HEAVY METAL IN CONTAMINATED SOILS: A REVIEW OF SOURCES, RISK AND AVAILABEL STRATEGIES FOR HEAVY METAL ESTIMATION

Ankit Chand Mishra[1], Dr. Sneha Gupta[2]

[1]M.Tech Student, Department of Civil Engineering, Madan Mohan Malviya University of Technology, Gorakhpur 273010, India
[2] Assistant professor, Department of Civil Engineering, Madan Mohan Malviya University of Technology, Gorakhpur 273010, India

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Abstract - *A Heavy metal pollution in soil is a rising concern, and little is known about how it is distributed in the soils of different districts with different land uses on a broad scale. The pollution of soil is a source of threat to the health of people at various levels including villages and cities. Heavy metals released as toxic effluents from smelters are deposited into nearby environment and are linked with health risk. Modern industrialization is main cause to discharge various heavy metals which reaches to the soil in the form of aerosols, particulate matter, dust, effluents and solid waste. These heavy metals will transmission from soil to plants and ultimately endanger for human health summarizes, This review article is mainly focusing on extensive literature survey in respect of soil contamination through heavy metals, employing of various analytical techniques including as(atomic absorption spectroscopic) inga(instrument neutron activation analysis), libs and libs in estimation of heavy metal.*

Key Words: Soil heavy metal concentration, Heavy Metal Pollution, Toxicity, Manmade practices, Technique

1. INTRODUCTION

Soil pollution with anthropogenic heavy metals, mainly from industrial activities, agricultural practices and atmospheric deposition, has received increasing consideration in recent years. Constant urbanization and industrialization, leads to increasing heavy metal pollution in urban soils. The metals can be easily amassed in the topsoil, resulting in bio-toxicity to plants & animals. Extremely high levels of pollution with heavy metals in urban soils had been found in many countries.

Soil is not only the key nutrient-bearing environment for plant life, but also a supplier of many pollutants to plants because plants can acceptance toxic substances through their roots from soils. The accumulation of heavy metals from soils to vegetables has been studied extensively due to the close relation of vegetables to human health. There is increasing contamination of soil due to pollution effect on water and air from activities like urbanization, industrialization, application of chemical fertilizer and pesticide. Polluted soils transfer of heavy metals to plants is the major pathway of human exposure to soil contamination.

Heavy metals are harmful to humans, animals and tend to bio-accumulate in the food chain. Activities such as mining and smelting of metal ores, industrial emissions and applications of insecticides and fertilizers are contributed to elevated levels of heavy metals in the environment.

Heavy metal pollution in soil is often mentioned by several countries. Scanty information is available on heavy metal transfer from soil to vegetable. Few studies reported that the bioavailability of soil metal to vegetable was controlled by soil properties, soil metal speciation, and plant species.

1.1 HEAVY METAL CONCENTRATION

A metal of relatively high density (specific gravity greater than about 5) or of high relative atomic weight is defined as a heavy metal. The term "Heavy metals" is used to describe more than a dozen elements that are metals or metalloids (Vogel's; 1989); e.g. chromium, arsenic, cadmium, lead, mercury, manganese, etc. Heavy metals are natural constituents of the Earth's crust. Because they cannot be degraded or destroyed, heavy metals are persistent in all parts of the environment. In small amounts, they enter the human body via food, drinking water and air. Living organisms require varying amounts of "heavy metals". Iron, cobalt, copper, manganese, molybdenum, and zinc are required by humans. Excessive levels can be damaging to the organisms. Therefore, heavy metals can be described as any metallic element that has a relatively high density and is toxic or poisonous at low concentrations.

Human activities affect the natural geological and biological distribution of heavy metals through pollution of air, water, and soil. Humans are also responsible for altering the chemical forms of heavy metals released to the environment.

1.2 HEAVY METAL POLLUTION IN SOIL

Land application is considered to be the most advantageous method for sludge as well as industrial disposal from both economic and environmental point of view. This practice has raised concern to the effect of effluent and sludge on soil microorganisms e.g. those involved in the bio cycling of elements such as carbon, nitrogen and Sulphur. Heavy metals discharged from industries, mines, smelters etc. are scarcely washed out from soils due to the strong binding force of soil components such as humus, clay and hydrated equinoxes, and as a result of this, the biological systems in soil are threatened by increasingly higher concentration of heavy metals. In addition, pollutants also affect complex microbial interactions such as parasitism (e.g. bacteriophage host bacterium) and mutualism (e.g. Rhizobium - leguminous plants). Inorganic heavy metal pollutants that occur as water soluble salts and hence are available for uptake by the microbiota may exert greater toxicities than water insoluble forms of the same pollutants

2. SOURCES OF HEAVY METALS

Heavy metals enter the ago-ecosystem through natural processes as well as anthropogenic activities. Numerous researches have indicated that compared with anthropogenic activities, natural sources of heavy metals in the environment are usually of little importance. Some soils inherit these metals from parent material possessing a high background of naturally occurring heavy metals, which may have adverse effects on plants and organisms, as the parent material usually owes high concentrations of these metals. For example, the selenium (Se) toxicity problem in the San Joaquin Valley of California was caused by contamination from natural geological sources.

The primary source of heavy metals in soils is the parent material from which they are originated. Of the total Earth's crust, 95% is made up of ingenious rocks and about 5% sedimentary rocks. In general, basaltic ingenious rocks are rich in heavy metals such as Cu, Cd, Ni, and cobalt (Co), whereas shales contain large amounts of Pb, Cu, Zn, manganese (Mn), and Cd. Heavy metals contained in rocks can enter the soil environment through natural processes such as meteoric, biogenic, terrestrial, and volcanic processes; erosion; leaching; and surface winds.

The disturbance of nature's slowly occurring geochemical cycle of heavy metals by anthropogenic processes results in the accumulation of one or more of heavy metals in the soil. Recent advancements in the agricultural sector, industrialization, and urbanization have contributed substantially to elevated heavy metal contamination in the soil. Anthropogenic activities such as mining and smelting, combustion of fossil fuel refining, disposal of municipal wastes, application of pesticides, sewage irrigation, and fertilizer application contribute to enhance concentrations of heavy metals in the agricultural soil environment

3. SURVEY ON SOIL CONTAMINATION BY HEAVY METALS

Oluwa, O.D et.al, reported the level of metals present in selected dump sites in Lafia metropolis, Nasarawa state, Nigeria [26]. The author has evaluated the concentration of metals in soil at site-A was As(0.66), Cd(0.48), Co(0.58), Cu(0.91), Fe(0.63), Ni(0.31), Pb(0.49) and Zn(0.38), the site-B was As(0.55), Cd(0.84), Co(0.63), Cu(0.82), Fe(0.64), Ni(0.42), Pb(0.53) and Zn(0.40) mg/kg. The metal concentration in plant leaves and crops showed high level of Co(0.33) and Fe(0.32) in roselle leaves; Cu(0.71) and As(0.37) in groundnut; Cu(0.48) and As(0.28) in maize grains; As(0.36) and Co(0.32) in spinach leaves; and Cu(0.36) and Co(0.32) mg/kg in okro.In summary, the author concluded that although these metals were found in soils and plants around the dump sites analysis by using AAS VGB 210 system, the reported values were below WHO permissive levels

Pawan. Bharati et.al work has been conducted in heavy metal contamination of agricultural soil around textile industrial area at Panipat city, India [31]. The contamination due to irrigation with contaminated ground water affected by industrial effluents. The metal transferred from ground water to agricultural soil and from soil to ground water was analyzed for heavy metals using Atomic Absorption Spectrophotometer (Model ECIL-4129). The authors found that the average concentration of heavy metals, i.e. Cd (1.927), Cu (26.633), Fe (44.078), Mn (9.90), Ni (7.96), Pb (42.358) and Zn (13.127) mg g-1 in the surface soil. The Fe, Pb, Cu were in high level due to their cumulative and adsorptive nature in soil after continues irrigation by contaminated ground water. Cd and Zn were found minimum due to their weak adsorptive nature in soil. Transfer factors for heavy metals from effluent to ground water were observed to be 0.43, 1.180, 6.461, 2.401, 2.790, 3.178 and 0.634 for Cd, Cu, Fe, Mn, Ni, Pb and Zn respectively.

A.M. Basha et.al work was conducted to investigate the quality of hen eggs due to the heavy metal contamination around mining site. The concentration of essential elements like Fe 34.4-98.3 mg/kg, Al 2.5-71.1 mg/kg, and Zn 3.9-63.0 mg/kg. The heavy metals like U and Cd in the range of 1.3-12.6 mg/kg and 2.3-15.4 mg/kg. The metal analysis by using ICP-MS. The authors reported these concentration levels in metals are found to be below the permissible limits in hen egg.

Dubey et.al, reported that sewage sludge and effluents are frequently disposed of on agricultural lands for irrigation/manure purposes and both of them aggravate the problems, because sewage sludge and effluents may contain high amount of heavy metals. Soils normally contain low background levels of heavy metals. The effluent samples were analyzed for EC, pH, DO, BOD, COD, TDS, micronutrients (Zn, Fe and Cu), heavy metals (Cd, Cr, B, Ni and Pb).

Noor-ul amin et.al focused on heavy metal contamination of soils and green vegetables by industrial effluents at Peshawar, Pakistan. The authors intention of work is accumulation and bio-concentration of seven heavy metals in vegetables growing in a mixed industrial effluent irrigated agricultural fields. They reported the concentration of metals like Cu 0.044-0.504, Co 0.009-0.085, Fe 0.243-7.737, Pb 0.496-0.474, Cr 0.005-0.033, Mn 0.019-2.019, Zn 0.045-0.703 and Ni 0.017-0.108 ppm in edible parts of different vegetables in that area. The iron accumulated to the highest levels ($P < 0.05$) in all vegetables then compared with remaining metals

P.K. Chhonkar et.al observed the source of irrigation water from pulp and paper factory effluents contain appreciable amount of plant nutrients, like N, P, K, Ca, Mg and S etc. which can be utilized for crop production. The distillery waste water is characterized by low pH, high BOD and COD values and contains a high percentage of organic and inorganic materials.

4. ANALYSIS OF HEAVY METALS IN CONTAMINATED SOILS BY VARIOUS ANALYTICAL TECHNIQUES

The review considers the benefits and the drawback of some of the analytical techniques used to identify different elements in a variety of system. In earlier days the metals determination in both liquid and solid sample by using titration process and electrode methods. Now a days it improving the technology advance instruments are available in markets.

Instrumental Neutron Activation Analysis (INAA)

INAA was the first technique able to perform non-destructive, multi-element analysis on small (50–100 mg) solid samples with detection limits < 1mg kg-1 (parts-per-million). Its applications include 'high-value' samples such as the soils recovered by Apollo astronauts from the lunar surface. Disadvantages are the requirements for specialist irradiation facilities and highly-trained personnel, which limit the availability of the technique to national facilities or workers with access to a local research reactor. Recent applications include a study of the accumulation of Cr, Fe, Mn and Zn in arable soils amended with chemical fertilizer and animal manure, an investigation of soils affected by sapphires exploitation and measurement of 16 trace elements to assess anthropogenic influence on agricultural soils in Argentina. However, the scarcity of facilities, concerns over nuclear radiation, and improvements in other analytical techniques mean that the use of INAA is becoming less common.

X-ray Based Techniques

A key advantage of XRF for measuring heavy metals in soils is the availability of instruments suitable for use in the field. Portable XRF instruments have been used to measure As, Cu, Pb and Zn at a former waste site (now a sports ground used by children) and in soils affected by mining; As, Cu and Cr in soil polluted by chromated copper arsenate wood preservatives, and Cr, Cu, Mn, Ni, Pb, V and Zn in industrial soil. Results obtained by portable XRF were found to be broadly similar to those of laboratory-based techniques, but the detection limits are poorer. The method is therefore most suited for rapid screening of contaminated sites to identify samples of interest that can then be taken back to the laboratory for more detailed or confirmatory analysis.

Recent developments in X-ray analysis include total reflection-XRF in which the incident X-ray beam is directed at the sample surface at such an acute angle that it is reflected, thus reducing background interference problems caused by penetration into the bulk and the advent of powerful, synchrotron-based techniques – reviewed recently by Lombi and Susana suitable for direct measurement, mapping and speciation of heavy metals in soils.

Laser-Induced Breakdown Spectroscopy (LIBS)

This is an emerging form of atomic emission spectrometry applicable to a wide variety of sample types, including solids such as dusts and soils, with minimal sample preparation. A high powered, pulsed laser (typically a Nd: YAG at either 1,064 nm or frequency-doubled to 532 nm) is used to ablate the surface of the sample. This forms a high temperature micro plasma in which the constituents of the ablation plume are atomized, ionized, excited, and then emit light of characteristic wavelengths. This light is measured after a short delay (around 500 ns) during which the intense broadband emission from the plasma decays

T **Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS)**

Conventional (solution sample) ICP-MS is described. However, there is also considerable current interest in the use of lasers to generate ions for introduction to the plasma. This allows the technique to be applied to a wide variety of solid samples, including soils, plants and related materials, yielding important information on, for example, the distribution of heavy metals in response to pedogenic processes. As in XRF, the sample must be finely ground before analysis. The particle size has a strong influence on the quality of the measurement and use of <1 mm diameter particle is recommended. The powdered sample is pressed into a pellet, sometimes with the addition of a binder, and placed in an ablation chamber. Early workers used aqueous calibrants for LA-ICP-MS.

5. CONCLUSION

The purpose of this review article is the possibility of ways of soil contamination by various activities result to emitted various metals beyond the threshold limit which are very harmful for human health and interfering to different activity. the deception of various articles in respect of heavy metals contamination of soil, vegetables and planted roots.to explore the need and demand of various analytical technique including address the different environmental issue particularly with toxic metals and their estimation at their trace level

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