

# **Environmental Chemistry**

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# Soil Pollution?

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## Definition

Soil pollution is defined as the presence of toxic chemicals (pollutants or contaminants) in soil, in high enough concentrations to pose a risk to human health and/or the ecosystem. In the case of contaminants which occur naturally in soil, even when their levels are not high enough to pose a risk, soil pollution is still said to occur if the levels of the contaminants in soil exceed the levels that should naturally be present.

## Types of Pollution

### Soil Pollution Causes

All soils, whether polluted or unpolluted, contain a variety of compounds (contaminants) which are naturally present. Such contaminants include metals, inorganic ions and salts (e.g. phosphates, carbonates, sulfates, nitrates), and many organic compounds (such as lipids, proteins, DNA, fatty acids, hydrocarbons, PAHs, alcohols, etc.). These compounds are mainly formed through soil microbial activity and decomposition of organisms (e.g., plants and animals). Additionally, various compounds get into the soil from the atmosphere, for instance with precipitation water, as well as by wind activity or other types of soil disturbances, and from surface water bodies and shallow groundwater flowing through the soil. When the amounts of soil contaminants exceed natural levels (what is naturally present in various soils), pollution is generated. There are two main causes through which soil pollution is generated (<https://www.environmentalpollutioncenters.org/soil/causes/>): anthropogenic (man-made) causes and natural causes.

### Natural Pollutants

Natural processes can lead to an accumulation of toxic chemicals in the soil. This type of contamination has only been recorded in a few cases, such as the accumulation of higher levels of perchlorate in soil from the Atacama Desert in Chile, a type of accumulation which is purely due to natural processes in arid environments.

### Man-Made Pollutants

Man-made contaminants are the main causes of soil pollution and consist of a large variety of contaminants or chemicals, both organic and inorganic. They can pollute the soil either alone or combined with several natural soil contaminants. Man-made soil pollution is usually caused by the improper disposal of waste coming from industrial or urban sources, industrial activities, and agricultural pesticides.

### Types of Soil Pollutants

Soil pollution consists of pollutants and contaminants. The main pollutants of the soil are the biological agents and some of the human activities. Soil contaminants are all products of soil pollutants that contaminate the soil. Human activities that pollute the soil range from agricultural practices that infest the crops with pesticide chemicals to urban or industrial wastes or radioactive emissions that contaminate the soil with various toxic substances.

### Biological Agents

Biological agents work inside the soil to introduce manures and digested sludge (coming from the human, bird and animal excreta) into the soil.

### Agricultural Practices

The soil of the crops is polluted to a large extent with pesticides, fertilizers, herbicides, slurry, debris, and manure.

### Radioactive Pollutants

Radioactive substances such as Radium, Thorium, Uranium, Nitrogen, etc. can infiltrate the soil and create toxic effects.

### Urban Waste

Urban waste consists of garbage and rubbish materials, dried sludge and sewage from domestic and commercial waste.

### Industrial Waste

Steel, pesticides, textiles, drugs, glass, cement, petroleum, etc. are produced by paper mills, oil refineries, sugar factories, petroleum industries and others as such.

### Examples of Soil Contaminants

There is a large variety of pollutants that could poison the soil. Examples of the most common and problematic soil pollutants can be found below.

#### Lead (Pb)

Potential sources: lead paint, mining, foundry activities, vehicle exhaust, construction activities, agriculture activities

#### Mercury (Hg)

Potential sources: mining, incineration of coal, alkali and metal processing, medical waste, volcanoes and geologic deposits, accumulation in plants & vegetables grown on polluted soils

#### Arsenic (As)

Potential sources: mining, coal-fired power plants, lumber facilities, electronics industry, foundry activities, agriculture, natural accumulation

#### Copper (Cu)

Potential sources: mining, foundry activities; construction activities

#### Zinc (Zn)

Potential sources: mining; foundry activities; construction activities

#### Nickel (Ni)

Potential sources: mining; foundry activities; construction activities

#### PAHs (polyaromatic hydrocarbons)

Potential sources: coal burning, vehicle emissions, accumulation in plants & vegetables grown on polluted soils; cigarette smoke; wildfires, agricultural burning; wood burning, constructions

### Herbicides/Insecticides

Potential sources: agricultural activities; gardening

### The Effects of Soil Pollution

Soil pollution affects plants, animals and humans alike. While anyone is susceptible to soil pollution, soil pollution effects may vary based on age, general health status and other factors, such as the type of pollutant or contaminant inhaled or ingested. However, children are usually more susceptible to exposure to contaminants, because they come in close contact with the soil by playing in the ground; combined with lower thresholds for disease, this triggers higher risks than for adults. Therefore, it is always important to test the soil before allowing your kids to play there, especially if you live in a highly industrialized area.

### Diseases Caused by Soil Pollution

Humans can be affected by soil pollution through the inhalation of gases emitted from soils moving upward, or through the inhalation of matter that is disturbed and transported by the wind because of the various human activities on the ground. Soil pollution may cause a variety of health problems headaches, nausea, fatigue, skin rash, eye irritation and potentially resulting in more serious conditions like neuromuscular blockage, kidney and liver damage and various forms of cancer.



# Food Pollution?

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## Definition

Food pollution is generally defined as the presence in food or associated with food of toxic chemicals (elements or compounds) and/or biological contaminants which are not naturally present in food or are above their natural background levels (for those chemicals which are naturally found in some foods).

## Types of Pollution

### Radiation Effects of Food Pollution

Food pollution can affect each of us) by causing mild to severe food illnesses or, worse, contributing to or causing the development of serious health problems such as hormonal and metabolic problems, or even various types of cancer. Nervous system problems may also be induced by food polluted with certain pesticides. Additionally, in rare cases when highly polluted food is consumed, serious food poisoning or death may occur almost immediately. Food contamination can trigger anything from a small discomfort to life-threatening diseases. On average, more than 70 million cases of food-borne illnesses occur in the U.S. every year, resulting in approximately 5,000 deaths per year!

## Causes of Food Pollution

There are numerous causes of food pollution. Basically, any pollutant that comes in contact with food has the potential to pollute it. Various vegetables may get contaminated with toxic bacterial strains (from irrigation water, groundwater, or soil) which may only be destroyed by processing the polluted food at high temperatures. Toxic chemicals can also get into the food in a variety of situations including:

- growing of food (e.g. crops, fruits, vegetables) in polluted soils, solid wastes (e.g. mine tailings) or areas with polluted groundwater;
- irrigation of grown food (e.g. vegetables, fruits, crops) with polluted water
- growing of food (e.g. crops, fruits, vegetables) in areas with polluted air;
- agricultural treatments with pesticides, insecticides, and/or herbicides

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- agricultural application of sewage sludge and/or polluted fertilizers (which contain ash from power plants);
- consumption of polluted water and/or food by fish or other animals;
- food processing, packaging, and handling;
- propagation and concentration of pollutants through the food chain.

The fact that plants (vegetables, crops, or trees) become contaminated with pollutants from the environment comes from the ability of plants to extract environmental pollutants through their roots, along with water and nutrients. In the case of air pollutants, those usually enter plants also through roots, after being first deposited on the ground with precipitation water. This is why some plants (non-edible species) are actually used to remediate little to moderately polluted soil by extracting pollutants from soils (an innovative remediation called phytoremediation).

### **Sources of Food Pollution**

The sources of food pollution are numerous and hard to identify or exclude from our daily environment. They include various chemicals and/or microorganisms that get into contact with food during the growing, processing or packaging stages. Basically, any existent environmental pollutant might get into our food, one way or another. Thus, any of the sources polluting the air, water, and soil may also become sources of food pollution. Additionally, animal fodder contains antibiotics and potentially toxic chemicals that may be retained into animals (which later on become human food).

### **Food Pollution Risks**

Food pollution risks depend on a variety of factors, including:

- Type of pollutant – while any pollutant present in food may pose a health risk, the pollutants that are persistent and bioaccumulative are those that pose the higher risks because they may accumulate in food over time resulting in concentrations much higher than in a surrounding environment (e.g., accumulation of persistent chemicals such as organomercurial compounds or PCBs in fish). Hormones in food may also pose serious risks that are still uncertain.

For example, contamination of cow milk with an artificial hormone (rBGH) used to increase milk production may be linked to some types of cancers in humans. Thus, a safe alternative is to avoid, if possible consumption of food with hormones.

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- Type of food – fish are more dangerous than other food due to their potential exposure to a higher variety of contaminants and the accumulation and concentration of certain compounds in fish. Also, any bird or animal consuming polluted fish may become contaminated itself and thus transmit the pollution further through the food chain.
- Each individual person's health – children, elderly, as well as pregnant women are usually more sensitive to food pollution. So are people with chronic food diseases or illnesses, for which food pollution risks are higher. However, healthy individuals may also develop food-poisoning diseases and anyone may be at risk

### How Does Pollution Affect the Food Web?

Pollution from the environment (soil, sediments, water, and air) gets into the food web by polluting plants or animals that come in contact with environmental pollution. For example, water pollution may accumulate and concentrate in fish. Fish may be consumed by birds and other animals and the pollution gets transferred through the food chains until it reaches humans. By the time the polluted meat or fish reaches humans, the pollution may be substantially increased compared to the original concentration. Thus, human intoxication cases may be serious.

### Safe Food Alternative

An alternative that may ensure production of less polluted food was recently proposed in Japan. Thus, it was proposed to grow vegetables in factories which would eliminate the unpredictable effect of environmental pollution, unpredictable weather, or pests. The process would be all computerized, controlling various factors affecting growth. This safe food alternative is proposed by the Ozu Corporation in Tokyo. Would this constitute the future of agriculture? Only time will tell... In the meantime, we are still dealing with food grown on dirty land subjected to various food pollutants, pests, and unpredictable weather! Food pollution risks are everywhere and all we can do is minimize individual exposure to polluted food by informing ourselves and taking action.



# Chemical Pollution

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## Definition

Chemical pollution is defined as the presence or increase in our environment of chemical pollutants that are not naturally present there or are found in amounts higher than their natural background values. Most of the chemicals that pollute the environment are man-made, resulted from the various activities in which toxic chemicals are used for various purposes.

Chemical intoxication is caused by exposure to chemical pollutants and can have immediate effects or delayed effects, which may appear after weeks or even months after the exposure occurred. Severe chemical intoxication may cause the death of the person that inhales an increased quantity of such substances.

Chemical compounds are organic or inorganic chemicals that are the main causes of chemical pollution. The most common chemical pollutants are those compounds used across large areas and which are persistent, meaning they do not easily degrade in nature. Examples are most pesticides, herbicides, insecticides used in agriculture and gardening, as well as chlorinated solvents used in many industrial processes and dry-cleaning activities.

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Based on their chemical structure, chemical contaminants can be classified into naturally-occurring and man-made categories. They can be organic or inorganic (organic compounds always contain carbon and carbon-hydrogen bonds, whereas most inorganic compounds do not contain carbon).

### **Examples of Chemical Pollutants**

Chemical pollutants mostly result from various human activities like the manufacturing, handling, storing, and disposing of chemicals. These occur in industrial places and activities such as oil refineries, coal power plants, construction, mining & smelting, transportation, agricultural use of pesticides and insecticides, as well as household activities.

The chemical industry is another example in this sense, mainly because it is usually linked to polluted waste streams. In fact, the waste streams from chemical industry are now strictly controlled and treated before being released into the environment. But this was not always the case in the past and many rivers and surface water bodies were contaminated by the numerous waste streams coming from various chemical plants, as well as other industrial sources. Even though measures were taken to reduce this type of pollution, its effects are still visible.

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Various chemical pollutants may accumulate in the aquatic sediments over longer periods of time. This means that, if no tests are performed, chemical pollution in the ocean water could pose serious health risks to the ecosystem and ultimately could cause mild or deadly chemical intoxication in humans after the consumption of contaminated fish or seafood. However, there are prevention tips you can follow to minimize exposure to chemical pollution.

### Relevant Popular Articles About Chemical Pollution

Determining whether chemical pollution has crossed a planetary boundary is complex because there is no pre-human baseline, unlike with the climate crisis and the pre-industrial level of CO<sub>2</sub> in the atmosphere. There are also a huge number of chemical compounds registered for use – about 350,000 – and only a tiny fraction of these have been assessed for safety.

So the research used a combination of measurements to assess the situation. These included the rate of production of chemicals, which is rising rapidly, and their release into the environment, which is happening much faster than the ability of authorities to track or investigate the impacts.

## Detergents Pollutants

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One of the main sources of chemical pollutants is everyday detergents. Specific contaminants leading to water pollution include a wide range of chemicals (such as bleach) and microbes. Several chemicals that we use our daily life are harmful elements and compounds. These could be magnesium or calcium based substances that affect water. Detergents sometimes could be carcinogenic, so they should be eliminated from the water. According to Enviroharvest Inc, "The detergents can contain suspected carcinogens, and ingredients that do not fully biodegrade."

### The Hazards of Detergents to Environment

Detergents also contain oxygen-reducing substances ("i.e." a chemical compound that readily transfer oxygen atoms) that may cause severe damage to the fishes and marine animals. This may also lead to eutrophication. Eutrophication is a process by which a water body becomes enriched in dissolved nutrients (e.g., phosphates, calcium and magnesium). It has negative impacts on environment,

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especially on aquatic animals because water rich in nutrients stimulates the growth of aquatic plant life, resulting in depletion of oxygen. A few more harmful components of detergents such as anthropogenic components such as herbicides, pesticides and heavy metal concentrations (e.g., zinc, cadmium and lead) can cause the water to grow murky thus blocking out light and disrupting the growth of plants. Turbidity also clogs the respiratory system of some species of fishes. Pathogens from these toxic water bodies bring about in human or animal hosts diseases, which may be fatal. Furthermore, these contaminants alter the chemical composition of water that includes electrical conductivity, temperature, acidity and eutrophication.

### **Hazard to Human Health**

Chemicals could be a source of drinking water contamination.

Drinking water contaminated by detergents can be hazardous to human health. Humans become ill with a range of symptoms such as:



skin irritation

sore throat

nausea

stomach cramps

liver damage

This can be poisonous and accounts to death in several cases. Such contaminated water is also not preferable for the growth of crops e.g., rice, wheat and soybean.

### Detergents and Foams

Detergents are surface-active agents, which tend to produce stable, copious foams in rivers. These foams generally form a thick and dense layer over the surface of the water, extending over several hundreds of meters of the river water. These foams also prove to be an unhygienic source of domestic water.

## Environmental Disasters

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The environmental movement took a big leap forward in 1969 as a result of an environmental catastrophe. Here we review that event and other disasters of human origin that are remembered less for their impact on Mother Nature than for the upheaval they brought to society. We learnt lessons from them that have led to greater protection of the natural environment.

### Cuyahoga: the river that caught fire (1969)

During the 20th century, one of the largest industrial centres in the USA flourished around Cleveland (Ohio). Parallel to this industrial development, the Cuyahoga River, which flows through the city, also quickly rose to the top of the pollution list. The Cuyahoga was so full of flammable substances and floating debris that from time to time its surface would catch fire. More than a dozen fires were reported on the river until, in 1969, some floating mass of fire caught the attention of Time magazine conspiracy The magazine published spectacular photos of the river that “oozes rather than flows

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The article and photos rattled American society and led to major changes. Until then, local industries could dump waste into rivers unchecked. In the wake of the Cuyahoga fire, a movement in the USA in defence of the environment was also ignited. Incoming president Richard Nixon read the mood of the nation with respect to environmental issues and after the first Earth Day ((22 April 1970), Nixon responded by creating the federal Environmental Protection Agency (EPA). The Cuyahoga fire, which flows into Lake Erie, also prompted an agreement between the US and Canada to protect the Great Lakes on the border between the two countries. And one year later, the federal Clean Water Act came into being.

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Seveso is a town near Milan that would be unknown outside Italy were it not for an accident at a small chemical plant that manufactured pesticides. Toxic gases reached nearby towns, exposing tens of thousands of people to the highest levels ever recorded of a dioxin: specifically TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin), one of the most lethal of these substances and known for a component of Agent Orange, used by the US in the Vietnam War.

No one died in the so-called Seveso disaster in contrast to what happened after the most infamous gas leak in history: in 1984, another pesticide plant in Bhopal (India) caused nearly 4,000



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confirmed deaths and left more than half a million people affected.

In Seveso the immediate aftermath was panic and evacuations.

80,000 animals were slaughtered to prevent toxins from entering the food chain, and several thousand people were treated for dioxin poisoning.