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Geoenvironmental Assessment of Household Dust in Some Areas of Greater Cairo

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Abstract

Dust samples were taken from uncontaminated surfaces including closets, fans, and office shelves to identify the source of heavy metals in household dust. The Greater Cairo Environmental Monitoring Program's measurements of the sources of heavy metals in dry and wet air sediments were the primary topic of discussion. Dust from previously contaminated soil and air pollutants from factories in Greater Cairo are two potential culprits. Samples of household dust from the polluted area were examined. Cadmium and lead concentrations in household dust in the affected area were estimated to be expected.

Key Words:

Greater Cairo, Heavy metals, Atmospheric emissions, Household dust

1. Introduction

The purpose of this study was to examine the mineralogical makeup of home dust in a few chosen Greater Cairo locations. Assessing the amounts of metallic pollution and locating possible sources were the objectives. Advanced scientific techniques were used in the investigation to gather

samples and analyze them utilizing analytical chemistry methods.

Important Results Metallic contaminants were substantially more prevalent in industrial and high-traffic areas than in less urbanized areas.

Metallic contaminant sources traffic and vehicle emissions: Lead and nickel concentrations were higher in areas with high traffic, most likely because of fuel combustion and brake wear. Industrial Activities: Areas close to industrial zones showed higher levels of mercury and cadmium, which may be the result of emissions from manufacturing operations. Environmental Factors: The distribution of metallic pollutants in household dust was impacted by seasonal fluctuations and wind direction.

. Certain regions had higher than permissible levels of heavy metals in household dust when compared to international environmental guidelines Anticipated Effect and Consequences. The results show that extended exposure to contaminated household dust, especially in industrial and high-traffic regions, may pose health hazards. To lower exposure, the study highlights the necessity of better ventilation and dust management techniques in households. The findings lay the groundwork for future investigations into metallic pollution and air quality in urban settings.

Suggestions Public Awareness: Inform locals about the possible risks posed by household dust and how to avoid it. Enhancements to Urban Planning: Put in place more stringent laws governing industrial emissions and the reduction of vehicle pollution. Future Research: To gain a better understanding of long-term pollution trends, extend the study to include other regions and seasonal fluctuations.

The objectives of this study are to determine the sources of metal pollution, evaluate the levels of metal pollution in household dust in a few chosen Greater Cairo, and investigate the effects these pollutants have on the environment and human health. Additionally, it aims to offer suggestions for enhancing air quality and lowering the health hazards connected to metal pollution exposure in urban settings.

2. The Theoretical Framework

A heavy metal is defined as a hazardous metallic element having a large atomic weight and

density and refers to any metal that has the potential to harm human health or the environment (Helmenstine, 2019).

Heavy metals are naturally occurring substances that have substantial harmful effects and densities larger than 5 (g/cm^3). They are referred to as hazardous metals and have atomic weights ranging from 63.545 to 200.5 g.

Human activity is frequently the cause of heavy metal contamination. Numerous industries, including manufacturing, agriculture, and medicine, require heavy metals. Some of these elements, like copper and zinc, are present in the human body at amounts that are safe and adequate for the body to carry out its duties. When a heavy element is absorbed in significant amounts by the body's tissues, toxicity results.

Lead, mercury, and cadmium are examples of heavy metals. Less frequently, any metal—such as cobalt, chromium, lithium, and even iron—that may have detrimental effects on human health, or the environment is referred to as a heavy metal. One of the worst contaminants in our food supply is heavy metals (Zaidi, *et al* 2005).

Anthropogenic heavy metals tend to become more mobile in soils, which makes them accessible through the processes involved in soil formation. Numerous anthropogenic sources, such as mining checkpoints, leaded gasoline and lead-based paints, fertilizer applications, the disposal of high-metal waste in landfills with insufficient protection, animal manure, biosolids (sewage sludge), coal combustion residues, compost, petrochemicals, pesticides, and atmospheric deposition, can produce metal-containing solids in contaminated areas (Sardar et al., 2013).

Exposure to lead and cadmium is the main heavy metal-related health concern to consumers. Even though heavy metals' detrimental effects on health have long been recognized, exposure to them is still an issue in developing nations. Heavy metals like lead and cadmium can build up in the diet and cause serious health problems (Oliver, 1997). Usually found in soil, heavy metals can enter the human body through a variety of exposure pathways (Qashlaqi, Moore, & Forghani, 2008).

Toxic heavy metals found in sewage are carried to plant roots, aquatic systems, and soil (Khan, Cao, Cheng, Huang, & Zhou, 2008). The surfaces of leaves are where heavy metals tend to collect when they are present in aerosols. Since fine particles might infiltrate the leaves, there is no efficient method to eliminate all heavy metals originating from aerosol deposition. The physical and chemical characteristics of the soil and crops affect how quickly heavy metals build up in the soil (Qashlaqi et al., 2008).

Wastewater cannot be cleaned with heavy metals. They disrupt plant roots when they get into the soil, and when animals or people eat these tainted plants, they make their way up the food chain. As a result, heavy metals have an impact on crop yield and quality, and given the rising need for food safety, these contaminations are quite concerning.

Because it is used in batteries and frequently disposed of in household garbage, cadmium emissions persist. Cadmium can also be obtained by smoking. The main way that non-smokers are exposed to cadmium is through food. Even at modest exposure levels, cadmium exposure can have negative health effects, such as kidney impairment or bone deterioration and fractures (WHO, 1992).

Lead exposure can also come from food and the air. Airborne lead emissions from gasoline have resulted in serious pollution. Lead's high gastrointestinal absorption and blood-brain barrier permeability make children more vulnerable to exposure. Children's blood lead levels should be kept within permissible limits because even low exposure levels might have neurotoxic effects. Additionally, lead should not be utilized in food packaging or paints that contain lead (Järup, 2003).

The United States Environmental Protection Agency proposed maximum pollution thresholds for heavy metal concentrations of cadmium in drinking water, soil, and air at 0.15, 0.85, and 0.005 mg/kg, and for lead at 0.420 and 0.01 mg/kg.

Living things are poisoned by heavy metals. They can enter the body via several different ways, including absorption, inhalation, and ingestion. One of the most significant pollutants in our food are heavy metals (Zaidi et al., 2005). When their rate of deposition surpasses

their rate of emission, they become dangerous. Because heavy metals build up gradually in bodily tissues and can eventually reach dangerous concentration levels, exposure to large concentrations does not always result in toxicity in the body (Suruchi, 2011).

Numerous illnesses, including those of the neurological system, kidneys, and heart, as well as disorders of the bones, are linked to excessive levels of these metals in diet (Sánchez et al., 1998; Steenland and Bovetta, 2000). It is well established that lead is harmful to public health. Serious health hazards, including anemia, constipation, and colic, can result from ingesting lead (Bolger et al., 1996).

High dietary buildup of heavy metals like lead and cadmium can cause serious systemic health hazards (Khair, 2009; Oliver, 1997). The detrimental effects of heavy metals entering the body when ingested in doses over the advised biological limits are referred to as the biotoxic effects of heavy metals. The following symptoms have been reported as general indicators of cadmium, lead, arsenic, mercury, zinc, copper, and aluminum poisoning, despite the fact that each metal has its own specific toxicity markers: gastrointestinal disturbances, diarrhea, stomatitis, tremors, rusty-red discoloration of stool due to hemoglobin-urea chloride, ataxia, paralysis, vomiting, convulsions, depression, and pneumonia when inhaled vapors and fumes (McClagh, 1991).

Greater Cairo is the name of an administrative territory in Egypt that consists of the cities in the governorates of Cairo, Qalyubia, and Giza. Given that they share a common transportation system, such as the Cairo Metro and the Cairo Monorail, the regions are all a logical urban extension of Cairo.

There are two definitions of Greater Cairo. The first is more specific and adds the city of Giza as well as the cities of Banha, Shubra El-Kheima, El-Khosoos, El-Obour, Khanka, Qalyub, and Qanater El-Khayriyah in Qalyubia Governorate. This definition is no longer in use and has since disappeared (Fig,1). The official definition, which is currently accepted by the Egyptian government, is that Greater Cairo includes the whole area of the three governorates (Qalyubia, Cairo, and Giza).

Greater Cairo is the largest urban agglomeration in Africa and the Middle East, with

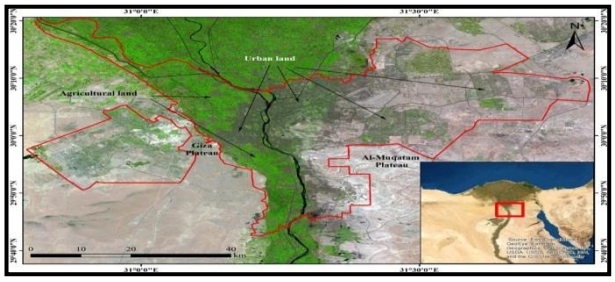

Figure (1): A Google Earth map of Egypt showing the location of Greater Cairo and a satellite image with the administrative boundary of Greater Cairo (red line). Note the occurrence of urban landscape and the rural agricultural lands

a population of approximately 20,500,000 people in 2012, according to some statistics.

Greater Cairo's weather is always hot or warm, with pleasant nights. There are only two seasons: intense heat, with average temperatures reaching 35°C (95°F) between May and October, and a mild winter from November to April. Cairo is very dry, with an average annual rainfall of less than one centimetre, but humidity is high in the summer due to its location on the Nile River.

The city occasionally experiences dust storms in March and April. The best time to visit Greater Cairo is during the cooler winter months of November and April, when average temperatures range from 19 to 29°C (66°F) during the day and from 5 to 11°C (41°F) at night. The Cairo Ring Road is a 100-kilometer (62-mile) circular road that surrounds most of the contiguous urban areas of Cairo, Giza, and Shubra El-Kheima, in the Greater Cairo area of Egypt.

The most important sources of heavy metal air pollution in Greater Cairo are:

.**1**. Industrial sources: The Greater Cairo region is home to 524 big manufacturers and 13,840 small and medium-sized factories, accounting for 52% of all factories in the country (Fig,2). This source accounts for 23% during periods of air pollution and 32% overall.

Exhaust from automobiles: Of the 4.8 million vehicles, 50% (or about 2.4 million) are found in Greater Cairo. This source accounts for 23% during periods of air pollution and 26% overall.

Figure (2): Atmospheric emissions by the Greater Cairo industry**.**

Throughout the year, burning agricultural waste accounts for 6% of emissions; however, during the fall, when air pollution is at its highest, this number rises sharply to 42%. Open burning of municipal waste: This source accounts for 36% of annual air pollution and 12% during air pollution episodes. It is caused by the careless burning of accumulated refuse, whether through. spontaneous combustion or other careless methods.

Weather-related causes and phenomena: Egypt's arid climate, dusty winds, and infrequent rainfall. (Ministry of Environment, Egypt).

Why is Greater Cairo so severely affected by air pollution?

The terrain of Greater Cairo greatly increases the strength of storms when thermal inversion and stagnant air occur. From Shubra in the north to Helwan in the south, Cairo, Giza, and Qalyubia are situated in a rectangular depression on either side of the Nile. As a result, toxins from human activity—both domestic and imported by northern winds—accumulate in this melting pot. Instead of 2,000 meters, these contaminants are contained in a layer that occasionally only reaches a height of 25 meters. (Ministry of Environment, Egypt)

3.Methods of Research and the tools used

3.1. The Study Area

Urban house dust samples were taken from seven locations in Greater Cairo as well as from a reference site to identify the source of heavy metals in dust samples. Because house dust contains particulate matter, which is produced by the deposition of fine particles from the air, it was selected. House dust accumulates over a shorter periodroughly three months (Fig,3).

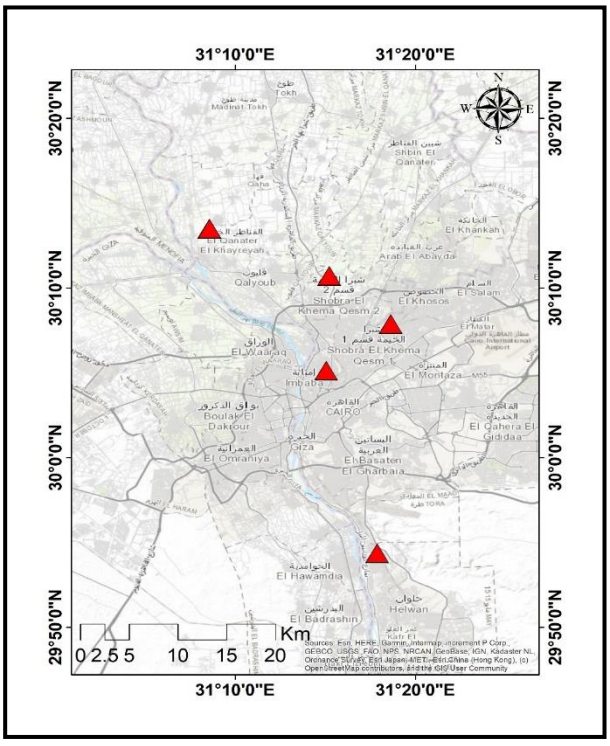

Figure (3): Dust samples locations.

3.2. Chemical Analysis

The dust samples analysis conducted by the Desert Research Institute in Matariya

4.Result and Discussion

Table (1) and figure (4) represent an analysis of heavy metal concentrations dust samples from different locations in Egypt, with precise geographic coordinates.

Arsenic (As): Ranges between 2.6 – 6 ppm the highest concentration (6 ppm) is in Arab El Hisn, Ain Shams, Elmataria.. The lowest value (2.8ppm) found in Bahada, Al-Qanater Alkhayria, Al-Qalyubia Governorate, Egypt

Cadmium (Cd): Ranges between 0.8 – 2.8 ppm the highest concentration (2.8 ppm) is in Bahada, Al-Qanater Alkhyaria The lowest value(0.8ppm) found in Wasef. El Barad. El sahel

Chromium (Cr): Ranges between 40 – 60.6 ppm the highest value (60.6 ppm) is in 3 Mahmoud Bassiouni, Sherif, Al-Sahel the lowest value (40 ppm) is in Bahada, Al-Qanater Alkhyaria

Nickel (Ni): Ranges between 30.6 – 44.6 ppm The highest concentration (44.6 ppm) is in Bahada, Al-Qanater Alkhyaria.

The lowest concentration (30.6 ppm) is in Bahada, Al-Qanater Alkhyaria

Lead (Pb): Ranges between 121 – 150 ppm the highest concentration (150 ppm) is in Altirea, Ma'asara station, Helwan

The lowest concentration (121 ppm) is in Bahada, Al-Qanater Alkhyaria.

Arsenic is recognized as a hazardous element, and it's frequently associated with either industrial processes or natural geological origins.

The table data shows a concerningly high concentration of Arsenic in the Arab El Hisn, Ain Shams, Elmataria region of Cairo.

This confirms the initial analysis and prompts further inquiry into whether industrial activities or natural geological factors are responsible. Arsenic levels were lower than the other sampling sites.

Table (1): The values resulting from the chemical analysis of samples (ppm) taken from areas of Greater Cairo

	North	East	As	Cd	Cr	Ni	Pb
1	30°13`28``	31°8`33``	4.5	2.8	40	30.6	121
2	30°10`43``	31°15`13``	3.2	1.2	60.5	33.5	140
3	30°13`29``	31°8`35``	2.8	0.9	54.5	44.6	147.8
4	29°54`22``	31°17`53``	3	1.1	55	43.5	150
5	30° 5` 7``	31°15`4``	3.1	0.8	60	42.5	149
6	30°5' 40"	31°15' 5"	3.2	0.84	60.6	42.3	148
7	30°7' 52"	31°18' 38"	6	2.6	60.5	40.8	140

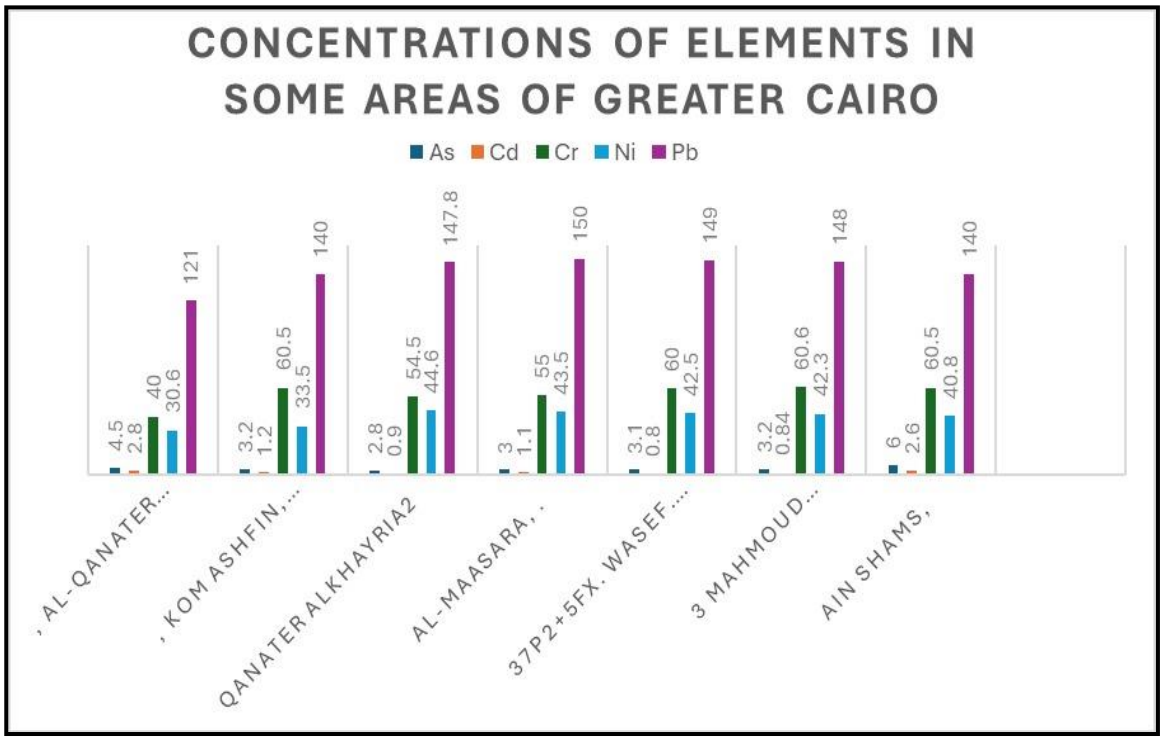

Figure (4): Chart showing the results of dust sample analysis collected from Greater

Cadmium (Cd) is considered a highly toxic heavy metal that poses significant risks to human health and the environment. Because of industrial processes including mining, metal refining, battery manufacture, and the usage of phosphate fertilizers, it is frequently found in soil and water.

Even at low concentrations, the cadmium can accumulate in living organisms, leading to harmful effects over time.

Monitoring cadmium levels in environmental samples is critical for determining pollution causes and preserving public health. 2.8 ppm is the highest concentration: Location:Al-Qanater Alkhayria, Bahada

This score points to a potential agricultural or industrial source of cadmium pollution. Phosphate-based fertilizers and battery manufacturing industries may be responsible for this high level.

Wasef had the lowest concentration (0.8 ppm). El Barad. El Sahe shows a little amount of fluctuation within the same geographical area, which could be the result of local activities or variations in the sampling location.

Chromium's existence in the environment is shown by its presence in of dry and wet air sediment samples.

Many industrial processes that use chromium or its derivatives can cause elevated levels. To evaluate the possible hazards to human health and the environment in the regions where the samples were gathered in Egypt, it is critical to ascertain the amounts of chromium and its oxidation state (+3 or +6).

Ni (nickel) Findings at Bahada, Al-Qanater Alkhayria, Al-Qalyubia Governorate, showed the highest concentration (44.6 ppm).Bahada, Al-Qanater Alkhayria, Al-Qalyubia Governorate had the lowest concentration (30.6 ppm) (in another sample from the same location).

The disparity in levels within the same area raises the possibility that pollution is localized or influenced by other local causes.

Altirea, Maasara station, Al-Maasara, Cairo Governorate, Helwan had the highest concentration of lead (150.0 ppm). Areas of Cairo have other high values.

Lead is a major environmental contaminant that comes from businesses (such as paints and batteries), building waste, and old automobile emissions (although these days they are less common due to unleaded gasoline). The history of industrial and urban pollution may be the cause of higher levels in Cairo's metropolitan districts. Lead is poisonous, particularly to children's neurological systems.

Found in Bahada, Al-Qanater Alkhayria, Al-Qalyubia Governorate, the concentration was the lowest (121.0 ppm).

This considerably lower level could imply less Lead pollution impact in this area compared to Cairo areas.

Ma'asara, Qanater Khayriya (from whom two samples were collected), Shubra El-Kheima, El-Khalfawy, Kom Ashfin, and Ain Shams were the seven sampling locations chosen. A thorough investigation of these regions showed that Ma'asara is close to several factories that significantly contribute to the elevated levels of heavy metals, such as: The Tourah Cement Factory is well-known for having a major negative influence on the environment because of the emissions from the cement-making process.

The waste from the Sigwart Cement Pipes Factory, which specializes in making cement pipes, could raise the levels of heavy metals.

Heavy metals may be used in the production of telephone equipment by Telephone Factory (Egyptian Company for Telephone Equipment Manufacturing).

Water and electricity meters are produced by Ma'asara Engineering Industries Company (Military Factory 45), whose operations may need the usage of different metals.

Furthermore, the refinery has additional factories, including paint and coating and brick factories, which might possibly be a contributor in the elevated levels of heavy metals in the surrounding area.

Through air emissions, the discharge of industrial waste, and possible leaks into soil and groundwater, these factories contribute to the environmental release of heavy metals. Thus, it is crucial to keep an eye on these sources and implement the necessary environmental controls

to lessen their negative effects on the environment and public health.

The high concentrations of heavy metals in the Shubra-Al-Khalfawy area are directly caused by a few factories, including:

General Bearings: situated near to the Omar Ibn Al-Khattab Mosque at 216 Shubra-Al-Khalfawy Street. They work in a variety of industries, such as cranes, hoists, and associated supplies; metal forms and scaffolding; bearings; and dealers of belts, angles, and sections. Metals including iron, zinc, chromium, and lead are involved in this industrial operation. Metal dust that floats in the air or settles in the earth is created during cutting, welding, and painting. Additionally, if workshop trash is disposed of carelessly, it might seep into groundwater.

Al-Majd Locks is situated adjacent to Khair Zaman Supermarket at 54 Silwans Street, off Shubra Al-Khalfawy Street. The production and distribution of locks and keys is their area of expertise. Iron, nickel, and copper are frequently used to make locks. Chemicals used in manufacturing and polishing procedures may contain cadmium or lead. These products' residues have the potential to contaminate nearby soil or sewage.

First Trade: 273 Shubra Street, Shubra, in front of the Khalfawy Metro Station, importers of tractor, generator, and agricultural equipment spare parts. Lead, chromium, and cadmium are among the metals found in generators and spare components. When old parts are stored or disassembled, heavy metal-containing lubricants and grease spill out.

There may also be old batteries, which are a significant source of mercury and lead. Since the Shubra El-Kheima area is regarded as an industrial urban center, there are also a number of significant factories there that directly contribute to the rise in heavy metal levels, including:

1- Address: Ismailia Canal Street, Sharq District, Shubra El-Kheima, Qalyubia; Al-Taawon Foundry for Castings and Metalworking.

Activity: Metalworking and smelting foundry

Possible Impact: Emissions from metal smelting processes may contain heavy metals like lead and cadmium, which can pollute the air and soil.

2- Address for Atlas Dyeing: Shubra El Kheima, Qalyubia.

Activity: Dyeing textiles and fabrics.

Potential Impact: Using chemicals and dyes that include heavy metals like chromium, which, if improperly handled, can seep into soil and water.

3- Friends Plastic Factory, Shubra El-Kheima, Qalyubia, 71 Ahmed Abd Rabbo Street.

Activity: Producing goods made of plastic.

Possible Impact: Compounds containing heavy metals may be used in the creation of plastic, and inappropriate waste disposal practices may pollute the land and water.

4- The Al-Zahra Al-Bayda Spinning, Weaving, and Dyeing Factory is opposite the Asmaa Preparatory School for Girls in Shubra El-Kheima, Cairo, at the end of Crystal Asfour Street.

Task: Dyeing, weaving, and spinning

Possible Effects: Chemicals used in dyeing procedures may include heavy metals, and improper disposal of spent water can pollute the environment.

5 .Universal Foundry, Fahd, and Al-Zaeem

Plastic Club Street, Shubra El-Kheima, Cairo is the address.

Activity: Metal-smelting foundry.

Possible Impact: Smelting procedures may discharge heavy metals into the environment, much like in other foundries.

Among the agricultural regions impacted by the overuse of fertilizers are Qanater Khayreya and Shibin El Kom, including:

Naturally occurring phosphate fertilizers, including calcium superphosphate, include cadmium (Cd), and occasionally lead (Pb) and mercury (Hg).

As time goes on, these metals build up in the soil, seep into plants, and eventually make their way into human diets.

A. Untreated organic fertilizers (poultry dung or compost): These may include significant quantities of heavy metals if their source is dirty or includes industrial or medical waste. These metals build up in groundwater and soil over time.

B. Pesticides: Certain pesticides contain elements like copper (Cu) and arsenic (As), which also raise the levels of heavy metals.

6. Conclusion

In summary, this work has emphasized the geoenvironmental evaluation of home dust in certain Greater Cairo neighbourhoods, highlighting its direct influence on indoor environmental quality and human health. Research has demonstrated that because household dust contains chemical compounds and small particles that may be harmful to health, it is not just a daily annoyance but also a hidden source of environmental pollution.

Dust samples were gathered and examined from many locations using the chosen approach, which made it possible to comprehend the spatial variation in pollutant concentrations. Significant variations in the amounts of several components were found in the results, which emphasizes the necessity of improving interior ventilation and cleaning procedures as well as increasing inhabitants' knowledge of environmental issues.

The results of this study highlight a serious environmental problem that must be addressed right now and over time in order to guarantee healthy living circumstances in metropolitan areas that are expanding quickly, such as Greater Cairo.

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References and Sources

Bolger, P. M., Coker, R. D., Stasikowski, J. A., & DiNovi, M. J. (1996). Health effects of lead: Colic, constipation, and anemia. Journal of Environmental Health, 58(6), 8–13.

Helmenstine, A. M. (2019). Definition of heavy metals and their properties. Retrieved from https://www.thoughtco.com

Järup, L. (2003). Hazards of heavy metal contamination. British Medical Bulletin, 68, 167–182. https://doi.org/10.1093/bmb/ldg032

Khan, S., Cao, Q., Cheng, H., Huang, Y., & Zhou, L. (2008). Health risks of heavy metals in contaminated soils and food crops irrigated with wastewater in Beijing, China. Environmental Pollution, 152(3), 686–692. https://doi.org/10.1016/j.envpol.2007.06.056

Khair, K. (2009). Dietary heavy metal exposure and its risks in urban populations. Toxicology Reports, 2, 1–5**.**

McClagh, M. (1991). Toxicity profiles of heavy metals. Journal of Toxicological Sciences, 16(4), 243–250**.**

Oliver, M. A. (1997). Soil and human health: A review. European Journal of Soil Science, 48(4), 573–592. https://doi.org/10.1111/j.1365-2389.1997.tb00558.x

Qashlaqi, A., Moore, F., & Forghani, G. (2008). Impact of heavy metals in urban dust and their bioavailability. Environmental Monitoring and Assessment, 142, 245–255. https://doi.org/10.1007/s10661-007-9925-2

Sardar, K., Ali, S., Hameed, A., Afzal, S., Fatima, S., & Shakoor, M. B. (2013). Heavy metal contamination and its sources in soils. Environmental Science and Pollution Research, 20(11), 7556–7566. https://doi.org/10.1007/s11356-013-1775-8

Sánchez-Castillo, C. P., Dewey, P. J. S., Aguirre, A., Lara, J. J., Vaca, R., & Escobar, M. L. (1998). The toxic potential of trace metals in food and drinking water. Science of the Total Environment, 217, 1–7

Steenland, K., & Boffetta, P. (2000). Lead and cadmium exposure and health risks: Review of epidemiologic studies. Environmental Health Perspectives, 108(1), 23–38. https://doi.org/10.1289/ehp.0010823

Suruchi, P. (2011). Assessment of heavy metal contamination in different vegetables grown in and around urban areas. Research Journal of Environmental Toxicology, 5(3), 162–179. https://doi.org/10.3923/rjet.2011.162.179

U.S. Environmental Protection Agency. (n.d.). National Primary Drinking Water Regulations. Retrieved from https://www.epa.gov

World Health Organization. (1992). Cadmium: Environmental health criteria 134. Geneva: WHO**.**

Zaidi, J. H., Asrar, A., Mansour, M., & Farooqi, A. (2005). Concentration of heavy metals in food: Assessment of dietary intake. Science of the Total Environment, 337(1–3), 279–289 **.**

Egyptian Environmental Affairs Agency. (2022). Environmental pollution report in Qalyubia Governorate. Retrieved from https://www.eeaa.gov.eg

World Health Organization. (2021). Lead poisoning and health. Retrieved from https://www.who.int

Web Articles and News:

Egyptian Industry. (n.d.). Egyptian industry guide – Shubra El-Kheima. Retrieved from https://www.egyptianindustry.com

Researchers of Syria. (2015). Shubra El-Kheima – Between industry and pollution. Retrieved from https://www.syr-res.com

Youm7. (2009, March 21). Government study: Shubra El-Kheima is the most polluted area in Qalyubia. Retrieved from https://www.youm7.com

140 Online. (n.d.). Factories database – Shubra El-Kheima. Retrieved from https://www.140online.com

Marefa. (n.d.). Al-Maasara, Helwan. Retrieved from https://www.marefa.org

Steel Network. (n.d.). General Rollman Bearing Company profile. Retrieved from https://steel-network.com

Yellow Pages Egypt. (n.d.). Factories and commercial shops guide – El-Khalafawy and Shubra. Retrieved from https://yellowpages.com.eg