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A Review On Heavy Metal Characterization Of Rural And Urban Soil: A Comparative Study From Sriganganagar District

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Abstract:- Investigating the level of Heavy Metal contamination in the Ganganagar district's agricultural area was the goal of this study. The study was carried out in 2014 during the post-monsoon season. Using an Atomic Absorption Spectrophotometer (AAS), the concentrations of Cd, Cr, Cu, Mn, Ni, Pb, and Zn in the research area's water, soil, and a few crops were measured. One of the biggest problems facing the globe today is the poisoning of plants and water by heavy metals, which needs to be addressed. Excessive levels of heavy metals pose a serious risk to plant and animal life. The overuse of pesticides, fertilizers, irrigation, atmospheric deposition, and industrial effluents are some of the causes of heavy metal contamination in many ecosystems. There were notable differences in the concentrations of certain heavy metals in the soil, water, and specific crop samples. In some of the samples, the levels of some heavy metals were higher than the maximum allowable levels. Because urban dust concentrations were linked to short-term emissions in the urban region, whereas soil concentrations mostly reflected the long-term effects of urban pollution, there was no correlation between the concentrations of heavy metals in urban dust and soil. The non-carcinogenic risk of heavy metals in urban dust and soil for children was generally at a safe level in the majority of cities. The main cause of the overall health risk posed by heavy metals in urban dust and soil was lead. Therefore, it is recommended that frequent heavy metal monitoring be done in order to lessen the negative effects of the metals.

Keywords: Atomic Absorption Spectrophotometer; Heavy metals; Maximum permissible concentrations.

Introduction

One of the biggest problems facing the globe today is the poisoning of plants and water by heavy metals, which needs to be addressed. Excessive levels of heavy metals pose a serious risk to plant and animal life. The overuse of pesticides, fertilizers, irrigation, atmospheric deposition, and industrial effluents are some of the causes of heavy metal contamination in many ecosystems. Careful soil management is based on an accurate understanding of heavy metal concentrations, their forms, and how they depend on the physicochemical characteristics of the soil. When soil and water resources are not managed properly, heavy metals may become more mobile and end up in the food chain. The majority of heavy metals build up on soil surfaces and in the topmost sedimentary layers of water basins. They alter their properties by combining with the materials found in these upper layers. By functioning as a buffer and keeping these materials for an extended period of time, soil reaction (pH) conditions organic materials and heavy metal concentrations in sediments in a mobile form. In the past, a study was conducted in Bikaner to evaluate the levels of heavy metal contamination in vegetables that were irrigated with waste water. The results of this study showed increased levels of Fe, Mn, Zn, and Cu. That was some information about heavy metal exposures in the area. Therefore, the present study was conducted to investigate the problems of heavy metals and their contamination in water, floors and selected plants in Sri Ganganagar district.

Survey Area:

Ganganagar District is located at the northernmost tip of Rajasthan. The district occupies an area of about 11,154.66km² and is surrounded by Hanumangarh district in Rajasthan. Dry climate types are mostly available. It features hot summers and cold winters. The Southwest Monsoon wins in the Ganganagar area from June to mid-September and after the monsoon until the end of November. The main plants include wheat, mustard, cotton, and other large-scale plants of cultures, bajra, sugarcane, gram, and more. The presence of the cancar layer (calcareous concrete) was found in a depth range of 75-100 cm. The soil is deep and gently drained. Permeability is slower, has a water retention capacity, and natural fertility is generally poor. Lehmsand and Sandlhm are the common types of soils that collide in this soil. Four major cultures (Cyamopsis Tehronoloba, Vigna Radiation, Vigna Radiation, Pennisetum Glaucum, and Gossypium Arboretum) were selected for studies on heavy metal contamination. The research choices of these cultures were based on the field of their cultivation. A study analyzing heavy metal contamination in floors in Rajasthan, Sri Ganganagar district, India, involves assessment of different heavy metal sizes in both rural and urban areas. This probably includes testing for concentrations of Lead_(Pb), Iron_(Fe), Manganese_(Mn), Zinc_(Zn), and Copper_(Cu). This study would like to determine whether there are significant differences in heavy metal levels between rural and urban environments that can be influenced by factors such as industrial activity, agricultural practices, and proximity to urban centers. The results are important to understand the potential risks to human health and the environment due to heavy metal pollution in this region.

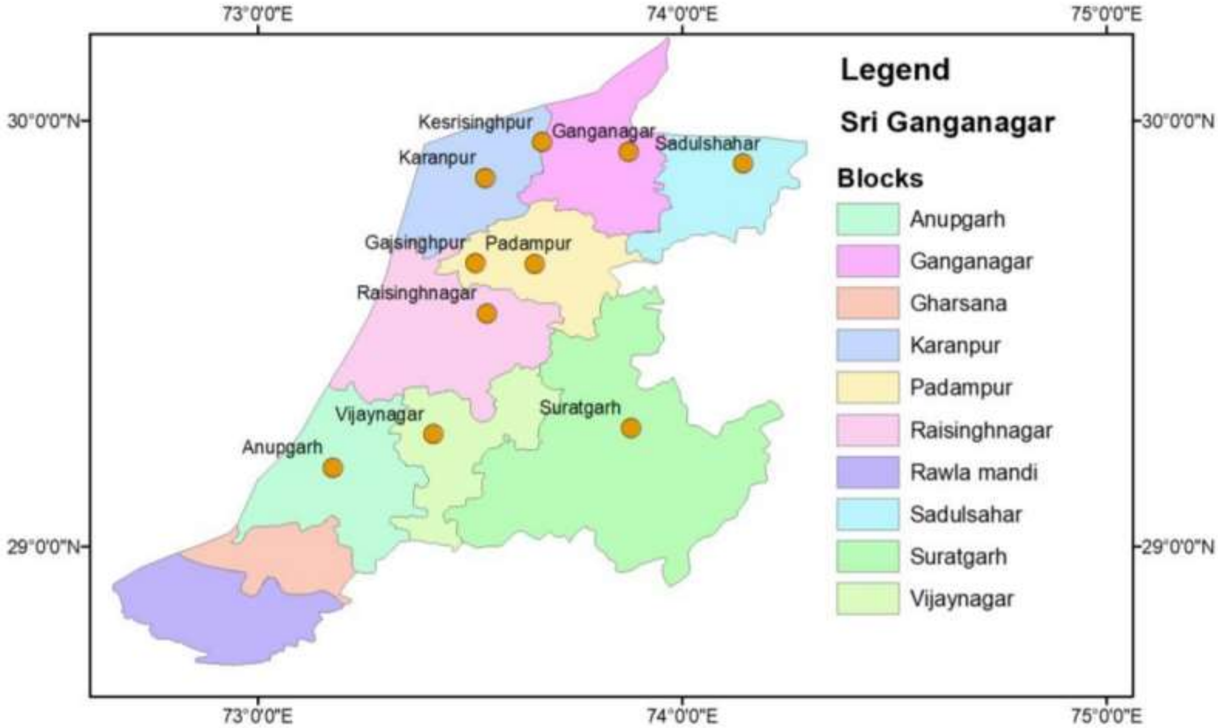

Figure 1:District map of Sri Ganganagar

Heavy metals are sustainable environmental pollutants. As soon as it is inserted into the soil, it becomes difficult to remove, and the physicochemical properties of the soil change dramatically, opposing biodegradation or pyrolysis. These heavy metals exceed certain thresholds and cause toxic effects in soil micromania, plants and animals that have serious effects on soil enzymes and microbial activity [1,2,3]. Plants absorb heavy metals through their roots and leaves. This is a process that is primarily influenced by plant species and intrinsic defense mechanisms against toxicity. A significant reduction in photosynthetic activity of plants poisoned by heavy metals leads to a decrease in biomass production [4]. Additionally, vegetable physiological and biochemical activities such as respiratory, metabolism, transcription, translation, and cell cycle are affected. The toxicity of different heavy metals compared to plants is cumulative. For example, the combined effects of Cu and Cd in barley plants lead to root and stem stump growth [5]. Bioaccumulation in the ecosystem's food chain [6] causes a large accumulation of heavy metals that enter the human body through skin contact, with food, air, and water, [7]. Regular absorption of heavy metals can interfere with growth and weaken the immune system [4], representing a direct or indirect threat to human health. Furthermore, heavy metals can penetrate the human body through the skin and air [5]. These metals are naturally mutagenic and carcinogenic [7] and, in severe cases, can cause health problems related to growth and development, cardiovascular, respiratory, skin, reproductive, and immune systems [8]. Urban soil is an important part of urban ecosystems, and its quality has a major impact on the quality of life and health of its residents. The urban floor inherits certain fundamental characteristics of the original natural counterparts, but their properties vary widely due to dense groups and more frequently human activity. These soils have unpredictable stratification, low permeability, low moisture content, and high trace element content [2,3]. It serves as a key repository and decomposition point for heavy metals and other contaminants. Along with limited environmental transport capacity and self-development of urban floors, the rapid expansion of urban areas leads to the influx of heavy metals due to accelerated urbanization and industrialization. This influx places a significant burden on urban ecosystems and biogeochemical cycles, causing a variety of environmental problems, such as, deterioration of soil function, changes in soil structure, changes in soil properties [4,5]. Heavy metals reach urban floors to two major trucks, natural sources and anthropogenic disorders [6]. Natural sources refer primarily to parental materials and soil formation processes. However, humanitarian activities such as fossil fuel burning, waste burning, traffic emissions, metal melting, and intensive agricultural practices have a significant effect on the content of floor metals [7.8]. Despite the rare use of urban soils, comprehensive production and mulch use tightens pollution, especially in agricultural production activities. Heavy metals accumulate in the soil .These heavy metals accumulate in the human body through inhalation, absorption or skin contact and absorption. This puts the health and wells of urban residents, especially children, at significant risk [9, 10]. Although usually, areas such as parks and residential areas are not used to grow food, they also serve as important points of transmission of heavy metals in humans [11]. Investigating the distribution of heavy metals in urban soils is critical to ensuring human life and health from prolonged exposure to dirty environments.

Topography

This district is part of the large Thar Desert. The district generally has wavy topography in the northeast and northeast, but the dune complex occupies the southwestern part of the district. Ganganagar is located under the outer pool. The Ghaggar river is the only large river in the district and is also known as Ghaggar nala. A typical topographical survey of the district is between 125-150 m from the Mediterranean level in most blocks. The height of at least 104.8 m from the Nakaumi level from the Anoopgarh block in the SW section of the district is at a maximum of 230.2 m at the Nakaumi level in Suratgarh, southeast of the district.

Soil Types and Irrigation Practices

The northern part of the district is characterized by sierozem or dry soil, with pale yellowish brown to pale colour. The presence of cancar layer (calculated concrete) was found in a depth range of 75-100 cm. The soil is deep and gently drained. Permeability is moderately slow until moderately slow, with moisture retention ability and natural fertility generally poor. Clay sand and sandy clay are the common type of soil that is filled with this soil group. Sand stains also appear in the area. The southern part of the district is characterized by desert floors, with a very light brown to yellowish colour, and generally free of lime concrete. The floor is generally well drained, with low moisture container capacity and high permeability. The district's main watering agents are via channels, but fountain/pipe holes travel through several areas.

Heavy Metal Analysis

- **Metal Selection:** Lead_Pb, Cadmium_Cd, Chromium_Cr, Copper Cu, Iron_Fe, Manganese _Mn, Nickel_Ni, and Zinc_Zn are among the metals that the study is most likely to concentrate on.
- **Analytical Methods:** The amounts of these metals would be ascertained using methods such as Inductively Coupled Plasma Mass Spectrometry (ICP-MS) or Atomic Absorption Spectroscopy (AAS).

Data Analysis

- **Descriptive Statistics:** For every metal at various locations, calculations of the mean, median, standard deviation, etc., would be made.
- **Statistical Tests:** To compare the concentrations of heavy metals in rural and urban locations, one may use ANOVA or T-tests.
- **Geostatistical Analysis:** Methods such as kriging could be used to map the spatial distribution of heavy metals.
- **Contamination Assessment:** The level of heavy metal contamination may be evaluated using the Geo accumulation Index (igeo) or alternative indices.
- **Source Identification:** Possible causes of heavy metal pollution may be found using Principal Component Analysis (PCA).

Factors to Consider

- **Type of Soil:** The soil of Sri Ganganagar is sandy to sandy loam, has a high pH, and contains soluble salt.
- **Environment:** The district experiences little precipitation and a semi-arid environment.
- **Agricultural Practices:** Heavy metal levels can be impacted by pesticide use, fertiliser use, and irrigation.
- **Industrial Activity:** Heavy metal contamination may result from close proximity to industrial regions.
- **Urban Development:** As cities grow, soil may change and perhaps get contaminated.

Anticipated Results:

- **Greater Concentrations in Urban Areas:** Because of traffic, industrial emissions, and other man-made causes, soils in urban areas are likely to contain higher concentrations of specific heavy metals.
- **Potential for Bioaccumulation:** Heavy metals have the ability to build up in soil, endangering plants and even making their way into the food chain.
- **Need for Remediation:**

If significant contamination is found, remediation strategies may be needed to mitigate the risks.

Material and Methods

Samples were collected by Sriganganagar farm bodies during post-monsoon monsoon to analyze heavy metals in water, soil and plants. The water and samples were collected in plastic sample bottles, washed completely with nitric acid and rinsed multiple times with distilled water. After the wet season from the area, soil samples (5-20 cm) and plant leaves from the surface mineral layers (5-20 cm) were collected with large agricultural covers. Prior to analysis, soil samples were air-dried at 20°C, ground in mortar and passed through a 2 mm screen. The leaves of the selected plant were thoroughly washed with drainage to remove particles, dried and powdered at 70°. 0.5 g of plant and soil samples were weighed and collected in hard borosil glass tubes. Concentrated nitric acid and perhydrochloric acid were added to each sample in a 4:1 ratio. Rehearsals were stored in a water bath for 5-6 hours or until fully digested and clear. Three to four drops of H_2O_2 (30%) were then administered to neutralize and dissolve the fat. After cooling, each rehearsal was diluted to up to 10 mL with anyonized water, transferred to a sterile borosil glass vial and stored before analysis at room temperature.

Conclusion

In summary, studies on heavy metals in the soil of Sri Ganganagar provide valuable information on the extent of contamination, potential sources, and human health and environmental risks. This information can be used to develop strategies to manage and reduce heavy metal contamination in the region. The main goal of this study was to assess the concentrations of various heavy metals in the ground, water and frequently grown plants in Sri Ganganagar districts. The issue of heavy metal contamination in urban soil environments is complex and requires comprehensive, proactive and integrated strategies for management, assessment and repair. This research paper contributes to an understanding of the complex relationships between urbanization, industrialization, pollution, and human health and sustainable development by clarifying sources, distribution patterns, chemical composition, exposure channels, health risks, damage strategies and regulatory frameworks in urban land environments. Researchers, legislators, practitioners, community leaders and stakeholders can create more innovative, more collaborative, knowledge exchange environments that make urban environments safer, healthier and more sustainable for the present and future.

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