M. A. KHALID, D. S. MALIK, R. A. BALIKAI,
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ENVIRONMENTAL PROBLEMS, PROTECTION AND POLICIES

ISBN: 978-81-969585-2-7

This book on "Environmental Problems, Protection and Policies" goes on to highlight the unfavourable conditions created by the human approach to nature. In other words, this book highlights what environmental pollution is! It can be understood how important the issue of environmental pollution is in the situation where even the air we breathe is threatened with pollution. The book contains 30 chapters encompassing different aspects of environmental problems, protection, and policy issues. This book summarizes the Green technologies for sustainable development, Soil pollution, Microplastic pollution in the aerial, soil and marine ecosystem, Plastic pollution, Water pollution, Ozone layer depletion, Biodiversity loss, Air pollution, Marine pollution, Deforestation, Acid rain, Environment degradation and disasters, Human impact on the environment, Pollution and its impact on animal and human health, and Light pollution as the driving force behind loss of biodiversity.

ACADEMIC
PUBLISHERS & DISTRIBUTORS
ACADEMIC PUBLISHERS AND DISTRIBUTORS LUCKNOW
Mob : 9528893336
Website: www.publishersacademic.org
Email: acadpublishers@mail.com

ISBN: 978-81-969585-2-7
₹ 1180/- $ 200

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Environmental Problems, Protection and Policies
pp. 261-267, 2024, ISBN- 978-81-969585-2-7
Editors: M A Khalid, D S Malik, R A Balikai, Baseem Tamini, K K Yadav and P R Yadav
Publisher: M/S Academic Publishers & Distributors, Lucknow, India
Website: https://publishersacademic.org

SOIL POLLUTION - IT'S CAUSES AND IMPACTS

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(Received 28 December 2023, Revised 22 January 2024, Accepted 24 February 2024)

ABSTRACT : Soil pollution refers to the deterioration of physical, chemical and biological properties which has adverse effects on crop production, animal and human health. Soil pollution is caused by human activities such as mining, modern practices in agriculture, deforestation, indiscriminate dumping of human generated trash and unregulated disposal of untreated wastes of various industries. Impacts of soil pollution are not confined to soil and its biota, but are carried over to every aspect of the environment and affect every organism from the earthworm to humans. Hence, there is a need to address this issue seriously and adopt measures and practices to stop this pollution and conserve our soil for our long-term existence.

Key words : Soil pollution, chemical fertilizers, pesticides, pollutants.

Introduction

The word pollution is derived from the Latin word "Pollutionem" which means to make dirty. Pollution is the undesirable changes in the physical, chemical and biological characteristics of any component of our environment by unwanted substances causing negative impacts. The pollution occurs, when pollutant from various sources contaminate our natural surrounding and there by affecting our ecosystem as wells as human health.

Soil, the uppermost layer of the earth's crust which is a mixture of many solid, liquid and gaseous substances having both living and non-living matter such as mineral particles, decaying organic matter, microbes along with water and air contained in pore spaces. Formation of soil is a very slow process, starting from weathering (Breakdown of bed rock into mineral particles) to soil development, *i.e.* pedogenesis (modification of mineral matter through interactions between biological, topographic and climatic factors). It may take 200 to some thousand years to form an inch of topsoil, depending upon the local conditions of the area. Thus, soil is an important natural resource, formed over the centuries that supports the variety of plants and provides habitat for various microscopic and macroscopic life-forms apart from other ecological functions.

Composition of soil is listed below (Fig. 1)

Organic mineral matter 45%	Organic matter 05%
Soil water 25%	Soil air 25%

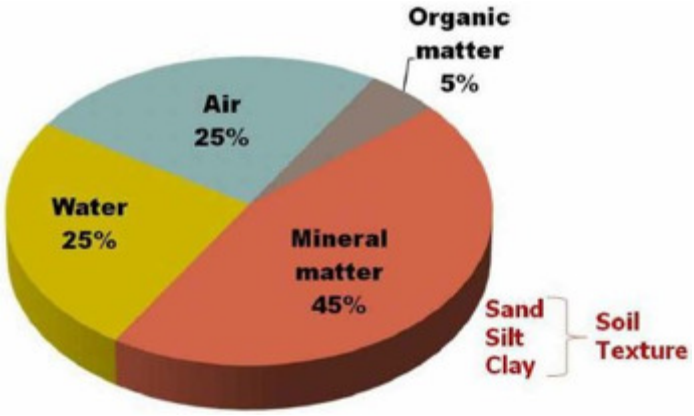

Fig. 1 : Typical Components of Soil (Toor and Shober, 2009).

Soil is an essential part of our natural environment. It is just as important as plants, animals, 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. Sustenance of life would be impossible without healthy soil. Nearly 95% of food is derived from soil on this earth. Degradation of the soil is a significant problem. Soil pollution results in the reduction of the productivity of soil due to the presence of soil pollutants, which alter the physical-chemical and biological properties of the soil.

The United Nations declared 2015 as "International Year of Soils". 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 (Mishra *et al*, 2016).

Soil Pollution

Soil pollution is the contamination of the soil with pollutants, toxic chemicals or any contaminant in such a quantity that reduces soil quality and makes it inhabitable to organisms such as insects and other microbes. Or it can be referred to as the addition of chemicals to the soil in quantities that are toxic to the environment and its residents. This addition is mostly by human activities such as mining, modern practices in agriculture, deforestation, indiscriminate dumping of human generated trash and unregulated disposal of untreated wastes of various industries. There are numerous ways the soil is contaminated like pesticides, herbicides and fumigants, chemical fertilizer, air pollutants washed down from atmosphere through rain, overuse of soil unplanned urbanization and building of roads, houses, *etc*. (Al-Taai, 2021; Pierzynski *et al*, 2000).

Causes of Soil Pollution (Fig. 2)

1. Industrial and Mining activities : Industrial activities are one of the main sources and contributor to environmental pollution, especially water resources. Large numbers of industries coming up since the dawn of the industrial era without proper waste management systems are the biggest contributor to soil pollution. Mining and manufacturing have increased and most industries are dependent on extracting minerals from the Earth. As a result, the industrial waste dumped on the soil surface for a long period of time degrades it. The unguided industrial development, devoid of safety measures and the increasing market demands that lead to an increase in solid waste ultimately resulting in soil pollution. The best solution to

Fig. 2 : Sources of Soil pollution. Courtesy:Pixabay (https://pixabay.com/) and Unsplash (https://unsplash.com/).

this type of pollution is to establish advanced factories in all governorates to burn waste, or crush them. Also, environmental laws have to be enacted to compel every company or factory to bear the full cost of collecting, transporting, and treating waste (Al-Taai, 2021).

2. Synthetic Chemical Fertilizers and Pesticides : To increase the yield from limited land area, in order to meet the increasing demand of food for ever-increasing population, synthetic chemical pesticides and fertilizers are being used rampantly in the last few decades leading to toxicity of the soil. They seep into the ground after they mix with water and slowly reduce the fertility of the soil. Other chemicals damage the composition of the soil and make it easier to erode by water and air. Plants absorb many of these pesticides and when they decompose, they cause soil pollution since they become a part of the land (Carvalho, 2017). Pesticides are used to kill pests and control weeds using chemical ingredients; hence, they can also be toxic to other organisms, including birds, fish, beneficial insects and non-target plants, as well as air, water, soil, and crops (Tudi *et al*, 2021).

Fertilizers

Fertilizers are plant nutrients and trace elements applied generally to the soil to promote the growth of crops.

Three types of fertilizers are added to the soil, namely, organic, bio-fertilizers and chemical.

(i) Organic fertilizers : They are made from naturally occurring substances. Waste products of animals and plants are known as organic fertilizers.

(ii) Bio-fertilizers : Microbial formulations based on natural agri-products, which are applied to fulfill different requirements are known as Bio-fertilizers.

When organic fertilizers and bio-fertilizers are used, the farming is referred to as organic farming.

(iii) Chemical fertilizers : These are the chemical substances that are synthetically prepared so as to provide the vital nutrients to the plant, which are necessary for its growth

process. All of them have a chemical composition in such a manner that they contain the normal NPK requirement as well as any other nutrients as required.

- **Effect of chemical fertilizers on soil**

Many farmers, especially in developed countries, rely on commercial inorganic synthetic origin macro-and micronutrients. They act on soil very fast unlike organic fertilizers that need to break down before absorption. This is beneficial to malnourished plants. They are easy to use and immediately affect the soil fertility. Also, they are easily available in gardening stores (Usman *et al*, 2015). But without careful control, these fertilizers, especially the synthetic fertilizers, can pollute water bodies. Fertilizers are a mixture of toxic chemicals which are absorbed by the plants, leading toxins to enter the food chain via vegetables, cereals and water, create serious health issues.

- **Deterioration of soil quality**

Fertilizers contaminate soil from waste material release from raw material that are used in manufacturing processes. As metals are not degradable, they can contaminate soil by accumulating in it due to use of phosphate fertilizers in excess. Agricultural practices have been reduced due to overuse of NPK fertilizers. When wheat, maize or gram are grown on such soils, they have lower protein content. Moreover, the carbohydrate content of such crops also reduces in quality. When excess of potassium is present in soil, it decreases the vitamin C and carotene content of vegetables and fruits. Excess use of fertilizers can alter fertility of the soil and its acidic level. This is the reason that soil is advised to be tested at least once in 3 years in order to check the exact amount of fertilizers should be used. The pH of soil can vary from 0 to 14, where 0 is refereed as most acidic and 14 as the most basic while, 7 is considered to be neutral. The pH of soil can be altered by making some changes to soil and also the pH varies from one plant to another (Sharma and Chetani, 2017).

Chemical pesticides

The word "pesticides" describes a group of synthetic agrochemicals used to destroy or control pests and pathogens of all kinds. Pesticides are a general class of chemicals or biological agents used to control, repel, attract or kill pests. Insects, weeds or other plants, birds, mammals, fish and microorganisms are known as pests. They strive for food with humans and destroy the property of food and spread diseases. Almost all categories of organisms can be a pest. Pesticides are used for destroying pests. They are generally derived from Arsenic, Mercury, Fluorine, Sulphur and Copper and Cyanide.

Pesticides are named according to their intended use. For example, insecticides are used against insects, herbicides against weeds and fungicides against plant pathogenic fungi, Bacteroicides against plant pathogenic bacteria.

Chemical pesticides belong to major chemical groups such as organophosphates, carbamates, organochlorines, triazines and dithiocarbamates. The mode of action and ecological and human health effects of the formulations vary according to the chemical groups. For instance, herbicides are the major group of agrochemicals consumed in the United States, whereas insecticides are the major group in countries like India. This is mainly decided by the

cropping pattern, climate and technology diffusion (Devi *et al*, 2022).

- **Harmful effects of pesticide on soil**

Pesticides contain chemicals that are persistent soil contaminants, which means they can harmfully influence soil fertility, conservation and this type of situation can exist for exist for years. Additional harmful effects of pesticides are:

- Reducing the soil natural conditioning, which decreases the soil quality and reduces the level of organic matter.
- Water retention and absorbing capacity is affected.
- Persistent pesticides residue present in soil causes toxicity and enter into food chain.

Example : DDT, one of the first synthetic organic (organo-chlorine) insecticides to be used, was very popular insecticide until we could see its shortcomings. The half-life of DDT is around 10- 15 years. Half-life is the amount of time required by the chemical to decompose into its half quantity. The main cause of biomagnification in ecosystems is the high usage of DDT. The use of this insecticide has a residue in soil which results in short-term and long-term health effects to both the person using pesticides and to the public who consumes the food grown in these pesticides.

- **Effect of chemical pesticide on soil organisms**

Pesticides are toxic to living organisms. Excessive use of pesticides damages agricultural land as it destroys beneficial insect species (which control insect pests) and other soil microorganisms which are accountable for nitrification, nitrogen fixation, phosphate solubilization, plant growth promoting rhizobacteria, lignin degradation microbes, therefore reducing the organic matter resulting in loss of soil fertility. Excessive usage of pesticides kills worms which naturally limit pest populations and maintain soil health, which weakens the plant root and immune systems.

3. Waste Disposal : Modern lifestyle, urban as well as rural, produces a huge amount of waste and lack of waste management procedures adds to the problem of soil pollution. Urban wastes comprise both commercial and domestic wastes consisting of dried sludge and sewage, garbage and rubbish materials like plastics, glasses, metallic cans, fibres, paper, rubbers, street sweepings, fuel residues, leaves, containers, abandoned vehicles and other discarded manufactured products. Plastic and other non-biodegradable wastes are the major cause of concern.

4. Radioactive pollutants : Radioactive pollution has its effect on the global scale. Radioactive substances resulting from explosions of nuclear testing laboratories, research laboratories, radioactive fallouts, hospitals and industries giving rise to nuclear dust and radioactive wastes penetrate the soil and accumulate, giving rise to soil pollution *e.g.* Nuclear reactors produce waste containing Ruthenium-106, Iodine-131, Barium-140, Cesium-144 and Lanthanum-140 along with primary nuclides Sr-90 with a half-life of 28 years and Cs-137 with a half-life of 30 years. Rain water carries Sr-90 and Cs-137 to be deposited on the soil where they are held firmly with the soil particles by electrostatic forces. All the radio nucleoside

deposited on the soil emits gamma radiations. It occurs when humans are exposed to industrially radioactive materials such as fallout from nuclear bombs, and the industrial and military use of nuclear energy and other radioactive materials such as uranium. This requires the collection of war remnants by sound scientific methods and a comprehensive radiological survey.

5. **Biological agents :** Soil gets a large amount of human, animal and bird excreta which constitute a major source of land pollution by biological agents. E.g. Heavy application of manures and digested sludge can cause serious damage to plants within a few years.

6. **Accidental Oil spills :** Oil leaks can happen during storage and transport of chemicals. This can be seen at most of the fuel stations. The chemical present in the fuel deteriorates the quality of soil and makes them unsuitable for cultivation. These chemicals can enter into the groundwater through soil and make the water unfit for drinking.

7. **Acid Rain :** Acid rain is caused when pollutants present in the air mixes up with the rain and fall back on the ground. The polluted water could dissolve away some of the important nutrients found in soil and change the structure of the soil.

Strategies to control soil pollution

To control soil pollution many measures have been suggested. Some of the steps to reduce soil pollution are (Mishra *et al*, 2016):

- **Ban on use of plastic bags:** The use of plastic bags should be replaced by cloth and paper bags. 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, degradable plastic bags should be produced and popularized for consumption.
- **Proper disposal method:** Industrial and domestic waste is one of the sources of soil contamination. Disposal of plastics, cans, and other solid waste falls into the category of soil pollution. Leaking of sewerage system can also affect soil quality and cause soil pollution by changing the chemical composition of the soil. 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 of. At the same time, responsible methods should be used for disposing of the industrial as wells as domestic waste. The best, however, is to avoid the use of harmful chemicals unless they are of extreme importance.
- **Use of organic manures /bio-fertilizers and bio-pesticides instead of chemical fertilizers and pesticides:** The use of organic manures, bio-fertilizers and bio-pesticides should be used as alternatives to synthetic agrochemicals. These are natural and eco-friendly products as they have no harmful effects on soil and they maintain organic content and natural fertility of soil. 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. At least if not complete eradication of these chemicals in view of crop yield to prevent the food scarcity, reduction of agrochemicals can be achieved by adopting integrated nutrient management and integrated pest management practices. Another

common measure used to minimize soil pollution is controlling the growth of weeds. Weeds are unwanted plants that grow alongside the main plant and often result in the accumulation of various minerals into the soil layer. One of the common methods to control weed growth is covering the soil with layers of newspapers or plastic sheets just before cultivation.

- **Avoiding deforestation and promoting forestation:** Cutting of trees on a large scale should be stopped and afforestation should be done at a rapid pace to surpass the rate of deforestation. 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 overcropping and overgrazing, as it leads to flood and soil erosion and further deterioration of the soil layer.
- **Recycle and Reuse of materials:** Reuse and recycle unwanted items. Or even better, reduce consumption and reduce your trash. The less rubbish we create, the less chance the waste will end up in our soil. In addition, reducing the volume of refuse or waste in landfills by recycling materials such as plastics, papers and various other materials is another effective and common method of preventing the phenomenon of soil pollution.
- **Soil pollution awareness program:** Regular awareness programs should be conducted to educate the public about soil pollution and their harmful effects. Farmers should shift to bioorganic fertilizers, pesticides and biocontrol methods. These products will take a little longer to react, but they do not have an 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.

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