

A review of soil pollution, causes, and health effects

Revisión de la contaminación del suelo, causas y efectos en la salud

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ABSTRACT

Soil pollution is the biggest problem of today. When the chemical, biological and physical properties of the soil change, its quality is affected and the soil becomes polluted. Today the cause of soil pollution is Natural and Anthropogenic Soil Pollution. In which industrial activity, agricultural activities, mining, Waste disposal, deforestation, oil, Radioactive Wastes, Acid Rain, Coal Ash, Microplastics, Indiscriminate use of pesticides, insecticides, herbicides, etc. are prominent. Due to changes in soil properties, groundwater is getting polluted here. Soil pollution affects kidney damage, liver, headache, nausea, fatigue, eye irritation, skin rash, etc. human health. Soil pollution control on Reusing of materials, Recycling and recovery of materials, Reforestation, Solid Waste Treatment, Public Awareness, Soil Erosion, Production of Natural Fertilizers, Ban on Toxic Chemicals, Reducing chemical fertilizer and pesticide use. The causes of soil pollution, control, and their effects on health have been described in this review.

Keywords: Soil pollution, health, control, causes and sources of soil pollution.

RESUMEN

La contaminación del suelo es el mayor problema de la actualidad. Cuando las propiedades químicas, biológicas y físicas del suelo cambian, su calidad se ve afectada y el suelo se contamina. La causa de la contaminación del suelo hoy en día es la contaminación natural y antropogénica del suelo. En el que se encuentran la actividad industrial, las actividades agrícolas, la minería, la eliminación de desechos, la deforestación, el petróleo, los desechos radiactivos, la lluvia ácida, las cenizas de carbón, los microplásticos, el uso indiscriminado de plaguicidas, insecticidas, herbicidas, etc. Debido al cambio en las propiedades del suelo, el agua subterránea se está contaminando aquí. La contaminación del suelo afecta la salud humana como daño renal, hígado, dolor de cabeza, náuseas, fatiga, ardor en los ojos, erupción cutánea, etc. Control de la contaminación del suelo sobre reutilización de materiales, reciclaje y recuperación de materiales, reforestación, tratamiento de residuos sólidos, conciencia pública, erosión del suelo, producción de

fertilizantes naturales, prohibición de productos químicos tóxicos, reducción del uso de fertilizantes químicos y pesticidas. Esta revisión describe las causas, el control y los efectos en la salud de la contaminación del suelo.

Palabras clave: Contaminación del suelo, salud, control, causas y fuentes de contaminación del suelo.

INTRODUCTION

The soil, along with air and water, is the environment with which a human is directly connected throughout his life. The soil cover is a self-regulating biological system and is one of the components of the Earth's biosphere, determining several processes occurring in it (Nikiforova, V., et al., 2021, & Problems of protection and reproduction of natural resources). Environmental pollution is the burning challenge of current living organisms on the earth. Pollution is the introduction of contaminants into an environment, and may also be defined as an undesirable change in the physical, chemical and biological characteristics of air, water, and soil which affect human life, lives of other useful living plants and animals, industrial progress, living conditions and cultural assets (Toccalino, P. L., & Norman, J. E. 2006). Most soil contaminants are from human activity, including, industrial processes, mining, household, business waste, and human and animal pharmaceuticals. Different overviews of current research and present case studies are concerning heavy metals and synthetic organic chemicals as the major soil contaminants. Soil also contains a great number of biological contaminants such as pathogens, (tetanus) and parasites, (hookworms) which cause many well-documented impacts on human health (Burgess, L.C. 2013).

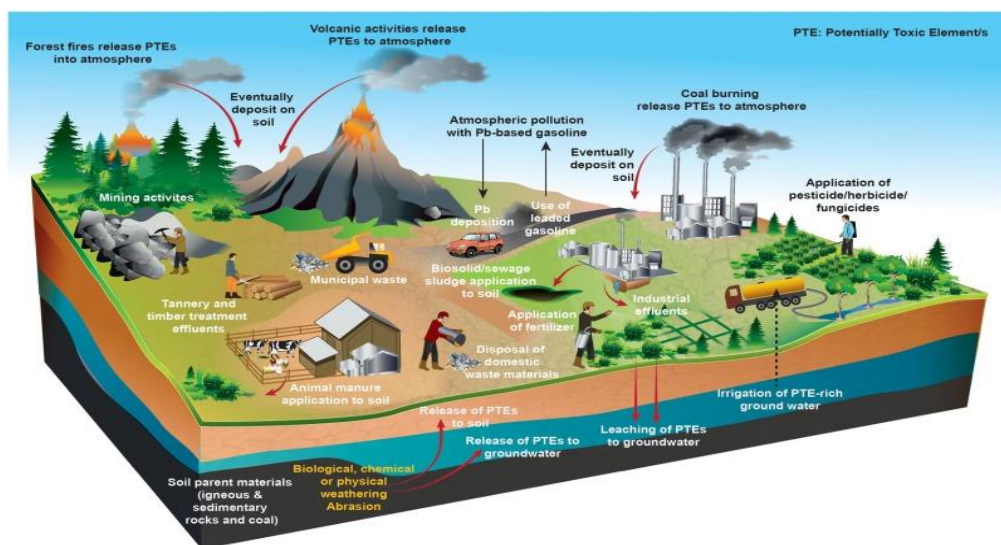


Figure: 1 potentially toxic element (PTE) sources in soil ecosystems. (Palansooriya, K. N., et al., 2020)

Soil pollution: Soil pollution is defined as the accumulation in the soil of persistent toxic compounds, chemicals, salts, radioactive materials, or pathogens that have adverse effects on plant growth and animal health (Okrent, D. 1999). Soil is the thin layer of organic and inorganic materials that covers the rocky surface of the earth. The organic part, which comes from the decomposition of plant and animal remains, is concentrated in the dark topsoil. The inorganic part of rock fragments was created over millennia by the

physical and chemical weathering of bedrock. Productive soils are necessary for agriculture to provide the world with sufficient food (Belluck, D. A., et al., 2003).

CAUSES OF SOIL CONTAMINATION / SOURCES OF SOIL CONTAMINATION SOIL POLLUTION CAN BE CLASSIFIED INTO NATURAL AND ARTIFICIAL CAUSES (HAVUGIMANA, E. R. N. E. S. T. E., ET AL., 2017).

A. Natural contamination of the soil

In some extremely rare processes, some pollutants naturally accumulate in the soil (Shaltami, O.R. 2014). This can occur due to the differential deposition of soil by the atmosphere. Another way this form of soil contamination can occur is through the transport of soil contaminants with the precipitation water. An example of natural soil contamination is the accumulation of compounds containing the perchlorate anion (ClO_4^-) in some dry and arid ecosystems. It is important to note that some contaminants can be produced naturally in the soil under the influence of certain environmental conditions. For example, perchlorates can form in soils containing chlorine and certain metals during a thunderstorm (Tao, H., et al., 2020).

B. Anthropogenic soil pollution

Almost all soil contamination is of anthropogenic origin. Various human activities can lead to soil contamination. However, here are some of the causes of soil pollution (Osama R. et al., 2020).

1. Industrial activity

Industrial activities have been major contributors to soil pollution over the past century, especially since mining and manufacturing have increased. Most industries depend on extracting minerals from the earth. Whether it is iron ore or coal, the by-products are contaminated and not disposed of safely. As a result, the industrial waste remains on the surface of the ground for a long time and makes it unusable (Havugimana, E. R. N. E. S. T. E., et al., 2017).

2. Agricultural activities

The use of chemicals has skyrocketed since technology has provided us with modern pesticides and fertilizers. They are full of chemicals that are not produced in nature and that you cannot break down. As a result, they seep into the soil after mixing with water and slowly reduce the fertility of the soil. Other chemicals affect the composition of the soil and facilitate the erosion of water and air. Plants absorb many of these pesticides and when they decompose they cause soil pollution as they become part of the earth (Havugimana, E. R. N. E. S. T. E., et al., 2017).

3. Random use of pesticides, insecticides, and herbicides

The plants we depend on for food are attacked by insects, fungi, bacteria, viruses, rodents, and other animals and must compete with weeds for nutrients. To kill unwanted populations living on or on their crops,

farmers use pesticides. The first widespread use of insecticides began at the end of World War II and included DDT (dichlorodiphenyltrichloroethane) and gamma-xene (Havugimana, E. R. N. E. S. T. E., et al., 2017, & Toccalino, P.L., & Norman, J.E. 2006). The insects quickly became resistant to DDT, and because the chemical did not decompose easily, it persisted in the environment. Because it was soluble in fat instead of water, it strengthened the food chain and disrupted calcium metabolism in birds, making eggshells thin and brittle (Havugimana, E. R. N. E. S. T. E., et al., 2017, & Toccalino, P. L., & Norman, J. E. 2006). As a result, DDT for large birds of prey such as the brown pelican and osprey is now banned in most developed countries. But ironically, many of them still produce DDT for export to other developing countries whose needs outweigh the problems it causes (Havugimana, E. R. N. E. S. T. E., et al., 2017 & Toccalino, PL, & Norman, J. E. 2006).

4. Extraction

The main source of metal pollutants in the soil are mining and smelting activities. Mining can contaminate the soil over a large area. Agricultural activities close to a mining project can be particularly affected (Mench, M., et al., 2000). Mining operations regularly alter the surrounding landscape by exposing previously undisturbed earthen material. Erosion of exposed soils, mined ores, tailings piles, and fines in waste rock piles can result in significant sediment loading of surface waters and drainage routes. In addition, spills and releases of hazardous materials and the deposition of contaminated dust carried by the wind can lead to soil contamination (Mench, M., et al., 2000). Risks to human health and the environment from soils generally fall into two categories, namely soils contaminated by windblown dust and soils contaminated by chemical spills and residues. Volatile dust can cause significant environmental problems in some mines. The inherent toxicity of dust depends on the proximity of environmental receptors and the type of those degraded. High levels of lead, arsenic, and radionuclides in windblown dust usually pose the greatest risk. Soils contaminated with chemical discharges and residues in mine sites can pose a direct contact hazard when these materials are handled improperly (Havugimana, E. R. N. E. S. T. E., et al., 2017).

5. Waste disposal

Therefore, the way we dispose of our waste is a growing source of soil pollution. While industrial waste will certainly cause pollution, there is another way we increase pollution. Each person produces a certain amount of personal waste through urine and feces (Evans, J., et al., 2006). There is also a large amount that is dumped directly into landfills in the form of diapers. The sewer also ends up in landfills, where biological waste contaminates the soil and water. This is because our bodies are full of toxins and chemicals that now penetrate the earth and contaminate the soil. In general, solid waste includes waste, municipal waste, and solid waste materials such as those from commercial, industrial and agricultural activities (Evans, J., et al., 2006). They contain more and more paper, cardboard, plastic, glass, old building materials, packaging materials, and toxic or otherwise dangerous substances. Since a significant amount of municipal solid waste consists mainly of paper and food waste, most of it is recyclable or biodegradable in landfills. Likewise, most agricultural waste is recycled and mining waste is left on site. The portion of hazardous solid waste, such as

oils, battery metals, heavy metals from the foundry industry, and organic solvents, are the ones we should pay particular attention to. These can end up in the soil of the environment in the long term and contaminate it by altering its chemical and biological properties (Patterson, B. M., et al., 2007).

6. Deforestation

Soil erosion occurs when weathered soil particles are loosened and carried away by wind or water. Deforestation, agricultural development, extreme temperatures, precipitation, including acid rain, and human activities all contribute to soil pollution by this type of erosion. Humans are accelerating this process through construction, mining, logging, farming, and overgrazing. It causes flooding and causes soil erosion. Forests and grasslands are excellent binders that keep the soil intact and healthy (Havugimana, E. R. N. E. S. T. E., et al., 2017 Leon Paumen, M. 2006). They support many habitats and ecosystems, providing countless food pathways or food chains for all species. There is also a large amount that goes directly to landfill in the form of diapers. In recent years, many vast green lands have turned into deserts (Havugimana, E. R. N. E. S. T. E., et al., 2017 Leon Paumen, M. 2006). Valuable rainforest habitats in South America, tropical Asia, and Africa are under pressure from population growth and development, especially timber, construction, and agriculture. Many scientists believe these forests contain a large number of medicinal substances, including a cure for cancer and AIDS. Deforestation is slowly destroying the most productive areas of flora and fauna in the world, which also form large areas of valuable CO₂ deposits (Havugimana, E. R. N. E. S. T. E., et al., 2017, & Leon Paumen, M. 2006).

7. Oil pollution

Petroleum materials and their derivatives have a long history of soil pollution due to transportation or storage. Oil pollution is an inevitable consequence of rapid population growth and the industrialization process, on the basis of which soil pollution by petroleum hydrocarbons can be observed on a large scale around exploration and refining facilities. , usually through the transfer of these materials. In addition to the direct emission of these pollutants, the dust from the combustion gases, associated with the oil, has been able to introduce toxic and polluting substances into the soil of the region for many years. As oily materials penetrate deep into the soil, eliminating its pollution becomes a difficult and costly task (Bari, C. 2003).

8. Radioactive waste

Living organisms are constantly exposed to various types of radiation called background radiation. When the level of radioactive radiation exceeds a certain limit, it has harmful effects on living beings. This harmful radiation emitted by radioactive elements is called radioactive pollution. There are two sources of radiation exposure, namely natural sources and anthropogenic sources. Atomic radioactive minerals are one of the natural sources of radioactive pollution. Radon gas is constantly released into the air during uranium extraction. The parent of radon 222 ($t_{1/2} = 3.82$ days) is radium 226 with a half-life of 1602 years. Radium-226 is widely distributed in rocks, sediments, and soil, along with the isotopes of uranium (Marshall, A. (2005). the

radiation from these natural sources is known as natural or background radiation (Havugimana, E. R. N. E. S. T. E, et al., 2017).

9. Acid rain

Acid rain has a high content of hydrogen ions, which makes it acidic. When this rain penetrates the soil, it can negatively alter the soil chemistry. This means that acid rain can negatively affect important plants and microbes that live in the soil; affecting the food chain (Chen, S., et al., 2012).

10. Coal ashes

These are fine dust that is expelled with the combustion gases from coal-fired boilers. These particles contain traces of toxic elements such as arsenic, cadmium, and mercury (Komonweeraket, K., et al., 2015).

11. Corrosion of underground storage tanks and discharge of Sewage

Storage tanks, which contain toxic chemicals or may alter soil chemistry, can be a potential source of soil pollution if the tanks begin to corrode (Hudak, P.F., ET AL., 1999). Wastewater Discharge Wastewater, if returned untreated to the environment, can lead to contaminants entering the soil. When these pollutants enter water sources, waterborne diseases can develop (Chung, B. Y., et al., 2011).

12. Microplastics

Microplastics are extremely small pieces of plastic that are less than 5mm in length. Plastic does not decompose easily - it can take 10 to 500 years to decompose. Therefore, microplastics can cause soil contamination (Fayiga, A. O., & Saha, U. K. 2016).

Effects on health

Contaminated or contaminated soil has a direct impact on human health through direct contact with the soil or through the inhalation of evaporated soil contaminants; potentially greater threats are posed by the infiltration of soil contamination into aquifers used for human consumption, sometimes in areas away from any apparent source of above-ground contamination. This usually leads to the development of pollution-related diseases (Fayiga, A. O., & Saha, U. K. 2016 and Ma, L., et al., 2020). The health effects of exposure to soil contamination vary widely depending on the type of pollutant, the route of attack, and the vulnerability of the exposed population. Chronic exposure to chromium, lead and other metals, petroleum, solvents, and many pesticide and herbicide formulations can be carcinogenic, cause birth defects, or cause other chronic health problems. Industrial or man-made concentrations of naturally occurring substances, such as nitrates and ammonia in farm livestock manure, have also been identified as health risks in soil and groundwater (Fayiga, A. O., & Saha, UK 2016, & Ma, L., et al., 2020). It is known that chronic exposure to benzene in

sufficient concentrations is associated with a higher incidence of leukemia. Mercury and cyclodienes are known to be more likely to cause kidney damage and certain irreversible diseases. PCBs and cyclodienes have been linked to liver toxicity. Organophosphates and carbonates can induce a series of reactions that lead to a neuromuscular block. Many chlorinated solvents cause liver, kidney, and central nervous system depression (Fayiga, A.O. and Saha, UK. 2016, & Ma, L., et al., 2020). There is a full spectrum of other health effects such as headaches, nausea, fatigue, eye irritation, and skin rashes for the chemicals mentioned above and others. With a sufficient dose, many soil contaminants can lead to death through direct contact, inhalation, or ingestion of contaminants in soil-contaminated groundwater. The Scottish Government commissioned the Institute of Occupational Medicine to undertake a review of methods for assessing the human health risks of contaminated land (Fayiga, A. O., & Saha, U. K. 2016 and Ma, L., et al., 2020). The overall aim of the project is to provide guidance that should be useful to Scottish local authorities in assessing whether sites have significant potential for significant harm (SPOSH) to human health. It is envisaged that the output of the project will be a short document providing high-level guidance on health risk assessment about existing published guidance and methodologies that have been identified as being particularly relevant and helpful. The project will examine how policy guidelines have been developed for determining the acceptability of risks to human health and propose an approach for assessing what constitutes an unacceptable risk in line with the criteria for SPOSH as defined in the legislation and the Scottish Statutory Guidance (Fayiga, A. O., & Saha, U. K. 2016, & Ma, L., et al., 2020).

Control of Soil Pollution:

1. Reducing chemical fertilizer and pesticide use

The application of organic fertilizers and manure can reduce the use of chemical fertilizers and pesticides. Biological pest control methods can also reduce the use of pesticides, thereby minimizing soil pollution (Havugimana, E. R. N. E. S. T. E., et al., 2017, Aggarwal, R. 2017).

2. Reusing of materials

Materials such as glass containers, plastic bags, paper, cloth, etc. can be reused at home instead of being thrown away, reducing pollution from solid waste (Havugimana, E. R. N. E. S. T. E, et al., 2017, & Aggarwal, R. 2017).

3. Recycling and recovery of materials

It is a sensible solution to reduce soil pollution. Materials such as paper, certain types of plastic, and glass can and will be recycled. This reduces the amount of waste and helps preserve natural resources. For example, recovering a ton of paper can save 17 trees (Havugimana, E. R. N. E. S. T. E., et al., 2017 Aggarwal, R. 2017).

4. Reforestation

Control of land loss and soil erosion can be attempted by restoring forest and grass cover to counteract desolation, soil erosion, and flooding. Crop rotation or mixed crops can improve soil fertility (Havugimana, E. R. N. E. S. T. E., et al., 2017, & Aggarwal, R. 2017).

5. Solid Waste Treatment

Appropriate methods should be used for solid waste disposal. The industrial waste can be physically, chemically, and biologically treated until it is less hazardous. Acid and alkaline waste must first be neutralized; insoluble material, if biodegradable, should degrade under controlled conditions before being discarded. As a last resort, new areas for hazardous waste storage should be explored, such as deep freight injection and safer landfills. Burial of waste in locations outside residential areas is the simplest and most widely used solid waste management technique (Havugimana, E. R. N. E. S. T. E, et al., 2017 e Aggarwal, R. 2017).

6. Ban on Toxic Chemicals

There should be a ban on chemicals and pesticides such as DDT, BHC, etc. which are deadly to plants and animals. Nuclear explosions and improper disposal of radioactive waste should be prohibited (Yuvaraj, M., & Mahendan, P. P. 2020, & Biswas, T. D., & Mukherjee, S. K. 1987).

7. Production of Natural Fertilizers

Biopesticides should be used instead of toxic chemical pesticides. Organic fertilizers should be used instead of synthetic chemical fertilizers. Ex: Organic waste in livestock manure can be used to prepare compost manure instead of uselessly throwing it away and contaminating the soil (Yuvaraj, M., & Mahendran, P. P. 2020, & Biswas, T. D., & Mukherjee, S. K. 1987).

8. Soil Erosion

Soil erosion can be controlled by a variety of forest and agricultural practices. For example: planting trees on bare slopes. Contour machining and strip cropping can be practiced instead of displacement machining. Earthworks and the construction of diversion channels can be undertaken. Reducing deforestation and replacing chemical fertilizers with animal waste also helps to halt soil erosion in the long term. Proper Disposal of Unwanted Materials Excess human and animal waste poses a disposal problem. Open burial is the most commonly practiced technique. Today, for the disposal of solid waste, a controlled landfill is followed. The resulting surface is used as a living space or sports ground (Yuvaraj, M., & Mahendran, P. P. 2020, & Biswas, T. D., & Mukherjee, S. K. 1987).

9. Public Awareness

Informal and formal public awareness programs should be imparted to educate people on health hazards through environmental education. Ex: Mass media, Educational institutions, and voluntary agencies can achieve this (Yuvaraj, M., & Mahendran, P. P. 2020, & Biswas, T. D., & Mukherjee, S. K. 1987).

CONCLUSION

Soil properties are changing due to the chemical, biological and physical changes of the soil. Factors that pollute the soil more are industrial waste, agricultural waste, plastic waste, oil, etc. which are constantly changing the properties of the soil. It is affecting human health through soil pollution, air, water, food, etc and it is causing many diseases. Through this review we have to run an awareness campaign, it is also the duty of the government to take appropriate steps for the conservation of soil, and understand the utility of soil among the people through NGOs.

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