. Researchers investigated the effects of oil extraction on the migration, speciation, and temporal distribution of heavy metals, sch as Cu, Zn, Pb, Cd, Cr, Mn, Ni, V, and Mn in soils of an oil region of Shengli Oilfield, China. It was detected that the most vital component of Cd is ion exchangeable and acid soluble; thus indicating that Cd is the most labile, available, and harmful heavy metal in comparison to other elements which damage the soil environment in oil-polluted soil [6].

Petroleum hydrocarbons are highly concentrated in organic contaminants which frequently feature in the marine environment in not too high concentrations as automobile wastes, industrial effluents, domestic wastes, stormwater and urban runoff; and seldom present in higher concentrations as a major spill which are made up of combusted fossil fuels, degraded crude oils and normal alkanes [7]. On the whole, these compounds are characteristically of decreased water solubility, but undergo instant adsorption on particulate matter whereby the compounds are eventually scavenged to benthic sediment as a reservoir for inordinate number of hydrophobic contaminants. The resultant impact is the long-term bioaccumulation and bioconcentration in aquatic organisms which are later consumed by humans and animals. Petroleum hazard is obvious on a global scale. The petroleum-rich Niger Delta is exposed to expansive and debilitating petroleum contamination [8]. Samples of drinking water wells have been detected to contain inordinate quantities of petroleum hydrocarbons, such as benzene at levels circa 1800 times greater than the USEPA drinking water standard. The findings recommended investigation of health symptoms ostensibly related to contaminated water exposure as well as assessment of the sufficiency and consumption of public available drinking water [9].

In essence, Nigeria exemplifies a country in the throes of environmental crisis, and may encounter problems associated with resource depletion, industrial, mining and petroleum pollution. In the near future, there will be complete depletion of our timber, petroleum

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and other mineral resources. With overfishing and marine pollution, fish stocks approach severe depletion, affecting present and future fishing incomes of fishermen and the nutritional intake and buying cost of the population. The impact of crude oil pollution in Nigeria's Niger Delta is inter alia depletion of crop and fish yields as well as soil sterilization [10]. In Nigeria, an excess of one million barrels of oil in eighteen significant oil spillages between 1970 and 1980 led to increased production and compensation costs. Attempts at cleanup and estimation of the toxicity of waste drilling fluids have sometimes been exasperating and frustrating [11]. Microorganisms on drill mud curings obtained from the Agbara oil fields were isolated on mineral salts agar plates, but 27 of the 32 isolates did not grow on any of the drilling fluids [12]. Also, the forest habitat that from an aerial view seems to obliterate much of southern Nigeria has actually undergone extensive alteration by anthropogenic activities such as the petroleum and mining industries both in relation to its fauna and flora [13].

How the issues of petroleum contaminated sites have affected health and environment

The various issues which have been realised on an international scale, invariably propound the inextricable linkage of environmental concepts and human health, welfare and well-being. The global community demonstrates concerns over numerous questions including the purity and cleanliness of the water consumed, clean air for our respiratory and physiological functionalities, and optimum disposal of wastes. Realisation is salient on the same purposeful oil, mining and chemicals are inimical to inter alia human health; thus, depicting an upsurge in the awareness and information dissemination in the interrelatedness of environment, health, petroleum contamination and industrial pollution. In recent times, environmental health issues and concepts have evolved rapidly with the impact of novel technologies, advanced data collation including encompassing functional conceptual framework in public health risk assessment or monitoring and evaluation [14]. It is of immense importance that the public and private sectors of production assume predictive measures for environmental protection in anticipation of untoward events, or their impacts become evident. Thus, environmental consequences or questions must not be exclusively perceived of the economic, political and social paradigms in which they are interrelated. Environmental and developmental issues emanating from mining, petroleum and other industrial activities must not be viewed in isolation. The encompassing policy must acquire concurrent concern to the sources, channels and multiple or aggregate consequences of pollution. The sources may inculcate the social milieu and vulnerable populations which generate specific or unique polluting habits related to demographic, sociocultural and exoticized forces. Also, the unanticipated deranging effects of numerous large-scale development projects in rural communities where these industries are extant become challenges and causes for concern [13]. There is the need for economic planners and policy makers to adopt newfangled paradigms to reason as to effectively manage the complex interplay of petroleum questions in their benefits and debilitating impacts.

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A study [15] revealed that (a) human health was ranked as the highest in importance in Nigeria, followed by natural resources and living settlements, with environmental pollution shadowing them; (b) health and safety was found to be urgent as regards environment and development problems; (c) overpopulation, price supports/farm income for farmers in adverse agricultural conditions, structural adjustment programme and sanitation all ranked in first place for possible improvement at the turn of the century, whereas solid waste disposal and rural Nigeria/poverty were presented with worse outcome; (d) a vast majority of respondents indicated that government actions in dealing with environmental problems before the creation of the Federal Environmental Protection Agency had not been adequate; (e) an urgency for governmental action, the economy (inflation/unemployment) ranked highest followed closely by social welfare (health, social security, education), law and order, environmental and energy problems; (f) 93% of the respondents perceived the need to periodically determine the probable health effects on fauna and flora before the inception of any industrial or mining activity; and (g) 93% of the respondents would oppose any industrial or mining activity in their area of residence that may be harmful to the environment even if it presents more jobs or is economically viable. Another similar study [16] with much greater financial endowments on an international comparative basis showed similar results as in Nigeria that (a) environmental issues are now salient; (b) environmental problems are of grave concern and rated poorly; and (c) the proportion of those selecting environmental protection over economic growth was higher in every nation except Nigeria.

Selection of methodologies for petroleum-contaminated sites

At present, there are extant diverse remediation methods for petroleum-contaminated sites; however, selection of the best tool includes the treatment efficiency and the costs in energy consumption on application [17]. The linkage between the environment, health and successful economic development has assumed intense global momentum, thus generating environmental impact assessment (EIA) that is fundamentally associated with the identification and assessment of the environmental consequences of projects, plans, programmes and policies of development; so that, appropriate choice from extant alternatives is made [18]. EIAs have strictly adhered to development projects, whereas a significant few have been applied to land use and sectoral plans; and in particular, the domestic policies which gave the impetus for the development activities. The intricacy of identification and assessment of environmental development impacts are due to the variants of effects which are liable to be induced by natural, anthropogenic and other activities as observed in the petroleum exploitative industry on environmental and social systems. The identification and assessment of these impacts require extensive data collation and, of course, to present, communicate or articulate the findings to stakeholders; a vast majority of whom may be deficient in the rigorous technicalities associated with the procedure. In order to obviate EIA-related debacles, there is latitude to develop structural aids or paradigms for assessment duly referred to as EIA methods or methodologies [4]. Moreover, following the cessation of the petroleum industry or with an on-going process after a short- or long-term, it is pertinent to conduct an environmental risk assessment (ERA) of the probable consequences on health and the

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environment. The combination of both EIA and ERA generally constitute what is termed environmental assessment (EA). These are necessary to ascertain the extent of contamination in sites resulting from the petroleum industry for correct remediation strategy.

A significant challenge in the future associated with environment and development is configuring how long-term and large-scale interactions can be optimally managed from improved ecological sustainability in extant anthropogenic and other activities in the petroleum sector. The issue is the determination of long-term trends of environmental metamorphosis which pose the potential to limit societal development and growth; to configure applicable information, knowledge and expertise regarding these limits and alternatives or choices to obviate or abate same; to determine, demonstrate, and explicate the scientific experimentation and research, institution or tools necessary in the present and foreseeable future to enhance freedom of action and rights for sustainable development [18-20].

Relevance of appropriate remediation technologies

The technology specific requirements for soil and groundwater treatment methods are gathering great momentum which encourage new and innovative remediation methods combined with adequate monitoring to validate the progress of remediation; and are inter alia (i) bioremediation that takes into cognisance addition of oxygen and nutrients in a controlled setting; (ii) soil vapour extraction (soil venting) that entails installing vertical or horizontal piping in petroleum-contaminated sites; (iii) air sparging involves installing a system that injects clean air below the groundwater table causing air to flow upward via the groundwater conveying volatile contaminants into unsaturated zone above the water table; (iv) aeration evaporates volatile components of petroleum from the soil into the air; (v) thermal desorption heats soil to elevated temperatures resulting in evaporation of certain hydrocarbons; (vi) landfills are least preferred for wastes and may be used in the absence of other solutions; and (vii) groundwater pump and treat is feasible when groundwater is beneath a petroleum contaminated site. Hydrocarbons are, however, located in diverse petroleum-contaminated sites. Within these sites are onshore releases of hydrocarbons, wherein enormous amounts are trapped by capillary pressure as a discrete liquid phase within the pores of the soil. With the release of adequate amount or volume of hydrocarbons, it may be incorporated in a disparate, mobile phase that floats on the groundwater. Hydrocarbons also exist as a vapour in air-saturated pores. It has also been determined that groundwater and soil contamination from light nonaqueous phase liquids (LNAPLs) spills and leakage in the petroleum industry currently constitutes a significant environmental concern in North America [21].

In more than two decades several site remediation technologies, frequently classified as *ex situ* and *in situ* remediation techniques, have been developed and implemented for the cleanup of petroleum-contaminated sites. In recent years, the associated cost of operation using *ex situ* remediation has been expensive. *In situ* remediation techniques are currently in vogue due to operational costs. The selection process of the efficient and effective

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technique necessitates expansive knowledge and expertise, though. The resultant impact of inadequate expertise in the process is untoward augmentation of expenses. Petroleum waste management experts and Artificial Intelligence (AI) researchers co-operatively developed an expert system (ES) to manage petroleum contaminated sites by employing diverse AI techniques to construct an important tool for contaminated site remediation to assist in decision-making. Certain practitioners [22] have established that the remediation procedure is complicated using dual phase vacuum extraction (DPVE) residual phase with groundwater treatment. Individual system components are not conducive to effectively reflect interactions within varied procedures of contaminated fate and transport. In that regard, an integrated process that employs transport, DPVE-assisted remediation and contaminant trafficking may be tenable for both the remediation process and contaminant mitigation at the petroleum hydrocarbon-contaminated site. A model that incorporates a three-dimensional multi-phase and multi-component subsurface is coupled with a DPVE-numerical simulation remediation procedure. As pertaining to western Canada, the developed simulated system is applied to a petroleum-contaminated site in an extant functional DPVE remediation procedure. The developed system presents an effective simulation impact of free-product recovery and groundwater clean up via methodologies of DPVE and groundwater remediation.

Recommended assessment and remediation methodology

In the United States of America, The Petroleum Remediation, Superfund, and Brownfield Programs is geared towards an expansive electronic document management system [23]. The Petroleum Remediation Program (PRP) convened a Consultant's Day training event at the Continuing Education and Conference Center at the University of Minnesota in St. Paul. The PRP safeguards the environment and human health by investigating, evaluating, mitigating, or ameliorating the impacts of petroleum contamination on soil and ground water due to leakage or release from storage tank systems. The main concerns are those incidents which have resulted or may culminate to inimical situations resulting from petroleum vapours, impacted or may impact surface water quality. Thus, the main goal is to make steady provision of clean drinking water and air supplies, as well as prevention of hazards of explosive vapours.

Pathways linking sources of contamination to receptors are eliminated. Prompt response is mandatory where there are extant verifiable detectable affects of petroleum contaminants in drinking water, petroleum vapours in habitat spaces, or petroleum vapours leading to explosive potential in confined spaces. The requirement is free product recovery to a practicable magnitude. On the whole, the PRP undertakes a risk-based trajectory to corrective approach at petroleum release sites [23]. Where there are extant pathways connecting contaminant sources to receptors, risk removal actions may include replacement of the water supply wells or provide potable water from the municipality; long-run point-of-use treatment of contaminated groundwater; or active remediation of soil and groundwater contaminated by petroleum. However, water supply replacement is usually done as it provides the obvious manner of demarcating the pathway linkage between contaminant sources to receptors. In the event of low risks to

receptors and contamination plumes are stable, and contamination is encouraged to occur by time-dependent natural degradation. These measures ensure investigations, cleanups, and prompt closures without compromising the mandate to protect the environment and human health. The PRP makes provision to coordinate with the appropriate or responsible partner and the Department of Commerce for prompt reimbursement of eligible expenses from the investigation and cleanup of petroleum releases [23].

The process of site characterization is determinant of the expansiveness of the contamination and makes provision for the basis for a remediation strategy. It is essential to know the features of contaminants released at the site, such as phase partitioning, mobility and degradation to predict their behaviour in the subsurface and to make the optimum choice of corrective action technology; (ii) amount released to assist predict if the contaminant has reached the saturated zone; and (iii) duration since the release to predict the degradation, volatization, and flushing from infiltrating rainfall which may cause compositional alterations of contaminants over time. These changes known as weathering, may determine the strategy of sampling and the optimum choice of remediation technology. For instance, a long-time release may not be amenable to utilise field observation and screening to fixate sampling locations. Samples need to be obtained and analysed [24] to characterize the contamination, plan and evaluate remedial procedures at a site. Adequate sampling is necessary for the determination of the type and extent of contamination and final cleanup status. All sampling activities must be carefully documented at the petroleum-contaminated site. The rationale of soil sampling is to give information required to decide if soil contamination is extant at unacceptable levels, and if that is the case, to define the expansiveness of the contamination and to make informed planning decisions as well as enhance full site check or site assessment.

These are as follows: (a) to study soil, fauna and flora characteristics or attributes on the site in varied climatic conditions; (b) analysis and estimation of the potential of plants for bioindicating and biomonitoring as well as remediation and phytoremediaion via revegetation [25]; (c) creating a requirement for the incorporation of the economic or pecuniary burden of remediation/revegetation at the cessation of oil exploration for site reclamation and detoxification; (d) conduct spatiotemporal baseline data evaluation for soils and plants in the vicinity of/or proximal to the oil operations; (v) undertake data evaluative assessment of the petroleum-contaminated site (vii) encourage community participation in the assessment and remediation process by inter alia conducting a social evaluation survey of the environmental impact and public health risk assessments relative to other socioeconomic development projects necessary in the area; and (vii) take into consideration the geographical, ethnocultural, religious and land use variations which cut across the sociocultural spectrum of the pluralistic society, such as Nigeria [26] and the United States of America.

The statistical approach entails area-wide sampling of sites where product release has occurred in an expansive area and sites where product may have disseminated over a long distance, making it difficult to ascertain that all areas of contamination have been detected and accurately mapped. These sites may necessitate the use of either random or systematic method to determine where to take samples. A systematic approach involves

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utilisation of the map site, define the suspected area of contamination, minutely partitioning the area by placing an imaginary grid over it; and from each section of the grid, do a sample analysis. By means of a random approach [24], the contractor defines the area of interest and collects samples from locations in that area by random selection. The systematic approach is preferred to the random approach because it gives even coverage of the area. However, when the sampling approached is employed, statistical methods such as a statistical software package (MTCAStat) may be convenient to assist with the calculations. Adequate guidance must be followed with excavated soils concerning the number of representative discrete grab samples to take from stock-piled soils using hand tools or appropriate field instruments or other approved techniques about 18 cm beneath the surface of the pile. The analytical methods are based on the substances released.

Benefits and responsibility in applying this paradigm

This strategy makes provision for a basis for the development of approaches to the management of biological diversity, plant, animal and human health, as well as food-chain linkage, air, soil and water. It is intended to provide information required by owners, consultants, operators and government agencies to assess and clean up contaminated sites resulting from the petroleum industry due to spills, overfills or leaks, commonly observed from underground storage tanks [27] and associated piping. It also makes provision for information on reporting, sampling strategies, standards and regulations for cleanups, as well as to assist operators to conduct cleanup activities at petroleum-contaminated sites without direct supervision of the regulatory authorities. Whereby contaminated soil is in contact with groundwater, or the contamination reaches below the lowest sampling depth, it is necessary to obtain groundwater samples to test for extant contamination, with prompt removal of extant free product by the owners or operators. Owners and operators have direct responsibility to prevent petroleum hazardous materials from disseminating, to monitor and ameliorate fire and hazards due to vapours and free product, and to promptly mitigate the threat posed by exposure to contaminated soils. The rationale for remediation of petroleum-contaminated soils given the budget size, site and regulatory requirements include (a) excavation and disposal of petroleum-contaminated soil; and (b) excavation and beneficial-reuse of petroleum-contaminated soil [27].

For an integrative assessment and remediation petroleum-contaminated sites as well as planning and management of petroleum activities, it is pertinent to inter alia perform site characterization, construction management, remediation design, and regulatory agency liaison. The process of site characterization is determinant of the expansiveness of the contamination and makes provision for the basis for a remediation strategy. In the Nigerian petroleum industry, consultation and public enlightenment have often been reactive rather than proactive. Hence, it is pertinent to adopt strategies that are action-

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oriented and within the encompassing interest of the target groups. Inadequate effective and efficient consultation and public enlightenment have been the impediment of several government programmes that are intended to improve the well-being and welfare of the citizenry [28]. Relevant stakeholders are usually not involved at the conceptual stage of major policies. When efforts are made to inform and prevail on people to appreciate the inherent factors of certain adjustments, they were frequently peremptorily done. The resultant effect is that most Nigerians have, therefore, become indifferent in patronising to the insincere appeals which culminate in more sacrifices from them but fall short in the improvement of their welfare. Consultations with various stake holders to reach a common friendly understanding and consensus on issues pertaining too the oil industry as regards assessment and remediation of petroleum contaminated sites is necessary for a durable policy formulation and implementation. The relevance of the oil industry to the economy and human well-being and welfare makes consultation, participation and creation of awareness among the people necessary to stimulate understanding and interest. Consultation and public enlightenment are essential in promoting understanding of the problems and challenges of petroleum contaminated sites and Government efforts to improve conditions in that sector.

Discussion and Conclusion

The resultant impact of the petroleum extractive and exploitative industries are intricately complex and varied, and are consequences of diverse factors and conditions . These necessitate a multidimensional presentation to harness and curb environmental derangement emanating from noxious agents, such as toxic chemicals and wastes from petroleum-contaminated sites. The sustained success of select environmental programmes in the assessment and remediation of petroleum-contaminated sites in the industrialised nations, and the continuous refinement of environmental goals in a contextually designated sustainable paradigm in conjunction with remarkable accrued knowledge and information in environmental planning and management have culminated in a decision for global concerted trajectories for the maintenance and sustenance of the environment for the health and safety of extant and future generations. However, these goals suffer immensely in less developed countries, and are not entirely undergirded by the perceived gains from the petroleum, mining, chemical industries, certain pecuniary activities and interested stakeholders because they are deficient in the will, capacity and dedication to realise that economics and environmental management are inextricably linked [29]. The quality of the environment and environmental impacts of ecotoxic agents on human health [30] depend expansively on the policies developed and adopted by governments, domestic and international communities. Worldwide environmental perturbations constitute challenges and threats to human health [31],well-being and welfare; but all countries must act cooperatively to decipher trajectories addressing those turbulent issues which present unique conceptual and disparate environmental challenges. Varied concepts have been presented to elucidate environmental issues and concepts which are increasingly pertinent to health [14], well-being and welfare as regards development projects, extractive and exploitative mining and petroleum industries.

Salient environmental perturbations due to large scale consumption of petroleum products in the transportation, agricultural and industrial sectors are due to petroleum hydrocarbon contamination, such as seepage of crude oil, diesel, gasoline, heavy oil, kerosene and augmentation of heavy metal levels. Soil contamination of these products are debilitating to the growth and development of fauna and flora [32]. Oil spills frequently occur accidentally due to errors in anthropogenic activities from inter alia equipment breakdown, and natural disasters accompanied by consequential environmental, human health and economic costs. The degree of exposure is paramount in the risk to human health and the environment as well as the area and human organ involved [33]. Crude oil, refined petroleum products and polycyclic hydrocarbons are commonly present in diverse environmental media. These are capable of bioaccumulation in food chains leading to the derangement of organismal, biochemical or physiological activities which are depicted as carcinogenesis, mutagenesis, perturbation of reproductive capacity and haemorrhagic diathesis in at risk populations. The aetiology and of oil are quantifiable by means of biological end-point parameters or biomarkers. Soil contamination due to spills constitutes a limiting factor to soil fertility. It is, therefore, pertinent to have measures to control petroleum hydrocarbon pollutant in the environment. The main strategy of oil spill bioremediation includes bio-stimulation, nutrient application, bio-augmentation, adapted or competent seeding with hydrocarbonoclastic bacteria or combinations thereof, and genetic genetically-engineered microbes [34].

Due to the complex dissemination of contaminants in the biosphere, it becomes imperative to conduct an encompassing site assessment by considering the potential impact on the environment and human health preceding the choice and appropriate application of an adequate remediation procedure. Several remediation methodologies are effective and efficient to expunge contaminants within shorelines and other petroleum-contaminated sites. There are remarkable variations of these tools for spatiotemporal eradication of contaminants and pecuniary considerations because a vast majority of the remediation procedures invariably entail considerable environmental hazards. For complete remediation/cleanup, on-site treatment is encouraged so that it does not cause a threat to the environment or to health from release of heavy petroleum fumes, contaminated run-off or airborne contaminated soil. The main health and safety modalities for temporary treatment facilities include site safety plans, site monitoring and personnel training. The extent (both vertical and horizontal) of the contamination must be clearly defined. This must be conducted during initial characterization and during treatment. The objective of the sampling is to evaluate treatment progress, perform air monitoring, soil and groundwater sampling as needed, and determine the extent of the cleanup. Following complete maintenance by frequent and regular checks, the treated soil or/and water must be characterized and contaminated soils/water transported to obviate inter alia threat to health and the environment.

Recently, the UN Environment conducted a workshop to strengthen the national capacity to assess and clean up oil contaminated sites due to the Iraqi conflict that was characterized by expansive destruction of looting and infrastructure encompassing petroleum resources and archeological artefacts [35]. The focus was on sampling

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strategies and techniques on the practical aspects of petroleum- and environment-contaminated site assessment. The package comprised potable oil contamination analyses and sampling tools including personnel protective equipment. There emanated the pertinence to undergird the capacity of environmental experts to assess contaminated sites and petroleum activities as well as in the development of pollution monitoring programmes which involve inter alia threat to local communities with impact to extend to future generations without sparing present generations.

In recent years, Iraq witnessed a transformative stride in oil production induced by expansive investments [35]. This portends a major capacity challenge for an environmental staff to monitor and evaluate the performance of the petroleum industry, assess the extant situation and extrapolate future scenarios as could be evident globally. It is, therefore, pertinent to provide the clamour on the environment and human health concerning petroleum-contaminated sites in the provision of leadership and encouraging partnership to care for the environment and human health via inspiration, information, enabling the society and peoples without comprising the quality of life of present and future generations by overcoming the constraints and challenges in petroleum-contaminated sites generated by anthropogenic activities and natural presentations.

Currently, society needs (a) to orientate and promote pecuniary measures for renewable energy sources and efficiency; (b) to create rapid and clean petroleum and mining operations [36]; (c) sustainable environmental petroleum industrial processes; and (d) propound improvement of the management of fisheries, tropical forestry and agriculture as well as other renewable and non-renewable resources. The major objective of this strategic presentation includes poverty alleviation in affiliation with improved predictive understanding of the integrated petroleum-contaminated sites, human interactions, provision of direct benefits as impacts of the petroleum activities are anticipated on resource allocation, agriculture, commerce, energy, human safety and health. It is, therefore, reasonable to assert that environment and development policies are achievable in societies having extant petroleum and chemical establishments when social. Economic, political and technical considerations are taken into effect and mobilized [19]. All interests must be sensitized to the challenges and constraints as well as subsequent solutions of petroleum-contaminated sites per sustainable human health and the environment. Thus, assessment and remediation of petroleum-contaminated sites are pertinent for the optimum planning and management of oil operations to obviate dire consequences for sustainable human health and the environment.

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References

1. Russell, D' Jones, A, P; Davies, P; G, et al., Petroleum hydrocarbons, JP-8 spillage, environmental contamination, community exposure and multi-agency response. JEHR 2009; 9(1). http://www.cieh.org/jehr/fuel_spillage_contamination.html

2. Singh, K; Chandra, S. Treatment of petroleum hydrocarbon polluted environment through bioremediation: A Review. Pakistan Journal of Biological Sciences 2014; 17 (1): 1-8.

3. Yunlatti, M, D. Bioremediation of petroleum-contaminated soil: A Review. Volume 185, 4th International Conference on Agricultural and Biological Sciences, 2018; 26-29 June 2018, Hangzhou, China.

4. Chukwuma, Sr C. Environmental impact assessment of development projects and natural resources – a viewpoint. Intern J Environ. Studies, 1996; 50: 187-200.

5. Zhang, J; Fan, S, K; Yang, J, C. et al. Petroleum contamination of soil and water, and their effects on vegetables by statistically analyzing entire data set.. Sci Total Environ 2014; 476-477:258-65.

6. Fu, X; Cui, Z; Zang, G. Migration, speciation and distribution of heavy metals in an oil-polluted soil affected by crude oil extraction processes. Environ Sci Process Impacts. 2014; 16(7):1737-44

7. Adeniji, A, O; Okoh, O, O; Okoh, A; I. Analytical methods for the determination of the distribution of total petroleum hydrocarbons in the water and sediment of aquatic systems: A Review. Journal of Chemistry, Article ID 5178937, 2017; 13 pp.

8. Ite, A, E; Harry, T, A; Obadimu, C, D; Asuaiko, E, R; Inim, I, J. Petroleum hydrocarbons contamination of surface water and groundwater in the Niger Delta Region of Nigeria. Journal of Environmental Pollution and Human Health 2018; 6(2): 51-61.

9. Kponee, K, .Z; Chiger, A; Kakulu, I, B; Vorhees, D; Heiger-Bernays, W. Petroleum contaminated water and health symptoms: a cross-sectional pilot study in a rural Nigerian community. Environmental Health 2015; 14: 86.

10. Ite, A, E; Ibok, U, J; Ite, M, U; Petters, S, W. Petroleum Exploration and Production: Past and Present Environmental Issues in the Nigeria's Niger Delta. American Journal of Environmental Protection 2013; 1 (4): 78-90.

11. Ikporukpo, C, O. Environmental deterioration and public policy in Nigeria. Applied Geography, 1983; 3:303-316.

12. Nnubia, C; Okpokwasili, G, C. The microbiology of drill mud currings from a new offshore oilfield in Nigeria. Environ. Pollut 1993; 83:153.

13. Chukwuma, Sr C. Defining environmental management and planning policy in Nigeria. IAAMRH Journal 1996; 20(1):13-15.

14. Chukwuma, Sr C. Environmental health concepts and issues – A viewpoint. Intern. J. Environ. Studies, 2001; 58: 631-644.

15. Chukwuma, Sr C. Environment and development: a social evaluation survey in Nigeria in 1992. Env. Edu. & Inf 1994; 13(2):183-208.

16. Dunlap, R, E; Gallup Jr, G, H; Gallup, A, M. Of global concern – results of the health of the planet survey. Environment 1993; 35(9): 7-15, 33-39.

17. Streche, C; Cocarta, D, M; Istrate, I-A; Badea, A, A. Decontamination of petroleum-contaminated soils using the electrochemical technique: Remediation degree and energy consumption. Scientific Repots 8 Article Number: 3272, 2018.

18. Chukwuma Sr, C. Environmental impact assessment, land degradation and remediation in Nigeria: current problems and implications for future global change in agricultural and mining areas. The International Journal of Sustainable Development and World Ecology, 2011; 18: 36-41.

19. Chukwuma, Sr, C. Perspectives for a sustainable society. Environmental Management and Health 1996; 7(5):6-20.

20. Clark, W, C; Munn, R, E. Sustainable Development of the Biosphere. Cambridge University Press, 1986; 491pp.

21. Chen, Z; Huang, G, H; Chan, C,W, et al. Development of an expert system for the remediation of petroleum-contaminated sites. Environmental Modelling & Assessment 2003; 8(4):323-334.

22. Huang, Y, F; Huang, G, H; Chakma, A, et al. Remediation of petroleum-contaminated sites through simulation of a DPVE-aided cleanup process: Part 1. Model Development. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, 2007; 29(4):347-365.

23. PRP. Petroleum Remediation Program – Minnesota Pollution Control Agency 2014. http://www.pca.state.mn.us/index.php/waste/waste-and-cleanup/cleanup/petroleum-remediation-program/index.htm

24. Correl, R, L. The use of composite sampling in contaminated sites – a case study. Environmental & Ecological Statistics, 2001; 8(3):185-200.

25. Ribeiro, H; Mucha, A, P; Almeida, C, M; Bordalo, A, A. Potential of phytoremediation for the removal of petroleum hydrocarbons in contaminated salt marsh sediments. J Environ Manage 2014; 1, 137:10-15.

26. Chukwuma, Sr, C. Integrative procedure for environmental impact assessment, planning and management of non-ferrous metal mining operations in Nigeria. Academic Dissertation, Faculty of Agriculture & Forestry, Dept of Limnology & Environmental Protection, University of Helsinki, Helsinki, Finland, University of Helsinki, 1995.

27. Cole, G, M. Assessment and Remediation of Petroleum Contaminated Sites. CRC Press Inc., 1994; 384pp.

28. Report of the Special Committee on the Review of Petroleum Products Supply and Distribution (October 2000); Federal Republic of Nigeria Press, Abuja, pp112.

29. Chukwuma Sr, C. Environmental issues and our chemical world – the need for a multidimensional approach in environmental safety, health and management. Environmental Management and Health 1998; 9(3):136-143.

30. Paustenbach, D, J. (ed). The Risk Assessment of Environmental and Human Health Hazards: A Textbook of Case Studies. Wiley-Interscience, 1989; 1184pp.

31. Paustenbach, D, J. Human and Ecological Risk Assessment: Theory and Practice. Wiley-Interscience, 2002; 1592pp.

32. Ahmed, F; Fakhruddin, A, N, M. A review on environmental contamination of petroleum hydrocarbons and its biodegradation. Int J Environ Sci Nat Res 2018; 11 (3) DOI: 19080/IJESNR.2018.11555811.

33. NIH. Oil Spills. 2018 https://medlineplus.gov/oilspills.html.

34. Onwurah, I, N, E; Ogugua, V, N; Onyike, N, B, et al. Crude oil spills in the environment, effects and some innovative clean-up technologies. Int J Env Res 2007; 1(4): 307-320.

35. UN Environment. Iraq officials trained in assessing oil-contaminated sites from the ISIL conflict. 2018 **www.unenvironment.org/news-and-stories/press-release/iraq-officials-trained-assessing-oil-contaminated-sites-isil.**

36. Chukwuma, Sr, C. The impacts of mining operations in Nigeria, with particular reference to the Enyigba-Abakaliki area. Env. Edu. & Info 1993; 12(4): 321-336.