Policy Research Journal
ISSN (E): 3006-7030 ISSN (P) : 3006-7022 Volume 3, Issue 10, 2025

UTILIZING FLAME PHOTOMETRY FOR ENHANCED DETECTION OF ELEMENTAL COMPOSITION IN SOIL SAMPLES FROM MIRPUR CITY

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DOI: https://doi.org/10.5281/zenodo.17464278

Keywords
Soil Quality, Genetic Disorders, Flame Photometry, Health Risks

Article History
Received on 09 Sep 2025
Accepted on 10 Oct 2025
Published on 27 Oct 2025

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Abstract

There are essential and toxic metals found in nature that can be harmful as their degradation process is difficult to detoxify. Many diseases and disorders can be linked to these metals, which can also lead to genetic disorders if levels are too high. The rapid growth of industry has contributed to the high levels of toxic metals in the environment, while the increasing demand for food due to a growing population has led to a higher consumption of cereals and grains that are known for their protein and energy content. This study aims to assess the food quality by analyzing the presence of various metals including Ca, Na, K, Ba, and Li in samples of cereals and grains collected from different locations. Flame photometers use a mixture of natural gas and air with a filter to detect metals in cereals and grains. Samples are aspirated and sprayed into flame atomizers, forming fine mists. Deionized water is used as a control. The concentration of metals in flame photometer readings can be determined by creating a graph correlating display or meter readings with standard concentrations. The main goal is to assess food quality in different areas by detecting metals in samples, and providing precautionary measures to address health concerns related to these metals in the environment.

INTRODUCTION

Soil is an important reservoir of toxins because it has the potential to bind numerous substances. These substances can exist in soil in a variety of forms, and different pressures hold them to soil particles. These interactions must be studied since the toxicity of substances can vary greatly depending on how they reside in the environment. Furthermore, the unpredictability of soil and some environmental circumstances (like climate) can alter the equilibrium in soil and lead to the leaking of trace harmful substances like heavy metals that are firmly attached to soil particles. (A Dube et al., 2001) Soil is one of the most important natural resources for human survival because it has a significant effect on ecological environment health as well as human health. Studying the role of arable soil microorganisms exposed to heavy metal contamination is beneficial for agricultural soil long-term use. The effect of heavy metals on the microbial soil community was assessed in this study. The paper's main subjects included the composition of the soil microbial community, the impact of heavy metals on soil microbial activity, soil enzyme activity, and the influence of soil microorganisms on soil ecosystems. Furthermore, a brief description of the main methods for identifying heavy metals in contaminated soil is provided, along with the procedures for analyzing the microbial community makeup in the soil. In the end, it is found

that microbial community analysis in the soil provides an accurate indicator of the level of heavy metal contamination and its impact on soil ecology. (Dian chu, 2018). Soil has a big influence on human health, either positively or negatively, directly or indirectly. The earth provides us with nutrients for our food supply and for medicines like antibiotics. Conversely, nutritional imbalances and human illnesses among the biological population of the soil may have deleterious effects on health. In addition, there are a number of locations where human activity or environmental factors have left dangerous quantities of particular elements or chemical compounds in the soil. The last several years have seen a rise in interest in urban soils, which also present a lot of problems and concerns for human health. Ideas like "soil security" might offer a framework for multidisciplinary and Tran's discipline research on soil and human health-related concerns. To properly address soil and human health concerns, professionals from a variety of scientific, medical, and social science sectors will need to contribute. (JJ Stefan and others, 2018). In terms of both its chemical composition and biological functions, the class of elements known as heavy metals is immensely diverse. Heavy metals are categorized as environmental contaminants because they are toxic to people, animals, and plants. Soil can get contaminated with heavy metals due to both natural and artificial activity. Anthropogenic mining, smelting, and farming practices have increased the hazardously high quantities of heavy metals such as Cd, Co, Cr, Pb, As, and Ni in soil in some regions. Heavy metals build up in plants and soils because they are naturally occurring. Plant development, dry matter buildup, and yield are all decreased by heavy metals because they obstruct photosynthesis, gaseous exchange, and nutrient absorption. Additionally, heavy metals lower the nutritional value of vegetables by interfering with antioxidant levels in plants. Consuming plants that are high in heavy metals can have long-term negative consequences for human health. (Rajesh Kumar Sharma *et al.*, 2005)The natural environment and human health are gravely jeopardized by heavy metals, which may be found in living things. This has become a major environmental issue worldwide. (Mengting Jin *et al.*, 2020) The mobility of heavy metals in soil profiles is a significant environmental problem because, even with delayed soil transport, groundwater quality may eventually deteriorate. (Zhenben Li *et al.*,1996). Because lithium is used in so many different industrial areas, it is an essential component of modern civilization (Anamaria lulia torok *et al.*, 2021) Since they are neighboring elements in Group 1 of the Periodic Table, potassium and sodium share comparable chemical characteristics. However, these two substances play quite distinct functions and are handled differently by processes engaged in short- and long-range transport in the biology of higher creatures. Between 2.5 and 3% (by weight) of sodium and potassium are thought to be present in the Earth's crust, with sodium being slightly more prevalent than potassium (1). These concentrations are comparable to those of calcium and magnesium (John Gorham, 2016). Although it is sometimes disregarded or solely thought of as a physical support for plant growth, soil is a component of vital importance in the production of crops. But given the growing public concerns about agriculture's sustainability, soil has to be seen as a living system. Its quality is the outcome of several interactions between biological and physical elements, particularly the microbial populations, which are essential to soil function. Diseases that are carried by the soil endanger crops. Because of the viruses' "hidden" nature and the lack, toxicity, or ineffectiveness of chemical therapies, they are sometimes challenging to control. In this context, there is a renewed interest in cultural practices such as the use of organic amendments (Janvier et al., 2007) There are numerous ways in which soil affects human health, and there is a correlation between soil and human health. Historically, attention has been drawn to the harmful impacts that soils can have on human health, such as exposure to toxins and pathogenic organisms or problems that crop growth in nutrient-deficient soils can cause. However, soils have numerous positive health effects on humans, ranging from food production and nutrient delivery to immune system stimulation and medication production. Growing evidence points to the soil as an ecosystem with many interdependent components that influence one another.

Human health is also improved when all essential components are present and functioning, or when the soil is in good condition. Even with the

advancements, there are still a lot of areas that require more research. Chemical combinations in soil are the norm, not the exception, and our knowledge of how they affect human health in the environment is lacking. The majority of chemicals' responses within the chemically and biologically active soil ecosystem, as well as the implications of such reactions for human health, are similarly little understood. (Eric c brevik *et al.*, 2020). Numerous factors related to soil health can result in specific diseases or more general health problems in humans. Certain diseases can be brought on by consuming soil (geophagia) or breathing it in, which can cause cancer if the soil contains best form of minerals. Pathogens in the soil can cause tetanus and hookworm infestations, and particles can enter the body through abrasions and result in an elephantiasis-like condition. Some cancers have been linked to soil radon, and infant mortality has lately been connected to poorly drained soil. Most cases of poor health linked to soil are brought on by toxic or insufficient element concentrations in food or water. Aluminum, arsenic, cadmium, copper, fluorine, iodine, lead, selenium, thallium, and zinc are some of these elements. Their concentrations may reflect the soil's inherent characteristics or human activities like pollution. Different relationships between components and the genesis of illnesses can be found in remote subsistence cultures that cultivate their food. Examples include itai-itai illness (induced by excess cadmium) and Keshan disease (caused by a lack of selenium). There are some hazy relationships between soil and health, as well as potential reasons (MA Oliver, 1997Soils are home to about 25% of all living things on Earth. Because of several complex interactions between the organisms and the soil, the majority of these animals provide a wide range of ecosystem services without endangering human health. These ecosystem services include those that are essential to life as we know it, like soil formation, the cycle of carbon and nutrients that sustains the global cycles of C and N, soil fertility, water filtration, and the supply of beneficial compounds like antibiotics and most of which have been isolated from soil organisms (Rolf Nieder *et al.*, 2018).

2. LITERATURE REVIEW

Heavy metal contamination in agricultural soils has gained international attention because of its toxicity and accumulation in the food chain (Li et al., 2009). Natural and anthropogenic activities, such as mining, industrial emissions, and agriculture, contribute to the sources. Contaminated soils threaten human health and the balance of the ecosystem since metals like lead, chromium, and cadmium disrupt plant growth, reduce crop yields and decrease nutritional quality (Kumar et al., 2005; Bharti et al., 2022). Heavy metals impact soil mobility and groundwater quality, with interactions influenced by soil composition and environmental factors like climate (Zhenben et al., 1996; Dube et al., 2001). Remediation efforts have focused on physical, chemical, and biological techniques, including bioremediation using plants and microorganisms, which have shown promise in detoxifying contaminated soils (Chibuike et al., 2014; Khalid Sana et al., 2017).

Most notably, anthropogenic activities such as mining, chemical wastes, and incorrect disposal of agrochemicals have significantly modified the metal cycle and increased the extent of soil pollution (Asati et al., 2016; Singh et al., 2011). The trace metals distribution and availability also depend upon the environmental factor that includes processes of soil formation and geochemical background (Roca et al., 2008; Zhou et al., 2017).

Soil contamination from heavy metals has detrimental effects on plant morphology, seed germination, and photosynthesis while posing long-term health risks to humans through pathways such as direct contact, contaminated water, and the food chain (Sodan et al., 2014; Xiang et al., 2021). Advancements in soil testing and monitoring have enhanced understanding of metal bioavailability and toxicity, offering insights into mitigating contamination and promoting sustainable soil management (Morais et al., 2012; Batey, 2009).

Morais *et al.*, (2012) indicated that Metals are naturally present in the earth's crust, and depending on one's geographic location, the amount of these elements in the surrounding environment may vary.

Tom Batey, (2009) demonstrated One of the main causes of the land degradation syndrome, which affects soil management globally, is soil compaction. It is a long-standing phenomenon linked to land restoration, pipeline construction, cutting forests,

trampling of wildlife, and the usage of land for recreational purposes.

Khalid Sana et al. (2017) Persistent and potentially environmentally dangerous heavy metal (loid) poisoning of soil is a global issue. The concentration of these heavy metals (loid) in soil has significantly increased over the last three decades, putting the ecology and human health at risk. For a very long time, several technologies have been utilized to eliminate harmful heavy metals (loid)s. The pillars of conventional heavy metal(loid) remediation approaches can be combined with physical, chemical, and biological procedures to clean up heavy metal(loid)-contaminated soils to an acceptable and safe level.

Diels et al. (2002) showed that the past surface treatment, mining, and metal processing industries—as well as the negligent dumping of waste in landfills—are all responsible for the widespread problem of heavy metal contamination of soil and groundwater. Indeed, there are numerous approaches to soil and groundwater remediation.

Chibuike et al. (2014) showed that increased geological activity and human activity have led to a global increase in the prevalence of heavy metal-polluted soils. Grown on these soils, plants show reduced growth, yield, and performance. Bioremediation is an effective technique for cleaning up heavy metal-contaminated soil. It is a well-proven method that is usually applied on-site, which makes it suitable for crop establishment or restoration on treated soils. Plants and microorganisms use different mechanisms to bioremediate polluted soils. Plants are another widely used bioremediation technique for detoxifying soils contaminated with heavy metals. Soils contaminated by heavy metals can be cleaned up more effectively by bioremediation, which uses both bacteria and plants. However, the effectiveness of this method is heavily dependent on the kind of organisms engaged in the process.

According to Nafiu Abdu et al. (2017), heavy metal pollution is a global concern since metal contamination is associated to health risks. Many metals are essential to life, but when present in harmful amounts, they can be harmful to people, pets, plants, and microorganisms. Natural weathering of metal-rich parent material and human activities like mining, farming, and industry are the main drivers of heavy metal buildup in soil. This overview covers how soil microorganisms affect the biosorption and bioavailability of heavy metals, how plants and bacteria store heavy metals, and how pollution affects the variety and activity of soil microbes. The main points are: that human activities are the primary source of heavy metals in the environment. Soil chemistry is the primary factor influencing metal solubility, transport, and availability in soil. High quantities of heavy metals in living tissues induce serious organ damage, neurological problems, and death. Heavy metals in soils reduce microbial population, variety, and activity. Nonetheless, several soil bacteria tolerate and utilize heavy metals in their systems, making them useful for bioremediation of damaged soils. Soil microorganisms can be employed to remediate polluted soils directly or to make heavy metals accessible in plant rhizospheres.

According to research by Xiang et al. (2021), heavy metal contamination poses a serious risk to agricultural productivity. While heavy metal contamination in crops can present a risk to human health, heavy metal pollution in soil can present an ecological risk (ERI). However, the majority of past studies missed the connection between heavy metal contamination in crops and soil and instead concentrated on the former. Although not all heavy metal pollution in crops comes from the soil, heavy metals in the soil can still harm crops to some degree. It is important to take into account the internal relationship of contamination risk in the soil-crop system.

According to Roca et al. (2008), weathering and soil-forming processes, as well as the makeup of the parent rocks from which the soil material is formed, are the main factors influencing the trace element concentration of soils. Even though soil and rock are closely related, the processes involved in soil formation change the regolith and redistribute heavy metals throughout the soil layers. A morphogenetic method of soil classification, the World Reference Base (WRB) is primarily reliant on soil genesis at the Reference Soil Group (RSG) level. The present differences in trace element composition among different RSG could be attributed to the impact of their respective pedogenic routes on the initial distribution of trace elements. Finding the presence of heavy metal pollution in soils starts with analyzing the natural variation in heavy metal concentration. With

the growing consciousness of environmental issues, the term "geochemical background" gained significance. In the municipal district of Fray Mamerto Esquiú, Argentina, thirty Catamarca profiles were examined to determine the distribution and amount of Cd, Cr, Cu, Ni, Pb, and Zn. According to WRB, RSG has a significant influence on the concentration of heavy metals, with the exception of Cd. One process that contributes to the formation of soil and becomes relevant in the dispersion of heavy metals is the intermittent or continuous addition of sediments, as in alluvial soils. At lower Fluvisol levels, the soil's organic matter content becomes significant when Humic or Mollihumic qualifiers are applied. When compared to the nearby bedrock, the Pb levels in all tested soils were noticeably higher. This shows that the infilling of the alluvial valley comes from a different source rather than the nearby bedrock. The higher silt content of the soils in the southern side of the alluvial valley is reflected in the concentration of Ni. Pedogenic pathways therefore had little effect on the distribution of Ni in a given location. The display of the upper bound of the backdrop makes it possible to distinguish between concentrations of natural elements and abnormal ones. The majority of samples exhibiting mild enrichment anomalies are for the heavy metal cadmium. The modest enrichment anomalies in Cd, Cr, Cu, Pb, and Zn that Profile 29 displayed were indicative of human contamination.

According to Ranjeet Kour Sodan et al. (2014), both natural and human activity expose soil, a crucial environmental medium, to a range of pollutants, including dangerous heavy metals. Because of this, soil contaminated with heavy metals has the potential to seriously endanger human health as well as the health of other living things in the ecosystem through several exposure pathways, such as direct ingestion, contaminated drinking water, food crops, soil contact, and the food chain. Therefore, it's imperative to look into several methods that could be used to precisely determine whether heavy metals are present in soil. Numerous commercial laboratories and regulatory bodies have devised various methods for measuring and tracking soil matrices. According to Weihong Zhou et al. (2017), the issue of heavy metal contamination in soil is becoming more serious due to the rapid growth of the economy and culture, endangering human health and food security. Unfortunately, the method used to determine the overall amount of heavy metals in soil does not accurately reflect the actual toxicological bioavailability of such metals. Both the current forms and the concentrations of heavy metals need to be evaluated to gain a better understanding of the heavy metals in soil and their biotoxicity. Heavy metal pollution in agro-soils has remained a global concern. Shi et al. (2018) need to study pathways of heavy metal intake and outflow in the soil, which is a direct input to addressing the problem of contamination. Both input and output inventories, although popular, showed a striking variation among regions owing to geographic, climatic, and industrial practices.

A method noted as reliable for detecting alkali and alkaline earth metals in soil samples is flame photometry, as also cited by Gaeva et al. (2020). Thus, flame atomic absorption spectrometry is one of the spectroscopic methods that raised the accuracy of metal analysis on the level of concordance with authentic samples.

Sharma and Zhang clearly stated that industrial and agricultural activities including effluent discharge, oil spills, pest-destroying pesticides, and mining activities are large contributors of heavy metals into the environment. Accumulating such metals in the food chains poses a severe health risk to both human and ecosystem levels. Sound identification of the sources of contamination and acquiring strategies to mitigate them is probably important for sustainable environmental management.

Heavy metals also remain in the soil, and Tang et al. (2019) pointed out that the increasing application of microbiological indicators shows great promise in monitoring heavy metal pollution. He highlighted the risk caused by heavy metals through the food chain in the open water and crops by soil interaction, mentioning the necessity for accurate detection methods on this subject by Sodan et al. (2014). According to Laughlin et al. (2000), soil test technology has improved considerably and is improving the determination of contamination. However, while Smolders et al. (2009) stated that total concentration of metals is not the only indicator of

toxicity, heavy metals are influenced by environmental conditions such as pH and salinity concerning their behavior and toxicity.

3. MATERIALS AND METHODS

3.1 Sampling Sites

Perched 459 meters above sea level, Mirpur City is connected to the main Peshawar-Lahore Grand Trunk Road at Dina. New Mirpur, which is located on the banks of Mangla Lake, was made possible by the construction of the new city in the late 1960s. The buildings are primarily of modern style, and the city was thoughtfully designed. Mirpur is quickly becoming an industrial metropolis. There are existing industrial operations in the neighborhood that produce textiles, vegetable ghee, soap, cosmetics, marble, ready-made clothing, matches, rosin, turpentine, and Vespa scooters. There are a large number of industries in Mirpur city. The Mirpur city is elevated 459m (1506ft) above sea level. Soil samples were collected from different sites in Mirpur near busy roads.

3.2 Sample Collection

Samples were collected from different sites in which a crowd of people were present. Samples were collected during the week of 10-15th of March 2024. Samples collected from the soil were around 4_5 g which is sufficient for analysis. The samples were collected by using an instrument to remove the upper layer. The samples were stored in clean labeled airtight packets and saved for analysis by flame photometry SA-30. The sampling site coordinates, and explanation of soil samples are shown in the Table given below

Table 1: showing the description of the sampling sites

Sample name	Site description	Coordinates of sampling sites
S-1	Heavy traffic, busy road, construction activities	N 33°08.984' E 073°43.762'
S-2	Excavation activities, release of chemicals during different lab activities	N 33°08.098' E 073°43.773'
S-3	Excavation activities, near busy road	N33°08.991' E 073°43.754
S-4	Chemicals, dust	N 33°08.950' E 073°44.668'
S-5	Busy road, construction activities of road	N 33°08.944' E 073°43.887'
S-6	Busy intersection, vehicle exhaust	N 33°08.952' E 073°43.888'
S-7	Near busy road, automobiles exhaust	N 33°08.970' E 073°43.734'
S-8	Busy road and vehicle exhaust	N 33°08978' E 073°43.722'
S-9	Chemical exhaust, busy intersection	N 33°09.006' E 073°44.795'
S-10	Greenery and plantation, No road near office	N 33°08.974' E 073°43.803'
S-11	Busy intersection	N 33°08.976' E 073°44.688'
S-12	Busy intersection, vehicle exhaust, dust, food shops, and workshop near mall	N 33°08.923' E 073°43.928'
S-13	Near road, heavy traffic, construction activities	N 33°08.981' E 073°43.754'
S-14	Near road side, busy intersection, Construction activities	N 33°08.982' E 073°43.755'
S-15	Busy intersection, Dust, near road side	N 33°08.943'

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		E 073°43.748'

3.3 Instruments
Flame photometer model SA-30 was used for the detection of metals.

3.4 Chemicals Required
Sulphuric acid and perchloric acid were used for the digestion of samples. Both acids were in a ratio of 3:1 in a mixture. Solutions were diluted with deionized water.

3.5 Sample Preparation
All samples of soil were oven at 100 Celsius for 3h for the removal of moisture content. The samples were sieved through a stainless-steel sieve. After this, samples were used for acid digestion and further analysis.

3.6 Sample Digestion
The acid digestion method was used for sample preparation. Dried and sieved 1g powder of soil samples in 50ml round bottom flask was taken then the mixture of two acids (H2SO4 and HClO4) was added. After the addition of acids, the solution was placed on the hot plate at room temperature of 80_90celsuis 1hout for the digestion process. The resultant solution was again heated until 1ml of solution was left. After cooling few drops of deionized water were added.

3.7 Experimental Procedure
After digestion of soil samples, for elemental analysis flame photometer SA_30 was used. A standard stock solution with a 30 ppm concentration was used to calibrate the flame photometer. To fine-tune the flame further instrumental settings were changed. After device configuration, it was used to examine the soil samples under observation that were sucked up by an aspirator and sprayed as a fine mist into the flame atomizer to find the concentration of metals. Deionized water was used as a control in the process.

a. Statistical Methodology

4. Descriptive statistical analysis (MS Word)
5. MVSP 3.5 version
6. Cluster analysis
7. Box and whisker plot

4. Results

The concentrations of five essential minerals - sodium, potassium, calcium, barium, and lithium - were measured in various cereal and grain samples using a photometer flame. The data obtained from this analysis is presented in Table 3.

Table 2: showing the concentration of Metals present in the sample (ppm)

Sample Name	Concentration of Na+ (ppm)	Concentration of K+ (ppm)	Concentration of Ca^{2+} (ppm)	Concentration of Ba+ (ppm)	Concentration of Li^{+} (ppm)
S-1	10.55	7.33	6.22	4.42	3.97
S-2	8.41	4.78	7.90	5.01	7.11
S-3	8.23	8.32	9.12	5.23	9.61
S-4	12.15	3.45	4.45	5.10	14.09
S-5	14.77	9.78	7.65	6.56	15.61
S-6	14.90	15.04	13.22	15.11	14.43
S-7	10.01	9.19	10.11	12.90	13.10
S-8	9.06	7.90	9.98	10.12	11.10
S-9	15.45	13.12	7.45	6.11	6.78
S-10	10.76	9.67	7.21	4.90	4.90
S-11	9.01	8.19	4.74	3.10	3.56
S-12	4.44	6.90	5.11	4.54	4.01
S-13	6.56	8.11	7.01	9.67	9.22
S-14	5.88	4.56	7.33	3.05	3.65
S-15	7.34	6.89	4.73	12.61	8.13

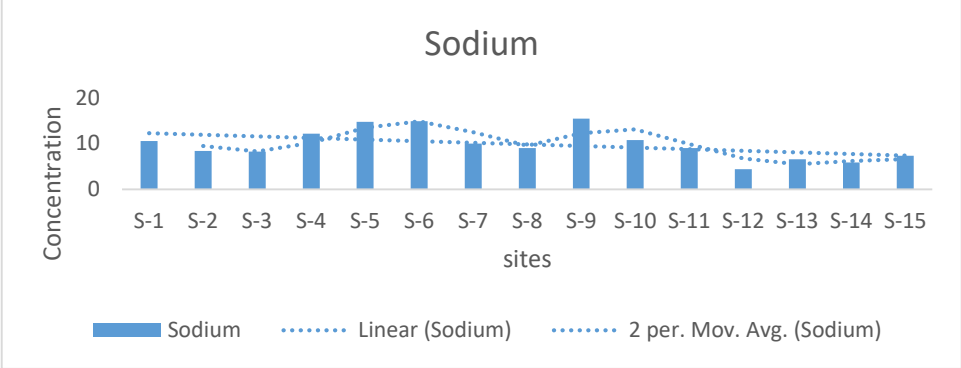
4.1 Graphs Showing Concentrations of Metals

In the figures given below, the concentration of metals in soil is presented graphically. Samples were collected from 15 different sites in Mirpur. In graphs, the standard deviation of all concentrations was calculated and then a moving average trend line was drawn which shows fluctuations between the concentrations of metals present in soil samples.

4.1.1 Sodium (Na)

Sodium concentration is shown below in the graph. Site 9 has an elevated peak and concentration is 15.45 ppm. By graphical representation, it is concluded that Sodium concentration showed less variation.

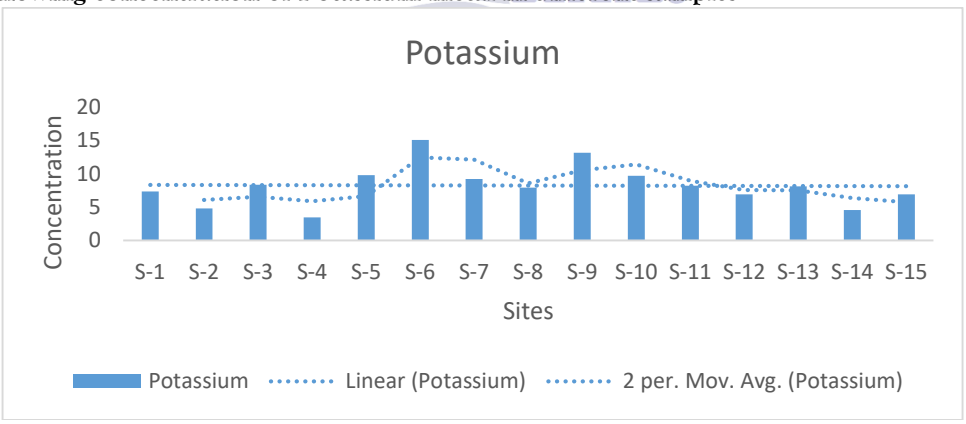
Fig. 1 showing the concentration of Sodium metal in different samples



4.1.2 Potassium (K)

Potassium concentration is shown below in graph. Site 6 has elevated peak and concentration is 15.04 ppm. By graphical representation, it is concluded that Potassium concentration showed less variation.

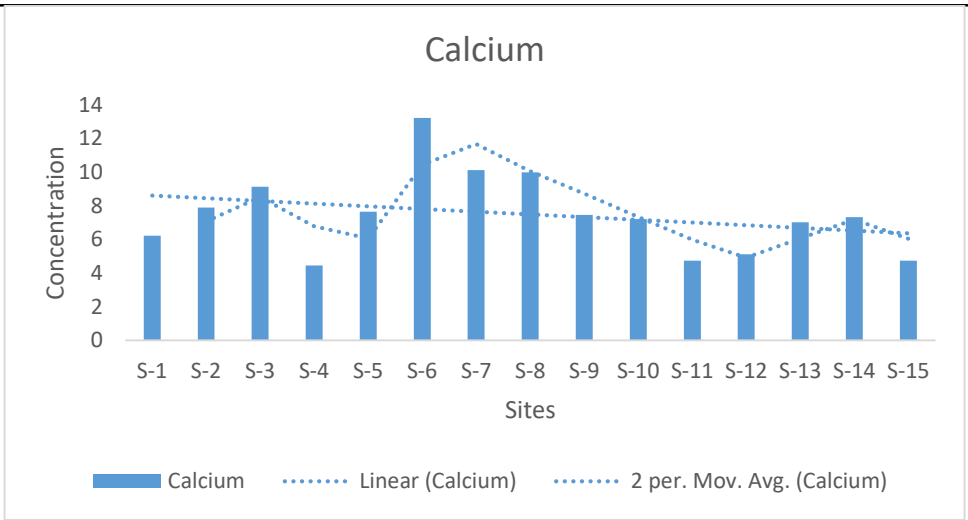
Fig. 2 showing concentration of Potassium metal in different samples



4.1.3 Calcium (Ca)

Calcium concentration is shown below in graph. Site 6 has elevated peak and concentration is 13.22 ppm. By graphical representation, it is concluded that Calcium concentration showed notable variation.

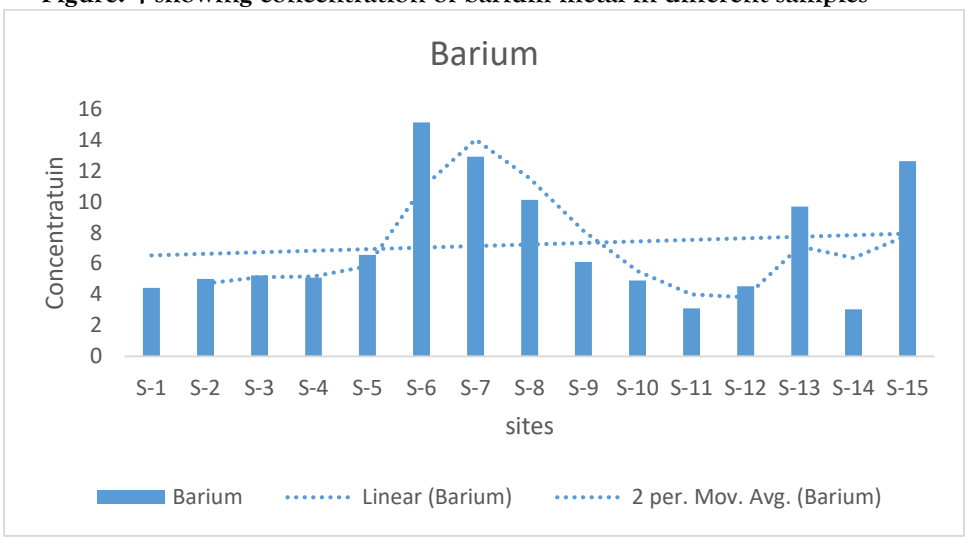
Fig. 3 showing concentration of calcium metal in different samples



4.1.4 Barium (Ba)

Barium concentration is shown below in graph. Site 6 has elevated peak and concentration is 15.11 ppm. By graphical representation, it is concluded that Barium concentration showed notable variation.

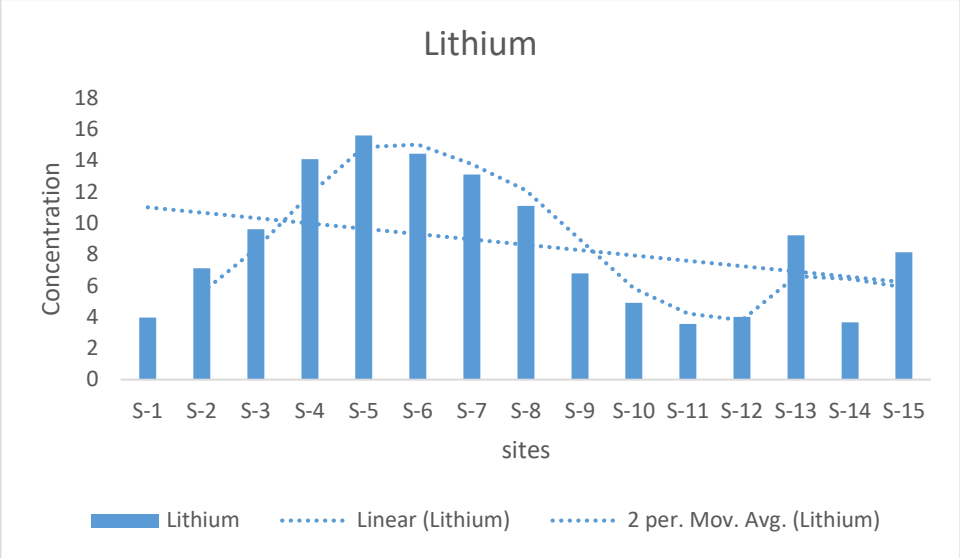
Figure: 4 showing concentration of barium metal in different samples



4.1.5 Lithium (Li)

Lithium concentration is shown below in graph. Site 5 has elevated peak and concentration is 15.61 ppm. By graphical representation, it is concluded that lithium concentration showed notable variation.

Figure: 5 showing concentration of lithium metal in different samples



4.1.6 Cumulative Graph of Five Metals

Figure: 6 showing cumulative graph of metals in different samples

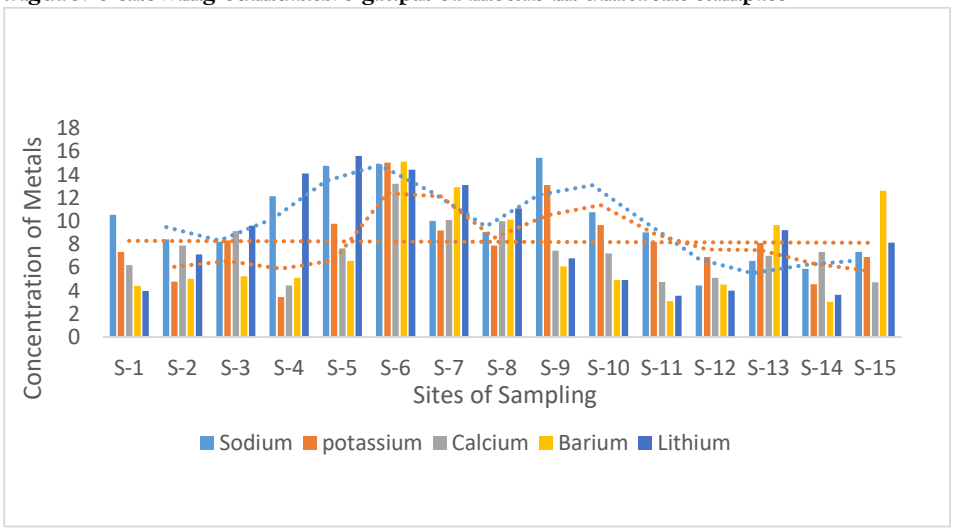


Figure: 7 showing stacked area graph of metals in different samples

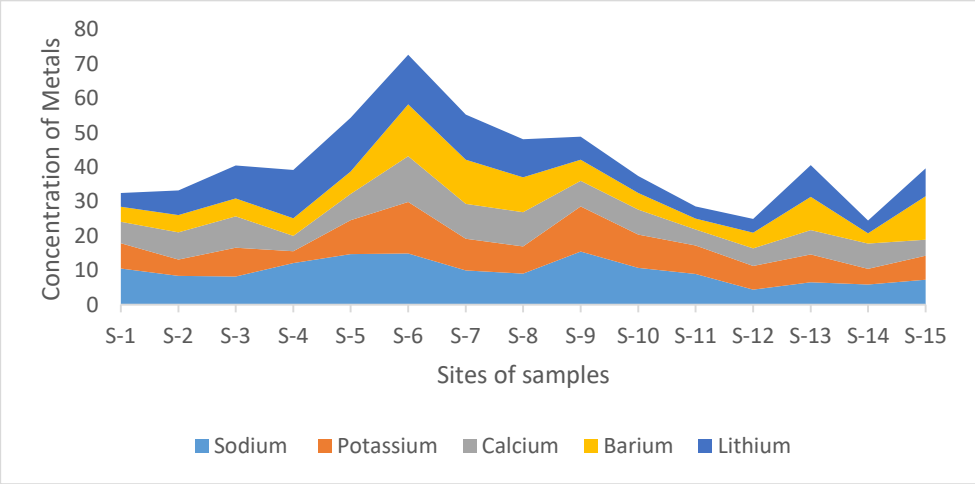
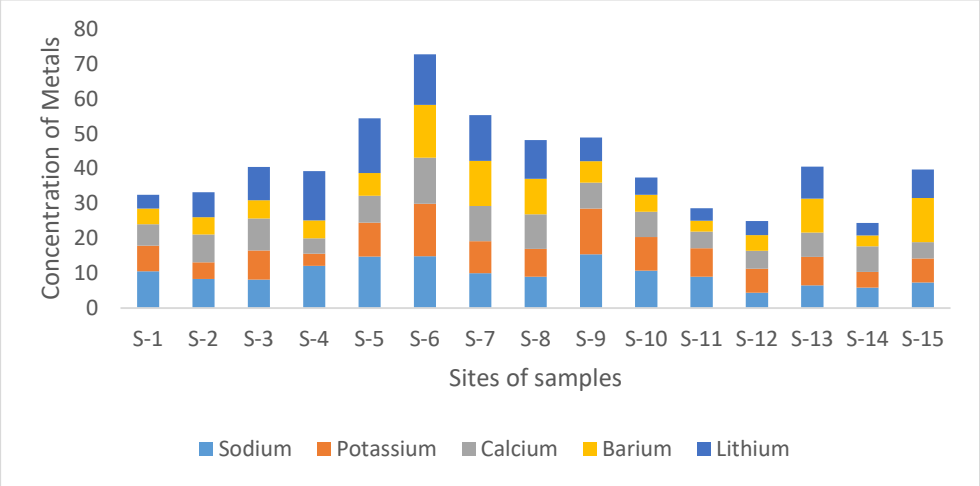


Figure: 8 showing stacked column graph of metals in different samples



4.1.7 Cluster Analysis

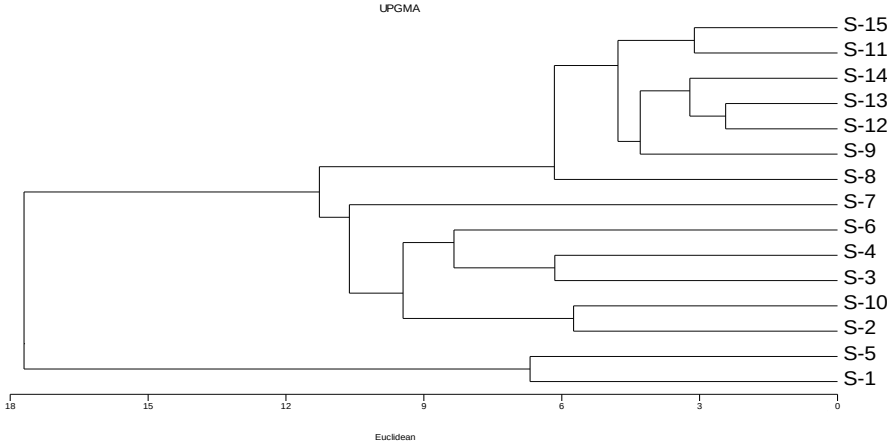
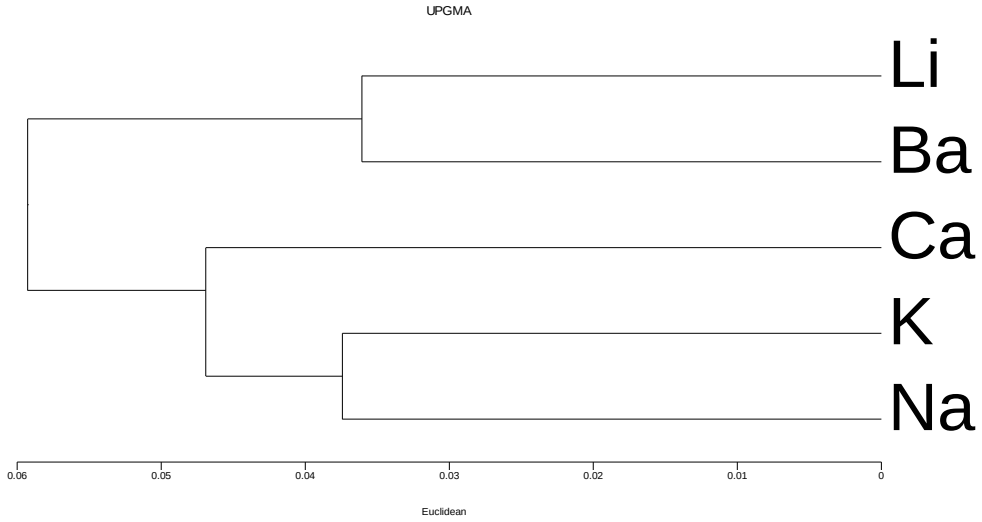


Fig: 9 showing Cluster analysis of fifteen sampling sites

Cluster analysis of all sampling area is shown. Elevated peak was found on site1 and site5. Fifteen sampling areas aggregated into five cluster due to variation in concentration of metals found in soil. By plotting cluster analysis, we noticed that site1 and site5 formed cluster1 (C1) this cluster showed that both areas have similarity in terms of soil.

Fig: 10 showing Cluster analysis of five alkali Metals



Cluster analysis of five metals are shown. By plotting cluster analysis, we noticed that sodium and potassium formed cluster1 (C1) this cluster showed that both metals have similarity in terms of soil contamination and barium and lithium formed cluster2 (C2) this cluster showed that both metals have similarity in terms of soil contamination

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4.1.8 Box and Whisker Plot

Fig: 11 Figure showing Box and Whisker Plot of Metals

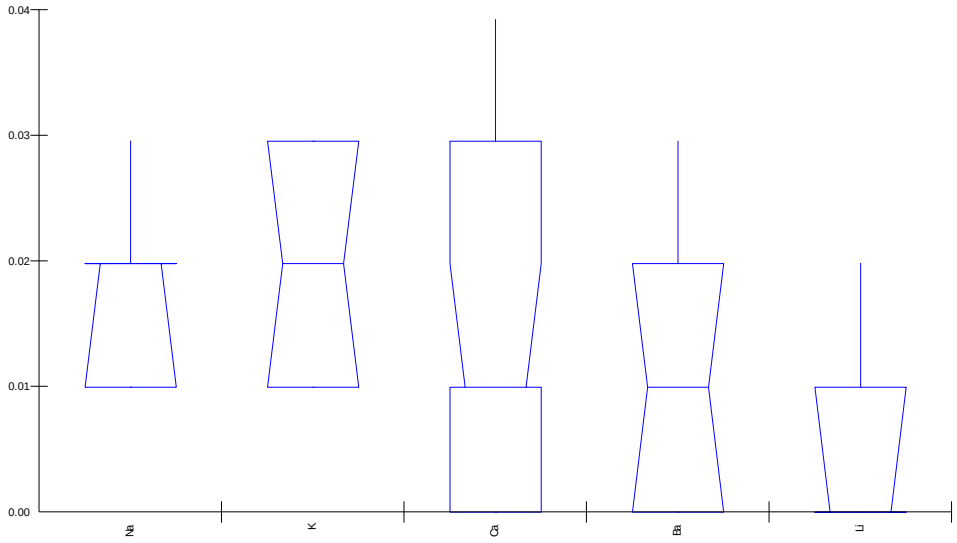


Figure 13 shown above is a box and whisker plot of alkali metals. In graph five metals are compared based on concentration in food samples. By analysis, it is concluded that sodium metal is the highest among all metals while lithium concentration is the lowest. The middle 50% of the group's scores are represented by the middle "box." The interquartile range is the range of scores between the lower and upper quartiles. The interquartile range encompasses the middle 50% of score values. 75 percent of the scores are lower than the top quartile. Given that the distance from the third quartile to the upper extreme is more than the distance from the median to the third quartile, the longer whisker on the upper side implies that there might be more variance among the higher values.

5. DISCUSSION

This study examined the concentration of sodium, potassium, calcium, barium, and lithium in soil samples from public testing sites using a Flame Photometer SA-30. Though site S-6 recorded elevated concentrations for all metals, it is highly likely that such an occurrence. The reasoning can be attributed to mining activities, vehicular emissions, and construction work ongoing within the area. These elevated levels pose threats-they may cause environmental and health problems, namely, sodium solders plants; potassium creates skin irritations; calcium results in burns and eye irritation; barium is responsible for cardiovascular diseases; and lithium is linked to neurological impacts. Cluster analysis established similarity patterns of the contamination process, showing some pairings among metals (namely sodium and potassium, barium and lithium) and among sampling sites (site S-1 and S-5) based on metal concentrations. The box-and-whisker plots depicted sodium as the most abundant and lithium the least abundant metal, highlighting the variance from one site to another. Risk assessments, done with the USEPA formula, showed potential inhalation hazards associated with these contaminants. These results highlight the need for attention on these pollutants using stem-rails for specific targeting of mitigation, with a corresponding realization that their health effects will really require a detailed analysis for these regions.

Table 3: Parameters Used in Health Risk Assessment (USEPA, WHO)

Parameters	Units	Values
Highest Concentration of metals (C)	ppm/kg^{-1}	Na(15.45),K(15.04),Ca(13.22),Ba(15.11), Li(15.61)
Exposure frequency (EF)	Day year^{-1}	350
Exposure duration (ED)	Year	30 (Adults), 6 (Children)
Average Time (AT)	Days	70 × 365
Inhalation rate (InhR)	m^3 day^{-1}	20 (Adults), 7.6 (Children)
Reference doses (Rfd)	mg kg^{-1} day^{-1}	Na(2000),K(3500),Ca(1000),Ba(2), Li(1.8)

Evaluating an inhalation exposure risk, such HI and HQ values were determined for Na, K, Ca, Ba, and Li. HI values were calculated and revealed negligible risk for sodium (3.15 × 10 ^{6}), about 1.5 times for potassium 1.7×10^{-6} and 5.39×10^{-6} 5.39 \times 10^{-6}5.39×10−6for calcium (indicating potential risks). The HI value of barium was slightly higher at 3.08×10−33.08 \times 10^{-3}3.08×10^{-3}; however, lithium reflected the highest HI at 0.3×10^{-2}, which is also a minor potential assessment found for risk. The hazard rankings allocated Li > Ba > Na > Ca > K. Whereas most metals showed low risk (HI and lt;1), the greater HI of Ba and Li sustain their important monitoring and mitigation, wherein possibilities may causally diminish health risks in the areas in question

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Table 4: Health Risk Assessment of Metals

Metals	Hazard index (HI)	Risk assessment
Na	3.15×10^{-6}	No risk
K	1.7×10^{-6}	No risk
Ca	5.39×10^{-6}	No risk
Ba	3.08×10^{-3}	Low risk
Li	0.3×10^{-2}	Low risk

CONCLUSION

After heavy metals analysis of all 15sites soil samples using Flame photometer SA-30 it is concluded that, sodium concentration was more in all soil samples. Sample of soil were collected from different locations of Mirpur (AJK) and examined using flame photometer SA_30 for up to alkali metals. The concentration of these metals change from place to place and results achieved shown that soil impacts on human health.Heavy metal pollution was caused by anthropogenic activities such as poor agricultural practices and the disposal of waste effluents. In the light of results and discussion it is concluded that the soil samples of Mirpur (AJK) was contaminated with some of tested heavy metals that is not useful for useful purpose such growing of plants and other use without prior treatment To withstand the quality of soil, appropriate supervision is required. Furthermore, people who construct houses in soil should be made aware of the potential dangers and health risks associated with the use of soil in which concentration of heavy metals are more. The findings provide recommendation for controlling heavy metal pollution and protecting soil in AK.

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