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Hydrocarbons and Their Impact on Certain Soil Properties: A Review

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ABSTRACT: The petrol stations and in their immediate surroundings is affected by emissions stemming from evaporated vehicle fuels, unburnt fuels from fuel loading and unloading operations, refuelling and liquid spillages. The distances depend on the number of petrol pumps, the amount of fuel drawn from them, traffic intensity, the structure of the surroundings, and weather conditions. According to literature available, the more contaminated the zone surrounding the petrol station as a result of other causes (traffic), the lower the impact of the two pollutants at the service station. If traffic in the area surrounding the petrol station is very intense, and exceeds the emissions from the station itself, pollution at the service station is "overlapped and goes unnoticed" over short distances. The literature study shows that a "minimum" distance of 50 metres should be maintained between petrol stations and housing, and 100 metres for "especially vulnerable" facilities such as hospitals, health centres, schools and old people's homes. However, petrol stations are not the only source of emission of these pollutants. This article will review the different studies petroleum products and their impact on the different soil properties.

Keywords: Petroleum, contamination, soil properties, threats

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INTRODUCTION

The effects of contamination at petrol stations that are potentially harmful to health, which can be noted in buildings less than 100 metres from the service stations. Some airborne organic compounds -- such as benzene, which increases the risk of cancer -- have been recorded at petrol stations at levels above the average levels for urban areas where traffic is the primary source of emission (Clark, 2004).

Gas stations pollute their immediate surroundings as well. Considering the high risk and dangers associated with petroleum product as a highly inflammable product, its exploration, transportation, offloading, storing and sale points and facilities should not be taken for granted like other products. The growing threat to the natural environment caused by oil products due to leakage from tanks and pipes, truck tanks, during distribution process as well as by car and railway transport and petrol station is growing (Terres, 2010).

Oil products, including petrol not only modify physico-chemical and biological properties of the soil but also contribute to limitations of the productive ability of arable crops. It is known that these compounds are able to affect the quality of surface and ground water and that these products are potentially dangerous for animal and human health. Acceleration of the process of reclamation of product soils polluted by oil might be performed by soil aeration, optimization of soil moisture and inoculation of the soil by microorganisms. Biological methods of pollutant removal are more effective and more environmentally friendly than physicochemical ones. This results in bioremediation and transforms pollutants into microbial biomass and stabile and not-toxic compounds as: water, CO_2 and in anaerobic conditions CH_4. The aim of presented studies was to determine the biochemical properties of soil contaminated with lead-free petrol and lead petrol 98 and to check the possibility of utilization of organic substances in detoxication of such soils (Wyszkowska, 2000).

Environmental pollution with petroleum and petrochemical products has attracted much attention in recent years. The presence of various kinds of automobile and machinery vehicles has caused an increase in the use of motor oil. Spillages of used motor oils such as diesels or jet fuels contaminate our natural environment with hydrocarbon. Pollution of soil with petroleum derivatives is often observed in soils around industrial plants and in areas where petroleum and natural gas are obtained processed or distributed. Processes such as oil exploration, drilling, refinement, transportation, oil processing and storage are accompanied by environmental contamination. Oil spillage occurs through tanker accidents, well blow outs, sabotage and accidental rupture of pipelines, resulting in the release of crude and refined oil into terrestrial and aquatic environments (Sui, 2014).

Petroleum and its products are of major concern in pollution studies due to their structural complexity, slow biodegradability, bio magnification potential and above all, serious health hazards associated with their release into the environment, also lead to water and oxygen deficit which causes shortage in availability of nitrogen and phosphorus, affect its chemical characteristics, reduce fertility of animals and negatively influence plant production and threatens human health and that of the organisms that are dependent on the soil. The toxicity of petroleum hydrocarbons to microorganisms, plants, animals and humans is well established (Serrano *et al,* 2009).

Prolonged exposure to high oil concentration may cause the development of liver or kidney disease, possible damage to the bone marrow and an increased risk of cancer. Total petroleum hydrocarbons (TPHs) are classified into different fractions: Fractions 1 (C6-C10) and 2 (C10-C16) are volatile or semi volatile, whereas fractions 3 (C16-C33) and 4 (C34-C50) are hydrophobic and recalcitrant. Compounds from fractions 3 and 4 can be highly toxic and are regulated due to their mutagenicity and carcinogenicity. During the last decade, concerns about hydrocarbons in the environment have considerably increased (Beirkens, 2014). Various techniques were employed to recover degraged land but often it becomes difficult to recover it even were the land is little bit contaminated (Javanmard 2015; Kumari Amita 2018; Zohreh *et al.,* 2018; Mohamed and. Mazen, 2018).

Hydrocarbon pollution of the subsurface, especially in unsaturated soils, has become a big problem with the development of the petrochemical industry and installation of numerous petrol stations and underground pipes (Husaini, 2008). Keeping the above facts in view the present study is an attempt to study the impact of hydrocarbons on the properties of soil.

Effects of petroleum on soil

Bernat *et al* (2015) reviewed the effect of hydrocarbons released at gas stations. At gas stations, fuel is stored and transferred between tanker trucks, storage tanks, and vehicle tanks. During both storage and transfer, a small fraction of unburned fuel is typically released to the environment unless pollution prevention technology is used. While the fraction may be small, the cumulative release can be substantial because of the large quantities of fuel sold. The cumulative release of unburned fuel is a public health concern because gas stations are widely distributed in residential areas and because fuel contains toxic and carcinogenic chemicals. The pathways through which gasoline is chronically released to atmospheric, aqueous, and subsurface environments, and how these releases may adversely affect human health has been reviewed. Adoption of suitable pollution prevention technology should not only be based on equipment and maintenance cost but also on energy and health care saving benefits.

Chaudhary and Singh (2016) studied on the behavioural change in the soil contaminated with petrol. One of the legacies of the past in industrialized countries is that land has been contaminated due to mining, industry and society disposing of waste with little regard for future consequences. Contamination of the soil layers forms one of the major topics of Environmental Geo-technology. The accidental spillage or leakage of highly aggressive industrial effluents has detrimental effects on the properties of soil. The addition of these effluents in to the subsoil directly affects the use and stability of the supported structure. In the present day Geotechnical engineering, little consideration has been given to the potential influence of physio-chemical interactions on the mechanical performance of soil confronted with increasing occurrence of soil contamination. The modern construction requires a detailed study of the foundation material as well as its working during the course of lifetime of the structure supported by it. In this study, an experimental investigation is done to quantify the influence of contamination in two different types of locally available soils i.e. sand (SP) and clay (CL-ML), so as to understand the engineering behaviour of the soil under the effect of pollutants. Therefore, due to the multitude of these pollutants the study was restricted to the contaminant fluid, Petrol. Through this study it has been found that, the contamination of soil with petrol has a significant influence on the engineering behaviour of the soil and the consequent change in the engineering properties of the soil has been reported in this paper. Both air pollution and soil pollution are associated with gas filling stations. While air pollution is created by volatile chemicals vaporizing during the gas filling process, soil pollution can be caused by underground pipes or tanks rusting or leaking slowly releasing contaminants into surrounding area. The constant spilling of gasoline can also cause significant pollution. When gasoline evaporates, it gives off toxic fumes; a 2011 study found that the air surrounding gas stations can contain much higher concentrations of these cancer-causing vapours than average. Conducted by the Energy and Resources Institute (TERI) in India, the study examined air quality at 40 gas stations in Delhi. The researchers pointed out that this pollution should be particularly concerning for station attendants, who may spend long hours at a station every day. Soil surrounding a gas station can become contaminated with gasoline. Gasoline in the soil can be dangerous, as it contains the toxic chemical benzene, which can leach into the water supply. In August 2012, soil near a former Exxon gas station in Wilmington, North Carolina, was found to be contaminated. In October 2011, gasoline was detected in the soil near a Citgo gas station in Shorewood, Wisconsin. Toxic fumes emanating from gas stations can be mitigated by a vapour recovery system. The system is installed at the underground tank's filling point, and uses carbon to absorb any vapours being released. The EPA has outlined systems that could be used to detect any leaks from an underground tank, such as a secondary containment with interstitial monitoring, automatic tank gauging systems and groundwater monitoring. As a temporary system, the EPA recommends combining tank tightness testing with inventory control or with manual tank gauging, for smaller tanks.Phased out by the dawn of the 21st century, leaded gasoline used to be a conventional automobile fuel around the world. As a result, some soils near old or long-standing gas stations could be contaminated with lead. The biggest risk of exposure is through eating or swallowing lead-contaminated soil. Young children are at the greatest risk for this type of exposure, as they often play in dirt and then put their hands and other objects into their mouths. When children are repeatedly exposed to small amounts of lead this way, the metal can build up in their bodies and cause damage.

Wyszkowska *et al* (2000) reviewed the bio chemical properties of soil contaminated by petrol. In this experiment the effects of lead and lead-free petrol applied at the following doses of: 0, 2, 4 and 6 cm^3 -kg^{-1} of soil on growth and development of triticale and biochemical properties of the soil were studied. For detox cation of petrol organic amendment with barley straw was applied. The experiment was performed in two experimental series with and without triticale cover. It was found that the soil contamination by petrol adversely affected growth and development of tested crops. Barley straw appeared to be ineffective in detoxication of the contaminated soil. Lead and lead-free petrol (irrespective of plant cover and application of straw) adversely affected activity of soil dehydrogenases and urease. Straw application and growing of triticale positively affected biochemical properties of the soil. These positive effects were diminished by petrol, irrespective of the lead addition. Biochemical index of soil fertility calculated on the basis of enzymatic activity and carbon content was negatively correlated with the level of soil contamination by petrol and positively with triticale yield.

Heuland Jonker (2009) investigated the environmental degradation of petroleum hydrocarbons. Petroleum hydrocarbons are causing widespread pollution in both the aquatic and the terrestrial environment. Petroleum consist of alkanes, cycloalkanes, aromatics, polyaromatics (PAHs) and other compounds. All of these hydrocarbons groups are toxic for the environment, but especially the PAHs and their degradation products are known for their carcinogenic properties. The partitioning of hydrocarbons in the environments depends on volatility and hydrophobicity, influencing the partitioning between soil, water and sediment. The risk and degradation rates of hydrocarbons are besides this partitioning strongly dependent on bioavailability. Presence of other reactive or absorbing substances and environmental conditions has shown to influence the fate and degradation rates of hydrocarbons in the environment. Sediments, and more specific the carbon compounds in sediment, are the most important absorbing substances. The most important degradation pathways in the environments are performed by light and organisms, bacteria, fungi and algae. Where bacterial degradation results in total degradation of nearly all hydrocarbons light is only able to make some photochemical modifications in the hydrocarbons. The degradation mechanisms have shown enormous influence not only on degradation but also on physical and chemical properties of hydrocarbons, resulting in change of partitioning in the various compartments in the environment. Environmental condition influencing degradation are pH, temperature, oxygen, nitrogen compounds, humic acids and salinity. Due to the widespread use of hydrocarbons and subsequent pollution several methods for soil and water remediation have been developed. These methods include physical based methods as evaporation of hydrocarbons and biodegradation methods by stimulation of bacteria able to degrade hydrocarbons. For water treatment absorption and biodegradation are the most used methods. The consequences of soil and sediment remediation for society in the Netherlands are enormous, which is illustrated by two examples; PAH pollution in the river delta in the Netherlands and soil pollution of former gas factories in the area of Utrecht.

William (2001) explains that the physical environments that are harmful to man and are caused by forces extraneous to him. Hazards also are threat to future source of danger and have the potential to cause harm to people (death, injury, disease and stress); harm to human activities (economic and educational activities); harm to property (property damage and economic loss) and environmental harm (loss of fauna and flora, pollution and loss of amenities). This is in conformity with EFOA, (1999) that safety of people and protection of the environment should at all-time be the major concerns at petrol stations because they are potentials for accident especially where the general public has unrestricted access. The necessity therefore for well designed, construction and operation of such facilities should be of paramount importance. Noting that, petrol and other fuel are potentially hazardous at ambient temperature and they give off vapours which when mixed with air in a proportion and ignited, can burn with explosive force. In addition, all petroleum products are potential pollutants which if released, can cause injury to aquatic life, harmful effects to human health and environmental damage if incorrectly handled. It is generally important in the planning process for development particularly in the urban centres, to give much consideration to measures that reduces hazards. Planners should at all times assess possible hazards in planning and promote ways of avoiding or mitigating damage that might cause hazards, risk and vulnerability.

Sui *et al* (2014) studied on the influence of soil and hydrocarbon properties on the solvent extraction of high concentration weathered petroleum from contaminated soils. Petroleum ether was used to extract petroleum hydrocarbons from soils collected from six oil fields with different history of exploratory and contamination. It was capable of fast removing 76–94 % of the total petroleum hydrocarbons including 25 alkanes (C–C) and 16 US EPA priority polycyclic aromatic hydrocarbons from soils at room temperature. The partial least squares analysis indicated that the solvent extraction efficiencies were positively correlated with soil organic matter, cation exchange capacity, moisture, pH, and sand content of soils, while negative effects were observed in the properties reflecting the molecular size (e.g., molecular weight and number of carbon atoms) and hydrophobicity (e.g., water solubility, octanol–water partition coefficient, soil organic carbon partition. Influence of soil and hydrocarbon properties on the solvent extraction of high concentration weathered petroleum from contaminated soils of hydrocarbons. The high concentration of weathered crude oil at the order of 10 mg kg in this study was demonstrated adverse for solvent extraction by providing an obvious nonaqueous phase liquid phase for hydrocarbon sinking and increasing the sequestration of soluble hydrocarbons in the insoluble oil fractions during weathering. A full picture of the mass distribution and transport mechanism of petroleum contaminants in soils will ultimately require a variety of studies to gain insights into the dynamic interactions between environmental indicator hydrocarbons and their host oil matrix.

Zhang *et al* (2014) cited on the petroleum contamination of soil and water, and the effect on vegetables by statistically analysing entire data. The soil, water, and vegetables were contaminated in the outskirts of Xi'an, China Beijing. Inputs of herbaceous plants and floating macrophytes were differentiated, pollution characteristics of *Brassica* and *Apium* were differentiated, effect of petroleum contamination in soil/water on vegetables was presented. Also Correlation coefficient between multidimensional data sets was calculated. On 22 October 2013 Petroleum hydrocarbons Soil Water Vegetables Principal component analysis Aliphatic hydrocarbons have been used to assess total oil concentrations, petroleum sources, and petroleum degradation. In this study, surface soil, groundwater, surface water, and vegetables were collected from the outskirts of Xi'an, the largest city in north-western China, and the samples were analysed for aliphatic hydrocarbon contents. The concentrations of n-alkanes were 1.06–4.01 µg/g in the soil. The concentrations and the geochemical characteristics of n-alkanes showed that the low carbon number hydrocarbons were mainly from petroleum sources, whereas the high carbon number hydrocarbons received more hydrocarbons from herbaceous plants. The concentrations of n-alkanes were 9.20–93.44 µg/L and 23.74–118.27 µg/L in the groundwater and the surface water, respectively. The water had characteristics of petroleum and submerged/floating macrophytes and was found in concentrations that would cause chronic disruption of sensitive organisms. The concentrations and geochemical characteristics of n-alkanes in *Brassica chinensis* L. and *Apium graveolens* were different, but both were contaminated by petroleum hydrocarbons. The results from principal component analysis (PCA) indicated that the sorption of n-alkanes to soil particles could not be described by linear models. The distributions of n-alkanes in vegetables were positively correlated with those in soil, and the correlation coefficient was up to 0.9310 using the constructed vectors. Therefore, the researchers should pay close attention to the effect of soil contamination on vegetables.

Isabel *et al* (2011) discussed about the gas stations polluting their immediate surroundings. This studyfinds - It is relatively common to come across gas stations surrounded by houses, particularly in urban areas. Researchers have noted the effects of contamination at gas stations at buildings less than 100 meters from the service stations. "Some airborne organic compounds such as benzene, which increases the risk of cancer have been recorded at petrol stations at levels above the average levels for urban areas where traffic is the primary source of emission," The study of Gonzalez (2011) showed that the air at petrol stations and in their immediate surroundings is affected by emissions stemming from evaporated vehicle fuels (unburnt fuels from fuel loading and unloading operations, refuelling and liquid spillages). The research team measured the levels of "typical traffic" pollutants in different parts of the urban area of Murcia, and calculated the quotients for the levels of an aromatic compound (benzene) and a hydrocarbon (n-hexane) at three Murcia petrol stations (near the petrol pumps and surrounding areas) to find the distance at which the service stations stop having an impact. "In the three cases studied we obtained maximum distances of influence of close to 100 metres, although the average distance over which this contamination has an effect is around 50 metres," González, led the research team, said. However, the distances depend on the number of petrol pumps, the amount of fuel drawn from them, traffic intensity, the structure of the surroundings, and weather conditions. According to the researcher, "the more contaminated the zone surrounding the petrol station as a result of other causes (traffic), the lower the impact of the two pollutants at the service station." If traffic in the area surrounding the petrol station is very intense, and exceeds the emissions from the station itself, pollution at the service station is "overlapped and goes unnoticed" over short distances. Advice for new constructions The research study shows that a "minimum" distance of 50 metres should be maintained between petrol stations and housing, and 100 metres for "especially vulnerable" facilities such as hospitals, health centres, schools and old people's homes. "Ideally, the 100 metre distance should be respected in plans for building new houses," says Doval. The researchers propose carrying out this study at new construction areas in which it is planned to build these kinds of facilities. However, petrol stations are not the only source of emission of these pollutants. However, Gonzalez (2011) stressed "There is not much use in protecting people from petrol stations if the other sources of emission (above all traffic and industries near population hubs) are not controlled or reduced". They say the air in the immediate vicinity of garages is often polluted with airborne particles from evaporated fuel and therefore harmful to local residents. The scientists said a 'minimum' distance of 50 metres should therefore be maintained between petrol stations and housing, and 100 metres for 'especially vulnerable' facilities such as hospitals, health centres, schools and old people's homes. Doval, said: 'Some airborne organic compounds - such as benzene, which increases the risk of cancer - have been recorded at petrol stations at levels above the average levels for urban areas where traffic is the primary source of emission. 'The study, published in the Journal of Environmental Management, shows the air at petrol stations and in their immediate surroundings is especially affected by emissions stemming from evaporated vehicle fuels. This includes unburnt fuel from fuel loading and unloading operations, refuelling and liquid spillages. The research team measured the levels of 'typical traffic' pollutants in different parts of the urban area of Murcia. They then calculated the quotients for the levels of an aromatic compound (benzene) and a hydrocarbon (n-hexane) at three Murcia petrol stations - near the petrol pumps and surrounding areas - to find the distance at which the service stations stop having an impact.In the three cases studied a maximum distances of influence of close to 100 metres was found although the average distance of contamination was around 50 metres.

But the distances depend on the number of petrol pumps, the amount of fuel drawn from them, traffic intensity, the structure of the surroundings, and weather conditions. The proposed gas station in East bridge would be 25 meters from income-qualified housing. The locations of three out of the four gas stations built as part of the Stapleton redevelopment are within 100 meters of housing. Yet 89 percent of all respondents in a recent SUN survey said a gas station should be at least 300 feet (91.4 meters) away from any homes or daycares.

The proven causal relationship between benzene and cancer is well documented and accepted by the scientific community—and gas stations are classified by the Environmental Protection Agency as a point source for benzene. However, the distance from a gas station at which benzene levels become similar to urban background levels depends on several factors including vapour recovery methods used, the volume of gas pumped from a station, spills during fuelling, and the meteorological conditions. Thomas, indicated that within 60-90 meters of I-70 the concentration of benzene drops rapidly. He then stated that specific site plans for gas stations could reduce the off-site effects of any pollutants, and suggested that, where possible, the stations be located in a way that minimizes the potential for off-site effects. When this suggestion was presented, it was noted that the city has no authority over the site plan of a gas station in a "right by use" situation (privately owned land where zoning allows gas stations). Thomas added that he does not believe the health risks from benzene emissions on nearby residents are sufficient to justify a citywide setback requirement. In addition, Adgate, submitted that "While there is a limited scientific basis with which to determine an appropriate minimal setback, the potential for human exposure to hazardous air pollutants is real and I concur with the position that some sort of minimum setback is needed to address the health and safety concerns of Denver residents living near these facilities."Two other recently-built neighbourhoods in Denver (Lowry and Green Valley Ranch) have been built while avoiding having housing and gas stations at such close proximity.

Shelia *et al* (2010) investigated the environmental effect of petrol stations at close proximities to residential buildings in Maiduguri and Jere, Borno State, Nigeria. Proliferation of petrol stations in Maiduguri and Jere has now reached a level of unimaginable nightmare with perceived consequences on both human health and the environment. It is against this the paper evaluates the environmental effects of the petrol stations in their neighbourhoods in Maiduguri and Jere. Specifically, it examined the presence of those petrol stations vis-a-vis residential houses within 100m radius of location in the township; hazards associated with their activities/operation; and the perception of residents/petrol stations workers on the effects pose by those petrol stations. Only purposed-built petrol stations both functional and non-functional as at 2010 were considered in the study. Out of the 138 petrol stations in the study area, 122 (88.41%) were functional and 16 (11.59%) were non-functional. These petrol stations are spatially located unevenly across the major road network in the township. Data for the study were therefore obtained through field survey where the functional statuses of those petrol stations were recorded and GPS (Garmin 76 CSX) devise was equally used to determine their co-ordinates. Three household heads around each of the 35 sampled petrol stations were randomly sampled to provide information on the activities of the petrol stations that are either improving on the well-being of the residents or detrimental to their lives. From the sampled petrol stations also, two workers each were selected at random to source vital facts on the way and manner they are carrying out their duties and knowledge with regards to DPR guidelines. Five staff of DPR and FSD, each were also used as samples for the study. Data sourced were then analysed using simple descriptive statistics and GIS Software and the results presented in charts and tables. The finding revealed that the guidelines for siting petrol stations have not been adhered by most of the petrol stations thereby posing serious hazards on residence in close proximity to them even though some of these petrol stations were located much earlier than the residential houses close to them. It is expected of the State legislature therefore to enact law forbidding either government or individuals from converting plots of land for location of petrol stations within the township forthwith. Any attempt by either of the two sides to convert the use of any land within township should be resisted by the people and the court. Despite all the modern health and safety guidelines they must follow, gas stations can still pose significant hazards to neighbours, especially children. Some of the perils include ground-level ozone caused in part by gasoline fumes, groundwater hazards from petroleum products leaking into the ground, and exposure hazards from other chemicals that might be used at the station if it's also a repair shop. Ozone pollution is caused by a mixture of volatile organic compounds, some of which are found in gasoline vapours, and others, like carbon monoxide, that come from car exhaust. Most gas pumps today must have government-regulated vapour-recovery boots on their nozzles, which limit the release of gas vapours while you're refuelling your car. A similar system is used by the station when a tanker arrives to refill the underground tanks. But if those boots aren't working properly, the nearly odourless hydrocarbon fumes, which contain harmful chemicals like benzene, can be released into the air. Higher ozone levels can lead to respiratory problems and asthma, while benzene is a known cancer-causing chemical, according to the National Institutes of Health (NIH). The quest to reduce ozone levels has led the state of California to implement a more stringent vapour-recovery law, effective April 1, 2009, which requires that all gasoline pumps have a new, more effective vapour-recovery nozzle. Underground gasoline storage tanks can also be a problem. The U.S. Environmental Protection Agency (EPA) estimates that there are some 660,000 of them from coast-to-coast. Many a lawsuit has been filed against oil firms in communities across the country by people whose soil and groundwater were fouled by a gas station's leaking underground storage tank. In the past, most tanks were made of uncoated steel, which will rust over time. Also, pipes leading to the tanks can be accidentally ruptured. When thousands of gallons of gasoline enter the soil, chemicals travel to groundwater, which the EPA says is the source of drinking water for nearly half the U.S. If buying a home, consider its potential loss in value if a nearby underground storage tank were to leak. Gasoline additives such as methyl tertiary-butyl ether (MTBE), which has been outlawed in some states, make the water undrinkable—and that is only one of 150 chemicals in gasoline. Repeated high exposure to gasoline, whether in liquid or vapor form, can cause lung, brain and kidney damage, according to the NIH's National Library of Medicine. Spilled or vaporized gasoline is not the only chemical hazard if the station is also a repair shop. Mechanics use solvents, antifreeze and lead products, and may work on vehicles that have asbestos in brakes or clutches. Auto refinishers and paint shops use even more potentially harmful chemicals. In today's car-centric world, we can't escape exposure completely, because these chemicals are in our air just about everywhere. But by choosing where we live, keeping an eye out for spills, and pressuring the oil companies to do the right thing for the communities they occupy, we can minimize our exposures.

Alrumman *et al* (2014) assessed about the effect of hydrocarbon contamination on soil microbial community and enzyme activity. Soil enzymatic activities and microbial biomass carbon are considered to be two important soil biological activities influenced by oil contamination occurring in the soil ecosystem. This study focused on changes in the soil microbial community enzymatic activities as a result of the potential inhibitory effects of hydrocarbon contamination. The relationship between hydrocarbons (kerosene and diesel), microbial biomass carbon and enzymatic activity (dehydrogenase and phosphatase) was evaluated in three amended soil types collected from different areas (Fresh Boyndie, Insch and Brechin) in Aberdeenshire (UK). Results showed that hydrocarbon contamination inhibited enzymatic activities in all the amended soil samples. The extent of inhibition increased significantly with increasing levels of hydrocarbons, and varied with the incubation period. Insch soil had high microbial biomass carbon values and high numbers of heterotrophic bacteria CFU, but it had the lowest dehydrogenase and phosphatase activities of all three soils. Brechin soils had the highest phosphatase activity. Results also showed that both Insch and Brechin soils had similar numbers of culturable hydrocarbon degrader bacteria across all soil treatments with the exception of kerosene treatments, while Brechin soils had the highest culturable numbers of hydrocarbon degrading fungi across all three soil treatments with the exception of incubated control and kerosene treatments. There were generally strong positive relationships in non-treated samples between bacterial heterotrophs and hydrocarbon degrading bacteria in all three soils. Both incubated Insch and Brechin soil treatments exhibited a strong correlation between fungal heterotrophs and hydrocarbon degraders. However, non-incubated Insch and Brechin soils had a weak relationship between fungal heterotrophs and degrading fungi. Hydrocarbons in soils provide a source of carbon for microbial growth and this helps to explain the high variation in fungal data between soils which may be associated with different microbial communities in each soil.

Okonokhua *et al* (2007) studied on the effect of spent engine oil (SEO) on soil properties and growth of maize (*Zea mays* L.) Five treatments (0.0, 0.2, 0.4, 0.6 and 0.8 l/kg) of the spent oil were applied to soil in perforated poly bags with maize stands at four weeks after sowing. Soil analysis showed that SEO had no effect on both the pH and texture of the soil. Organic C, N and Mg in the contaminated soils increased compared to the control. There was decrease in concentration of P due to soil contamination. Heavy metals (Fe, Cu, Zn and Pb) concentrations of soil increased with increasing concentration of oil. Plant height, root number and root length of maize plants grown in the contaminated soils were adversely affected. The grain yield of the plants in the contaminated soils was significantly reduced.

Serrano *et al* (2005) reviewed on the assessment of natural attenuation of volatile aromatic hydrocarbons in agricultural soil contaminated with diesel fuel. The natural attenuation of VAHs, in an agricultural soil, was studied after a simulated diesel fuel spill. A diesel fuel spill was simulated on a 12-m2 plot of agricultural land, at a concentration of 1 Lm of soil. The natural attenuation of Volatile Aromatic Hydrocarbons (VAHs) was monitored at different soil depths over a period of 50 days. The natural attenuation of VAHs in the surface layer would be attributed to two processes, namely: volatilisation (mainly linked to the boiling point of each VAH, with t1/2 from 2 to 71 min for benzene and p-isopropyl toluene, respectively); and dissipation (related to the boiling point as well as the analyse soil matrix interaction, with t1/2 from 2 to 169 h for benzene and p-isopropyl toluene, respectively). As expected, in the deeper layers, dissipation prevails over volatilisation. 50 days after the spill, only two VAHs were detected in the surface layer, at concentrations of 5e20 ng, which had disappeared after 80 days of the spill.

Semple *et al* (2000) made a review on the impact of the effectiveness of composting strategies on the treatment of soils contaminated with organic pollutants. Chemical pollution of the environment has become a major source of concern. Studies on degradation of organic compounds have shown that some microorganisms are extremely versatile at catabolizing recalcitrant molecules. By harnessing this catabolic potential, it is possible to bio remediate some chemically contaminated environmental systems. Composting matrices and composts are rich sources of xenobiotic-degrading microorganisms including bacteria, actinomycetes and lignolytic fungi, which can degrade pollutants to innocuous compounds such as carbon dioxide and water. These microorganisms can also biotransform pollutants into less toxic substances and/or lock up pollutants within the organic matrix, thereby reducing pollutant bioavailability. The success or failure of a composting/compost remediation strategy depends however on a number of factors, the most important of which are pollutant bioavailability and biodegradability. This review discusses the interactions of pollutants with soils; look critically at the clean-up of soils contaminated with a variety of pollutants using various composting strategies and assess the feasibility of using composting technologies to bioremediate contaminated soil.

Ekundayo and Obuekwe (2000) estimated on the effect of an oil spill physio chemical properties of a spill site. Physico-chemical analysis of soil samples at an oil spill site in the Niger Delta Area of Nigeria showed that the total hydrocarbon content of top soil layers ranged from 0.8 to 12.4 ppm in the heavy impact zone and the oil had penetrated to a depth of 7.2 m. Hydrocarbon concentration in the medium impact zone ranged from 0.02 to 0.40 ppm while hydrocarbons were not detected in 75% of samples from the unimpacted reference zone. Measurement of heavy metal concentrations in the soils revealed a significant build-up ($p<0.05$) of lead, iron and zinc in the heavy impact zone. Other parameters including electrical conductivity, exchangeable cations, available phosphorus and total nitrogen in impacted soils were also considered for this study.

Amadi *et al* (1996) investigated on the chronic effects of oil spill on soil properties and microflora of a rain forest ecosystem in Nigeria. Soil and microbiological properties of a tropical rain forest soil were evaluated 17 years after oil spillage to access the chronic effects of, and interrelationship between population of petroleum hydrocarbon utilizing and nitrifying microorganisms. The spatial distribution of petroleum hydrocarbons (oil), the nutrient status and the abundance of heterotrophic microbes along soil transect lines in the contaminated zones served as the index for corroborating the results. The pH status of soil in the contaminated (Heavy impact — HI, and moderate in pact — MI) zones varied from acidic, that is 4.0 to near neutral PH, that is 6.0. The C content of soils decreased from 3.6% at the HI zones to 2.84% at the MI zones. Total N in the HI and MI zones differed by a factor of 0.10%. Available P was higher at the MI than HI zone, while CEC decreased from a combined mean of 6.48 at the HI zones to 4.46 at the MI zones. Although residual oil content was higher in the HI zones than MI zone, the soil nutrient status within these two zones did not vary significantly (P=0.05). However, soil microbes responded differently. For instance, petroleum hydrocarbon utilizers correlated positively with the distribution of oil in the environment. But, not the nitrifying microorganisms. aerobic nitrifiers were abundant at the HI than MI zones, while anaerobic nitrifiers were higher at the MI than HI zones. With the presence of petroleum hydrocarbon utilizers and nitrifying microbes, it is possible to enhance the degradation of oil in the 17 yr old spillage by adopting bioremediation.

Eukandayo *et al* (1996) cited on the effect of an oil spill on soil physiochemical properties. Physico-chemical analysis of soil samples at an oil spill sitein a Typic Paleudult of mid-western Nigeria showed that the total hydrocarbon content of top soil layers ranged from 0.6to 12.6 ppm in the heavy impact zone and the oil had penetrated to a depth of 9.2 m. Hydrocarbon concentration inthe medium impact zone ranged from 0.36 ppm while hydrocarbons were not detected in 80% of samples from the unimpacted reference zone. Measurement of heavy metal concentrations inthe soil revealed a significant build-up ($p< 0.05$) of lead, iron and zinc in the heavy impact zone. Other parameters including electrical conductivity, exchangeable cations, available phosphorus and total nitrogen in impacted soils were comparatively low while the total organic carbon was high, compared with the reference site. Textural class of soil from the different depths showed a predominantly brown sand at the topsoil, loamy sand and grey fine sand at medium depths and red sandy clay at greater depths.

Udo and Fayemi, (2000) reported about the effect of hydro carbon pollution on germination, growth and nutrient uptake by plants. The effect of crude oil pollution of soil on the growth of plants and uptake of nutrients was investigated by growing corn (*Zea mays* L.) on a soil polluted by crude petroleum. The levels of the crude oil application varied from 0 to 10.6% by weight of soil. Three corn crops were raised in succession, each for a period of 6 weeks, in the same soil. The yields and plant contents of N, P, K, Ca, Fe, and Mn were determined. The soil was analysed for organic C, total and available N, extractable P, and exchangeable K, Ca, Fe, and Mn after each cropping. Germination and yields were drastically reduced as the level of pollution increased. At 4.2% crude oil pollution level, the average reductions were 50% and 92% in germination and yield, respectively. The amount of organic C, total N, and exchangeable K, Fe, and Mn increased in the soil with level of crude oil addition, while extractable P, NO_3-N, and exchangeable Ca were reduced. The poor growth was attributed to suffocation of the plants caused by exclusion of air by the oil or exhaustion of oxygen by increased microbial activity, interference with plant-soil-water relationships, and toxicity from sulphides and excess available Mn produced during the decomposition of the hydrocarbons.

Gesine (2002) has done an investigation on the Occurrence and transport of polycyclic aromatic hydrocarbons in the water bodies of the Baltic Sea. 313 seawater samples were collected in the surface microlayer, the surface water and the deep water of the Baltic Sea. Fifteen individual parent polycyclic aromatic hydrocarbons (PAHs) were analysed at 41 different coastal and offshore stations. The study has provided the most comprehensive information available to date about PAHs in different water bodies of the Baltic Sea. In general, the levels of the PAHs in Baltic Sea water were below 20,000 pg./l for the sum of 15 PAHs. Higher concentrations were found in estuarine samples. One local source in the southern Baltic Sea is the River Oder. Hot spots were observed mainly in the western Baltic Sea. In particular, high concentrations of the two- and three-ring PAHs were detected. Phenanthrene, fluoranthene and pyrene were the major components in surface water of the Baltic Sea. PAH composition profiles were compared to establish whether different water bodies of the Baltic have characteristic PAH patterns originating from characteristic inputs. Cluster analysis was used as pattern recognition technique. Four characteristic water bodies can be identified in the surface water in February (Mecklenburg Bight (MB), Pomeranian Bight (PB), the eastern (EZOS) and western central Baltic Sea (WZOS)). After the spring algae bloom, these patterns disappeared. This may be due to the cleaning of the water column after the bloom by large quantities of settling particulate matter that takes the PAHs with it to the sediment. A seasonal variation of the PAH concentrations was observed with the largest amounts in February followed by

November, reflecting the increase of PAH sources during winter.

Hussein *et al* (2015) states that the Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous environmental pollutants generated primarily during the incomplete combustion of organic materials (e.g. coal, oil, petrol, and wood). Emissions from anthropogenic activities predominate; nevertheless, some PAHs in the environment originate from natural sources such as open burning, natural losses or seepage of petroleum or coal deposits, and volcanic activities. Major anthropogenic sources of PAHs include residential heating, coal gasification and liquefying plants, carbon black, coal-tar pitch and asphalt production, coke and aluminium production, catalytic cracking towers and related activities in petroleum refineries as well as and motor vehicle exhaust. PAHs are found in the ambient air in gas-phase and as sorbet to aerosols. Atmospheric partitioning of PAH compounds between the particulate and the gaseous phases strongly influences their fate and transport in the atmosphere and the way they enter into the human body. The removal of PAHs from the atmosphere by dry and wet deposition processes are strongly influenced by their gas/particle partitioning. Atmospheric deposition is a major source for PAHs in soil. Many PAHs has toxic, mutagenic and/or carcinogenic properties. PAHs are highly lipid soluble and thus readily absorbed from the gastrointestinal tract of mammals. They are rapidly distributed in a wide variety of tissues with a marked tendency for localization in body fat. Metabolism of PAHs occurs via the cytochrome P450-mediated mixed function oxidase system with oxidation or hydroxylation as the first step. Several different remediation technologies have been tested in efforts to remove these environmental contaminants. Among them, bioremediation is showing particular promise as a safe and cost-effective option. In spite of their xenobiotic properties, a variety of genera of gram-positive and -negative bacteria, fungi and algae have been isolated and characterized for their ability to utilize PAHs. The aim of this review is to discuss PAHs impact on the environmental and the magnitude of the human health risks posed by such substances. They also contain important information on concentrations, burdens and fate of polycyclic aromatic hydrocarbons (PAHs) in the atmosphere. The main anthropogenic sources of PAHs and their effect on the concentrations of these compounds in air are discussed. The fate of PAHs in the air, their persistence and the main mechanisms of their losses are presented. Health hazards associated with PAH air pollution are stressed. Ozone pollution is caused by a mixture of volatile organic compounds, some of which are found in gasoline vapours, and others, like carbon monoxide, that come from car exhaust. Most gas pumps today must have government-regulated vapour-recovery boots on their nozzles, which limit the release of gas vapours while you're re fuelling your car. A similar system is used by the station when a tanker arrives to refill the underground tanks. But if those boots aren't working properly, the nearly odourless hydrocarbon fumes, which contain harmful chemicals like benzene, can be released into the air. Higher ozone levels can lead to respiratory problems and asthma, while benzene is a known cancer-causing chemical, according to the National Institutes of Health (NIH). The quest to reduce ozone levels has led the state of California to implement a more stringent vapour-recovery law, effective April 1, 2009, which requires that all gasoline pumps have a new, more effective vapour-recovery nozzle. Underground gasoline storage tanks can also be a problem. The U.S. Environmental Protection Agency (EPA) estimates that there are some 660,000 of them from coast-to-coast. Many a lawsuit has been filed against oil firms in communities across the country by people whose soil and groundwater were fouled by a gas station's leaking underground storage tank. In the past, most tanks were made of uncoated steel, which will rust over time. Also, pipes leading to the tanks can be accidentally ruptured. When thousands of gallons of gasoline enter the soil, chemicals travel to groundwater, which the EPA says is the source of drinking water for nearly half the U.S. If buying a home, consider its potential loss in value if a nearby underground storage tank were to leak. Gasoline additives such as methyl tertiary-butyl ether (MTBE), which has been outlawed in some states, make the water undrinkable—and that is only one of 150 chemicals in gasoline. Repeated high exposure to gasoline, whether in liquid or vapour form, can cause lung, brain and kidney damage, according to the NIH's National Library of Medicine. Spilled or vaporized gasoline is not the only chemical hazard if the station is also a repair shop. Mechanics use solvents, antifreeze and lead products, and may work on vehicles that have asbestos in brakes or clutches. Auto refinishers and paint shops use even more potentially harmful chemicals. In today's car-centric world, we can't escape exposure completely, because these chemicals are in our air just about everywhere. But by choosing where we live, keeping an eye out for spills, and pressuring the oil companies to do the right thing for the communities they occupy, exposures can be minimized.

CONCLUSIONS

The presence of petroleum products may cause different changes in the soil properties as has been indicated in the literature. Plantation of trees and different grasses around these sites will help in reclamation of soil. The migration of the contaminants in the soil depends on a variety of factors like inter alia, the concentration of petroleum products, climate and the parameter of the soil: type, sorptive capacity, pH, and content of solid, liquid and air phase. When high temperature dominated for the wet soils they gave rise to the occurrence of fast biodegradation of petroleum-related pollutants, evaporation, soaking deep into the soil, mineralisation and humidification. But at lower temperatures, there was slower bio-degradation of petroleum-related products and there was reduction in the concentration of pollutants which was due to the process of diffusion and soaking. In Gwalior, the temperatures of the summer season support evaporation and diffusion in the surface and ground water. In the soil retention of petroleum related pollutants, the humus horizon is a major contributory factors which is attributable to its high water and air capacity, and its notable sorptive properties. Sandy soils favours separation of particular phases of petroleum products and migration of gases to the surface as they are highly permeable. The Polish standards (developed by the National Inspection of Environmental Protection) which specify the admissible soil concentrations for crude oil derivative substance relate these values to the soil profile where poorly water soluble aliphatic hydrocarbons move to the depth of the soil profile and form a layer which encloses the grains of the sand. Thus some asphalts, tars, waxes and oils accumulate on the soil surface. Aromatic hydrocarbons, characterized by comparatively higher water solubility, migrate towards precipitations and ground waters. Benzene, toluene and xylene are the most toxic petrol components of aromatic hydrocarbons present in the petrol products. The admissible concentrations of crude oil derivative substance in clean soil vary from 20mg/kg soil for ground water to 10μ/kg soil for water. Future studies need to be conducted for better understanding of hydrocarbon impact on soil fertility by taking into consideration the other parameters.

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