

## Toxic Trace Elements in The Environment and Their Effects on Human Health

### AUTHORS DETAIL

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### INTRODUCTION

The human population is snowballing and developing into modern societies. The surrounding of humans' external factors including living and non-living objects or materials is called the environment. (Seinfeld 1989) The environment has been divided into physical (water, soil, air, housing, radiation, etc.) biological (Plants, animals, microbes), and social factors (norms, values, culture, income, habitat, occupation). Excess of elements in the environment is called pollution or contamination. Modernization is a significant cause of environmental contamination. Modern industrialization converted farms into urbanization and industrialization. (Kampa and Castanas 2008) The combining effects of industrialization and urbanization exacerbate environmental contamination, which causes deleterious effects on human and animal health. Environmental contamination is a worldwide issue since the beginning of the 20<sup>th</sup> century. But, developing countries face more problems due to less control of developmental plans and their implementations. (Kramer et al. 2021) Rapid population growth and inadequacy of resources boost the situation. The most dominant effect of pollution is water and air pollution. Human health is mainly dependent on the environment. (Xie and Zhu 2020).

### History of Environmental Contamination

Before 1000 CE coal was used as fuel, and the conversion of coal into gases was probably the first human action that destroyed the surrounding. At the beginning of the 17<sup>th</sup> century, the era of industrialization and urbanization started which was the major source of congestion. (O'Neill et al. 2003) The proliferation of the population boosts the situation in the environment. By the end of the 20<sup>th</sup> century, pollution became a global problem. After the World War II, the Japanese faced health problems, because of post-war environmental effects, and radiation exposure These terrible

effects lasted many decades but, they made plans to evacuate the situation and emphasis on environmental control strategies (Mayer 1999).

In 1962, environmental safety precautions started at international level for balancing the pollutants in the environment. In 1972 the UN conference on humans and their environment facilitates a wider survey to assess the environmental contamination (Bai and Ogbourne 2016). Table I shows various histological events regarding environmental pollution. Ecological maintenance means environmental health, which includes primary prevention of diseases and improvement in quality of life.(Martins 2010) Essential elements include water, air, and sanitation. More than 2 billion people in the developing world have no access to a safe environment. The attainment of healthy environment is more complicated in the current situation (Briggs 2003).

In 1955 first Federal Control Act had passed to control and restrict the pollution by authorized state and local agencies. In 1967 Air Quality Act passed to check, maintain and measure the pollution causing agents and their control (Sun 2020). In 1970 Environmental Protection Agency passed Clean Air Act to deal with new industrial cities near populated areas against plants to protect environmental contamination (Khan and Ghouri 2011).

Major Environmental Pollutions involves

1. Air pollution
2. Water Pollution
3. Land/Soil pollution
4. Noise pollution

### Air Pollution

Presence or introduction of substances, which cause health hazards in the human, animal, and other living lives known as air pollution. There are different sources of these pollutants, most importantly atmosphere is sometimes acts as a self-pollutant.(Seinfeld 1989)

#### i. Primary air pollutants

Exhaust or chimney of the factory and suspension of dust particles from industrial areas are major sources of primary pollutants (Calvert and Englund 1984).

#### ii- Secondary air pollutants

Secondary air pollutants form when different primary particles present in the air chemically react with each other in the atmosphere, the most common example is ozone, which arises from different chemical toxins pollutant (Redekop 2010). Those pollutants which are present in gaseous form in the atmosphere. It may be a small molecule,

**Table 1:** Different historical perspectives of environmental pollution (Briggs 2003)

1	The first action was taken by the population	1868	The start of noticeable pollution in the environment
2	Before World War I (the era of industrialization)	1869-1914	Chemical exposure in the environment through industrialization
3	First World War	1914-1920	Use of weapons created congestion in the populated cities
4	First to second world war (industrial revolution)	1920-1945	Exposure to radiation, nuclear weapons use.
5	Population rapid growth	1945-1970	Urbanization causes congestion in cities
6	Control and preventive measures started through international organization	1970- 2000	Laws to reduce pollution

having ability to cross filters and can be inhaled through respiratory system. These gases are major sources of upper respiratory tract infections such as Asthma, bronchitis, allergic rhinitis etc. It includes carbon mono-oxide and nitrogen dioxide etc. (Burke et al. 2005).

### iii- Particulate air pollutants

A solid form of pollutants presents in the air but in very low quantity. These pollutants cover the wide range in the atmosphere. These smaller particles may be 1-3 micrometer in diameter (Peirce et al. 1998).

### iv- Local-scale pollutants

Some pollutants or particles having very short lifetime and may convert into other substances. These are easily encountered but poor countries have no resources to encounter these particles. For example biomass for fuels, burning of coal produces gases and solid particles (Peirce et al. 1998).

### v- Urban Scale Pollutants

Some pollutants significantly produced in urban communities which is highly produced by traffic. It includes nitrogen oxide, free lead, cadmium etc. These pollutants have longer lifetime and stay in air, which causes respiratory and ophthalmic disorders (Hirsh 2014).

### vi- Global scale pollutants

Accumulation of pollutants leads toward global damages. Pollution is now a worldwide problem (Alloway and Ayres 1997).

### vii- Metrological factors

The atmosphere extends into several layers and surround 30 km above the sea level. Man, directly interact with 8-10 km above sea level. Air movement, climate, temperature, dilution, and dispersal of atmosphere more significantly known as topography. The diffusion of pollutants into the air is highly dependent on these factors. Topography may be dominated by mountains, high buildings where it became calm and weak. Pollutant tend to concentrate because of topographical factors which causes breathing zone difficulties (Giesy et al. 2010).

## Sources of Air Pollution

Air pollution considered into two major categories

- i) Natural air pollutants which include wind-blown dust, volcanic gases and ash, natural radioactivity, pollens, gases from natural decomposition and Ozone-depleting layers (Hirsh 2014).
- ii) Manmade air pollutants are industrial pollutants, automobiles, combusting processes, plans, aerosol cans, incinerators, petroleum refineries, steam generation and

copper smelting. All these sources major contributor of air pollution (Vesilind et al. 2013).

## Classifications of Air Pollutants

Air pollutants can be classified into two categories. One is the origin of pollutants and the second is the state of pollutants (either liquid, solid, or gaseous).

### (i) Particulate Pollutants

The pollutants in a liquid or solid state are considered larger than a molecule or vapor. They dispersed in the form of aerosolized particles like smoke, fumes, dust, haze, and fog. The size of these particles varies from 1 micrometer to 100 micrometers. Fine particulates settled down too slowly, while heavy settled easily (Orlitzky et al. 2011).

The metallic emission produces trace elements such as mercury, lead, cadmium, zinc, selenium, manganese, and nickel. These heavy metal evaporators cause mutation in genes and produce carcinogenic effects. (Xu et al. 2018)

### (ii) Gaseous Pollutants

The release of gaseous substances into the air directly interacts with the human respiratory system which produces deleterious effects. Most of the gaseous pollutants originated from the combustion and industrial process. Gaseous pollutants can be divided into organic and inorganic pollutants. (Burke et al. 2005)

## Organic Pollutants

Oxygenated organic compounds are:

- i) Alcohol
- ii) Hyper oxides
- iii) Aldehydes
- iv) Ketones
- v) Cyanogen chlorides
- vi) Bromobenzyl cyanide
- vii) Dimethyl sulfide
- viii) Acetones

## Inorganic Pollutants include

- i) Paraffin (Methane, Ethane, Octane)
- ii) Acetylene

iii) Olefins (Ethylene, butadiene)  
Aromatics (Benzene group, Toluene, Benopyrene) (Dourish 2010)

### Indoor Air Pollution

Indoor air pollution contains a variety of contaminants which is majorly categorized into physical, biological, and chemical pollutants. These contaminants arise from multiple resources. Indoor pollutants categorized into two groups. One is most commonly causing discomfort and acute illness and second that causes chronic illness or carcinogens (Dourish 2010). Micro-organisms causes acute allergic reactions. If it remains persistence it will convert into poor chronic health. Indoor pollutants classified into i) occupational activity ii) wood combustion iii) construction materials iv) furnishing v) garages. (Xu et al. 2018) Temperature and humidity effects the contaminant's saturation. Elevated temperature boosted the volatile organic contaminants in the air. Humidity aggravates particular matters and release of heavy matter in the air (Fayiga et al. 2018).

### Combustion Process and its Effect on the Environment

Combustion process is the most common source of indoor air pollution. Kerosene, wood, coal, and oil generally produce a greater quantity of pollutants. These substances produce suspended particles in the air which are contributing to respiratory problems. Table 2 depicted the amount of emission per milligram per hour during the combustion process (Edwards 2013).

### Air Pollutants Responsible for Air Pollution

More than 120 substances are responsible for air contamination and health hazards including carbon monoxide, nitrogen dioxide, sulphur dioxide as organic substances while inorganic substances include arsenic, lead, zinc, photo chemicals, chloride, fluoride, mercury, benzene, asbestos, ozone, chlorine fluorocarbons, and other radioactive compounds. The combination of smoke that reacts with suspended particles in the air form smog (Khan and Ghouri 2011).

**Carbon monoxide:** The most common and widely distributed air pollutant produced during the process of combusting of oil, carbon materials, industrial heating generators, automobiles, hospital incinerators and other oil-based machinery. Incomplete fossil fuel burning produced carbon monoxide. The concentration of carbon monoxide is greater in urban areas. The reason behind the high saturation of carbon monoxide in heavy vehicles, traffic high density,

and emissions from small industries. Spikes occur during the evening hours in cities. It directly influences humans by producing carboxyhemoglobin. The high concentration of carbon monoxide attaches to hemoglobin in replacement of oxygen, which leads to multiple health disorders (Briggs 2003).

**Lead:** Second most common and most dangerous micro-pollutant is lead. Free lead produces from automobile fuel combustion. The degree of lead pollution varies from country to country. Lead pollution is more saturated in developing countries, while developed countries use lead filters and lead-free petrol (Downs 2016). Another most common cause of lead exposure is the smelting and mining of lead that creates pollution locally. Lead pollution in children causes behavioral changes or growth retardation. In adults, it causes lung disorders and skin irritations (Mayer 1999; Briggs 2003).

**Hydrocarbons:** Manmade activities and machinery producing excessive hydrocarbons. It releases in the environment leads to hydrocarbons pollution. Automobiles, coal and combustion, incineration, and local industries are liable for contamination of hydrocarbons. These hydrocarbons react through a photochemical process and produce smog (Berry 1977).

**Sulphur dioxide:** Sulphur contains in multiple forms including  $H_2S$ ,  $H_2SO_4$ , and  $SO_2$ . Sulphur dioxide is a colorless gas that is excreted from industrial fuels, coal burning, motor vehicles, and domestic wood fires. Sulphur dioxide causes respiratory disorders, irritation in the eyes, asthma, chronic bronchitis, coughing, mucosal secretion, and lower respiratory infections. More than 10 minutes of direct exposure to  $SO_2$  causes dyspnea and tachycardia. Sulphur dioxide combined with water and produce  $H_2SO_4$  which is the major component of acid rain (Ren et al. 2011).

**Carbon dioxide:** It is not considered a pollutant, but anthropogenic activities produce more carbon dioxide through the combustion process. It does not take part in any chemical reaction because it is a natural constituent. High carbon dioxide raises the temperature of the earth (Moldan et al. 2012).

**Cadmium:** In the steel industry, cadmium and zinc produces during the process of incineration. As tobacco contains cadmium, smoking raises the level of cadmium in the environment as well as in human lungs causing lungs damages (Azam 2018).

**Oxides of nitrogen:** The burning of coal, petrol, and the process of electricity generation produce nitrous oxides, which are responsible for a reduction in lung functioning, and growth (Malhotra et al. 2013).

**Table 2:** Indoor combustion emission of pollutants (Edwards 2013)

Equipment	Carbon Monoxide	Nitric oxide	Volatile organics	Aromatics	Particulates	Sulphur dioxide	Formaldehyde
Oven	1898	55.5	-	-	0.13	0.9	22.9
Gas heater	2659	-	-	-	0.38		41
Good radiant heater	588	4.8	16.2 <sup>5</sup>	0.06 <sup>4</sup>	00.01	34.3	
Poor Radiant heater	138	148			0.28	45.5	41
Airtight stoves	11-160			0.0001 <sup>3</sup>	2.5-8.7 <sup>2</sup>		
Non-airtight stoves	252-618			0.08 <sup>3</sup>	16-73		

**Particulate matters:** It is the complex mixture of organic and inorganic substances, including particles larger than 2.5 mm but small and fine particles less than 2.5 mm. Particulate produce in the process of burning fossil fuels, and industrial incineration. These particles reduce the growth in plants and bronchioles destruction in humans. Chronic exposure to particulate matter causes cardiovascular diseases as well as respiratory diseases. It is majorly responsible for lung cancer (Bilen et al. 2008).

### Measurement Methods of Air Pollution

Quantitative analysis is the effective and easiest method to assess the quality of air. Accurate sampling after study design sets a criterion for control. Sampling location is the most important step to evaluate the actual contaminants of the area. For example, in a cross-section following calculation is used to calculate an accurate sample size (Bask et al. 2018).

**Measurement of Gases:** A probe fitted with an integral filter is used to collect samples. This filter removed the particulate from the air as well as minimizes the loss of gaseous substances. Cooling methods are generally used for collection of samples. The knowledge of molecular weight and the actual velocity of gaseous substances is necessary to collect samples. There are following methods used to evaluate or analyze the gases amount in the air.

Major gaseous constituents are

- i) Carbon monoxide
- ii) Sulphur dioxide/ Sulphur trioxide
- iii) Nitrogen dioxide
- iv) Hydrocarbons

Photochemical oxidant (Long et al. 2021)

**Chromatographic analysis:** Sampling can be done through the collection in the glass or plastic bag. Following factors should be considered during the evaluation

1. Specificity (the instrument's response to other substances encountered in the sample).
2. Precision & Accuracy
3. Stability
4. Sensitivity
5. Sampling average time
6. Reliability and economic feasibility

For continuous monitoring, there should be further consideration

- Zero calibration and drifting

- Response, lag, rise, and fall time accurate changes measurements.

- Ambient temperature and humidity

- Maintenance requirements

Machine-readable format to check data output (Gómez-Puerta et al. 2021).

The standards of air quality assessment have been described in Table 3.

### Measurement of Particulate Pollutants

There are different methods to measure the particulates in the air. The commonly used methodology includes i) sizing of particulate ii) mass measurements iii) opacity

**Sizing of particulate:** There is no single unit of measurement of a particulate size. Size can be measured on the basis of linear dimension, projected area, surface area, volume, and mass. Some measurements of particulates are mentioned in the Table 4. By using the physical sizing method, the particulate size is determined (Khan et al. 2019).

### The Effect of Trace Elements on The Human Health

Well-being and human health are largely dependent on the surrounding environment. Multiple researchers working on the relationship between humans and the environment from the last two centuries (Khan and Ghouri 2011). Human health is majorly affected by numerous environmental factors, including what a person drinks, eats, lives and breath? The environment provides energy to humans in form of water, air, food, and exposure to sunlight. When there are micro-contaminants in the air, water, food, and sunlight it will produce an imbalance in the metabolism or normal mechanism of action in the human body. Significantly, pathogenic microbes are responsible for the disease process (Schweitzer and Noblet 2018). On the other hand, various human inventions and activities are also boosting the disease process. Occupational stressors in industrial cities disclose the hazardous material produced in drinking water contamination, noise pollution, high temperature, poisonous chemicals, pesticides, fertilizers, and pressure leading to pathological conditions (Bashir et al. 2020).

### Anthropogenic and Environmental Challenges

Population explosion, progressive economic developments, natural resource depletion, industrialization, soil degradation,

**Table 3:** Standards for Air Quality Assessment (Levy and Marans 2012)

Air Quality standards Reference			
Pollutants	Average time	Method	Principle of detection
Sulphur Dioxide	3 hours or 24 hours	Pararosaniline	Colorimetric
Carbon Monoxide	1 hour or 8 hours	Spectrometry	Infrared
Hydrocarbons	3 hours	Gas chromatographic	Flame ionization
Ozone	1 hour	Spectrometry gas-phase O <sub>3</sub> -ethylene	Chemiluminescence
Nitrogen dioxide	Annual	24 hours integrated samples in alkaline solution.	Colorimetric

**Table 4:** Contaminants measurements (Levy and Marans 2012)

Particle sizing and associated instruments		
Property measured	Method	Size Application(mm)
Length	Optical microscopy,	0.5-2000
	scanning electron microscopy, Transmission of electron	0.02-500
		0.002-10
Volume	Electrical resistivity	0.5-400
Mass	Sedimentation, Centrifuge, impaction	0.5-200
Surface area	Gas adsorption	0.001 m <sup>2</sup> /g and up
Crystallite volume	X-ray diffraction	0.015-0.050

deforestation, urbanization and modification in the temperature cycle are anthropogenic. All these human activities have influential effects on the environment. Process of continuous natural environmental modifications, the transformation of natural resources into profitable artificial resources leading towards health hazards (Bashir et al. 2020).

### Anthropogenic Effects

**Global climate changes:** The modification in the environment has a more significant impact on climate change. Extreme weather conditions, glacier melting, ozone depletion, increase in the amount and number of gases and UV radiation due to chlorofluorocarbon threatens human health and enhances the progression of diseases in human (Lan et al. 2012)

**Invasion of exotic species:** Manmade activities near the coastal line are directly associated with fisheries and marine life. The production of commercial fisheries results in the changes in environment of coastal life. The production of marine food at the commercial level leads to diminishing genetic diversity and extrinsic fertilization also deteriorates marine life (Rathore and Nollet 2012).

**Eutrophication:** The structural changes in the ecosystem due to the enrichment of water by nutrient salts and other pollutants is called eutrophication. Eutrophication is responsible to increases the algae, and aquatic plants, which are directly affected by fish species and marine food (Armeanu et al. 2018).

**Use of fertilizers:** Unethical practices in agricultural land cause the accumulation of pollutants, and chemicals in the environment. These pollutants are responsible for lung cancer, skin cancer, intestinal diseases, and congenital abnormalities (Asako 1979).

### Accumulation of Wastewater into Drinking Water

Sewage and industrial wastewater are discharged into water reservoirs, or drinking water, which are responsible for viral, bacterial, and fungal infectious diseases in humans. Aluminum, phosphorous and heavy metals causes indigestion, stomach abnormalities, intestinal obstruction, and cancer (Dandachi et al. 2020).

**Chemical hazards:** Exposure to chemicals leads to the chronic disorders such as allergic reactions, high blood pressure, immune system disorders, nervous system disorders, and carcinogenic effects. Some chemicals used in industries such as methyl mercury, arsenic, lead, and toluene directly affected on fetal development and can cause mutagenic, teratogenic, and carcinogenic problems. Exposure to the chemical environment, acids, vapors, and fumes are considered as bomb exploding symbols for pregnant women. DNA mutation is responsible for congenital disorders, birth defects, early life malignancy, tumors, bone marrow cancer, and scrotal changes (Ader 1995). The causative environmental factors of various diseases have been described in Table 5 (Khopkar 2007).

Long-term exposure to chemicals even at the minimal level interrupted the nervous system, and act like a venom for human leading to loss of electrochemical message and behavioral changes occurred. Hormones are chemicals (natural) that are responsible for human behavior, internal body mechanisms, learning patterns, reproductive cycle, and certain cardiovascular, and respiratory rhythms. Hazardous chemicals disturb the endocrine functioning, normal hormonal patterns, cardiovascular disorder, and respiratory depression (James and Card 2012).

**Biological Hazards:** Biological substances are major health threats to humans involving healthcare workers, laboratory workers, contact with animals, exposure to pathogens, and infections. There are four groups under consideration of risk:

**Table 5:** Biological Contaminants and their causative Environmental factors

Diseases	Causative environment
Diarrheal diseases, hepatitis, intestinal worms	Basic sanitation of water, drainage, and sewage accumulation into drinking water.
Measles, Pertussis	Aerosols, overcrowding,
Dengue, yellow fever, Chagas disease, leishmaniasis.	Vector-borne, lack of sanitation, inappropriate personal hygiene
Eyes and skin infections	Water pollution, inappropriate sanitation
Tetanus	Accidental injuries
Respiratory tract disorders	Contaminated air (chemical, biological contaminants)

Group 1. Microbial entities, that are unlikely to cause diseases in humans.

Group 2. Microbial entities, that are likely to cause diseases in humans.

Group 3. Agents that cause various infectious diseases and hazardous to human health.

Group 4. Agents having serious pathogenicity with no available treatments (Vennemo et al. 2020).

**Bioterrorism:** The use and transmission of infectious agents in a concentrated urban population for mass-level pathogenicity and deaths are called bioterrorism. It is a cheaper and mass-level destructive biological weapon in comparison with nuclear weapons. COVID-19 is also considered a biological warfare (Kohtala and Hyysalo 2015). Many countries spent billions of dollars on the development and producing biological weapons. Recombinant DNA technology is used to develop biological agents (Dolk and Vrijheid 2003).

**Physical Hazards:** The release of energy in various forms that causes harm with or without contact is considered as physical hazard. It includes:

- i) **Noise:** The most common and extreme physical hazard, that damages the ear drum, long-term exposure to noise leads to deafness. Noise is also responsible for cardiovascular disorders, hypertension, behavioral changes, and the reduction of erythrocytes in the serum. (Kassinis et al. 2016)
- ii) **Vibration:** In industrial cities, modern machinery produces vibrations at a larger scale, which is the biggest cause of workplace stressors that affects the whole body. (Watson et al. 2012).
- iii) **Pressure:** Above and below atmospheric pressure pose health hazards which is associated with certain occupation such as diving, aviation, etc. High altitude is affiliated with decompression and high-altitude sickness.
- iv) **Radiations:** Electromagnetic radiation causes severe tissue damage at a larger scale. It is also a major contributor to cancer and gene mutation. (Little et al. 2016).

**Extreme temperature:** Working under very high or freezing temperatures causes depression in the body's normal functioning, which leads to pathological conditions (Saxena et al. 2003).

## Global Warming and Human Health

Global warming causes climate changes which rise the floods, famines, extreme heat waves, and de-freezing of glaciers. The earth's biosphere releases and absorbs the gases like carbon dioxide, methane, and nitrogen dioxide which are significant parts of the atmosphere and weather. Anthropogenic activities modify these biogenic greenhouse gases and release methane in higher quantities. The release of chlorofluorocarbons depletes the ozone layer and is responsible for the greenhouse effect. The greenhouse gasses affect the atmospheric temperature and climate change. It includes CO<sub>2</sub>, nitrous oxide, water vapors, chlorofluorocarbons, methane, and other trace elements. Causes of global warming include fossil fuel burning, coal, Petroleum, natural gases, deforestation and use of fertilizer (Shore and Shemesh 2016).

**Effects of global warming:** Heat waves produce extreme dehydration and death in older adults with respiratory and cardiovascular disorders. Heat stroke, pulmonary malfunctioning, cardiovascular collapse, allergic reaction, and phlebitis occur during the heat wave (Kim et al. 2021).

## Control and Prevention of Air Pollution

Air pollution control should be considered under a total technology control system and environmental control system. There should be some important measures at the international level to prevent further damage to the environment and reduction of air pollutants (Hueting 2010). Following measures need to be taken to reduce air pollution:

- ✓ The prohibition of open burning or single chamber incineration.
- ✓ Low emission from transportation by using electric transport or less use of fuel-based transportation (O'Neill et al. 2003).
- ✓ Air control rules and regulations on the application of zoning ordinances that cause the sources of air pollution to be located or distributed to minimize the effect of air pollution.
- ✓ Imposition areal limits on emission rates that have been driven by air quality standard requirements (Seinfeld 1989).
- ✓ Air pollution zoning can be legally applied to prohibit new industries, expand on existing industries, and liquidate non-conforming industries and harmful industries (Jeswani et al. 2020).

## Toxic Trace Elements

- ✓ Reduce the hydrocarbons/lead emission from vehicle's by converting fuel into gaseous fuels i) Liquid natural gas (LNG) ii) liquid petroleum gas (LPG). It will reduce the particulates in the air.
- ✓ Improvement in operational practices such as food processing, storage of raw material, good sanitation, drying of residuals, grinding, minimization of local heating, and modification of incinerators into multi-chambered incinerators (Osaldiston and Schott 2012).
- ✓ Gravity settling chambers/ centrifuge separators in industries to prevent particulates pollution (Riffat et al. 2016)
- ✓ The adsorption process can reduce the gas elimination in the air directly. Certain adsorbant can be used such as activated carbon adsorb vapors of gases. Benzene adsorbed by Hexanol.
- ✓ Condensation is another process of liquefying the gases. Waste management and waste reduction are also useful to control contaminants (Stern 2018).

## Smog

Smog is the combination of smoke and fog, which was coined in 1908 in United Kingdom. The word smog is a portmanteau of the two words. Fog is a visible aerosol which consists of water droplets, ice crystals and pollutants suspended in the air. It is also considered as low-lying clouds (Mishra 2017). There are multiple contributing factors, includes temperature, wind, sunlight, and pollutant gases. The chemical reaction formed in 1952, the city London experienced longer episode of smog, which was called killer smog (Briggs 2003). There was increased morbidity and mortality reported during that outbreak in 1952. The combustion of coal produces smoke than combines and causes deleterious health issues. In Pakistan, Bangladesh and India free smoke ejected in the air by the combustion process of coal and burning of fossil fuels in last two decades. The air quality comprised and caused health problems. It was observed that, particulates level and size increases to 10  $\mu\text{m}$  in diameter to 3000  $\mu\text{g}/\text{m}^3$ . In 1952 it was 30  $\mu\text{g}/\text{m}^3$  and in 2002 it became double. (Tilman and Clark 2014) The blanket of smog in industrial cities and agriculture land surrounded from last decade in winters. Chemical reactions occur between key pollutants in the air (Ali et al. 2019). The excessive pollutants are volatile organic compounds and nitrogen oxides which interact with hydroxyl, ozone, and nitrates. The main sources of these pollutants are emission coal fire power plants, traffic emissions, burning of fossil fuels and eruption of volcanoes. These activities directly or indirectly contribute to the production of PM 2.5 which is main precursor for smog production. Globally, the occurrence of smog has been reported in many major cities around the world includes Lahore, London, Delhi, Mexico, Los Angeles, Tehran, and Beijing. The significance of smog and health effects of smog started to attract attention since 1952. Now it's a well-

known pollution around the world but difficult to tackle the pollutants (Dupont et al. 2016).

Air pollution is one of the most significant environmental concerns in recent decades. The situation has been worsening in Lahore, the provisional capital of Punjab. Lahore has a 4 % annual growth rate of economic and Pakistan's largest and most populated cities. In the latest air quality index Lahore ranked one of the most polluted cities in the world, Lahore ranked 6<sup>th</sup>, Karachi ranked 16<sup>th</sup> with air quality index points 170 and 155 respectively.

## Types of Smog and Constituents (Dong and Hauschild 2017)

### 1. Classical Smog (London type)

The composition of classical smog is the mixture of smoke, fog and sulfur dioxide, which act as reducing agent. Classical smog also called reducing smog. Commonly in winter season.

### 2. Photochemical (Los Angeles type)

Photochemical smog also called summer smog is the chemical reaction of sunlight, nitrogen oxides, and volatile organic compounds in the atmosphere. This reaction leaves airborne particles and ground level ozone. Photochemical smog dependent on primary pollutants and produces secondary pollutants such as peroxyacetyl nitrate, tropospheric ozone, and aldehydes.

Human health compromised due to smog. It causes eye irritation, skin irritation, allergic reactions, breathing disorders, asthma, COPD, skin cancer, and breathlessness. Although smog have temporary health hazards, but continuous exposure to smog leads to chronic disorders. (Ones and Dilchert 2012)

## Noise Pollution

An unpleasant sound that disturbs physiological and psychological parameters is called noise. Noise affects with different ways on the people. Noise levels can be measured in decibels. The human ear can detect a range of voice pressure, or mechanical movement (0 dB to 140 dB). The vibration transmits the voice from different mediums. The 20<sup>th</sup> century was described as "The Century of Noise". Noise is considered an important stress factor in the urban population. There are two important properties of noise which are contributing to stress and deafness. Noise level of more than 60 dB affects the human eardrum and cochlea. Continuous exposure to loud voices disturbs humans physically and psychologically. It will also influence the quality of life and impairment of work performance.

**Table 6:** Levels of noise in different areas (Dong and Hauschild 2017)

Different Area's	Maximum	Minimum
Commercial	88	62
Residential	82	67
Quite Region	75	53
Industrial	83	68

**Table 7:** Different Equipment's noise (Olah et al. 2020)

Household Equipment	Noise (decibel)
Vacuum cleaner	70
Washing machine	78
Refrigerator	45
Normal conversation	67
Whisper	30
MP3 player max volume	105
Lawn mover	85-90
Commercial equipment	
Jet take-off	130
Train	100
Jackhammer	110
Thunderstorm	120
Boom	110-120
Heavy traffic	85
Motorcycles	95
Sirens	120

Health and safety regulations are more stringent worldwide to prevent noise pollution. Anthropogenic noise is almost an omnipresent environmental stressor. There are two main types of noise pollution:

1. Intermittent
2. Chronic / frequent (Scoy and Tjeerdema 2014)

Table 6 depict the minimum and maximum levels of noise at different areas and Table 7 shows the noise level of various household equipment's.

### Effect of Noise on Human Health

Long-term exposure to environmental pollutants leads to physical, and mental disturbance which ultimately converts into chronic illness. Physical problems include:

1. **Cardiovascular disorders:** Continuous exposure to noise more than 60 dB causes hypertension and cardiovascular disorders.
2. **Endocrine responsiveness:** High-intensity noise raises adrenaline and norepinephrine, which increases the stressors in the body.
3. **Psychiatric disorders:** Exposure to noise changes the human normal responsive behavior. As stressor increases in the body, coping and challenges solving ability reduces.
4. **Tinnitus:** Loudness causes tinnitus in the human ear, which affects mental health capabilities.
5. Some industrial workers reported nausea, vomiting, and other physiological problems.
6. **Deafness:** High-intensity noise for long-term causes deafness.

7. **Sleep disturbance:** Noise reduces the sleep hours, relaxation and deep sleep is ultimately compromised
8. **Reduce work performance:** Industrial workers' performance reduces with longer exposure to vibration and noise ( Lambert et al. 2012; Thangavel and Sridevi 2016).

### How to Reduce Noise Pollution (Morelli 2011)

Noise pollution is unavoidable in cities, but it can be avoided in many places.

1. **Reduction of appliance noise:** Indoor noise including washing machines, dryers, vacuum cleaners, fans, and other electrical equipment produces a noisy environment. The reduction of equipment's noise will reduce overall noise pollution.
2. **Reduction of noise from media voice:** The loudness of television, mobile videos, radio, and video games voice should be reduced to control noise pollution.
3. **Repair old machinery:** old machinery produces high pitch and volume. Repairing may reduce the volume and pitch.
4. **Soundproof:** Insulating strategies may reduce noise pollution.
5. **Ear protection:** If noise is unavoidable, ear protection is necessary such as earplugs or earmuffs.
6. **Create more quiet time:** Try to regulate a noise-free environment.

### Land /Soil Pollution

7. Heavy metal toxicology is associated with potential toxicity in human and ecosystem. It is identified that several correlating factors are responsible for soil contamination (Bini 2010). There are multiple sources of these contaminants, which are responsible for human toxicity including agrochemicals i.e., fertilizers, pesticides, inappropriate irrigation, surface runoff, mineral extraction, industrial waste disposal, waste sludge, livestock manures and atmospheric deposition (Gao et al. 2016).

### Land /Soil Pollution

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There are multiple disorders directly associated with contaminated land which include skin rash, corneal infection, gastrointestinal disturbance, Asthma and cancer. Soil contamination can be prevented through proper measures such as law enforcement, industrial waste management, and restrict the usage of inappropriate fertilizers to reduce the soil contamination and its toxicity (Bini 2010).

## Conclusion

Population explosion around the world is responsible for the development of toxic environment in the form of gases and industrial explosion. Minor toxic elements are mainly responsible for health hazards. Human, animals, and plants are massively affected by these pollutants. Its causes multiple diseases including depression, respiratory, hematological, cardiovascular and neuromuscular disorders. The misuse of land, inappropriate agricultural practices, and explosion of plastic are not only dangerous for human but also for aquatic life. Law enforcement, proper agricultural practices, industrial and urbanization control can reduce the environmental toxicity.

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