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REVIEW ARTICLE

Effect of Soil Contamination on Human Health and Environment with Preventive Measures: A Review

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ABSTRACT - This study reviews the identification and effect of soil contamination to human health and environment. Soil contamination give direct and indirect impact to human health and environment. Various methods have been introduced and briefly elaborated in this review study in order to identify and monitor soil quality. The contamination status of soil is determined by several approaches and analysis of heavy metal in soil. The land uses of industry and landfill were found to have higher hazard for human and environment, when compared to the mining, plantation, and residential areas. As a preventive measure to the soil contamination, most country worldwide has developed and enforced Soil Quality Standard and Guidelines. With the enforcement of the standard and guidelines, the soil and land can be well managed and controlled from contamination by irresponsible person. This study is important for the environmental management of potentially toxic metals especially in the land uses of industry and landfill.

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1.0 INTRODUCTION

Soil is a part of the earth's surface made up of minerals and organic matter. Soil formation is the combined effect of physical, chemical, biological, and anthropogenic processes on the original geological material that produces the soil layer. Other than the ocean, the soil was the most part of the earth that fought with the soil pollution [1]. Waste from human activities including industries, domestic, farming, decomposition of organic chemical and petroleum products from agriculture and transportation were the main contributors to the soil contamination around the world [2]. The main sources of soil pollution around the world are agriculture activities followed by urban settings, transport, and municipal waste treatment, industrial activities, mining, military activities, nuclear activity, oil industry and the least is the geogenic source [3]. Soil pollution was recorded in 80,000 areas in Australia and more than one-fourth of soils in China. Other than that, European Economic Area and the United States are also on the list of higher intensity of soil pollution in the world. This study This study reviews the effect of soil contamination to human health and environment as well as the preventive measures.

2.0 TYPES OF SOIL CONTAMINANT

Soil contamination, often known as soil pollution, is defined as the presence of man-made substances and modifications in soil [2]. It has the potential to cause long-term health problems as well as ecosystem disruption. Soil contaminants are categorized as Macro and Micro contaminants based on their number, whereas microcontaminants are divided into two groups: organic and inorganic pollutants [2]. A case study of soil contamination in the dumping area of the Czech Republic shows that heavy metals such as Co, Cd, Pb, and Zn exceeded the legislation limits [4]. On the other hand, a case study in the United States has recognized that one source of soil contamination was lead products such as an additive in gasoline, paint, and unfiltered emissions from chemical industries [5]. Cadmium (Cd) from the regular application of fertilizer consolidated with industrial and transportation emissions can be centred on the source of soil contamination [6]. A study of soils from open dumping sites in the Philippines, Cambodia, India, and Vietnam clarified that the potential source of soil contamination was concentrations of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) that related to the open burning activities and unlegislated disposal of hazardous chemicals [7].

In Malaysia, one of the factors that soil is vulnerable to contamination is illegal dumping and burning activities. It led to dangerous chemical contamination and leachate from industrial waste deposition, plastic waste and heavy metals. The contamination that occurred in Langat Water Catchment Area was from the topsoil of landfills and non-landfill sites such as agricultural soil, the residential and industrial area which contain heavy metal (Cadmium (Cd) and Copper (Cu)) [8]. While heavy metals including Iron (Fe), Plumbum (Pb), and Copper (Cu) were present in contaminated soil at Ampar Tenang non-sanitary landfill [9]. However, the contamination rate was decreased with the increasing depth of soils due to the mobility of heavy metals concentration. Hydrogen sulphide was detected released from the industrial waste deposition that has been associated with heavy metals contamination to the soil in closed and post-closure dumpsite areas

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in Selangor [10]. A previous study revealed that activity from agriculture and industries has been linked as sources of the main contaminant to the soil in the Langat Basin area [11]. The study also found that pesticides from the agricultural activity and poorly maintained factory waste disposal nearby the study area have considerably contributed to the contaminated soil. Research in North Malaysia has reported that the higher traffic density and industrial activities gives a higher value to heavy metals such as Mn, Zn, Cu, Ni, Cr and Cd in the soil [12].

An investigation of heavy metal contamination at the Dengkil Waste Disposal Site discovered Fe, Mn, Cu, Cr, Ni, Zn, Pb and Co. [9]. Siti Norbaya et. al.[13] undertook heavy metal pollution analysis and evaluation in order to determine the distribution of heavy metal contamination in the soils around Perlis as a result of industry, urbanization and agricultural activities. Heavy metal concentrations in soil show the following declining trend: Cu>Pb>Cr>Ni>Cd. In comparison to other locations in Perlis, Ain [17] observed that the level of heavy metal in soil near centralized Chuping industrial zones gives the highest value. Only 11% of Cu and 6% of Cd were classified as seriously contaminated according to the Pollution Index. Meanwhile, Cu and Pb were found to be moderately polluted in 6% of all samples, while the other elements were found to be low contaminated. The results of a combined heavy metal concentration and assessment show that the most important sources of Cu, Cd, and Pb are industrial activities and traffic emissions, whereas Cr and Ni come mostly from natural sources. Increased anthropogenic environmental influences, particularly pollution loads, have resulted in detrimental changes in natural ecosystems and a reduction in biodiversity.

Sharifah [14] carried out a study on soil contamination from non-sanitary garbage landfills. Overall findings in Malaysia's Langat Water Catchment Area revealed that Al, Fe, Cu and Cd levels in agriculture soil were extremely high whilst in the residential area soil, Al and Fe were also high. Other elements including Mn, Zn, and Pb were found in abundance in garbage landfills. Yap et.al [16] analyses the ecological and health implications of potentially harmful metals in the topsoils of various types of land. The potential ecological risk index for single metals suggested that the severity of contamination of the five metals decreased in the following order: Cd > Cu > Pb > Zn > Ni in the ecological risk assessments. The areas of industry, landfills, garbage dumps, and mining were deemed to be of ‘very high ecological risk’. A study conducted by Su et.al [18] on a review on heavy metal contamination in the soil worldwide concluded that heavy metals in the soil refers to some significant heavy metals of biological toxicity, such as mercury (Hg), cadmium (Cd) and lead. In recent years, as the global economy has grown, the type and concentration of heavy metals in the soil produced by human activities has continuously increased, resulting in major environmental degradation. Yong Ming [20] revealed that some farmland soil in the suburbs of most cities and sewage irrigation districts in China is contaminated to some extent with heavy metals such as Cd, As, Zn, Cu, and Hg, leading in metal contamination of agricultural goods and posing a possible harm to human health. Noeland and Cyrus, [20] conducted a study on heavy metal contamination in soil around steel rolling mills in Jinja Municipality, Uganda, and discovered Cu > Pb > Zn > Ni > Cd > Cr was the overall heavy mean metal concentration around the factory, in descending order. Soils around the industry were moderately to highly polluted according to the Geoaccumulation Index, Igeo.

3.0 EFFECT OF SOIL CONTAMINATION TO HUMAN AND ENVIRONMENT

Soil contamination will give direct and indirect impact to human health and environment. It has become a global problem due to various human activities on different land uses in many countries, which urgently needs immediate solutions [21]. A lot of human health concerns, including cancer, renal damage and many more health issues have been linked to the consumption of contaminated water and vegetables from contaminated land. Consuming polluted vegetables will increase environment and human health hazard all over the world resulting in disorders in people and animals. Metals may seep into the ground, ground water, and eventually into the agricultural plants [21]. Heavy metals can have serious consequences for human health when vegetables polluted with these metals are ingested. To minimize the passage of metallic pollutants into the food chain and to develop appropriate remediation techniques, soil pollution must be mapped quickly and precisely [21]. Several approaches have been explored to improve the soil quality. For example, the addition of soil amendments reduced the plant’s absorption and declined the mobility and bioavailability of heavy metals in contaminated soil. However, further investigations are required to determine whether the amendment is a tool for the long-term remediation of multi metal-contaminated soils at the field scale. Moreover, its application may also bring certain environmental and health risks [22]. Chee [23] has conducted a study on ecological risks and human health risk assessments of five potentially toxic metals in the topsoil of six land uses in Peninsular Malaysia. It was found that industry, landfill, rubbish heap, and mining areas were categorized as ‘very high ecological risk’. The land uses of industry, landfill and rubbish heap were found to have higher hazard quotient values for the three pathways of the five metals for children and adults, when compared to the mining, plantation, and residential areas. The present findings are important for the environmental management of potentially toxic metals especially in the land uses of industry, landfill, and rubbish heap in Peninsular Malaysia. Giusti, [24] reviewed the most recent information on waste arisings and waste disposal options in the world and the potential of direct and indirect impact of waste management activities on health. They found out that there were very little data on direct human exposure and health impact of composting on resident populations even though there is some evidence that some workers have significantly affected with respiratory tract and other health issues. From the overall assessment, it can be concluded that the evidence of adverse health outcomes for the general population living near landfill sites, incinerators, composting facilities, and nuclear installations is usually insufficient and inconclusive because the existing epidemiological evidence linking waste management and human health is quite controversial. While the need to protect human health and the environment at these sites is rarely debated, there are questions about the magnitude of risk posed by the chemicals in such soils and about the clean-up levels that should be achieved. Raymond [25] has studied the issues associated with chemical bioavailability along with a review of current data on the availability of organic chemicals in both treated and untreated soils.

The leakage of leachate from landfills will contaminates the groundwater, soil, surface water, and natural ecosystems especially when the leachate is released uncontrolled, and hence can have a severe impact on environmental and human health. The presence of toxic metals in landfills leachate threaten the quality of the soils and plants in vicinity of the landfill area. Drinking of water and inhalation of soil particles have been identified as the major pathway for human exposure to toxic [26]. It is important to regularly monitor the quality of the dis-charged leachate to ensure the efficiency and suitability of the treatments provided. Munirah [27] has conducted a study on heavy metals contamination in leachate and surface soils from different landfills in Malaysia. Leachate from unlined and uncontrolled landfills can easily escape and interact with the sur-rounding soils. The presence of several pollutants including suspended particles (organic and inorganic), toxic, and heavy metals in landfill leachate can pose a serious threat to public health such as cardiovascular and liver diseases, male infertility, neurological disorders, birth disability, and bone defects. Some of the toxic compound in excess amount has noxious effects on the intestine, liver and damage the stomach. If ingested in higher concentrations, it can lead to skin cancer, dermal lesions, angiosarcoma, peripheral neuropathy, and vascular disease. Other effects of toxic materials if present in excess can damage the lungs, liver, induces osteotoxicity and nephrotoxicity, pulmonary adenocarcinomas, prostatic proliferative lesions, pulmonary adenocarcinomas and disturbs the immune system of the body. Other than that, ingestion of certain toxic also can cause changes in heart rhythm or paralysis in humans, difficulties in breathing, irregulating in blood pressure, diarrhoea, vomiting, and muscle weakness and may cause mortality if did not seek medical advice. It also can cause hypertension, damage the skeletal, immune system, endocrine, reduces intelligence potential in kids and among adults, and will affects the functioning of kidney and heart [26].

In agriculture development, pesticides application is essential in protecting crops and increases their productivity. However, this activity will cause the pesticide residues to contaminate the crops and their surrounding environment that will eventually lead to exposure to human being. In conjunction to that, there are various analytical methods on multi-residue pesticides analysis been developed over the years [28]. A study provides an overview of the reported concentration of pesticides, the extraction and determination techniques of pesticides in environmental samples and the potential health effects they imposed on human in Malaysia from 2007 to 2017 has been done [28]. Sardar [29] has studied the concentrations, sources, pollution levels and human health risk of potentially harmful elements in the soil of urban parks present in Peshawar, Pakistan. From the study, they found out the that the main exposure pathway of potentially harmful elements to human was ingestion, inhalation and by dermal contacts of contaminated dust or soil. The data showed that children will have higher possible health risk than adults in the studied area. The potentially harmful element contamination sources were due to heavy traffic, wastewater irrigation, sludge application and waste disposal. Lee [30] has reviewed the potential environmental and health impacts on miners and surrounding communities in the perspective of recent bauxite mining in Malaysia. The environmental issues of bauxite mining including air, water, and soil pollution due to bauxite dust; leaching of bauxite into water sources resulting in reduced soil fertility as well as affecting agricultural food products and aquatic life. Bauxite occupational exposure affects the health of miners and has negative consequences on the health of surrounding communities, such as increased respiratory symptoms, contamination of drinking water and other potential health risks from ingestion of bauxite and heavy metals, including noise-induced hearing loss and mental stress.

4.0 SOIL QUALITY IDENTIFICATION METHODS

Various methods have been introduced to identify and monitor soil quality. Soil heavy metal pollution has become a major environmental issue in recent decades as a result of rapid urbanization and industrialization. It is crucial to reduce and eliminate the already present contamination in the environment for our future generations. Ismail et al. [31] investigate heavy metals contamination in the soil of non-sanitary landfills in Langat River water catchment area in Selangor. In their study, a total of four (4) non-sanitary landfill marks as site A, B, C and D and three (3) non-landfill sites consisting of agriculture, industrial and residential areas were chosen for sampling location. Soil samples are transported to the laboratory for preliminary soil testing. To determine heavy metals concentration, Ethylenediaminetetraacetic acid (EDTA) was used. The samples were then analyzed using Inductively Coupled Plasma Spectroscopy (ICPOES) Model Iris Advantage ICP-OES Spectrometer for heavy metal detection. Othman et al. [32] carried out a study on landfill heavy metal contamination at different soil depths and location. Twelve points at 4 different sites of closed landfill located at Selangor were selected for this study and soil samples were collected at three different depths between 0-30 cm, 30-60 cm, and 60-90 cm. Then samples were stored at room temperature before being digested using Microwave Digestion Ethos D. Then, the ICP-MS (Perkin Elmer NexION 300X) was used to analyze heavy metals elements of Al, Cr, Mn, Fe, Co, Ni, Cu, Zn, Cd, and Pb to find the risk of heavy metal movement from the upper layer into the deeper layer soil. Electrical resistivity method is conducted at the location of study to detect soil pollution [33]. A cable of 250 m length was used with an electrode connected to the central switching system. From the result obtained, it shows that the presence of three low resistivity zones of decomposed waste saturated with highly conductive leachate is the most noticeable feature visible in the resistivity image. Soil samples were collected at three different locations (upstream, landfill area and downhill) for soil chemical testing. A study conducted by Abdul Hamid et al. [34] investigates topsoil contamination at Penang Island. They collected thirty-one (31) topsoil samples at two different places for comparison purposes. 12 samples were collected from granite residual topsoil, and the remaining 19 samples were collected from quaternary deposit topsoil. A series of laboratory testing including pH test, Methylene blue spot test method, soil organic matter and particle size distribution analysis were performed to determine the properties of soil samples. Inductively Coupled Plasma Mass Spectrometry (ICP-MS) was used to determine the concentrations of As, Pb, Ni, and Cd in the digested soil samples. Another study on toxic metals in the topsoil was conducted by Chee at al. [35] on six lands in Peninsular Malaysia. The sampling sites characteristics were divided into six groups: residential area, plantation area, landfill area, rubbish heaps, industrial area, and mining area. Sampling of topsoil at 0-10 cm deep was done at 23 sites location and three to five subsamples were collected from the topsoil using a stainless-steel shovel at each sampling site. The direct aqua-regia, which is a wet digestion method, was used to digest the topsoil samples. Procedural blanks and quality control samples made from the standard solution for each metal were analyzed along with the digested samples. These standard solutions were analyzed after every 5–10 samples to check for the accuracy of the analyzed samples. The accuracy of the methods for the analysis of Cd, Cu, Fe, Ni, Pb, and Zn was verified with the Certified Reference Materials (CRM).

Hossain [36] conducted a study on soil contamination at Gebeng industrial city located in Pahang. Chemical, food, detergent and manufacturing industries are part of industries located here. A total of thirty (30) soil samples were dug at three different sites for laboratory tests and further analyses. Firstly, soil samples need to be digested with concentrated nitric acid at a 130ºC temperature for 5 hours prior to being treated with hydrogen peroxide. After completion of the digestion process, soil samples are added with nitric acid before testing using coupled plasma mass spectrometry (ICP–MS) to identify As, Ba, Cd, Co, Cr, Cu, Ni, Pb and Zn. Another heavy metal, Hg is analyzed using 7471B: Mercury in solid or semisolid waste method using a direct mercury analyzer (DMA-80) (EPA 2007b). Moreover, analyses using Geo accumulation index (Igeo) and Pollution load index (PLI) are applied to investigate the soil contamination based on obtained results and using empirical indexes that provide a simple way to evaluate heavy metal index level. Suhaimi et al. [37] also conducted their study at Lynas Rare Earth Processing Plant, Gebeng industrial area. Approximately 0.10g to 0.15g of each twenty-seven of soil samples collected using auger sampling technique and were analyzed by using Neutron Activation Analysis technique for determination of elemental pollution. All soil samples were irradiated for 6 hours for determination of radionuclides such as As, Br, La, Sm, Sc, Eu, U, Sb, Yb, Lu, Nd, Ta, Th, Cr, Yb, Ce, Hf, Fe, Tb, and Zn. The samples were cooling for 2 to 3 days for decay process and counted by using gamma spectrometry for determination of As, Sm, Sb, U, La, and Lu (first counting) and followed by second counting after 3 to 4 weeks for determination of other radionuclides. Gamma ray with specific energy for each radionuclide were detected by using HPGe detector system supplied by ORTEC. Gamma vision software was used to determine the peak area of each radionuclide and finally, concentration of radionuclide was calculated using a spreadsheet program. According to finding results, most of the elementals in soil samples are detected and iron (Fe) element showed higher concentration compared to other heavy metal elements. Poh and Tahir [38] investigated heavy metals contaminant soil located in Kuala Terengganu. They concluded that, there are three (3) approaches to measure soil quality which comprise of taking measurements on a regular basis over time to track changes or trends in soil quality, make a comparison result obtained with standard reference and lastly evaluates anthropogenic influences on soil quality by calculating enrichment factors. The soil sample was transported to the laboratory for soil digestion and chemical analysis. The USEPA method was used to perform the soil digestion procedure for heavy metal analysis. By using an inductive coupled plasma optical emission spectrometer, all samples were analyzed for Al, Fe, Mn, Ca, Zn, Cu, Cr, Cd, Ni, and Pb. Pollution index (PI) was applied to the data set to discover possible sources that might influence different distribution of elements over study area around Perlis [14]. Concentration of 5 heavy metals (Cu, Cr, Ni, Cd, Pb) were studied to assess heavy metals contamination distribution due to industrialization, urbanization, and agricultural activities. Soil samples were collected at depth of 0-15cm for eighteen stations around Perlis. The inductively couple plasma mass spectroscopy (ICP-MS) technique was conducted to analyze five elements (Cu, Pb, Cr, Ni, Cd) of heavy metal in the soil at selected station.

The X-ray fluorescence (XRF) test was conducted to identify the elemental composition of Cu, Cr, Ni, Cd, Zn and Mn in the soil samples. Meanwhile, the Inductively Coupled Plasma Optical Emission Spectrometry (ICP - OES) was conducted to assess the concentration of heavy metals in the soil samples [12]. To study the presence of heavy metals and relationships between the metals and selected physico-chemical soil properties in Northern Ireland, Keshavarzi [39] used the Tellus database at three locations; agricultural, industrial, and urban. A total of 620 soil samples were collected for laboratory purposes to determine soil chemistry sample analysis and for further analysis using Tellus database. In addition, contamination indices (CF, EF, PLI, I-geo, RI, and MRI) were applied to the data to determine the level of soil pollution in Northern Ireland. The soil samples were collected at a depth of 0-10 cm at seven different point sampling sites where the locations were selected based on a distance 20 m radius from the centre of Erbil City industrial area. Heavy metals elements of Pb, Cd, Cu, Zn, Ni and Cr were analyzed using Flame Atomic Absorption spectrophotometer (Pg instrument AA500 Atomic Absorption) [40]. Electrical resistivity imaging (ERI) was used to assess the landfill leachate's pollution level at Simpang Renggam, Johor, Malaysia. The ERI survey was carried out in the research region, utilizing the ABEM Terrameter LS 2 equipment using the Schlumberger electrode configuration. Besides, seven (7) parameters of leachate characterization such as Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD5), Suspended Solid (SS), Power of Hydrogen (pH), Ammonia Hydrogen (NH3-N), Turbidity and Biodegradability Ratio (BOD5/COD) were also performed to identify and evaluate the current leachate condition of the landfill [41].

5.0 SOIL QUALITY GUIDELINES AND STANDARD

It is crucial for the authority to provide a stringent guideline in order to determine the quality of soil and subsequently prevent soil contamination. In this study, guidelines with summary and a brief explanation on the soil contamination and quality standard for different countries are highlighted in Table 1. In Malaysia, the Department of Environment provided guidelines for the site screening of contaminated land, followed by assessing and reporting the contaminated land as well as the remediation works for the contaminated land. New Zealand also developed various Soil Quality Guidelines such as assessing and managing contaminants in soil, reporting on contaminated sites, site investigation and analysis of soils and methodology for deriving standards for contaminants in soil to protect human health. The soil quality guidelines developed by other countries such as Rome, Canada, Japan, Denmark, Australia and Turkey are also briefly explained in Table 1.

Table 1. Guidelines for Soil Quality Standard for different countries with summary

Country	Soil Quality Guidelines	Summary of Guidelines
Malaysia	Contaminated Land Management and Control Guidelines No. 1: Malaysian Recommended Site Screening Levels for Contaminated Land [42]	Under the Ninth Malaysia Plan (2006-2010), the Department of Environment, has initiated a study on Criteria and Standards for the Management and Rehabilitation of Contaminated Soils in Malaysia. As a result of the study, a contaminated soil management framework that includes the value of soil filtration guidelines and a series of guidelines has been developed to enable the proper assessment and management of contaminated sites in Malaysia.
	Contaminated Land Management and Control Guidelines No. 2: Assessing and Reporting Contaminated Sites. June 2009 [43]	Provides a consistent and uniform approach to site investigation, assessment, risk assessment and reporting of all land properties classified as contaminated land. This guideline also covered the assessment approach, sampling design and techniques, quality assurance and quality control (QA/QC) protocols and report preparation as well as reviewing of such sites and to come out with the necessary actions to carry out remediation and rehabilitation measures when required
	Contaminated Land Management and Control Guidelines No. 3: Remediation of Contaminated Sites [44]	Provide an essential element or step in carrying out remediation at a contaminated site. It states the important process of contaminated soil remediation which includes remediation planning, implementation and closure of contaminated sites.
New Zealand	National environmental standard for assessing and managing contaminants in soil to protect human health [45]	A nationally consistent set of planning and value of soil pollutants. It ensures that soil affected by contaminants in the soil is identified and assessed accordingly before it is developed and if necessary, the soil is repaired or contaminants contained to make the soil safe for human use.
	Soil Contaminant Standards [46]	This guideline provides methods for setting applicable numerical standards for contaminants in soils that are protective of human health
	Contaminated Land Management Guidelines No. 1 - Reporting on Contaminated Sites in New Zealand (Revised 2011) [47]	This guideline includes checklists for reporting requirements for contaminated sites and for the removal of petroleum underground storage tanks
	Contaminated Land Management Guidelines No 2 - Hierarchy and Application in New Zealand of Environmental Guideline Values (Revised 2011) [48]	This hierarchy determines the order in which guideline values contained in those reference documents should be used in a contaminated site assessment. It will be of use to environmental consultants and landowners undertaking contaminated site investigations, and to council staff involved in reviewing contaminated site assessment reports.
	Contaminated Land Management Guidelines No 5 - Site Investigation and Analysis of Soils (Revised 2011) [49]	This guideline provides best practice for the sampling and analysis of soils on sites where hazardous substances are present or suspected in soils in New Zealand, and guidance on the principles governing the interpretation of the data obtained.

Table 1. (cont.)

Country	Soil Quality Guidelines	Summary of Guidelines
	Guidelines for assessing and managing petroleum hydrocarbon contaminated sites in New Zealand (Revised 2011) [50]	This guideline provides information on the assessment and management of sites contaminated with petroleum hydrocarbons.
	Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health (2011) [51]	This technical reference outlines a risk-based methodology for deriving soil contaminant concentrations.
Rome	Summary for policy makers Published by the Food and Agriculture Organization of the United Nations and the United Nations Environment Programme Rome, 2021 [52]	This report a joint effort coordinated by Food and Agriculture Organization of the United Nations (FAO's) Global Soil Partnership and supported by UNEP, contributes to raising awareness to the threats posed by soil pollution and to the interlinkage with other global environmental pressures.
Canada	Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health [53]	This guideline tabulates the values of heavy metal and chemical for different land usage as a guideline to determine soil quality
Japan	Ministry of the Environment, Government of Japan- Environmental Quality Standards for Soil Pollution [54]	These environmental quality standards for soil contamination consist of the elution standards (designed to conserve the capacity of soil to protect foods), each of which serves as the basis to detect the presence of contamination and come up with pollution control measures. This guideline also lists the substances and the target level of soil quality examined through leaching and content tests
Denmark	Guidelines on remediation of contaminated sites (Danish EPA) [55]	This guideline provides instructions on how to handle contaminated soil, from investigation phase, through risk assessment, to the establishment of remedial measures. Criteria for evaporation, soil quality and groundwater quality are indicated, along with various remediation measures and standard data. This guideline also provide advice on projection, reporting and handling/control related to remedial measures.
Australia	Assessment and management of contaminated sites [56]	This guideline provides general guidance in relation to the framework for soil quality guidelines (for arsenic, chromium (III), copper, DDT, lead, naphthalene, nickel and zinc) in the assessment of site contamination. The term 'soil quality guidelines' (SQGs) is used in this guideline to describe any concentration-based limit for contaminants in soils. This guideline also provides a guidance how Australian contaminated sites should be assessed.
Turkey	Development of human health risk-based Soil Quality Standards for Turkey: Conceptual framework, Environmental Advances, Volume 1, 2020 [57]	A novel conceptual framework is developed for derivation of human health risk-based SQSs for Turkey. In this paper, the main elements of the established conceptual framework, the methods used for specification of the generic site characteristics, the information sources used for compilation of needed chemical and toxicological data, the political decisions taken, and the challenges encountered during these studies are presented. It is believed that the presented road map developed through the conceptual framework will be beneficial for other countries that are in the stage of deriving g SQSs.

6.0 CONCLUSION

Soil contamination has direct and indirect effect to the long-term human health and environment. Soil contamination due to heavy metal has become a major environmental issue in recent decades as a result of rapid urbanization and industrialization. Various methods have been executed to identify soil pollution and heavy metal concentration such as Ethylenediaminetetraacetic acid (EDTA), ICPOES Spectrometer, Electrical resistivity, Neutron Activation Analysis technique and X-ray fluorescence (XRF). The data obtained then further analysed using empirical index such as Geo accumulation index (Igeo), Pollution load index (PLI) and Enrichment factor in order to determine the level of soil pollution. Soil contamination prevention measures are carried out by most countries worldwide with the development and enforcement on the Soil Quality Standard and Guidelines. Generally, the guidelines include the site screening, assessing and reporting the contaminated land, preventive measures as well as the remediation works. This study is very helpful in environmental and land management especially in industry and landfill area.

7.0 AUTHOR CONTRIBUTIONS

D. Che Lat: Conceptualization, Methodology, Writing and Editing
D. A. Mat Yusof: Data curation, Writing
M. H. Yasin: Investigation, Reviewing
S. N. A. Mohd Noor: Investigation, Writing
N. S. A. Rahman: Writing
R. Razali: Writing

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9.0 DATA AVAILABILITY STATEMENT

The data used to support the findings of this study are included within the article.

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11.0 CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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