SOIL POLLUTION— CAUSES, TYPES, EFFECT AND CONTROL MEASURES

SOIL: Soil, the uppermost layer of the earth's crust 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 top soil 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:

Components in Soil	**Percentage**
Organic mineral matter	45%
Organic matter	05%
Soil water	25%
Soil air	25%

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

Causes of Soil Pollution

1. **Industrial and Mining Activities:** Large numbers of Industries coming up since the dawn of industrial era without proper waste management systems are the biggest contributor to soil pollution. Also since the amount of mining and manufacturing has increased and most industries are dependent on extracting minerals from the Earth. Whether it is iron ore or coal, the by products are contaminated and they are not disposed off in a manner that can be considered safe. As a result, the industrial waste dumped on the soil surface for a long period of time degrades it.

2. Modern Agricultural Practices: 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 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.

3. Lack of proper Waste Disposal: Modern lifestyle, urban as well as rural, produces huge amount of waste and lack of waste management procedures adds to the problem of soil pollution. Urban wastes comprise of 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 substances resulting from explosions of nuclear testing laboratories, radioactive fallout 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 28 years and Cs-137 with a half life 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 nuclides deposited on the soil emit gamma radiations.

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

4. **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 make them unsuitable for cultivation. These chemicals can enter into the groundwater through soil and make the water undrinkable.

5. 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.

Effects of Soil Pollution

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. Some of the adverse effects are as follows:

Human health

Since we are dependent on the land for our food, pollution from the soil is transferred to us in this manner. Bio accumulation of toxins occurs in our bodies, causing chronic poisoning, and leading to various diseases. Reproductive health, birth and developmental defects, neurologic effects, malnutrition, and mutations in the cells of the body leading to cancers; all these are on the increase today.

Growth of plants

Plants will not be able to adapt to sudden changes occurring in the soil. Fungi and bacteria found in the soils cannot bind the soil due to chemical changes and this causes soil erosion. Large tracts of land become barren; unable to support any life on it. Even the plants that do grow on these lands will absorb the toxins and transfer to the food chain.

Air pollution

Toxic dust rises from landfills along with foul odour, pollutes the air and causes adverse effects to the people who live near them.

1. Effect on Human Health: Considering how soil is the reason we are able to sustain ourselves, the contamination of it has major consequences on our health. Crops and plants grown on polluted soil absorb much of the pollution and then pass these on to us. This could explain the sudden surge in small and terminal illnesses. Long term exposure to such soil can affect the genetic make-up of the body, causing congenital illnesses and chronic health problems that cannot be cured easily. In fact, it can sicken the livestock to a considerable extent and cause food poisoning over a long period of time. The soil pollution can even lead to widespread famines if the plants are unable to grow in it.

2. **Effect on Growth of Plants:** The ecological balance of any system gets affected due to the widespread contamination of the soil. Most plants are unable to adapt when the chemistry of the soil changes so radically in a short period of time. Fungi and bacteria found in the soil that bind it together begin to decline, which creates an additional problem of soil erosion.

The fertility slowly diminishes, making land unsuitable for agriculture and any local vegetation to survive. The soil pollution causes large tracts of land to become hazardous to health. Unlike deserts, which are suitable for its native vegetation, such land cannot support most forms of life.

3. **Decreased Soil Fertility:** The toxic chemicals present in the soil can decrease soil fertility and therefore decrease in the soil yield. The contaminated soil is then used to produce fruits and vegetables

which lacks quality nutrients and may contain some poisonous substance to cause serious health problems in people consuming them.

4. **Effect on landscape and Odour pollution:** Huge piles of refuse and garbage being open dumped and littered over an area spoils the serenity of the landscape. The emission of toxic and foul gases from landfills pollutes the environment and causes serious effects on health of some people. The unpleasant smell causes inconvenience to other people.

5. Changes in Soil Structure: The death of many soil organisms (e.g. earthworms, insects and microbes) in the soil can lead to alteration in soil structure. Apart from that, it could also force their predators to move to other places in search of food.

6. **Effect on Ecosystem and Biodiversity:** Soil pollution can lead to the lack of biodiversity in an ecosystem. The life of bird, insect, mammal and reptile species that live in the soil can get affected by pollution. The soil is an important habitat.

7. **Contamination of Water Sources:** When it rains, surface run-off carries contaminated soil into water sources causing water pollution. Pollutants can also infiltrate down to contaminate ground water. The contaminated water is thus unfit for both animal and human consumption. It will also affect aquatic life since the organisms that live in these water bodies will find their habitats inhabitable.

Control Measures for soil degradation:

A. Prevention of soil erosion:

1. **Conservational till farming or no-till farming**: Traditionally, land is ploughed to make a planting surface. This disturbs the soil and makes it susceptible to erosion. The no-till farming method makes minimum disturbance to the top soil by making slits in the unploughed soil. Seeds, fertilizers and water are injected in these slits.
2. **Contour farming**: In this method, crops are planted in rows along contours of gently sloped land. Each row acts as a small dam to hold soil thereby slowing water runoff.
3. **Terracing**: In this method, steep slopes are converted into a series of broad terraces that run across the contour. This retains water for crops and reduces soil erosion by controlling runoff.
4. **Alley cropping or Agro-forestry**: This method involves planting crops in strips or alleys between rows of trees or shrubs that provide fruits and fuel wood. Hence, when the crop is harvested, the soil will not be eroded as the trees and shrubs remain on ground holding the soil particles.

5. **Wind breaks or shelter belts**: In this technique, trees are planted in long rows along the boundary of cultivated land which block the wind and reduce soil erosion. Wind breaks help in retaining soil moisture, supply wood for fuel and provide habitat for birds.

B. **Ways to minimize the soil acidification process:**

- The use of less acidifying farming practices: Retain crop residue, no nitrate residue, less tillage etc.
- Applications of agricultural lime: The addition of lime raises the soil pH to some prescribed value (pH 6.0 to 7.0).

C. Remedies to correct salt affected soil

- **Deep Tilling:** Deep tilling can improve drainage for soils with high salt levels. This method works by breaking up hard soils or rocklike soil layers that prevent the downward flow of water. But is usually temporary, as some parts of the soil may harden and reseal.
- **Flushing Soil and Preventing Evaporation:** Flushing the soil is the process of irrigating the area with a low-salt water and washing the salt below the root zone; provided soils have good drainage.

  When water evaporates on a dry soil surface, it leaves salt behind. Mulching can help in retaining soil moisture.
- **Chemical remediation:** Modifying salty soils with sulphur, lime or calcium can help in removing or replacing the sodium in the soil. But several factors like area's groundwater, soil condition, geological factors etc. should be pondered before applying chemical remediation.
- **Combination of methods:** A combination approach can be more effective. Starting with correct amendment and working it in, using deep tilling. Then flushing the soil with water to leach the salt from the surface. Repeating this process, if needed.
- **Land reclamation:** Land reclamation incorporates activities centered towards restoring the previous organic matter and soil’s vital minerals. This may include activities such as the addition of plant residues to degraded soils and improving range management.

  Salinized soils can be restored by salt level correction reclamation projects and salinity control. There is a project funded by the World Bank for

reclaiming saline lands in Maharashtra, affecting 1,000 villages in the State. A significant percentage of the lands are in the farmer's suicide-prone Vidarbha region.

D. **Sustainable Practices**: Number of sustainable practices can be applied in order to prevent spreading of desertification. Such as following :

- Checking overgrazing- Fewer animals in the same area will allow plants to grow back.
- Integrated farming - Keep animals and grow crops. Use the manure from the animals to replace soil nutrients where the crops grow. Swap the place where the crops grow and the animals graze from time to time.
- Plant more trees - These will protect the soil surface from the impact of rain and the effects of wind. The roots will bind the soil together and trap water.
- Build earth dams - These are small dams which follow the contours of the soil. When it rains, the water does not run off the surface, but is trapped and infiltrates the soil

E. Production and use of natural fertilizers: To prevent harmful effects of chemical fertilizers, biological routes of soil fertility are being adopted. Organic farming should be practiced.

F. Education: Education is an important tool that needs to be utilized in order to help people to understand the best way to use the land. By educating them on sustainable practices, more land will be saved from being getting polluted.