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Review Article

Heavy Metal Pollutions in Soil: Sources, Speciation and Remediations; Review

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Abstract

The level of heavy metals above the permissible limit is toxic to human being as well as to animal welfare. The heavy metals enter the surrounding environment by natural and though anthropogenic activities. Soil erosion, natural weathering, mining, industrial effluents, urban runoff, sewage discharge, inorganic fertilizers, insecticides, herbicides, industrial emissions and transportations are some of the various sources of heavy metals induced to the environment, waterbody, soil and foods. Many instrumental analytical methods may be employed to measure the concentration of heavy metals in various samples. The most common techniques are atomic absorption spectrometry (AAS); atomic emission/ fluorescence spectrometry (AES/AFS); inductively coupled plasma mass spectrometry (ICP-MS); inductively coupled plasma optical emission spectrometry (ICP-OES); neutron activation analysis (NAA), X-ray fluorescence (XRF); and anodic striping voltammetry (AVS). The detection level of metals quantification depends on the instrument, method extractions and speciation. There are physical, chemical and biological techniques of heavy metals remediations in soil and human bodies. Biochar is one of the organic materials reduce the level of heavy metals, the plant species such as: Salix spp. (Salix viminalis, Salix fragilis), Castor (Ricinus communis), Corn (Zea mays),Populus spp. (Populus deltoides, Populus nigra, Populus trichocarpa), Jatropha (Jatropha curcas L.), Populus deltoides, Brassica juncea, Astragalus bisulcatus, Populus canescens can also remediate heavy metals from the contaminated soil. Chelate therapy ridding the body heavy metals with a chemical like Ethylene Diamine Tetraacetic Acid (EDTA) effective chelation of removing metals from body blood. Due to the increasing trend of HMs contamination, the negative impact on plants, environments and other organisms, it is important to mitigate the toxicity by developing effective and environmentally safe technologies. This paper therefore gives highlights of heavy metals sources, techniques of analysis and remediations.

Keywords: Heavy metals, Source of Heavy metals, Analytical Techniques, Remediations.

1. INTRODUCTION

Heavy metals are persistent, non-biodegradable, a long biological half-life and toxic if the limit is above the permissible limit. The existence is mainly anthropogenic sources from different industries and agricultural practices [1]**.** Water body, soil, environment and human body can affect with toxic heavy metals. Heavy metals accumulate and gradually build up into the body via inhalation, ingestion and skin absorption and forms toxins beyond the permissible level [2].

Heavy metals enter the surroundings by natural means and through anthropogenic activities. Soil erosion, mining, industrial emissions, urban runoff, sewage discharge, herbicides are some of sources of heavy metals [3-5].

The contaminated soil with heavy Metals can leads risks to humans and animals through absorption of plants that have bio-accumulated toxic metals from contaminated soil [6]. Soil minerals compositions and the performance of crop to remove metals from soil have direct relationship to the rate of heavy metal accumulated in the soil. Several health problems and disorders such as number of nervous, cardiovascular, renal, neurological impairment as well as bone diseases will occurs due to the Excessive level of heavy metals beyond the Maximum Permissible Level [7].

Due to the increasing trend of HMs contamination, pollutions and the negative impact on plants, environments and other organisms, it is important to mitigate the toxicity of Heavy metals which has become a burning issue. Hence, it is important to develop effective and environmentally safe technologies for soil remediation and reclamations. There are many methods to control heavy metals contamination of soil by physico-chemical and biological methods. Many traditional practices/ conventional technologies are extremely costly and time consuming; other methods use of chemicals that may always not be benevolent with respect to the various compartments. Biologically based remediation strategy such as phyto-remediation is a promising technology for the remediation of contaminated soil [8].

2. Heavy Metals and Sources

Mercury, arsenic, and lead are no beneficial effects in humans and able to induce toxic even at lower concentration, those can be induced by anthropogenic activities including agriculture, municipal wastewater discharge, mining, incineration, and discharges of industrial wastewater [9, 10]. Heavy metals occur naturally in the soil from the pedogenetic processes of weathering of parent materials at levels as trace (<1000 mg/kg) and rarely toxic [11, 12]. The heavy metals contaminants in the soil environments with the following reasons: the rates of generation via anthropogenic cycles are more rapid relative to natural ones; higher potentials of direct exposure which transferred from mines to random environmental locations occur; the level metals in waste products are relatively high compared to those in the receiving environment; and the species form in which a metal is found in the receiving environmental system may render it more bioavailable [13]. A simple mass balance of the heavy metals in the soil can be expressed as [14, 15]:

$$HM_{total} = (HM_p + HM_a + HM_f + HM_{ag} + HM_{ow} + HM_{ip}) - (HM_{cr} + HM_l)$$

Where "HM", heavy metal, "p", parent material, "a", atmospheric deposition, "f", fertilizer sources, "ag", agrochemical sources, "ow", organic waste sources, "ip", inorganic pollutants, "cr", crop removal, and "l", losses by leaching, volatilization, and so forth. It is estimated that the anthropogenic emission for each heavy metal is one-to-three orders of magnitude higher, more mobile, bio-available than the natural flux [16-18]. The anthropogenic sources heavy metals in contaminated sites are a wide source including metal mine tailings, disposal of wastes, lead-based paints, land application of fertilizer, animal manures, sewage sludge, pesticides, coal combustion residues, petrochemicals, and atmospheric deposition [19]. Table 1 also shows various sources of heavy metals contaminating soils in the world [20].

Fertilizers and Pesticides

Large quantities of fertilization are regularly added to soils in intensive farming systems to provide adequate primary macro-nutrients for crop growth and productivities. Fertilizer sources of major nutrients applications may contain trace amounts of heavy metals as impurities may significantly increase their content in the soil [21]. Heavy metal content is relatively low in nitrogen and potash fertilizers, while phosphoric fertilizers usually contain considerable toxic heavy metals. Heavy metals in the compound fertilizers are mainly from master materials and manufacturing processes. The content of heavy metals in fertilizers is generally as follows: phosphoric fertilizer> compound fertilizer> potash fertilizer> nitrogen fertilizer [22]. Cd is contaminant heavy metal in the soil which brought to soils with the application of phosphoric fertilizers [23]. Pesticides are also sources of heavy metals contaminant in soil used widely in agriculture and horticulturefor use as insecticides and fungicides on compounds which contain Cu, Hg, Mn, Pb, or Zn. Compared with fertilizers, the use of such materials has been more localized, being restricted to particular sites or crops [24].

Bio-solids and Manures

The application of livestock manures and animal wastes, composts (poultry, cattle, and pig manures), and municipal sewage sludge to land inadvertently buildup of heavy metals such as Pb, Hg, Ni, Se, Mo, As, Cd, Cr, Cu, Zn, Sb, and so forth, in the soil [25, 26]. The Cu and Zn added to diets as growth promoters and as contained in poultry health products may also have the potential to cause metal contamination of the soil [27]. Heavy metals most commonly found in biosolids are Pb, Ni, Cd, Cr, Cu, and Zn, and the metal concentrations are governed by the nature and the intensity of the industrial activity, as well as the type of process employed during the biosolids treatment [28].

Waste water for irrigation may produces heavy metals and are fixed in the soil in different ways [29]. Quality of irrigative sewage must be strictly controlled within the national quality standard for irrigation water [30]. Stack or duct emissions of air, gas, or vapor streams, and fugitive emissions such as dust from storage areas or waste piles are Air-Borne Sources of metals such as As, Cd, and Pb can also volatilize during high-temperature processing will convert to oxides and condense as fine particulates [31]. All solid particles in smoke from fires and in other emissions from factory chimneys are eventually deposited on land or sea; most forms of fossil fuels contain some heavy metals and this is, therefore, a form of contamination which has been continuing on a large scale since the industrial revolution began. Zn and Cd may also be added to soils adjacent to roads, the sources being tyres, and lubricant oils [32].

Table-1: Different sources of HMs contaminating soils annually in the world (1000 t • a^{-1}) [30]

Sources	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Agriculture and food waste	0~0.6	0~0.3	4.5~90	3~38	0~1.5	6~45	1.5~27	12~150
Farmyard manure	1.2~4.4	0.2~1.2	10~60	14~80	0~0.2	3~36	3.2~20	150~320
Logging and timber Industry wastes	0~3.3	0~2.2	2.2~18	3.3~52	0~2.2	2.2~23	6.6~8.2	13~65
Municipal wastes	0.09~0.7	0.88~7.5	6.6~33	13~40	0~0.26	2.2~10 7	18~62	22~97
Municipal sludge	0.01~0.24	0.02~0.34	1.4~11	4.9~21	0.01~0.8	5.0~22	2.8~9.7	18~57
Organic wastes	0~0.25	0~0.01	0.1~0.48	0.04~0.61	-	0.17~3.2	0.02~1.6	0.13~2.1
Metal processing solid wastes	0.01~0.21	0~0.08	0.65~2.4	0.95~7.6	0~0.08	0.84~2.5	4.1~11	2.7~19
Coal ash	6.7~37	1.5~13	149~446	93~335	0.37~4.8	56~279	45~242	112~484
Fertilizer	0~0.02	0 .03~0.25	0.03~0.38	0.05~0.58	-	0.20~3.5	0.4 2~2.3	0.25~1.1
Marl	0.04~0.5	0~0. 11	0.0 4~0.19	0.15~2.0	0~0.02	0.22~3.5	0.45~2.6	0.15~3.5
Commodity impurities	36~41	0.78~1.6	305~610	395~790	0.55~0.82	6.5~32	195~390	310~620
Atmospheric deposition	8.4~18	2.2~8.4	5.1~38	14~36	0.63~4.3	11~37	202~263	49~135
Total	**52~112**	**5.6~38**	**484~1309**	**541~1367**	**1.6~15**	**106~544**	**479~1113**	**689~2054**

2.1. Heavy metal polluted soil and its Impacts on plant growth

The heavy metals that are available for plant uptake are soluble and easily solubilized by root exudates [33]. The ability of plants to accumulate essential metals equally enables them to acquire other nonessential metals [34]. As metals cannot be broken down, when concentrations within the plant exceed optimal levels, they adversely affect the plant both directly and indirectly. Some heavy metals like Pb, Cd, Hg, and as are do not play beneficial role in plant growth. Most of the reduction in growth parameters of plants growing on polluted soils can be attributed to reduced photosynthetic activities, plant mineral nutrition, and reduced activity of some enzymes [35]. It is important to note that certain plants are able to tolerate high concentration of heavy metals in their environment. Literature [36] reported that these plants are able to tolerate these metals via three mechanisms, namely, (i) exclusion: restriction of metal transport and maintenance of a constant metal concentration in the shoot over a wide range of soil concentrations; (ii) inclusion: metal concentrations in the shoot reflecting those in the soil solution through a linear relationship; and (iii) bioaccumulation: accumulation of metals in the shoot and roots of plants at both low and high soil concentrations.

Table-2: Effect of heavy metal toxicity on plants

HM	Plant	Toxic effect on plant
As	Rice (Oryza sativa)	Reduction in seed germination; decrease in seedling height; reduced leaf area and dry matter production
	Tomato (Lycopersicon esculentum)	Reduced fruit yield; decrease in leaf fresh weight
Cd	Wheat (Triticum sp.)	Reduction in seed germination; decrease in plant nutrient content; reduced shoot and root length
	Garlic(Allium sativum)	Reduced shoot growth; Cd accumulation
	Maize (Zea mays)	Reduced shoot growth; inhibition of root growth
Co	Tomato (Lycopersicon esculentum)	Reduction in plant nutrient content
	Mung bean (Vigna radiata)	Reduction in antioxidant enzyme activities; decrease in plant sugar, starch, amino acids, and protein content
Cr	Wheat (Triticum sp.)	Reduced shoot and root growth
	Tomato (Lycopersicon esculentum)	Decrease in plant nutrient acquisition
	Onion (Allium cepa)	Inhibition of germination process; reduction of plant biomass
Hg	Rice (Oryza sativa)	Decrease in plant height; reduced tiller and panicle formation; yield reduction; bioaccumulation in shoot and root of seedlings
	Tomato (Lycopersicon esculentum)	Reduction in germination percentage; reduced plant height; reduction in lowering and fruit weight; chlorosis

Ni	Wheat (Triticum sp.)	Reduction in plant nutrient acquisition
	Rice (Oryza sativa)	Inhibition of root growth
Pb	Maize (Zea mays)	Reduction in germination percentage; suppressed growth; reduced plant biomass; decrease in plant protein content
	Oat (Avenasativa)	Inhibition of enzyme activity which affected CO_2 fixation
Zn	Pea (Pisum sativum)	Reduction in chlorophyll content; alteration in structure of chloroplast; reduction in photo system II activity; reduced plant growth

2.2. Effects of Heavy metals in human health

Heavy metals accumulations in human body comprises that direct breathing of polluted air, drinking of polluted water and direct contact with soil and ingestion of food comprising of plants developed in metal-polluted soil [37]. Heavy metal-polluted food can severely reduce some vital nutrients in the body that are accountable for declining immunological defenses, growth delay, reduced psychosocial abilities, incapacities related with malnutrition and greater occurrence of upper gastrointestinal cancer degrees; main environmental contaminants causing cytotoxic, mutagenic and cancerous effects in animals [38,39].

2.3. Plant selection considerations in remediation of heavy metals in soil

The criteria for selection of plants for phytoremediation are based on their root depth, the nature of the contaminants, the soil, and regional climate [40]. The root depth varies greatly among different types of plants, depending on soil structure, depth of a hard pan, soil fertility, cropping pressure, contaminant concentration, or other conditions [41]. The cleaning depths are approximately <3 feet for grasses, <10 feet for shrubs and <20 feet for deep rooting trees. The nature of on-site contaminants is a principal factor in the selection of a plant for phytoremediation [42].

Many researches work reported that grasses are the most effective plant for phytoremediation [43]. Herbaceous plants, especially grasses, have characteristics of rapid growth, large amount of biomass, strong resistance, effective stabilization, adapted to low soil nutrient content, stress environment and shallow soils with compared to trees and shrubs [44-46].

3. HEAVY METALS ANALYTICAL METHODS

3.1. Digestions of heavy metals in soil

There are different digestion methods and techniques are used to determine the concentration of trace elements in solid matrices [47]. Digestion on hot plates, in a block digester and digestion bombs placed in microwave ovens are the most commonly used techniques to digest solid sample matrices. If open systems are used during digestion, there are risks of atmospheric contamination and volatilization losses of volatile compounds during the extraction procedure [48]. The microwave-assisted sample digestion technique has become widely used due to its safe, rapid and efficient performance [49]. The microwave sample digestion technique reduces the risk of external contamination and requires smaller amount of acids which improve the precisions and the overall accuracy of the analytical method.

Inorganic acids such as HCl, H_3PO_4, HNO_3, $HClO_4$, HF, H_2SO_4 or their combination use as a digestion reagent and exhibit various peculiar properties which enables each acid to carry out specific functions during extraction [50]. The choice of those inorganic extractants depends on the objectives of the study, type of contaminants, properties of the extractant, experimental conditions, need to readily release extracted metal and need for minimum interference from contaminants [51]. Improper selection of inorganic acids could cause effects such as partial dissolution of soil sample resulting in reduced metal content levels in soil samples [52].

3.2. Speciation and speciation analysis

Determination of the total concentration of metals is not sufficient to evaluate their impact on the environment, bioavailability and toxicity because different elemental species can have different properties. Speciation refers to the distribution of an element amongst defined chemical species and speciation analysis is refers the analytical activities that identifying and/or quantifying the different chemical species or forms of an element existing in a sample [53]. Chemical species denotes to the specific form(s) of the element present in terms of oxidation or electronic state, isotopic composition and molecular structure. Bioactivity and bioavailability of trace metals severely depend on their chemical coexisting forms, and therefore their speciation [54].

The human toxicity and risk assessment would tell us as a result of the speciation of Electronic and oxidation states. Oxidation state can affect absorption, membrane transport, and excretion, as well as toxicity at the cellular or molecular target.

Table-3: Elements with more than one biologically relevant valence

Atomic number	Name	Symbol	Speciation	Reference
24	Chromium	Cr	III/VI	
25	Manganese	Mn	II/III/IV	
26	Iron	Fe	0/II/III	
27	Cobalt	Co	II/III	[54]
28	Nickel	Ni	II/IV	
29	Copper	Cu	0/I/II	
30	Zinc	Zn	0/II	
34	Arsenic	As	III/V	
35	Selenium	Se	II/IV/VI	
80	Mercury	Hg	0/I/II	
82	Lead	Pb	II/IV	

Chromium serves as a good example of the importance of oxidation state. Cr^{III} is considered as an essential element, but Cr^{VI} is genotoxic and carcinogenic. Bioavailability also depends on oxidation state. Cr^{VI} is better absorbed than Cr^{III} following both dermal and oral exposure [55].

It's difficult to predicting how the oxidation state of a particular element will affect toxicity. Thus, inorganic Mn^{III} species are more toxic than other oxidation states (II & IV). and more reduced species of inorganic arsenic are more toxic, in general following the order arsine (arsenic(III) hydride; AsH_3) >arsenites (As^{III}) > arsenates (As^{V}).

Speciation study in soil

Determination of the level of total metal concentration is not enough to assess the environmental impact of polluted soil; heavy metals may have different chemical forms and only a fraction can be remobilized easily [56, 57]. Different research work has denoted that the mobility, bioavailability, storage, retention and toxicity of trace metals in living organisms, food and the environment is a function of the chemical forms [58]. Therefore, in order to analyze the binding forms of heavy metals in soil chemical extraction procedures should be employed. Table 4 refers the most commonly used protocol of sequential techniques by the BCRProcedure.

Table-4: Three-step sequential extraction procedure developed by BCR [59-61]

Species	Reagent	Extraction time/temp.
Exchangeable, Water- and acid-soluble	40 cm^3 0.11 M CH_3COOH per 1.0g of sample	Shake using mechanical shaker overnight at 25˚C
Reducible species (metal oxides- and hydroxides-bound)	40 cm^3 0.1 M $NH_2OH.HCl$ (adjusted to pH = 2 with HNO_3) added to residue.	300 min at 25˚C
Oxidisable species (organic matter- and sulphides-bound)	10 cm^3 8.8 M H_2O_2 added to residue in water bath. Evaporate solution to few cm3 After cooling, add 50 cm^3 1 M CH_3COONH_4 (adjusted to pH = 2 with HNO_3) to residue.	60 min at room temperature 60 min at 85˚C 360 min (25˚C)

Alkaline Digestion and Other Extraction Methods

Numerous specific digestion/extraction techniques required for Cr, Hg, As, and Se. For these elements, instead of total metal concentration analysis speciation is more important because of distinctly different environmental effects that exist among different species. Different speciation techniques such as inductively coupled plasma mass spectrophotometry (ICP-MS), inductively coupled plasma atomic emission spectrophotometry (ICP-AES), and electrothermal atomic absorption spectrometry (ETAAS) could be considered as the most sensitive and selective techniques [62]. However, continuing developments in analytical chemistry, now days, the coupling of versatile separation techniques, such as high-performance liquid chromatography, gas chromatography and capillary electrophoresis (CE) to a highly sensitive detector, such as ICP-MS, which has generated substantial attractive analytical tools for ultra-trace elemental speciation analysis [63].

4. REMEDIATION OF HEAVY METALS

There are a number of mechanisms to remediate heavy metals contaminated soil

4.1. Biochar

Biochar is organic material created by heating organic material under condition of limited oxygen and at lower temperatures (200–400°C) that is currently being exploited in the management of heavy metal polluted soils. The plant absorption of available heavy metals reduced when the soil amended with biochar [64, 66]. The biochar can increase soil pH unlike most other organic amendments [65] may have increased sorption of these metals, thus reducing their bioavailability for plant uptake. The most important measures of biochar quality: high adsorption and cation exchange capacities and low levels of mobile matter [67]. The surface of biochars are rich in "oxygen-containing functional groups" that enable to forming complexes between cations (e.g., Cu^{2+}, Ni^{2+}, Cd^{2+}, Pb^{2+}, and Zn^{2+}) and the biochar surface [68] because of the negative surface attracts hydrogen ions from the soil solution can increase soil pH after biochar application to contaminated soils. A higher soil pH serves to further increase the sorption of metals especially in acidic soils from solution because of the deprotonation of pH-dependent cation exchange sites on soil surfaces [69].

4.2. Phytoremedation

Grow specific plants which have certain hyper-accumulation ability in contaminated soil can remediate heavy metals. When the plants are reach at certain heavy metals enrichment level remove by harvesting, burning and curing plants. This technique is cost-effective, efficient and eco-friendly technology. Now a days more than 400 species have been found in the world, and most of them belong to Cruciferae, including the genus Brassica, Alyssums, and Thlaspi [70]. Phytoremediation of heavy metal polluted soils can be achieved via different mechanisms include phytoextraction, phytostabilization, and phytovolatilization.

Table-5: Summarizes definition and main characteristics of phytoremediation processes [71]

Process	Definition	Process goal	Selection criteria of plant species
Phytoextraction	Uptake of a contaminant by plant roots from the environment & its translocation into harvestable plant biomass	Contaminant extraction and capture	-Tolerance to a high concentration metals -high metal-accumulation capacity -rapid growth rate -Accumulation of trace elements in the above ground parts -Easy to harvest -Easy agricultural management -resistance to pathogens and pests -extended root system for exploring large soil volumes
Phytostabilization	Reduction of mobility and Bioavailability of pollutants in environment either by physical or chemical effects	Contaminant containment	- the ability to develop extended and abundance root system, -the ability to keep the translocation of metals from roots to shoots as low as possible -the capacity to retain the contaminants in the roots or rhizospher(excluder mechanism) to limit the spreading though the food chain
Phytovolatilization	The process of absorption of pollutants by plants and volatilization into the atmosphere by the foliar system	Contaminant extraction from media and release to air	

Table-6: List of selected plants reported for phytoremediation of heavy metals [72]

HMs	Plant Species
Cd, Cu, Pb, Zn	Salix spp. (Salix viminalis, Salix fragilis)
Cd	Castor (Ricinus communis)
Cd, Pb, Zn	Corn (Zea mays)
Cd, Cu, Pb, Zn	Populus spp. (Populusdeltoides, Populusnigra, Populustrichocarpa)
Cd, Cu, Ni, Pb	Jatropha (Jatropha curcas L.)
Hg	Populusdeltoides
Se	Brassica juncea, Astragalus bisulcatus
Zn	Populuscanescens

5. DISCUSSIONS

An extensive range of analytical methods and digestions techniques are available for trace element analysis, some of techniques have been addressed in this review. The type of sample and concentration range of heavy metal influence the selection of the technique to be used. Regards to the precision of measurements ICP-MS and ICP-OES are more precise than (FAAS, XRF and ETAAS). ICP-MS can measure isotopic analysis. The digestion procedures are an essential part of the measurement procedure; Microwave acid digestion methods reduce the risk of external contamination and require smaller quantities of acids, thus improving detection limits and the overall accuracy of the analytical method. Table 7 showed recovery result in different digestion techniques.

Table-7: Certified concentrations and element mass fractions for three digestion procedure.

Certified concentrations and element mass fractions for three digestion procedure applied to SRM				
Measured mass fractions (mg/kg) (n = 3)				
Element	Certified value (mg/kg)	Hot plate open-vessel digestion	Microwave digestion HNO_3 :HF	Microwave digestion HNO_3 :HF:HCl
V	119 ± 3	88.4 ± 4	118 ± 5.3	118.9 ± 5.4
Cr	130 ± 4	92.7 ± 13.9	106.5 ± 16.0	124.8 ± 18.7
Mn	538 ± 17	413.4 ± 21	498.2 ± 22	497.8 ± 22
Co	17.6 ± 0.7	13.0 ± 1.1	14.3 ± 0.9	15.1 ± 0.9
Ni	88 ± 5	61.4 ± 7.9	64.3 ± 8.2	78.6 ± 7.2
Zn	106 ± 3	57.9 ± 14.3	100.6 ± 4	119.4 ± 3
Pb	18.9 ± 0.5	13.2 ± 3	14.0 ± 3.1	9.6 ± 4.3
U	3.0 ± 0.2	2.7 ± 0.3	3.1 ± 0.3	3.2 ± 0.3

Regarding to speciation study of heavy metals: Sequential extraction procedures, alkaline digestion/extraction are fractionated metals into exchangeable/bound to carbonates, Fe-Mn oxides, organic matter, and residual fractions; and in different oxidation forms. Among the different remediation techniques, phytoremediation is preferred method of alleviation of HMs from polluted soil. In addition, eating selected and fresh organic food provided ridding of HMs from body and helped to prevent many health ailments.

6. CONCLUTIONS AND FUTURE PERSPECTIVES

The level of heavy metals above the permissible limit has been proved to be toxic to both human and environmental health. Owing to their toxicity and their possible bioaccumulation, these toxic metals should be subject to required monitoring the anthropogenic practices. HMs contamination in soil, water and environments has been recognized as a potential risk to plants and crop productivities. due to industrial activities and other anthropogenic factors which eventually result in losses in agricultural yield, leading us to unsecure sustainable environment for future including food insecurity, biodiversity loss and soil infertility. Parallel to apply agricultural inputs in soil amendment and using wastewater for irrigation, have to be monitor the level of HMs by the appropriate analytical techniques. Phytoremediation and organic material inputs like biochar application for soil contaminated by heavy metals is necessary in order to reduce the associated risks, make the land resource available for agricultural production, enhance food security, and scale down land tenure problems.

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