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The Assessment, Sources and Indicators of Potentially Toxic Metals in the Soil

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Introduction

Potentially harmful metals have made soil pollution a global environmental problem. Both anthropogenic activities and geogenic processes are significant contributors to soil pollution. It's possible that soils inherit toxic metals from their parents; However, industrial and agricultural activities account for the majority of soil pollution. Changes in the chemical, biochemical and microbial properties of soils as well as plant responses can indicate metal contamination. Despite the fact that extractable amounts have been reported to be more closely related to plant uptake, the total concentration of toxic metals in soil remains the most widely used indicator for risk assessment. Although a number of models have been proposed for assessing toxic metal contamination of soil, none of them are widely accepted for use with a wide range of soils. The effects of toxic metal contamination on soil and the environment, food safety and quality and human health are all highlighted in this review paper. The efficiency of remediation and the diagnosis, modeling and regulatory standards of soil contamination all require additional research.

Description

Toxic pollutants in the air, water and soil are responsible for the deaths of 9 million people annually, or 16% of all deaths worldwide.As the largest natural filter for both inorganic and organic contaminants, soil plays a crucial role in reducing environmental pollution, such as air and water pollution, across all environmental components. However, when soil is overloaded with contaminants, it may also become a pollutant. Metals with an atomic number greater than 20 that are ductile, conductive and ligand specific are considered toxic because they cannot be broken down and remain in the environment as a result. Cadmium (Cd), copper (Cu), chromium (Cr), mercury (Hg), arsenic (As), zinc (Zn), nickel (Ni) and lead (Pb) are the most prevalent contaminants of toxic metals. The transfer (and toxicity) of these contaminants to humans, animals and plants can occur when they are present in the soil. In some cases, soil pollution can become toxic to organisms in a short amount of time while still affecting humans slowly over a long period of time.

Heavy metal contamination of soil has emerged as a global environmental problem that poses a threat to human health. According to Chinese standards for soil contamination, Cd is the most common pollutant, accounting for 7% of all contaminated soils, followed by Ni, As, Cu, Hg and Pb Cd has been found to pollute approximately 150 thousand tons of farm products each year in China, including fifty thousand tons of rice (0.025% of the world's rice production). It is essential to point out that cadmium-contaminated rice is a problem all over the world, not just in China. Because rice paddies are irrigated with Cd-contaminated groundwater, populations in Bangladesh who consume a lot of rice have higher Cd intakes. Since cocoa is a key component of chocolate, exports of the crop have had a significant impact on the economies of countries like Ecuador in South America. However, studies showed that cocoa bean Cd levels have increased significantly as a result of soil contamination, with Cd concentrations exceeding the critical value (0.6 mg kg1) set by the European Union at twelve out of fifteen field sites. Additionally, the Cd baseline levels for soil varied from nation to nation [1].

Additionally, the extent of soil contamination varies somewhat from country to country. Toxic metals like Cd, Pb, Hg and As polluted 26 million of arable land in China, contaminating approximately 12 million metric tons of grains annually and causing economic losses of more than USD 3.2 billion. A soil survey report that was published in 2014 by China's Ministry of Environmental Protection revealed that 82.8% of the country's agricultural soils were polluted by inorganic contaminants, accounting for 16% of the country's total contamination. To ensure safe food production, it is estimated that 137,000 km^2 (6.2%) of agricultural land in the European Union requires local evaluation and remediation.1344 sites in the United States are currently on the Superfund National Priorities List, while Australia has 80,000 polluted sites, as reported by the USEPA (2019). Overall, toxic metal contamination of the soil has negative effects on human health and food safety as well as on the availability of cultivable land resources, crop yield and agricultural product contamination. This has an effect on social and economic sustainability if it is not addressed. Numerous studies have been conducted over the past two decades to investigate the sources of toxic metal pollution, identify indicators of soil pollution and develop models to evaluate the effects soil pollution on human health and ecosystem functions [2].

The most common chemical indicator of soil pollution is the total concentration of metals and metalloids. Most public and worldwide rules or norms for poisonous metals in soil depend on the complete focus and the administrative guidelines of harmful metals in agrarian soils contrast among the nations/districts .Toxic metals from both natural and human-caused sources can be seen in the total concentration. Be that as it may, the versatile or bioavailable substance is under 5% of the all-out satisfied and, in this manner, the absolute focus may not show the genuine bioavailability or portability of the metals in soils .Some nations, like China, have altered the total concentration standards for toxic metals by taking into account factors like soil pH and land use. These factors affect the solubility of toxic metals in soil and are influenced by redox and pH. Labile or bioavailable pools of trace metals in soils have recently been studied as indicators of soil contamination. For toxic metals, the impact on the environment is evaluated using selective extraction techniques. The single extraction method is one of the most common methods and extractable metals could represent their bioavailability or toxicity. A few extraction systems were proposed to gauge the labile harmful metals in soil in view of their water solvency or synthetic relationship with soil constituents .The extractants are, according to the mode of the reaction, acids (HCl, HNO_3); agents that chelate (such as EDTA and DTPA) solutions of buffered salt, such as NH4OAc and salt solutions without buffering, such as $CaCl_2$ and NH_4NO_3. The most effective method for determining the quantity of readily available metals in soil, including exchangeable pools and water-soluble metals is single-step chemical extraction [3].

It is frequently referred to as the available number of metals or indicators of metal availability in soil due to the close correlation between the extractable

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metals in the soil and plant uptake or loads in runoff water. Among the four extraction methods extractable Hg provided the best indication of plant Hg uptake, according to (2008a). When soil and environmental conditions change, metal fractionation in soil can help clarify their association with soil constituents and release characteristics. Typically, successive extractions with specific chemical reagents separate water-soluble, exchangeable, organically bound, carbonate-bound, oxides-bound and residual pools of soil metal. Improved phase specificity and information on the potential mobility or bioavailability of toxic metals in soil are two benefits of sequential extraction Li and others. Following the European Community Bureau of Reference (CBR) protocol, they found that a significant amount of mercury remained in the residual fraction, which has less of an impact on soil biota and less of a potential to contaminate food chains through plant uptake. For the purpose of determining the bioavailability of toxic metals in soil, both the CBR protocol and the single extraction method are useful. Utilizing simulated human gastrointestinal systems, it is necessary to identify bio-accessible fractions in order to assess the health risk posed by ingestion [4,5].

Conclusion

Toxic metal contamination of soil has accelerated worldwide as a result of rapid industrialization. The fundamentals of sources, indicators and assessing soil contamination by potentially toxic metals were discussed in this review. Both anthropogenic activities and geogenic processes are significant contributors to soil pollution. It's possible that soils inherit toxic metals from their parents; however, the majority of soil pollutions are the result of agricultural and industrial activities. Changes in the chemical, biochemical and microbial properties of soils as well as plant responses can indicate metal contamination. Despite the fact that extractable amounts have been reported to be more closely related to plant uptake, the total concentration of toxic metals in soil remains the most widely used indicator for risk assessment. Although a number of models have been proposed for assessing toxic metal contamination of soil, none of them are widely accepted for use with a wide range of soils. To improve soil contamination diagnosis, modelling, regulatory standards and remediation efficiency, the review emphasizes the need for systematic studies.

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