

Chapter 2. Classification of Pollutants

2.1. Introduction

Providing a classification of pollutants is not an easy task, as it can be done based on numerous criteria, yet none of them are entirely satisfactory. Polluting agents can first be grouped according to their **physical, chemical, biological, or nuclear** nature, among others. They can also be classified **ecologically**, by considering the environment in which they are released and where they exert their harmful effects. Another approach is **anthropocentric**, focusing on the medium or the pathway through which they contaminate the human body such as **inhalation, ingestion, skin contact, or hearing**.

In reality, none of these methods are truly satisfactory, since the same substance may exhibit several modes of action.

Table 1: Classification of the main types of pollution and nuisances.

Nature of Pollution	Ecosystems		
	Atmosphere	Hydrosphere	Soils
1. Physical Pollution			
Radioactive (radiation)	+	+	+
Heating or thermal pollution	+	+	
Noise and low-frequency vibrations	+		+
2. Chemical Pollution			
Carbon-based gaseous derivatives	+	+	
Hydrocarbons		+	+
Sulfur derivatives	+	+	+
Nitrogen derivatives	+	+	+
Toxic metals and metalloids		+	+
Fluorides	+		+
Solid particles ("aerosols")	+		
Detergents		+	
Pesticides and other non-volatile synthetic organic compounds		+	+
Emission of foul-smelling chemical substances (olfactory nuisance)	+		
Fermentable organic matter		+	
3. Biological Pollution			
Microbiological contamination of inhaled and ingested environments (bacteria and viruses)	+	+	
Introduction of GMOs into rural areas			+
Alteration of biocoenoses by animal and plant species		+	+
4. Aesthetic Nuisances			
Degradation of landscapes and sites by uncontrolled urbanization or poorly designed planning	+		
Establishment of industries in pristine or minimally modified habitats	+		

2.2. Criteria for the classification of pollutants

Several criteria are used to classify the different environmental pollutants into various categories:

2.2.1. According to the nature (quality) of pollutants

There are several types:

- **Physical Pollution:** This type sometimes contributes to the alteration of the structure of the environment. Examples include **heat**, **radioactive pollution**, **noise pollution**, and **light pollution** (especially during nighttime). It can also result from the movement of **sand and clay particles** during heavy rainfall.



Figure 1. Physical Pollution (Light Pollution).

- **Chemical Pollution:** This type manifests through the release of **toxic mineral or artificial substances** such as **hydrocarbons**, **plasticizers** (used in plastic manufacturing), **phthalates** (derivatives of salts and esters), **chemical pesticides**, and **heavy metals**.



Figure 2. Chemical Pollution.

- **Biological Pollution:** Microorganisms can be toxic to the environment; their rapid multiplication within a medium facilitates their transmission among living beings. Examples include **algae**, **fungi**, **bacteria**, **pathogenic germs**, and **parasites**.



Figure 3. Biological Pollution (Eutrophication).

2.2.2. According to the natural reservoir of pollutants

- **Atmospheric Pollution:** Refers to gases and toxic particles suspended in the air.
- **Terrestrial Pollution:** Refers to all forms of pollution affecting agricultural, forest, or urban soils.
- **Aquatic Pollution:** Characterized by the presence of microorganisms, chemical substances, or waste materials in aquatic environments.

2.2.3. According to the form of pollutants

- **Gaseous Pollution:** Fossil fuels (petroleum, gas, coal) are the main sources of gaseous pollution.



Figure 4. Fossil Fuels

- **Liquid Pollution:** Involves any toxic molecule for the environment in liquid form.



Figure 5. Liquid Pollution

- **Solid Pollution:** Refers to harmful solid elements in the environment, such as heavy metals, plastics, pesticides, and urban waste.



Figure 6. Solid Pollution

2.2.4. According to the source or origin of pollutants

- **Pollution of natural origin:** Volcanic eruptions, submarine discharges of hydrocarbons, or heavy metals can cause pollution in multiple habitats.



Figure 7. Natural Pollution (Volcanic Eruptions)

- **Urban pollution:** Includes domestic discharges, wastewater from cleaning, and other substances released by urban populations.



Figure 8. Urban Pollution

- **Agricultural pollution:** Agricultural practices (use of pesticides and fertilizers) and animal husbandry play a major role in environmental degradation.



Figure 9. Agricultural Pollution (Pesticides)

- **Industrial Pollution:** Industrial technology and the discharges from factories and companies are among the main causes of pollution worldwide.



Figure 10. Industrial Pollution

2.2.5. According to the stages of pollutant formation

- **Primary Pollution:** Primary pollutants are those directly released into the environment and that retain their toxic form, such as **methane (CH₄)**, carbon monoxide (CO), and sulfur dioxide (SO₂).
- **Secondary Pollution:** Secondary pollutants result from physico-chemical transformations of primary pollutants. Examples include:
 - **Ozone (O₃)** formed by chemical reactions involving nitric oxide (NO) and volatile organic compounds (VOCs).
 - **Nitrogen dioxide (NO₂)** produced by the reaction between NO and O₂.
 - **Acid rain**, formed when SO₂ and NO react with water.

2.2.6. According to the pathway of contamination

- **In Plants:**
 - Stomatal absorption ;
 - Transfoliar absorption ;
 - Root translocation.
- **In Animals:**
 - Contamination by **inhalation** (in terrestrial species) ;
 - **Transbranchial absorption** (in aquatic species) ;
 - Contamination by **ingestion** (*per os*, oral route) ;
 - **Transcutaneous penetration**, following contact between the skin or integument and the pollutant.