Air pollution is defined as excessive foreign matter in the air which adversely affects the well-being of personnel or causes property damage. It also affects plants, animals, the human body, and buildings.

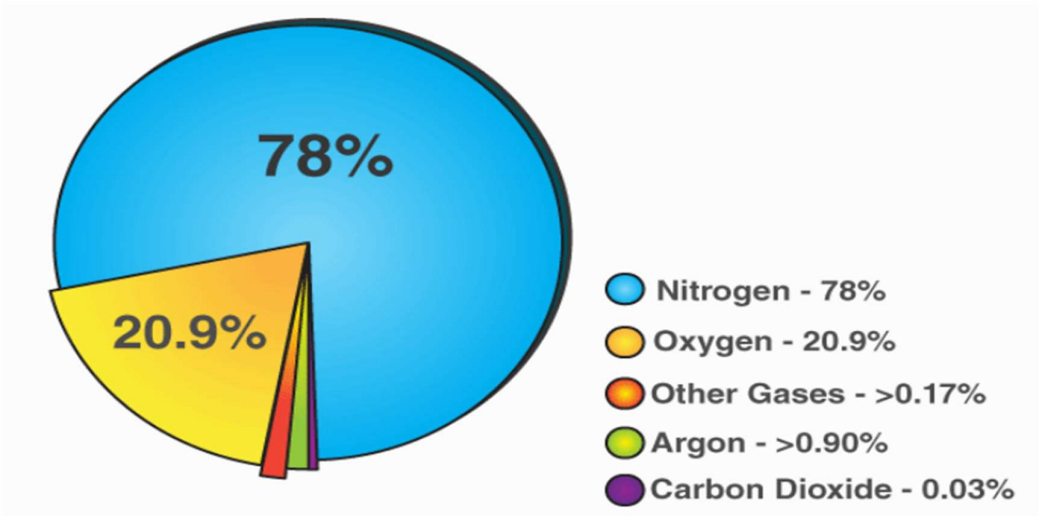
Air pollution refers to any physical, chemical or biological change in the air. It is the contamination of air by harmful gases, dust and smoke which affects plants, animals and humans drastically.

Air Pollution is the release of pollutants such as gases, particles, biological molecules, etc. into the air that is harmful to human health and the environment.

Air pollution is defined as the introduction of pollutants, organic molecules, or other unsafe materials into Earth's atmosphere. This can be in the form of excessive gases like carbon dioxide and other vapours that cannot be effectively removed through natural cycles, such as the carbon cycle or the nitrogen cycle.

Composition of Natural air

Air is a mixture of gases which makes up the Earth's atmosphere. These gases are colourless and odourless and hence, we can't see them but only feel them. The atmosphere is an ocean of these gases. It consists of 78% nitrogen, 21% oxygen and 1 % other gases and water vapour. The composition of air does not change as we travel through the layers of the atmosphere. The changes are the number of molecules. The air molecules decrease and become less. The moisture content varies from place to place. Arid regions have less moisture content as compared to wetlands



Composition of Air					
Element	*Volume by %*	*Weight by %*	*PPM(Parts per Million) by Volume*	*Symbol of the Element*	*Molecular Weight of the element*
Nitrogen	78.08	75.47	780790	N_2	28.01
Oxygen	20.95	23.20	209445	O_2	32.00
Argon	0.93	1.28	9339	Ar	39.95
Carbon Dioxide	0.040	0.062	404	CO_2	44.01
Neon	0.0018	0.0012	18.21	Ne	20.18
Helium	0.0005	0.00007	5.24	He	4.00
Krypton	0.0001	0.0003	1.14	Kr	83.80
Hydrogen	0.00005	Negligible	0.50	H_2	2.02
Xenon	8.7×10^{-6}	0.00004	0.087	Xe	131.30

Other Components of Air

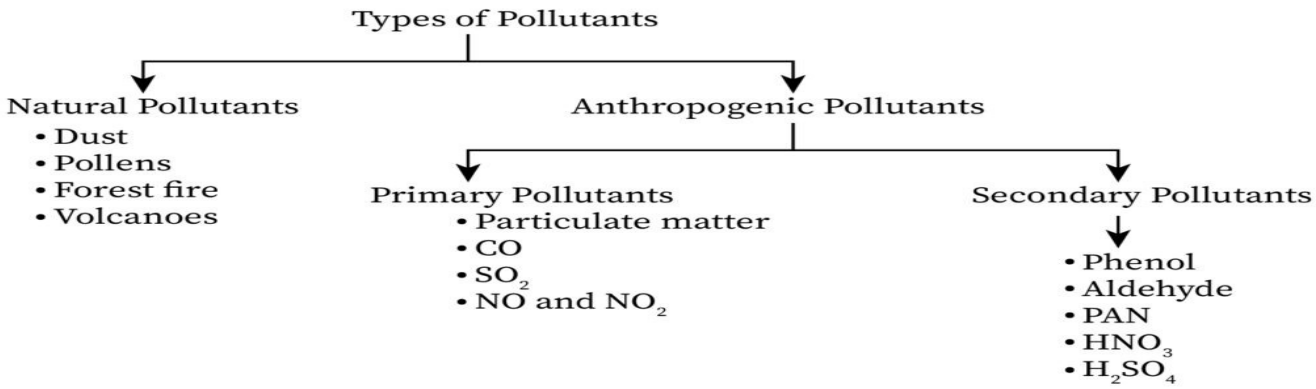
Some other components of air are mentioned below:

- Sulphur dioxide (SO_2) – 1.0 ppm
- Methane (CH_4)-2.0 ppm
- Nitrous oxide(N_2O) – 0.5 ppm
- Ozone(O_3)-0 to 0.07 ppm
- Nitrogen dioxide (NO_2) – 0.02 ppm
- Iodine(I_2)-0.01 ppm
- Carbon monoxide (CO) – 0 to trace ppm
- Ammonia (NH_3)-0 to trace ppm

Air pollutants

The pollutants that cause air pollution and degrade air quality can be distinguished into two types based on their origin. They are as follows:

- **Natural:** These types of pollutants occur as a byproduct of natural processes. Such pollutants include dust, pollen grains, forest fire debris, and ash produced from volcanoes.
- **Anthropogenic (human-made):** These types of pollutants originate from human activities. Examples of such pollutants include the emission from automobiles, industries, and power plants.



Anthropogenic Pollutants

1) Primary air pollutants

- Primary air pollutants are the pollutants that are emitted directly from the source to the atmosphere.
- Secondary air pollutants are formed in the lower atmosphere.

Primary air pollutants include oxides of sulphur, carbon, and nitrogen, volatile organic compounds, suspended particulate matter, H_2S, etc.

These pollutants are of concern as they are harmful to humans, animals and plants. They can also be the source of secondary air pollutants.

Sulphur oxide
About 95% of sulphur oxide is sulphur dioxide SO_2. It is a colourless gas with a pungent odour. They are mostly emitted by industries and the burning of fossil fuels. Effects of Sulphur oxide are:

- It interferes with the function of the mucous membrane.
- It creates breathing problems and causes a deficit of oxygen in the body.
- They combine with the rainwater and create acid rain which affects the building's appearance.

Carbon monoxide
It is mostly due to vehicular exhaust, due to incomplete burning of fossil fuels. It is a colourless, odourless toxic gas. Ill effects on humans are:

- It combines with haemoglobin in the blood and forms complex substances that result even in death.

Nitrogen oxides
They are generally suspended in the atmosphere by fly ash, tobacco smoke, smog, etc. Effects on human health include:

- It creates eye and nasal irritation.
- It also causes respiratory problems.

Hydrocarbons
They are compounds of hydrogen and carbon. They undergo photochemical reactions and formaldehyde and ketone which are very harmful.

Suspended particulate matter

They are the mixture of solid particles and liquid droplets which are found in the air. PM2.5 and PM10 are types of particulate matter based on their size.

- PM10 are inhalable coarse particles
- PM2.5 are fine particles.
- Ill effects: respiratory problems, lung cancer

Other pollutants

- Some other primary air pollutants like Lead can cause damage to the liver and kidneys.
- Aromatic hydrocarbons from automobile exhaust are carcinogens that causes cancer.
- Photochemical smog is formed due to the interaction of oxides of nitrogen with sunlight. They give rise to peroxyacetyl nitrate (PAN) and ozone which are very harmful.

2) Secondary air pollutant

- Ozone
- PAN (peroxy acetyl nitrate)
- Photochemical smog
- Aerosols and mists (H_2SO_4)

Ozone (O_3)

It is a highly reactive gas composed of three oxygen atom. It is both a natural and a man-made product that occurs in the Earth's upper atmosphere (the stratosphere) and lower atmosphere (the troposphere).

PAN

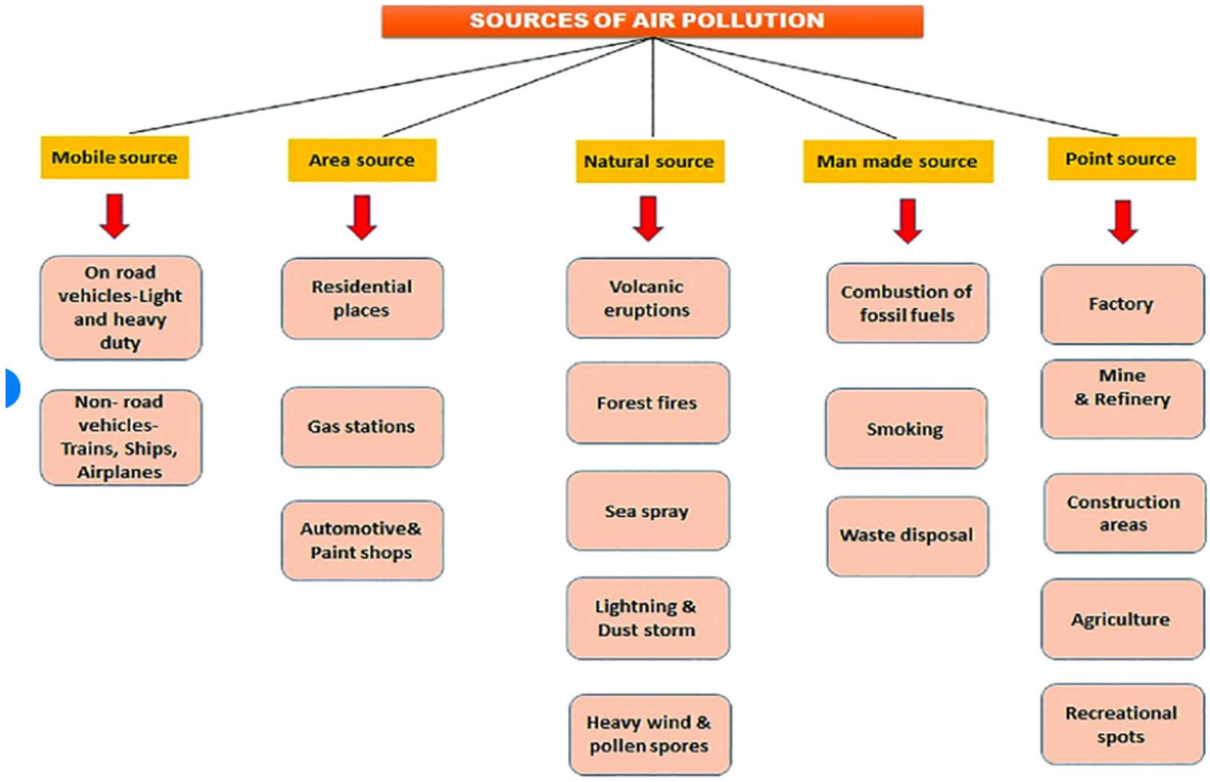
Smog is caused by the interaction of some hydrocarbons and oxidants under the influence of sunlight giving rise to dangerous peroxy acetyl nitrate (PAN).

Photochemical smog

Photochemical smog is a mixture of pollutants which includes particulates, nitrogen oxides, ozone, aldehydes, phenoxyethanol nitrate (PAN), unreacted hydrocarbons, etc. The smog often has a brown haze due to the presence of nitrogen dioxide. It causes painful eyes.

Aerosols and mists (H_2SO_4)

Aerosols and mists are very fine liquid droplets that cannot be effectively removed using traditional packed scrubbers. These droplets can be formed from gas phase hydrolysis of halogenated acids (HCl, HF, HBr), metal halides, organohalides, sulfur trioxide (SO_3), and phosphorous pentoxide (P_2O_5).



Classification of air pollutants

The air pollutants can be classified in many ways as shown below: -

1. According to origin
2. According to state of matter
3. According to sources

1. According to origin

A) Primary pollutants

The pollutants that are emitted directly from identifiable sources produced by natural events (e.g.: dust storms and volcanic eruptions) and human activities (e.g.: emissions from vehicles, industries etc.) are called primary pollutants. E.g.: smoke, dust, oxides of sulphur & nitrogen, hydrocarbons and particulate matter etc.

B) Secondary pollutants

The pollutants that are formed in the atmosphere by chemical interactions between primary pollutants and atmospheric constituents are known as secondary pollutants. E.g. Sulphur trioxide, ozone, ketones, sulphuric acid, nitric acid, carbonic acid etc.

2. According to state of matter

A) Gaseous air pollutants

These pollutants exist in a gaseous state at normal temperature and pressure. They are carbon dioxide, nitrogen dioxide, sulphur oxides etc.

B) Particulate air pollutants

These are not gaseous substances. They are suspended droplets, solid particles or mixtures of the two.

3. According to sources

A) Natural sources:

These include volcanic eruptions, deflation of sand and dust, forest or wild fires of natural vegetation, sulphur springs, natural geysers, organic and inorganic decays, vegetative decays, marsh gases, cosmic dust, pollen grains of flowers, photochemical reactions, soil debris etc.

B) Man-made sources

These include human activities such as industries, factories, urban centres, aircraft, nuclear experiments, automobiles, agriculture, domestic burning of wood and burning of fossil fuels, deforestation, mining, waste treatment plants and power plants.

Mobile sources – such as cars, buses, planes, trucks, and trains
Stationary sources – such as power plants, oil refineries, industrial facilities, and factories
Area sources – such as agricultural areas, cities, and wood burning fireplaces
Natural sources – such as wind-blown dust, wildfires, and volcanoes.

Aerosol

- . An aerosol is a suspension of fine solid particles or liquid droplets, in air or another gas. Aerosols can be natural or artificial.

Aerosols can be natural or anthropogenic.

- Examples of natural aerosols are fog, dust, forest exudates and geyser steam.
- Examples of anthropogenic aerosols are haze, particulate air pollutant and smoke.

Aerosols can be

- Primary aerosols
- Secondary aerosols

Primary Aerosols

. These are aerosols that make it into our atmosphere directly from some sort of natural sources.
• For example, smoke and soot from wildfires, desert dust, and ocean waves whipping sea salt into the atmosphere.

Secondary Aerosols

• These are aerosols that arise when gaseous substances are converted to particulate matter in the atmosphere.
• A great example of this is the sulphur dioxide gas emitted by a volcanic eruption.

Size

Aerosols particles can be as small as 0.001µm and large as 100-200µm

Sources

Aerosols have both
• Natural sources.
• Anthropogenic sources

Natural sources

- Ocean
- Volcanic eruptions
- Dust storms
- Forest fires
- Sea spray etc

Anthropogenic sources

- Burning of fossil fuels
- Biomass burning
- Nitrate fertilizers
- Mineral dust from industrial activities etc

Chemical composition

• Typical chemical composition of aerosol can vary at different locations, times and particle size fractions etc

• The atmospheric aerosol has a very complex and variable chemical composition.

* They are generally composed of variable amounts of sulphate, nitrate, ammonium, sea salt and other organic compounds.

Sulphate composition

• The main precursor of sulphate components in troposphere is SO, emitted from anthropogenic sources and volcanoes and dimethyl sulphide (DMs) from biogenic sources especially from marine planktons.

• In stratosphere sulphate aerosols mostly converted from carbonyl sulphide (COS)

Nitrate and chloride

- Nitrate is formed mainly from oxidation of atmospheric nitrogen dioxide (NO_2).

• Ammonium salts are also common component of atmospheric aerosols.

• Main sources of chloride are sea spray but ammonium chloride particles form during reaction between ammonia and HCl

Carbon

• Carbonaceous materials constitute a large but highly variable fraction of atmospheric aerosols.

• It consists of both elemental carbon (EC) or black carbon (BC) and organic carbon (OC).

Effects\Impacts of aerosols

• Direct effect

• Indirect effect

• Other effects

Direct effect

• Aerosols scatter and absorb incoming solar radiations.

• This will mainly lead to a cooling of the surface (solar radiation is scattered back to space)

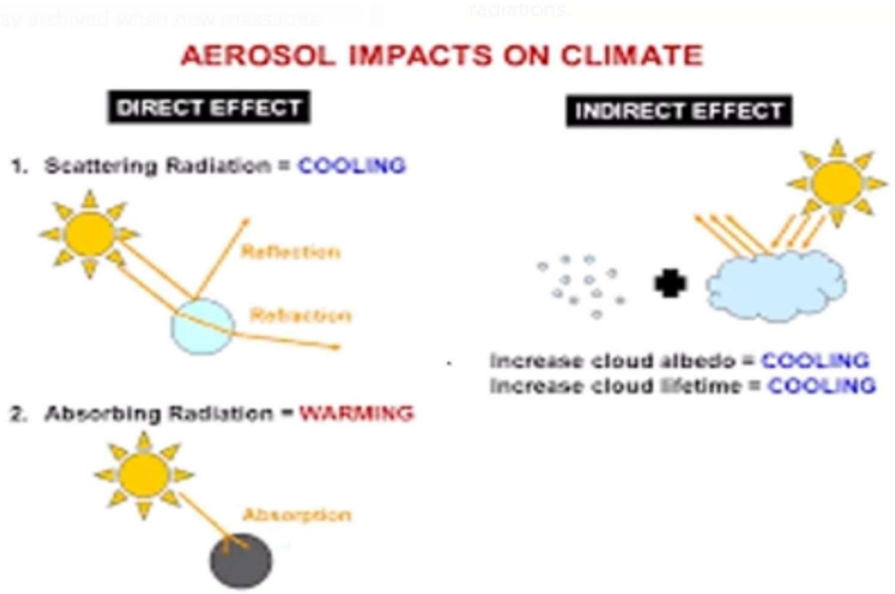
• It may also contribute to a warming of surface (caused by absorption of incoming solar energy)

Indirect effects

■ Aerosols influence the formation of clouds.

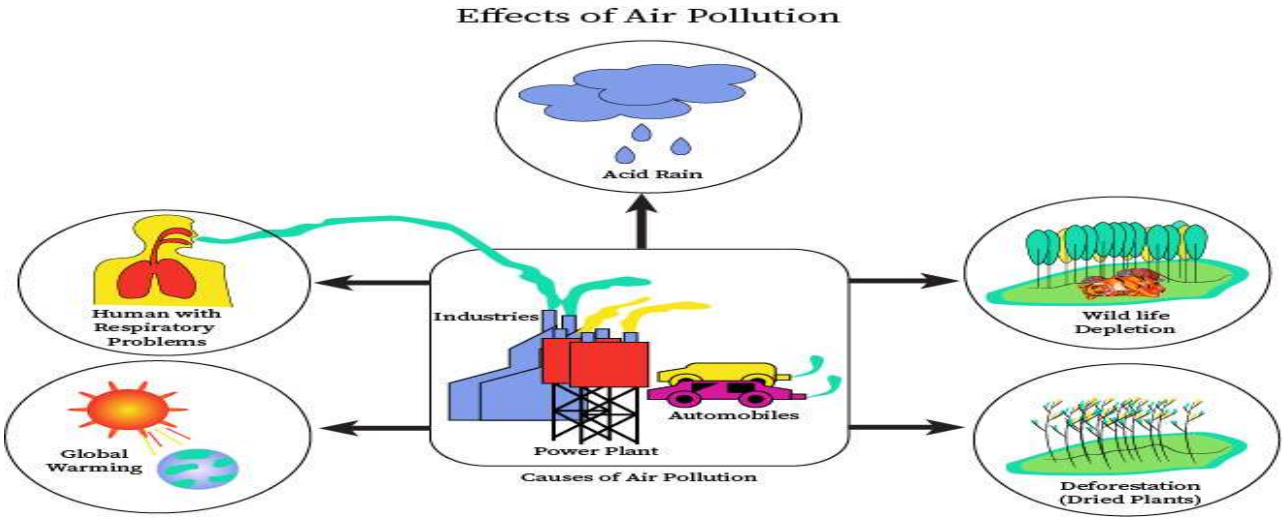
• They increase the amount of cloud droplets and made clouds more reflective.

• They can increase the lifespans of large storm clouds by delaying rainfall, making the clouds grow larger and live longer, and producing more extreme storms



Other effects

- When aerosols absorb pollutants, it facilitates the deposition of pollutants to the surface of earth as well as to bodies of water
- This has potential to damage both environment and human health.
- Aerosol particles with an effective diameter smaller than 10µm can enter the bronchi.
- While with an effective diameter smaller than 2.5µm can enter as far as the gas exchange region in the lungs, which can be hazardous to human health



EFFECT OF AIR POLLUTION

- Clean air is essential for good health.
- Respiratory problems like asthma, bronchitis.
- Chances of pneumonia in children.

There are many organs and bodily functions that can be harmed, the consequences including:

1. Respiratory diseases
2. Cardiovascular damage
3. Fatigue, headaches and anxiety.
4. Irritation of the eyes, nose and throat
5. Harm to the liver, spleen and blood
6. Nervous system damage.

EFFECT OF SOME AIR POLLUTANT ON HUMAN HEALTH

1) Carbon monoxide present in polluted air enters the blood and combines with haemoglobin leading to slow down the circulation of blood. Cause collapse, coma and even death. It also causes headaches, drowsiness, dizziness.
2) CO binds to haemoglobin 210 times more tightly than Oxygen.
3) Cigarette smoking is responsible for release of CO which interferes with haemoglobin to form carboxy haemoglobin. It causes nausea & headache.
4) Sulphur dioxide irritates respiratory tissues and corrosion of tissues of lungs.
5) Nitrogen oxides irritates lungs and causes chronic bronchitis and asthma.
6) Cadmium damage kidney (Itai-itai - high pain in joint and spine).
7) Mercury effect nervous system, eye vision problem, hearing problem (Minamata - neurological syndrome)
8) Smog and dust rise allergies. Children have more sensitive lungs; hence they are more easily affected. Cause - Chest pain, nasal and throat problems, eyes irritation and difficulty in breathing.
9) Ozone cause coughing and irritation of eye, nose, throat.
10) Suspended particles aggravate respiratory tract, leading to bronchitis and asthma. Prolonged exposure can cause cancer.
11) Many volatile organic compounds (eg: benzene and formaldehyde) and toxic particulates (eg: lead and cadmium) can cause mutations, reproductive problems or cancer.

EFFECT OF AIR POLLUTION ON MATERIALS

1) The damage due to air pollution on materials is really a serious concern since the service life of buildings is remarkably reduced.
2) The effect of air pollution on materials may be seen in terms of discoloration, material loss, structural failing and soiling.
3) Both discoloration and structural failure due to air pollution on buildings may be insignificant and that may not involve huge coasts. But the effect of corrosion due to acidic deposition costs a lot.
4) Air pollutants break down the exterior paint on cars and houses.
5) Discoloured monuments, historic buildings, marble statues, other heritage and natural beauty sites.

Main agents of air pollution	Material affected	Kind of damage
SOX – and other acids	Metals	Rusting
SOX, NO2 acids, and particulates	Textile	Rashes on the body and deformation
SO2, H2S, O3 and sticky particulates	Paints	Discolouration and surface damage
HF acidic vapours	Ceramics	Changes in surface structure
Ozone oxidants	Rubber	Cracking and weakening
SOX , and other acidic vapours and sulphur oxides	Building materials, skills and paper	Loss of coat of paint, rust, dustiness, surface damage, and creases

Effects of air pollution on plants

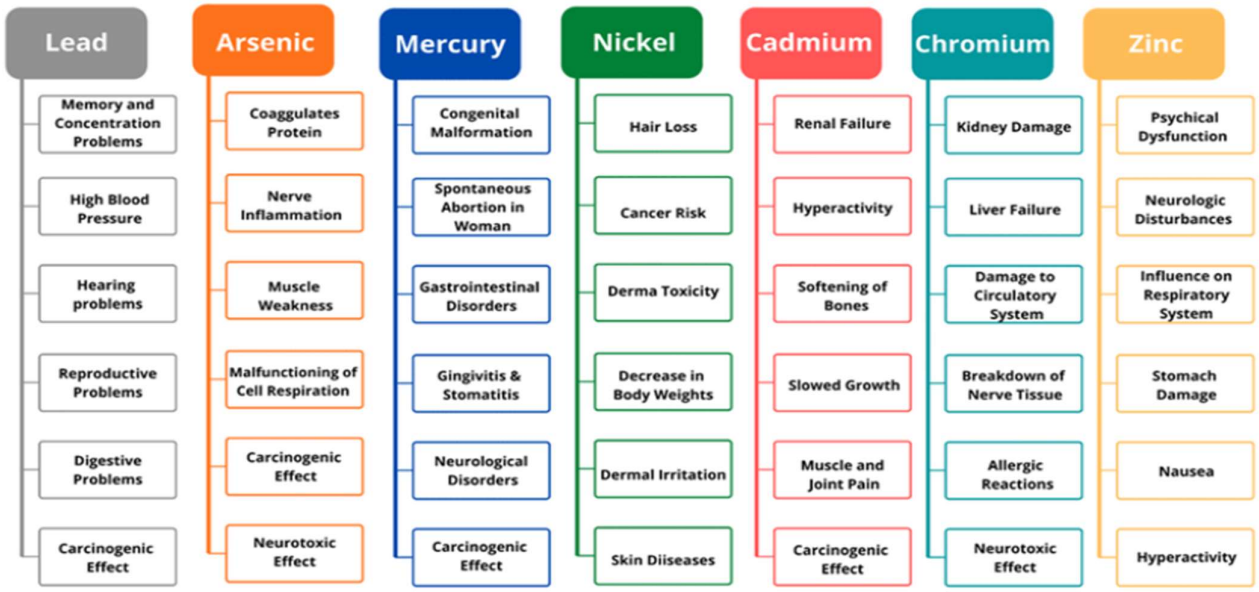
1) Chronic exposure of leaves to air pollutants can break down the waxy coating that helps prevent excessive water loss and leads to damage from diseases, pests, drought and frost.
2) Such exposure interferes with photosynthesis and plant growth, reduces nutrient uptake and causes the leaves to turn yellow, brown or drop off altogether.
3) At higher concentration of sulphur dioxide, most of the flower buds become stiff and hard; eventually fall off from the plants, as they are unable to flower.
4) Prolonged exposure to high levels of pollutants from iron smelters, coal- burning power plants and industrial units, as well as from vehicles, can damage trees and other plants.

Major toxic metals and their effects.

The effects on human health and the environment from exposure to the three most common heavy metal pollutants (mercury, lead and cadmium) include:

1) Mercury exposure can harm the brain, heart, kidneys, lungs, and immune system of people of all ages. In babies and young children, the nervous system can be affected making the child less able to think and learn.

2) Mercury accumulation in fish may harm the fish and other animals that consume them. Birds and mammals that eat fish are more exposed to mercury than other animals which live in aquatic ecosystems.
3) Cadmium is toxic to humans and exposure can cause pulmonary irritation, kidney disease, bone weakness and possibly lung, prostate, and kidney cancer. Food and cigarette smoke are the largest potential sources of cadmium exposure for the general population.
4) Lead cause neurodevelopmental effects in children, even at low levels of exposure.
5) Cadmium is toxic to humans and exposure can cause pulmonary irritation, kidney disease, bone weakness and possibly lung, prostate, and kidney cancer.



The Air (Prevention and Control of Pollution) Act, 1981

The Air (Prevention and Control of Pollution) Act, of 1981 is an essential legislation enacted by the Indian government to prevent and control air pollution. With rapid industrialization and urbanization, air pollution has become a severe problem in India, causing significant health and environmental impacts.

The Act aims to regulate and monitor air quality, establish pollution control boards, and enforce measures to prevent and control air pollution.

Prime Objectives:

1. To prevent air pollution by improving the quality and standard of the air.
2. To control air pollution by regulating industries causing air pollution
3. Preventing the emission of pollutants by industries into the atmosphere and abating them as necessary
4. To ensure that the environment and human life is protected from the adverse effects of air pollution
5. Reducing risk to public health from exposure to pollutants in ambient air quality

The Air Prevention and Control of Pollution Act 1981 has many features governed by the Central Pollution Control Board to protect the environment.

1. **Section 3** states that **State Pollution Control Boards and the Central Pollution Control Board** (CPCB) should exercise their range of powers without prejudice.
2. **Section 4** states that if a state has already established a Water Pollution Control Board, then the same should be given joint responsibility and prescribed authority to monitor and control air pollution. The joint body should be called State Pollution Control Board.

3. **Section 5** addresses the concern of a state not having a Water Pollution Control Board. It states that in such a case a new pollution Control Board should be set up.

4. **Section 16** carries the duties of the Central Pollution Control Board.

5. **Section 19**, State Pollution Control Boards can exercise their authority of declaring any area as an Air Pollution Control Area. Consultation with CPCB is required.

6. **Section 22** asserts that no individual or entity is allowed to emit pollutants in the air above the set standards by the relevant Pollution Control Board

7. **Section 26** provides special rights to officers of Boards for Pollution Control to carry out inspections and to take samples of the kinds of air pollutants from chimneys or ducts and test them for the existence of any dangerous pollutant.

8. **Section 28** allows the formation of new State Air Laboratories or declaring any existing lab as a State Air Lab by the relevant SPCBs

9. **Section 37** states that any person or entity who refuses to follow the rules and regulations of Section 21 and Section 22 will be seen as an offense punishable with an **imprisonment of 12 months and 6 months respectively,** but can be stretched to 6 years depending on type and intensity of the offense.

The key features of the Act include:

- Advising Central Government of Air and Air Pollution related issues
- Research about the causes and impact of Air Pollution.
- Spread awareness to stop air pollution
- To establish central and State Boards and empower them to monitor air quality and control pollution

Major environmental phenomenon

1) Acid rain

It is the term used for pollution caused by SO2 and NO2 when they combine with atmospheric moisture.

■When coal, oil and natural gas burn, sulphur dioxide and nitrogen dioxide are produced. These react with water in air and form sulphuric acid and nitric acid and return to the ground in the form of rain, fog or snow.

■Any precipitate or depositions having a pH lower than 5.6 as a result of contact with airborne particles having an adverse effect on flora & fauna on which it falls is called acid rain.

Causes Acid Rain

Acid rain results when sulphur dioxide (SO2) and nitrogen oxides (NOX) are emitted into the atmosphere and transported by wind and air currents.

The SO2 and NOX react with water, oxygen and other chemicals to form sulfuric and nitric acids. These then mix with water and other materials before falling to the ground.

While a small portion of the SO2 and NOX that cause acid rain is from natural sources such as volcanoes, most of it comes from the burning of fossil fuels.

The major sources of SO_2, and NO, in the atmosphere are

- Burning of fossil fuels to generate electricity. Two thirds of SO2 and one fourth of NOX in the atmosphere come from electric power generators.
- Vehicles and heavy equipment
- Winds can blow SO2 and NOX over long distances and across borders making acid rain a problem for everyone and not just those who live close to these sources.
  (1) Emissions of SO_2 and NO, are released into the air.
  (2) the pollutants are transformed into acid particles that may be transported long distances.
  (3) These acid particles then fall to the earth as wet and dry deposition (dust, rain, snow, etc.)
  (4) May cause harmful effects on soil, forests, streams, and lakes.

Measuring Acid Rain

■Acidity and alkalinity are measured using a pH scale for which 7.0 is neutral. The lower a substance's pH (less than 7), the more acidic it is; the higher a substance's pH (greater than 7), the more alkaline it is.

■Normal rain has a pH of about 5.6; it is slightly acidic because carbon dioxide (CO2) dissolves into it forming weak carbonic acid. Acid rain usually has a pH between 4.2 and 4.4.

Effects of Acid Rain on Fish and Wildlife

■The ecological effects of acid rain are most clearly seen in aquatic environments, such as streams, lakes, and marshes where it can be harmful to fish and other wildlife.

■Some types of plants and animals are able to tolerate acidic waters and moderate amounts of aluminium. Others, however, are acid-sensitive and will be lost as the pH declines.

■At pH 5, most fish eggs cannot hatch. At lower pH levels, some adult fish die.

Effects of Acid Rain on Plants and Trees

■Dead or dying trees are a common sight in areas effected by acid rain. Acid rain leaches aluminium from the soil. That aluminium may be harmful to plants as well as animals. Acid rain also removes minerals and nutrients from the soil that trees need to grow.

■At high elevations, acidic fog and clouds might strip nutrients from trees' foliage, leaving them with brown or dead leaves and needles. The trees are then less able to absorb sunlight, which makes them weak and less able to withstand freezing temperatures.

Solutions

■There are several solutions to stopping manmade acid rain. Regulating the emissions coming from vehicles and buildings is an important step.

■This can be done by restricting the use of fossil fuels and focusing on more sustainable energy sources such as solar and wind power.

■Also, each person can do their part by reducing their vehicle use. Using public transportation, walking, riding a bike or carpooling is a good start.

■People can also reduce their use of electricity, which is widely created with fossil fuels, or switch to a solar plan.

2) Greenhouse effect

The greenhouse effect is a natural process that warms the Earth's surface. When the Sun's energy reaches the Earth's atmosphere, some of it is reflected back to space and the rest is absorbed and re-radiated by greenhouse gases.

Greenhouse gases include water vapour, carbon dioxide, methane, nitrous oxide, ozone and some artificial chemicals such as chlorofluorocarbons (CFCs).

The absorbed energy warms the atmosphere and the surface of the Earth. This process maintains the Earth's temperature at around 33 degrees Celsius warmer than it would otherwise be, allowing life on Earth to exist.

Causes of greenhouse effect

The main reason for greenhouse effect is the emission of gases like nitrous-oxide, carbon-dioxide, methane, ozone and water vapor. The causes of these emissions have been listed below.

1) Deforestation: One of the major reasons for the greenhouse effect is deforestation. With the increase in population, more and more forests are being cut to provide accommodation and other amenities to people. This has led to an increase in the amount of carbon di-oxide in the atmosphere.
2) Burning of Fossil Fuels: We all know that burning of fossil fuels, like petroleum and oil, wood and gas results in release of pollutants into the atmosphere. With time, the consumption of fossil fuels, be it for industrial purposes or consumer purposes, has increased and with it, the pollution levels in the world.
3) Electrical Appliances: Electrical appliances are amongst the major contributors to the greenhouse effect. Refrigerators, air conditions or some other electric appliances emit gases, known as Chlorofluorocarbons (CFCs).
4) Industries: Most of the industries today add to the pollution levels and in turn, lead to the greenhouse effect. Aerosol cans, some foaming agents used in the packaging industry, fire extinguisher chemicals and cleaners used in the electronic industry contribute to this. Even some processes of the cement manufacturing industries can be counted amongst the culprits.

5) Automobiles: Automobiles, whether they run on petrol or diesel, create pollution and release harmful gases into the atmosphere. These gases, in turn, create the greenhouse effect in the atmosphere. The forever-increasing use of automobiles has only added to the problem.

3) Global Warming

Global warming is the slow increase in the average temperature of the earth's atmosphere because an increased amount of the energy (heat) striking the earth from the sun is being trapped in the atmosphere and not radiated out into space.

Since the pre-industrial period, human activities are estimated to have increased Earth's global average temperature by about 1 degree Celsius (1.8 degrees Fahrenheit), a number that is currently increasing by 0.2 degrees Celsius (0.36 degrees Fahrenheit) per decade.

Causes global warming

Global warming occurs when carbon dioxide (CO_2) and other air pollutants collect in the atmosphere and absorb sunlight and solar radiation that have bounced off the earth's surface.

Normally this radiation would escape into space, but these pollutants, which can last for years to centuries in the atmosphere, trap the heat and cause the planet to get hotter.

These heat-trapping pollutants-specifically carbon dioxide, methane, nitrous oxide, water vapor, and synthetic fluorinated gases-are known as greenhouse gases, and their impact is called the greenhouse effect.

Our current era of global warming is directly attributable to human activity-specifically to our burning of fossil fuels such as coal, oil, gasoline, and natural gas, which results in the greenhouse effect.

The carbon dioxide in the atmosphere has increased by 31% since pre-industrial times, causing more heat to be trapped in the lower atmosphere. Many countries have signed a convention to reduce Green House Gases (GHG) under the United Nations Frame work convention on climate change (UNFCC).

Effects of global warming

As the heat waves, droughts, and floods associated with climate change become more frequent and more intense, communities suffer and death tolls rise.

If we're unable to reduce our emissions, scientists believe that climate change could lead to the deaths of more than 250,000 people around the globe every year and force 100 million people into poverty by 2030.

Disappearing glaciers, early snowmelt, and severe droughts will cause more dramatic water shortages and continue to increase the risk of wildfires.

Rising sea levels will lead to even more coastal flooding on the Eastern Seaboard.

Forests, farms, and cities will face troublesome new pests, heat waves, heavy downpours, and increased flooding. All of these can damage or destroy agriculture and fisheries.

4) Ozone layer depletion

Ozone layer depletion is the gradual thinning of the earth's ozone layer present in the upper atmosphere.

When chlorine atoms react with ozone molecules, it leads to the depletion of ozone layer and releases oxygen molecules which do not absorb UV radiation.

Cause of ozone depletion

The main cause of ozone depletion and the ozone hole is manufactured chemicals, specially manufactured halocarbon refrigerants, solvents, propellants, and foam- blowing agents (chlorofluorocarbons (CFCs), HCFCs, halons).

Since the early 1970's, scientists observed reduction in stratospheric ozone and it was found more prominent in Polar Regions.

Effects Of Ozone Layer Depletion

The depletion of the ozone layer has harmful effects on the human health, animals, environment and marine life.

Studies demonstrate that an increase in UV-B rays causes a higher risk of skin cancer, plays a major role in malignant melanoma development, sunburns, quick ageing, eye cataracts, blindness and weekend immune system.

UV-B rays negatively affect plants, crops. It may lead to minimal plant growth, smaller leaf size, flowering and photosynthesis in plants, lower quality crops for humans. And decline in plant productivity would in turn affect soil erosion and the carbon cycle.

Direct exposure to ultraviolet radiations also leads to skin and eye cancer in animals.

Planktons and zooplankton are greatly affected by the exposure to UV-B rays. These are higher in the aquatic food chain. If the plankton's declines, it would likely have wide-reaching effects for all marine life in the lower food chain.

Solutions to Ozone Layer Depletion

Montreal Protocol was proposed in 1987 to unite the world to cut out production and import of ozone-depleting substances.

One should avoid using pesticides and shift to natural methods to get rid of pests instead of using chemicals.

The vehicles emit a large amount of greenhouse gases that lead to global warming as well as ozone depletion.

Air quality standards

• Air quality standards are generally health-based guidelines which seek to establish the concentrations of air pollutants to which the public can be exposed throughout their lifetime without significant adverse effects at a population level.

• Such standards cannot be totally protective, but risks to all but the most susceptible individuals should be negligible at concentrations below the air quality standard.

Types

The Clean Air Act identifies two types of national ambient air quality standards.

■ 1. Primary standards

■ 2. Secondary standards

Primary standards

■ Apply exclusively to human health

• Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly.

Secondary standards

• The secondary standards are concerned with protecting the environment.
• Apply to property damage and general welfare.
• These are designed to protect public welfare, transportation hazards, damage to animals, crops, vegetation, and buildings.

The six criteria air pollutants (CAP), or criteria pollutants, for which limits are set in the NAAQS (U.S. National Ambient Air Quality Standards) are

• Ozone (03)
• Atmospheric particulate matter.
•Lead
•Sulphur oxides (SOx)
• Carbon monoxide (CO)
• Nitrogen oxides (NOx).
• These are typically emitted from many sources in industry, mining, transportation, electricity generation and agriculture.
• In many cases they are the products of the combustion of fossil fuels or industrial processes.

Pollutant	Average Time	Concentration (µg/m3/or ppm)
PM10	Annual mean	20 µg/m3
	24 hour mean	50 µg/m3
PM2.5	Annual mean	10 µg/m3
	24 hour mean	25 µg/m3
O3	8 hour mean	100 µg/m3
NO2	Annual mean	40 µg/m3
	1 hour mean	200 µg/m3
SO2	24 hour mean	20 µg/m3
	10 minutes mean	500 µg/m3
CO	15	90 ppm
	30	50 ppm
	1 hour	25 ppm
	8 hour	10 ppm
Pb	Annual mean	0.5 µg/m3

AIR (Prevention and Control of Pollution) Act, 1981

• This is an Act for prevention, control and abatement of air pollution. It is also a comprehensive legislation with more than fifty sections.

It makes provisions for Central and State Boards, power to declare pollution control areas, restrictions on certain industrial units, authority of the Boards to limit emission of air pollutants, power of entry, inspection, taking same samples and analysis, penalties, offences by companies and Government and cognizance of offences etc.

• The Act specifically empowers State Government to designate air pollution areas and to prescribe the type of fuel to be used in these designated areas.

• According to this Act, no person can operate certain types of industries including the asbestos, cement, fertilizer and petroleum industries without consent of the State Board. The Board can predicate its consent upon the fulfilment of certain conditions.

The main objectives of the Act are as follows:

(a) To provide for the prevention, control and abatement of air pollution.

(b) To provide for the establishment of central and State Boards with a view to implement the Act.

(C) To confer on the Boards the powers to implement the provisions of the Act and assign to the Boards functions relating to pollution.

METEOROLOGICAL PARAMETERS INFLUENCING AIR POLLUTION

- Air movements influence the result of air pollutants. So any study of air pollution should include a study of the local weather patterns (meteorology).
- If the air is calm and pollutants cannot disperse, then the concentration of these pollutants will build up.
- On the other hand, when strong, turbulent winds blow, pollutants disperse quickly, resulting in lower pollutant concentrations.
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Meteorological data helps:

- identify the source of pollutants
- predict air pollution events such as temperature inversions and high- pollutant concentration days
- simulate and predict air quality using computer models.
- The meteorological parameters which have the most important influence on the diffusion of pollutants in the atmosphere are
  1) wind direction and speed
  2) Temperature
  3) Humidity
  4) Rainfall
  5) Solar radiation

Wind speed and direction

When high pollutant concentrations occur at a monitoring station, wind data records, can determine the general direction and area of the emissions.

Identifying the sources means planning to reduce the impacts on air quality can take place.

An instrument called an anemometer measures wind speed. At our monitoring stations, the type of anemometer we use is a sonic anemometer.

Temperature

Measuring temperature supports air quality assessment, air quality modelling and forecasting activities

Temperature and sunlight (solar radiation) play an important role in the chemical reactions that occur in the atmosphere to form photochemical smog from other pollutants.

Favourable conditions can lead to increased concentrations of smog.

Humidity

Like temperature and solar radiation, water vapour plays an important role in many thermal and photochemical reactions in the atmosphere.

As water molecules are small and highly polar, they can bind strongly to many substances.

If the water molecules attach to corrosive gases, such as sulfur dioxide, the gas will dissolve in the water and form an acid solution that can damage health and property.

Rainfall

Rain has a 'scavenging' effect when it washes particulate matter out of the atmosphere and dissolves gaseous pollutants.

Removing particles improves visibility. Where there is frequent high rainfall, air quality is generally better.

If the rain dissolves gaseous pollutants, such as sulfur dioxide, it can form acid rain resulting in potential damage to materials or vegetation.

Solar radiation

It is important to monitor solar radiation for use in modelling photochemical smog events, as the intensity of sunlight has an important influence on the rate of the chemical reactions that produce the smog

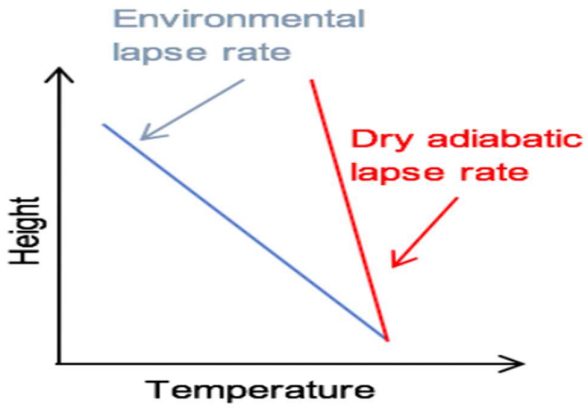
The cloudiness of the sky, time of day and geographic location all affect sunlight intensity.

An instrument called a pyranometer measures solar radiation from the output of a type of silicon cell sensor.

Environmental lapse rate

The environmental lapse rate (ELR), is the rate of decrease of temperature with altitude in the stationary atmosphere at a given time and location.

As an average, the International Civil Aviation Organization (ICAO) defines an international standard atmosphere (ISA) with a temperature lapse rate of 6.49 °C/km (3.56 °F or 1.98 °C/1,000 ft) from sea level to 11 km. From 11 km up to 20 km, the constant temperature is -56.5 °C (-69.7 °F), which is the lowest assumed temperature in the ISA.

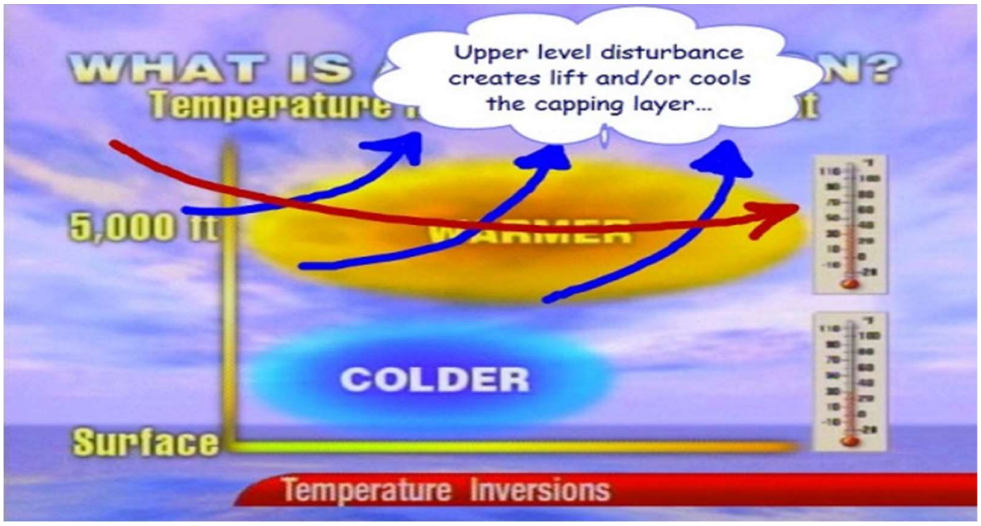


Temperature inversion

Temperature inversion, also called thermal inversion, a reversal of the normal behaviour of temperature in the troposphere (the region of the atmosphere nearest Earth's surface), in which a layer of cool air at the surface is overlain by a layer of warmer air.

Under normal conditions air temperature usually decreases with height.

Inversions play an important role in determining cloud forms, precipitation, and visibility. An inversion acts as a cap on the upward movement of air from the layers below.



ROLE OF NATIONAL GREEN TRIBUNAL IN INDIA

The National Green Tribunal, established in 2010, as per the National Green Tribunal Act is a specialised judicial body equipped with expertise solely for the purpose of adjudicating environmental cases in the country.

Recognising that most environment cases involve multi-disciplinary issues which are better addressed in a specialised forum, the Tribunal was setup as per recommendations of the Supreme Court, Law Commission and India's international law obligations to develop national laws on environment and implement them effectively.

The Tribunal is tasked with providing effective and expeditious remedy in cases relating to environmental protection, conservation of forests and other natural resources and enforcement of any legal right relating to environment. The Tribunal's orders are binding and it has power to grant relief in the form of compensation and damages to affected persons.

The Tribunal has a presence in five zones- North, Central, East, South and West. The Principal Bench is situated in the North Zone, headquartered in Delhi.

The Central zone bench is situated in Bhopal, East zone in Kolkata, South zone in Chennai and West zone in Pune.

The Tribunal is headed by the Chairperson who sits in the Principal Bench and has at least ten but not more than twenty judicial members and at least ten but not more than twenty expert members.

Any person seeking relief and compensation for environmental damage involving subjects in the legislations mentioned in Schedule I of the National Green Tribunal Act, 2010 may approach the Tribunal.

The statutes in Schedule I are:

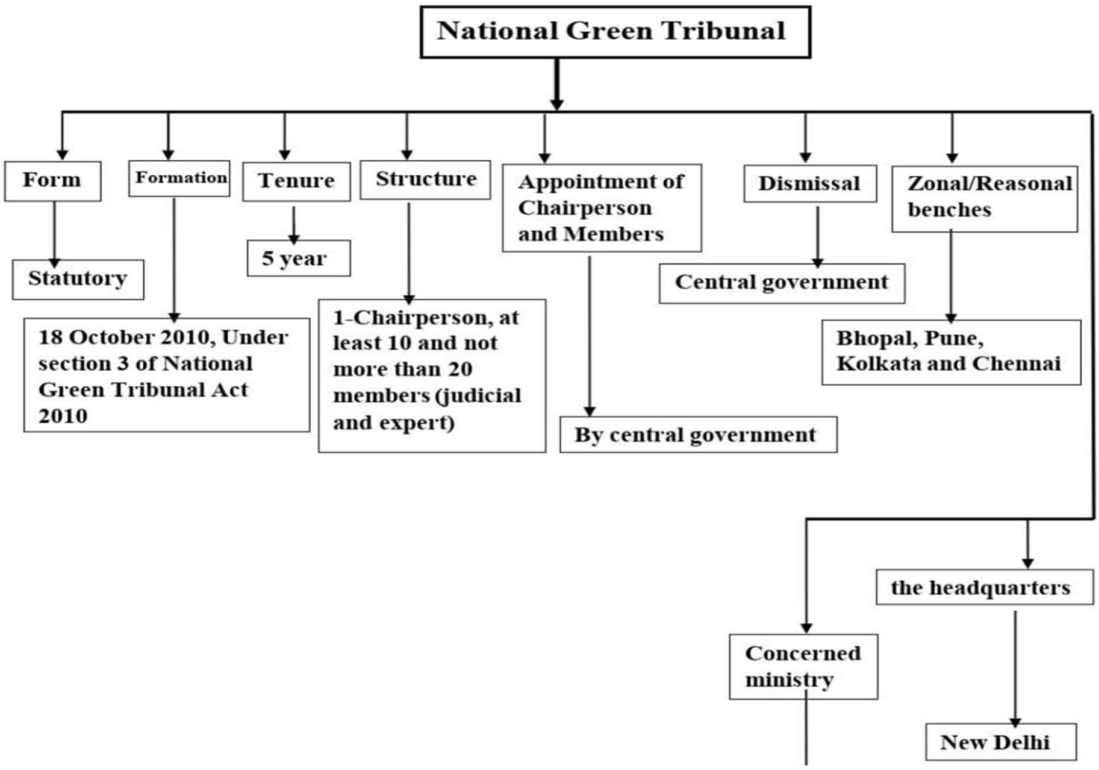
1. The Water (Prevention and Control of Pollution) Act, 1974;
2. The Water (Prevention and Control of Pollution) Cess Act, 1977;
3. The Forest (Conservation) Act, 1980;
4. The Air (Prevention and Control of Pollution) Act, 1981;
5. The Environment (Protection) Act, 1986;
6. The Public Liability Insurance Act, 1991;
7. The Biological Diversity Act, 2002.

The Tribunal has jurisdiction over all civil cases involving a substantial question relating to environment and the question. Additionally, any person aggrieved by an order/direction of any of the Appellate Authorities under the legislations mentioned above can also challenge them before the National Green Tribunal.

Some of the major objectives of the National Green Tribunal (NGT) are as follows:

- Effective and expeditious disposal of cases that are related to the protection and conservation of the environment, forests, and other natural resources.

- To give relief and compensation for any damages caused to persons and properties.
- To handle various environmental disputes that involve multi-disciplinary issues.



Functions Of The National Green Tribunal

- To resolve the issues related to the environment effectively and quickly.
- To protect and preserve forests.
- Conservation of natural resources.
- To protect the laws related to the environment.
- To provide financial security to any citizen in case of violation of his environment related rights.
- To spread awareness among the general public regarding environmental protection.
- To make efforts to provide clean environment to the common citizens of the country.
- It plays an important role in preventing activities that harm the environment.

FUNCTION OF REGULATORY BOARDS

1) CPCB
   - To promote cleanliness of water resources streams and wells in different areas of the States through prevention, control and abate
   - To improve the quality of air and to prevent, control or abate air pollution in the country;
   - Advise the Central Government on any matter concerning prevention and control of water and air pollution and improvement of the quality of air;
   - Plan and cause to be executed Nation-wide program for the prevention, control or abatement of water and air pollution
   - Provide technical assistance and guidance to the State Boards

- Plan and organize training of persons engaged in programs for prevention, control or abatement of water and air pollution
- Organize through mass media, a comprehensive mass awareness program on prevention, control or abatement of water and air pollution.
- Collect, compile and publish technical and statistical data relating to water and air pollution and the measures devised for their effective prevention, control and abatement.
- Prepare manuals, codes and guidelines relating to treatment and disposal of sewage and trade effluents as well as for stack gas cleaning devises, stacks and ducts.
- Lay down and modify, the standards for stream or well, and lay down standards for quality of air (in consultation with the State Government concerned)
- Establish or recognize laboratories to enable the Board to perform such other functions as and when prescribed by the Government of India.
- To issue directions to any industry, local bodies, or other authority for violation of the notified general emission and effluent standards, and rules relating to hazardous waste, bio-medical waste, hazardous chemicals, industrial solid waste, municipal solid waste including plastic waste under the Environment (Protection) Rules, 1986.

2) SPCB

- To plan a comprehensive programme for prevention, control or abatement of pollution of stream and well in the state.
- To advise the State govt. On matters relating to prevention control or abatement of water pollution
- To collect or disseminate information relating to prevention and control or abatement of water pollution
- To encourage, conduct and participate in investigations and research relating to prevention control of pollution.
- To collaborate with CPCB in organizing the training of person engaged in programmes relating to prevention, control or abatement of water pollution.
- To inspect sewage or trade effluent, works and plants for treatment of sewage.
- To lay down, or modify or annul effluent standards for the sewage and trade effluents and for the quality of receiving water and to classify the waters of the state
- To evolve economical and reliable method of treatment of sewage and trade effluent.
- To evolve methods of utilisation of sewage and suitable trade effluents in agriculture.
- To evolve efficient methods of disposal of sewage and trade effluents on land.
- To lay down standard of treatment of sewage and trade effluent to be discharge into in any particular stream.
- To make vary or revoke any order for the prevention and control or abetment of discharge of waste into streams or well.
- To lay down effluent standard to be complied with the person while discharging sewage