

Review Article

Soil Pollution their Causes, Effect, control & Health Indicator: Review

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Abstract

Soil pollution refers to anything that causes contamination of soil and degrades the soil quality. It occurs when the pollutants causing the pollution reduce the quality of the soil and convert the soil inhabitable for microorganisms and macro organisms living in the soil. Soil contamination or soil pollution can occur either because of human activities or because of natural processes. However, mostly it is due to human activities. The soil contamination can occur due to the presence of chemicals such as pesticides, herbicides, ammonia, petroleum hydrocarbons, lead, nitrate, mercury, naphthalene, etc in an excess amount. Soil quality indicators are physical, chemical, and biological properties, processes, and characteristics that can be measured to monitor changes in the soil. Soil quality indicators are important to: focus conservation efforts on maintaining and improving the condition of the soil; evaluate soil management practices and techniques; relate soil quality to that of other resources; collect the necessary information to determine trends; determine trends in the health of the Nation's soils; guide land manager decisions. Objectives of this paper are to review current efforts to define soil quality to discuss factors and processes which influence soil quality, to identify, soil and crop management practices that affect processes influencing soil quality, and to demonstrate a method for evaluating soil quality. A common focus among all proposed soil quality definitions is that the soil must reflect its ability to "function" in numerous ways at the present time and in the future. Soil and crop management practices that add or maintain soil carbon appear to be among the most important for restoring, maintaining, or improving soil quality.

Keywords: Soil Pollution, Soil health indicator, Herbicides, Soil effect & cause, Environment.

1. Introduction

Agricultural sustainability depends to a large extent upon maintenance or enhancement of soil health / quality. Soil quality is conceptualized as the major linkage between the strategies of conservation management practices & achievement of major goals of sustainable agriculture (Andrews, 2004). The quality & health of soils not only determine agricultural sustainability but also environmental quality & the plant, animal & human health. Thus the land care & soil quality management assume great significance for ensuring agricultural sustainability which is inevitable to feed the burgeoning population. World Soil Day was established in 2002. by the International Union of Soil Sciences (IUSS) to celebrate the importance of soil and its vital contributions to human health and safety. On December 20, 2013, the 68th UN General Assembly recognized December 5th, 2014 as World Soil Day and 2015 as the International Year of Soils. This official recognition of these events will emphasize the importance of soils beyond the soil science community.

It took two years for the leadership of Thailand and the FAO Global Soil Partnership (GSP) to get these dates approved by the UN, but their hard work prevailed and soil has garnered the attention it has so long deserved. World Soil Day is annually held on December 5 to highlight soil's importance on Earth. We need soil for basic survival - energy. It is linked with the United Nations' (UN) Year of Soil. World Soil Day serves as a reminder to all of us that we owe our existence to the soil. As we face mounting global production, climate and sustainability challenges Soil is fundamental to human life on Earth. Most plants require a soil substrate to provide water and nutrients, and whether we farm the plants directly or consume animals that feed on the plants, this means that we don't eat without soil. Having that, it is not hard to see that a) it is possible to have a sea-based diet and b) it is possible to grow our food hydroponically. In those cases, it is possible to reduce the importance of soil. However, we still have the other reasons that soil is fundamental: it is required for trees. I don't think I need to go into the importance of trees for shade, animal habitat, building materials. Soil is a vital part of the natural environment. It is just as important as plants, animals,

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rocks, landforms, loch and rivers. It influences the distribution of plant species and provides a habitat for a wide range of organisms. It controls the flow of water and chemical substances between the atmosphere and the earth, and acts as both a source and store for gases (like oxygen and carbon dioxide) in the atmosphere. Soils not only reflect natural processes but also record human activities both at present and in the past. They are therefore part of our cultural heritage. The modification of soils for agriculture and the burial of archaeological remains are good examples of this. Soil, together with the plant and animal life it supports, the rock on which it develops its position in the landscape and the climate it experiences, form an amazingly intricate natural system powerful and complex than any machine that man has created. Soil may look still and lifeless, but this impression couldn't be further from the truth. It is constantly changing and developing through time. Soil is always responding to changes in environmental factors, along with the influences of man and land use. Some changes in the soil will be of short duration and reversible, others will be a permanent feature of soil

In Africa region, adverse effect of soil quality arises from nutrient imbalance in soil, excessive fertilization, soil pollution & soil loss process. Consequently it cannot produce enough food to keep place with its needs, & therefore per capita food production is declining. Amongst the several factor of crop production, better soil quality is one of the key plays influencing sustainability.

2.Types of Soil Pollution

Soil pollution may be any chemicals or contaminants that harm living organisms. Pollutants decrease soil quality and also disturb the soil's natural composition and also lead to erosion of soil. Types of soil pollution can be distinguished by the source of the contaminant and its effects of the ecosystem. Types of soil pollution may be agricultural pollution, Industrial wastes and urban activities.

Agricultural Pollution

- Agricultural processes contribute to soil pollution.
- Fertilizers increase crop yield and also cause pollution that impacts soil quality.
- Pesticides also harm plants and animals by contaminating the soil.
- These chemicals get deep inside the soil and poison the ground water system.
- Runoff of these chemicals by rain and irrigation also contaminate the local water system and is deposited at other locations.

Industrial Waste

- About 90% of oil pollution is caused by industrial waste products.

- Improper disposal of waste contaminates the soil with harmful chemicals.
- These pollutants affect plant and animal species and local water supplies and drinking water.
- Toxic fumes from the regulated landfills contain chemicals that can fall back to the earth in the form of acid rain and can damage the soil profile.



Fig. 1.0 Industrial waste & dump to increase soil pollution

Urban Activities

- Human activities can lead to soil pollution directly and indirectly.
- Improper drainage and increase run-off contaminates the nearby land areas or streams.
- Improper disposal of trash breaks down into the soil and it deposits in a number of chemical and pollutants into the soil. These may again seep into groundwater or wash away in local water system.
- Excess waste deposition increases the presence of bacteria in the soil.
- Decomposition by bacteria generates methane gas contributing to global warming and poor air quality. It also creates foul odors and can impact quality of life.

3.Causes of Soil Pollution

Before World War II, the chemical nicotine chemical present in the tobacco plants was used as the pest controlling substance in agricultural practices. However, DDT was found to be extremely useful for malaria control and as pest control of many insects during World War II. Therefore, it was used for controlling many diseases.

Hence, post-war, people started using it as pest control in agriculture for killing rodents, weeds, insects, etc and avoiding the damages due to these pests. However, everyone gradually the adverse effects of this chemical which led to the ban of this chemical in many parts of the world including India.

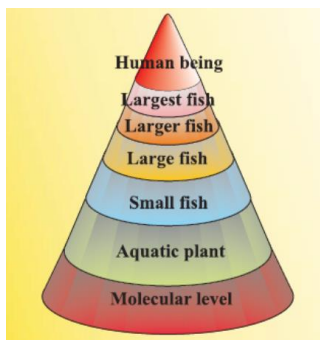


Fig. 2.0 Layer of tropic level, pollutant gets 10 times concentrated

Moreover, pests became resistance to DDT due to the chemicals regular use. Hence this led to the introduction of other harmful chemicals such as Aldrin and Dieldrin. Pesticides are synthetic toxic chemicals that definitely kill different types of pests and insects causing damage to agriculture but it has many ecological repercussions.

They are generally insoluble in water and non-biodegradable. Therefore, these chemicals will not gradually decompose and keep on accumulating in the soil. Therefore, the concentration of these chemicals will increase when the transfer of these chemicals take place from lower to higher trophic level via the food chain. Hence, it will cause many metabolic and physiological disorders in humans.

Industrial effluents like harmful gases and chemicals.

- Use of chemicals in agriculture like pesticides, fertilizers and insecticides.
- Improper or ineffective soil management system.
- Unfavorable irrigation practices.
- Improper management and maintenance of septic system.
- Sanitary waste leakage.
- Toxic fumes from industries get mixed with rains causing acid rains.
- Leakages of fuel from automobiles are washed off due to rains and are deposited in the nearby soil.
- Unhealthy waste management techniques release sewage into dumping grounds and nearby water bodies

4. Effects of soil pollution

The main reason for soil contamination is due to the presence of anthropogenic activities. These waste products are made of chemicals that are not originally found in nature and hence lead to soil pollution. Soil pollution is typically caused by industrial activity, chemicals used in agriculture and improper disposal of waste. Soil contamination leads to health risks due to direct and indirect contact with contaminated soil. Soil pollution causes huge disturbances in the ecological balance and the health of the organisms is under risk. The effects of pollution on soil are quite disturbing and can result in huge disturbances in the ecological

balance and health of living beings on earth. Normally crops cannot grow and flourish in a polluted soil. However if some crops manage to grow, then these crops might have absorbed the toxic chemicals in the soil and might cause serious health problems in people consuming them. Sometimes the soil pollution is in the form of increased salinity of the soil. In such a case, the soil becomes unhealthy for vegetation, and often becomes useless and barren. When soil pollution modifies the soil structure, deaths of many beneficial soil organisms (e.g. earthworms) in the soil could take place. Other than further reducing the ability of the soil to support life, this occurrence could also have an effect on the larger predators (e.g. birds) and force them to move to other places, in the search of food. People living near polluted land tend to have higher incidences of migraines, nausea, fatigue, skin disorders and even miscarriages. Depending on the pollutants present in the soil, some of the longer-term effects of soil pollution include cancer, leukemia, reproductive disorders, kidney and liver damage, and central nervous system failure. These health problems could be a result of direct poisoning by the polluted land (e.g. children playing on land filled with toxic waste) or indirect poisoning (e.g. eating crops grown on polluted land, drinking water polluted by the leaching of chemicals from the polluted land to the water supply, etc).

Effects on humans

- Soil pollution has major consequences on human health. Consumption of crops and plants grown on polluted soil cause health hazards. This could explain small and terminal illness.
- Long term exposure to polluted soil affects the genetic make-up of the body and may congenital illnesses and chronic health diseases.
- Chronic exposure to heavy metals, petroleum, solvents and agricultural chemicals can be carcinogenic.
- Exposure to benzene for a long term is associated with higher incidence of leukemia. Mercury causes higher incidences of kidney damage. Cyclodienes are linked to liver toxicity.
- Organophosphates can lead to chain of responses leading to neuromuscular blockage.
- Chlorinated solvents induce damages to liver, kidney, depression of the central nervous system.



Fig. 3.0 Degradation on quality of soil due to soil pollution

On plant growth

- The balance of ecological system is affected due to contamination of the soil.
- Plants are mostly unable to adapt to the change in the chemistry of the soil in short time period.
- The microorganisms found in the soil decline and create additional problems of soil erosion.
- Fertility of the soil decreases due to soil pollution, making it unsuitable for agriculture and local vegetation to survive.
- Soil pollution is hazardous to health.
- Polluted lands cannot support most forms of life.



Fig. 4.0 Degradation of soil and effect on plant growth

5.0 Control of soil Pollution

Number of ways have been suggested to curb the pollution rate. Attempts to clean up the environment require plenty of time and resources.



Fig. 5.0 Soil quality with required components

Some the steps to reduce soil pollution are:

- Ban on use of plastic bags below 20 microns thickness.
- Recycling of plastic wastes.
- Ban on deforestation.
- Encouraging plantation programs
- Encouraging social and agro forestry programs
- Undertaking awareness programs

- Reducing the use of chemical fertilizer and pesticides.
- Recycling paper, plastics and other materials.
- Ban on use of plastic bags, which are a major cause of pollution.
- Reusing materials.
- Avoiding deforestation and promoting forestation.
- Suitable and safe disposal of including nuclear wastes.
- Chemical fertilizers and pesticides should be replaced by organic fertilizers and pesticides.
- Encouraging social and agro forestry programs.
- Undertaking many pollution awareness programs.

Toxic chemical compounds, salts, radioactive agents, toxins and other waste contribute to soil pollution. These have adverse effect on plant and animal health. Soil contains both organic as well as inorganic material. The organic material is formed due to decaying of plant and animal matter. This often makes up the upper most layer of soil. The organic soil such as rocks, has taken over thousands of years to be formed. The top layer is made up of organic soil, while the layers below are inorganic soil. Pollution has gradually reached the inorganic layers as well. There are different types of soil pollution, namely agricultural soil pollution, industrial waste causing soil pollution, urbanization causing soil pollution. These different types of pollution cause the fertility of the soil to reduce and mineral content in the soil to be destroyed. Therefore, measures have to be taken for preventing soil pollution. To increase agricultural yield, most farmers took to using chemical fertilizers. No doubt that the yield did indeed increase, but at the cost of the soil losing its fertility. To restore the fertility of the soil to what it was, will take a very long time, however, one has to start at some point of time. Drastic measures are required for the same. Farmers should be encouraged to start using bio fertilizers. The microorganisms in these fertilizers will help in increasing the fertility of the soil. To avoid soil pollution, it is important, that along with fertilizers, farmers should shift to bio pesticides and fungicides, also known as herbicides. These products will take a little longer to react, but they do not have adverse effect on the soil. It is best to use manure both as a fertilizer as well as pesticide, as it has far less side effects as opposed to its chemical counterpart. If one has to look at the soil pollution facts, it will be seen that toxic waste has a big role to play in soil pollution. Hence, industrial toxic waste should be treated to reduce its toxicity before it is disposed off. At the same time, responsible methods should be used for disposing off the waste. The best, however, is to avoid the use of harmful chemicals unless they are of extreme importance. Although a lot of propaganda has been carried out about recycling waste, not many measures have been taken about the same. If each family has to take it upon themselves to recycle waste, the land pollution caused due to landfills will be reduced considerably. The land so saved can be used constructively for a number of better tasks. After

plastic was invented, people thought it was convenient to opt for plastic containers, bags, etc., which could be disposed off after use. However, plastic is one of the main causes of soil pollution, as it takes a very long time to disintegrate. Therefore, people should consider shifting to reusable containers like glass, cotton bags, etc. Although paper does disintegrate faster, a lot of trees are cut for producing paper bags. Therefore, it is best to opt for cloth bags. Similarly, instead of using tissue papers in the kitchen, etc., one should opt using cloth napkins, handkerchief, etc. This will go a long way in reducing landfills. There is no doubt that the organic products are costly as opposed to the chemically grown products. But choosing the organic products will encourage more organic production. This will help in preventing soil pollution. To prevent soil pollution, deforestation measures have to be undertaken at rapid pace. Soil erosion is caused, when there are no trees to prevent the top layer of the soil from being transported by different agents of nature like water and air. At the same time, measures should be taken to avoid over cropping and over grazing, as it leads to flood and soil erosion and further deterioration of the soil layer. Various chemicals such as pesticides, insecticides and fungicides play important roles in plant growth; however the overuse of these chemicals is considered to be one of the prime factors leading to soil pollution. Reducing or even avoiding the use of such chemicals is one of the most elementary and important preventive measures. Manures and bio-fertilization can be used as alternatives to chemicals. Manures are often recommended by environmentalists and agriculturists because, as compared to pesticides, manures have minimal adverse effect on the environment. Bio-fertilization is a process in which certain microorganisms such as rhizobium are used to increase the soil fertility in place of chemicals. Another common measure used to minimize soil pollution is controlling the growth of weeds.

6. Soil Health Indicators

There are two ways in which the concept of soil health (or the closely related concept of soil quality) has been considered, which can be termed either 'reductionist' or 'integrated'. The former is based on estimation of soil condition using a set of independent indicators of specific soil properties—physical, chemical and biological. The alternative, integrated, approach makes the assumption that the health of a soil is more than simply the sum of the contributions from a set of specific components. It recognizes the possibility that there are emergent properties resulting from the interaction between different processes and properties. The quality of soil is rather dynamic and can affect the sustainability and productivity of land use. It is the end product of soil degradative or conserving processes and is controlled by chemical, physical, and biological components of a soil and their interactions (Papendick and Parr, 1992). Indicators, however, will vary according to the location, and the

level of sophistication at which measurements are likely to be made (Riley, 2001).

Minerals in Soil

Minerals make up the most significant portion of your soil, generally around 45 to 50 percent. Depending on how coarse they are, these minerals are characterized as sand, silt, or clay. The texture of your soil is determined by the proportion you have of each. You can have your soil tested at a local extension office to determine if it is overly sandy or clayey and get advice on how to improve your soil.

Clay can be underappreciated because its tiny particles pack into a sticky soil that is often unworkable, doesn't drain, and rots the roots of plants that are not adapted to it. Clay is also not well suited to construction because it expands and contracts with moisture. However, clay is extremely rich in nutrients because of its fine texture. Silt and sand, meanwhile, don't contain much in the way of nutrients but help with texture and drainage. A mixture of 20 percent clay, 40 percent silt, and 40 percent sand makes up a well-balanced loam that many plants thrive in.

Water and Gasses in Soil

The second component of soil, water, is critical to sustaining life. Water is absorbed by plants and microorganisms and also helps organic materials decompose and enrich the soil. Soil can contain almost no water or as much as 50 percent water. While clay soils can get very waterlogged, a sandy soil does a poor job of retaining water — a feature you might find desirable for a rock garden but not for plants that require regular moisture. In either case, adding organic material can help to alleviate moisture problems with your soil. Add compost to break up heavy clay soil and make it easier for water to drain or use compost to help retain water in sandy soil.

Gases make up the third component of soil, providing oxygen and carbon dioxide for roots and microbes to breathe. Flooded and waterlogged soils can displace gases and lead to the death of plants.

Organic Materials in Soil

Organic materials are the compost, rotting leaves and wood, and decomposing animals and microorganisms that form the dark, rich layer on top of the soil. Microorganisms feed on these organic materials, further breaking them down into a crumbly humus, which helps capture nutrients and moisture.

Soil typically contains 1 to 5 percent organic matter. If your soil would benefit from more organic matter, you can till or turn 2 inches of compost into the top 6 inches of soil. In following years, simply apply a 1- to 3-inch layer of compost on top of the soil as a mulch. The compost will gradually break down and work into the soil below.

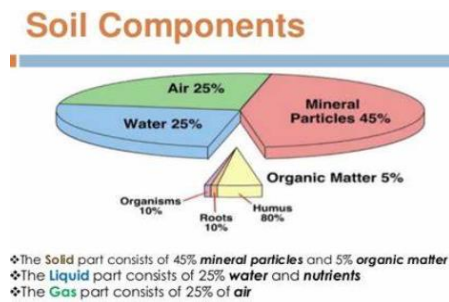


Fig. 6. Component contribution structure in rich soil

Microorganisms in Soil

Microorganisms are another critical component of healthy soil. Even though they make up less than 1 percent of its volume, there can be hundreds of millions of microorganisms in a handful of dirt. Decomposers, like earthworms, insects, fungi, and bacteria, break down organic matter into humus. Others symbiotically help roots absorb nutrients or nitrogen. Once microorganisms die, they become organic matter that decomposes, serving another important role in the continuous life cycle of soil.

Conclusion

In this paper, we review on Soil pollution their cause, effect, control and soil health indicator. Soil is an important part of the ecosystem as most of the food we consume comes from the soil. Thus, it is important that we keep it toxin free. Soil contamination occurs when there are high concentrations of toxic chemicals, contaminants or pollutants in the soil. They pose a risk to the ecosystem. Industrial activity, improper disposal of waste and agricultural chemicals cause soil pollution. Excessive use of chemical fertilizers can change the soil pH, and destroy the structure of the soil.

Toxic chemicals like arsenic, uranium and cadmium may accumulate in the soil and eventually enter the fruits and vegetables. In order to protect the soil from being polluted people should reuse and recycle things. Glass and other reusable containers should be used instead of plastic or paper containers which have to be thrown away. Plastic and paper should be recycled by the local waste management companies so that less amount of waste is sent to a landfill

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