



# Distance Learning Programme

UPSC Prelims

## Environment & Ecology





drishti

# **ENVIRONMENT & ECOLOGY**

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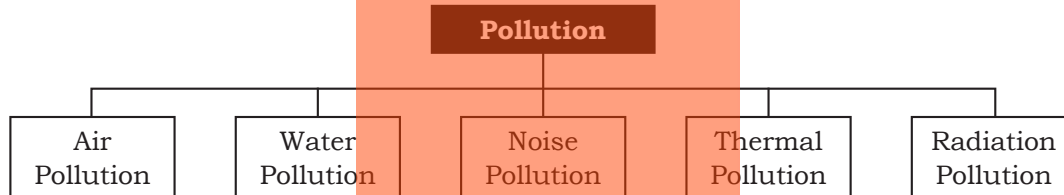
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As per Environment Protection Act (EPA), 1986 “Environmental Pollution” is the presence of pollutant. Pollutants have been defined as any solid, liquid or gaseous substance present in such a concentration as may be or may tend to be injurious to the environment.

The agents, which cause environmental pollution, are called pollutants. Pollutants are physical, chemical or biological substance intentionally or unintentionally released into the environment which is directly or indirectly harmful to humans and other living organisms. Pollution is studied under the following heads:



## Air Pollution

Air pollution is defined as the presence of any solid, liquid or gaseous substance, including noise and radioactive radiation in the atmosphere in such concentration that may be directly and indirectly injurious to humans or other living organisms, plants, property or interferes with the normal environmental processes.

Air pollutants can be classified into the following three types:

- **Natural Pollutants:** The pollutants which come out from natural sources such as forest fires started by lightning, dispersal of pollen, soil erosion, volcanic eruptions, volatile organic compounds from leaves and trees, decomposition of organic matter and natural radioactivity, etc. are natural pollutants.
- **Primary Pollutants:** A primary pollutant is a harmful substance that directly enters the air as a result of human activities. For example, when coal, oil, natural gas or wood is burnt, carbon dioxide and carbon monoxide are formed, automobiles contributing a large share of carbon monoxide. All these gases enter the atmosphere.

Another important pollutant is sulphur dioxide ( $\text{SO}_2$ ) which is added to the atmosphere by burning of coal and oil containing sulphur as an impurity in electric power plants. Other primary pollutants are oxides of nitrogen, hydrocarbons and suspended particulate matter.

- **Secondary Pollutants:** Secondary pollutants result from harmful chemical reaction between two or more air components. For example, sulphur dioxide, the primary pollutant reacts with oxygen in the atmosphere to form the secondary pollutant, sulphur trioxide ( $\text{SO}_3$ ) ( $2\text{SO}_2 + \text{O}_2 = 2\text{SO}_3$ ). The sulphur trioxide can then react with water vapour in the air to form droplets of sulphuric acid ( $\text{H}_2\text{SO}_4$ ), another secondary pollutant. Troposphere Ozone ( $\text{O}_3$ ) is another secondary pollutant.

## Sources of Air Pollution

- **Point Sources:** Industries, power plants, waste burning, etc.



- **Areal Sources:** Heating and cooling activities, burning of crop residues, forest fires, etc.
- **Line Sources:** Movement of traffic, air planes, etc.  
Air pollutants are of two types based on the state of pollutants:
- **Gaseous Pollutants:** Carbon Dioxide (CO<sub>2</sub>), Oxides of nitrogen, like NO<sub>x</sub> (N<sub>2</sub>O, NO<sub>2</sub>), etc.
- Suspended Particulate Matter (SPM).

<b>Gaseous Pollutants and Their Sources</b>	
<b>Pollutants</b>	<b>Source of Pollutants</b>
Carbon Compounds (CO and CO <sub>2</sub> )	Automobile exhaust, burning of wood and coal, indoor heating system, smoking. Burning of fossil fuels, power plants and refineries.
Sulphur Compounds (SO <sub>2</sub> and H <sub>2</sub> S)	Smelting of metallic ores like iron, copper, zinc, lead, rotting of weeds.
Nitrogen Compounds (NO and N <sub>2</sub> O)	Motor vehicle exhaust, electric power plants, soil microbes.
Hydrocarbons (benzene, ethylene)	Automobiles, cigarettes, refineries, paints and solvents, fossil fuels.
Aldehydes (Acrolein and formaldehyde)	Incomplete combustion of fossil fuels, formation of smog.

### Particulate Pollutants

Particulate matter suspended in air is dust, liquids and soot, is called Suspended Particulate Matter (SPM). It can be divided into dust, fume, mist, smoke and aerosols based on the size. Major source of SPM (suspended particulate matter) are vehicles, power plants, construction activities, oil refinery, railway yard, market place, industries, etc.

- Their size ranges from 0.001 to 500 micrometer in diameter. The size and weight, in particular, determine their suspension from a few seconds to months in the atmosphere.
- Particles less than 10µm (for example PM10 and PM2.5) are called Respirable Suspended Particulate Matter (RSPM). They float and move freely with the air current. Particles which are more than 10µm in diameter settle down.

### Aerosols

Aerosols are minute particles suspended in the atmosphere. They are of a size less than 1 micron. Particles of size less than 0.02µm form persistent aerosols. The aerosols remain constantly under the influence of the gravitational force of the earth.

The aerosols in the atmosphere are of two kinds: one is the natural, such as fog, bacteria, plant spores, pollen etc. These usually do not cause any atmospheric pollution.

The second type of aerosols, such as cement powder, flue dust from coal dust combustion, quartz and asbestos powder, oil smokes, tobacco smokes and radioactive aerosols are air pollutants due mainly to man's activities and cause constant damage and threat to the atmosphere.

### **Black Carbon (BC), or Carbon Black, or Elemental Carbon (EC)**

It is often called soot, composed of pure carbon clusters and skeleton balls, and is one of the most important light absorbing aerosols in the atmosphere. BC from fossil fuels, as estimated by the IPCC in the Fourth Assessment Report contribute, is a global mean radiative forcing.



## Hydrocarbons

Hydrocarbons are compounds made up of carbon and hydrogen. Some hydrocarbons have a direct effect on human beings and are carcinogenic in nature. They are produced during the production of coke and smouldering of refuse piles near coal mines or during improper burning of coal.

## Fly Ash

Fly ash is ejected mostly by thermal power plants as by-products of coal burning operations. Fly ash pollutes air and water and may cause heavy metal pollution in water bodies. It contains silica, iron oxides and other heavy metals. Fly ash affects vegetation as a result of its direct deposition on leaf surfaces or indirectly through its deposition on soil. Fly ash is now being used for making bricks and as a landfill material.

### Fly Ash

- **Use of Fly Ash:** Fly ash possesses good pozzolanic properties due to the presence of active and finely divided silica, alumina and calcium oxide, which provide it with cement like qualities in combination with lime rich material. Thus, fly ash emitted by thermal power plants can be used for manufacturing bricks, blocks, aggregates and cement production.
- The Fly Ash Utilisation Policy makes it mandatory to use only fly ash/ fly ash based products in the construction of buildings, roads and reclamation/compaction of land within a radius of 100 km from a coal or lignite based thermal power plant, thus displacing the cement use. It also mandates utilisation of Fly Ash for backfilling or stowing of the mines.

## Trace Air Pollutants

These are heavy metals found only in trace amounts. It causes extensive damage to ecosystem and human beings. The main causes of air pollution are:

- Industrial exhaust
- Burning of fossil fuels in Industries and automobiles, transport sector
- Particulates from road dust, crop burning, construction and demolition waste
- Emission from solid and liquid waste
- Mining operations
- Power plants

## Effect of Pollution

### On Human Beings

- Breathing polluted air puts you at a higher risk for asthma and other respiratory diseases.
- When exposed to ground ozone for 6 to 7 hours, healthy people's lung function decreased and they suffered from respiratory inflammation.
- Air pollutants are mostly carcinogens and living in a polluted area can put people at risk of Cancer.
- Coughing and wheezing are common symptoms observed on city folks.
- Damages the immune system, endocrine and reproductive systems.
- High levels of particle pollution have been associated with higher incidents of heart problems.



### **On Plants**

- Photochemical smog has a deleterious effect on plants. In the presence of sunlight, various pollutants combine to form ground ozone and per-oxy-acetyl nitrate (PAN).
- Ozone is extremely damaging to plants. It enters leaves through the stomata which are used for normal gas exchange, and alters the permeability of the membranes of the stomata. This causes nutrient-and electrolyte-imbances resulting in the death of the cells.
- In effect, ozone increases respiration of leaves, killing the plant by depleting its food. Chronic exposure to ozone may weaken plants and make them more susceptible to disease, or age them prematurely, reducing crop yields without signs of outward injury.
- PAN, the other component of photochemical smog, is phyto-toxic. It blocks the process of photosynthesis killing the plant by shutting down food production.
- Sulphur dioxide has a potential for serious damage to plants by contributing to acid rains. As said earlier, these rains leach nutrients from the soil and foliage, and affect soil organisms responsible for nitrogen fixation.
- Acids enhance the uptake by plants, of toxic heavy metals from soil. This has seriously affected the existing conifer forests in Europe and Western United States.

### **Control of Air Pollution**

#### **Control of Industrial Pollution**

- **Installing Devices:** Devices like filters, electrostatic precipitators, inertial collectors, scrubbers, gravel bed filters or dry scrubbers are used to control industrial pollution especially particulate matters.
- **Filters:** Filters remove particulate matter from the gas stream.
- **Electrostatic Precipitators (ESP):** The emanating dust is charged with ions and the ionized particulate matter is collected on an oppositely charged surface. The particles are removed from the collection surface by occasional shaking or by rapping the surface. ESPs are used in boilers, furnaces, and many other units of thermal power plants, cement factories, steel plants, etc.
- **Inertial Collectors:** It works on the principle that the inertia of SPM in a gas is higher than its solvent and as inertia is a function of the mass of the particulate matter this device collects heavier particles more efficiently. 'Cyclone' is a common inertial collector used in gas cleaning plants.
- **Scrubbers:** Scrubbers are wet collectors. They remove aerosols from a stream of gas either by collecting wet particles on a surface followed by their removal, or else the particles are wetted by a scrubbing liquid. The particles get trapped as they travel from supporting gaseous medium across the interface to the liquid scrubbing medium.
- **Removal of Gaseous Pollutants:** Gaseous pollutants can be removed by absorption in a liquid using a wet scrubber and depends on the type of the gas to be removed, for example, removal of sulphur dioxide alkaline solution is needed as it dissolves sulphur dioxide.
  - Gaseous pollutants may be absorbed on an activated solid surface like silica gel, alumina, carbon, etc. Silica gel can remove water vapour.
  - Condensation allows the recovery of many by products in coal and petroleum processing industries from their liquid effluents.



### Control of Vehicular Pollution

- **Use of Quality Fuel:** BS-IV has been adopted across the country in 2017 and the government has taken the decision to implement BS-VI norms by 2020 directly skipping BS-V.
- **Alternative Fuels:** Greater promotion and use of alternative fuels such as CNG/ LPG and electric vehicles/ Hybrid and battery based E- Rickshaw and buses.
- **Zero Emission Vehicles:** Non-motorised transport like cycle rickshaw, cycle and walking should be promoted.
- **Public Transport System:** Mass Transit System (MTS) should be promoted. Metro, BUS rapid transit, Urban rail should be adopted in big cities. It reduces dependence on private vehicles.
- **Urban Roads and Flyover Projects:** Dedicated bus lanes reduce congestion and hence emission can be reduced.
- **Tree Cover or Green Cover:** Plants reduce carbon dioxide and other pollutants.

### Green Crackers Developed by CSIR

- **Green Crackers:** These Crackers are named so because they “do not contain harmful chemicals”. Components in firecrackers are replaced with others that are “less dangerous” and “less harmful” to the atmosphere.
- **SWAS:** SWAS crackers eliminate usage of potassium nitrate ( $\text{KNO}_3$ ) and Sulphur with consequent reduction in particulate matter (30-35%),  $\text{SO}_2$  and  $\text{NO}_x$ . It has a matching sound intensity with commercial crackers in the range of 105-110 dBA.
- **STAR:** STAR eliminates usage of  $\text{KNO}_3$  and Sulphur with consequent reduction in particulate matter (35-40%),  $\text{SO}_2$  and  $\text{NO}_x$ . It has a matching sound intensity with commercial crackers in the range of 105-110 dBA.
- **SAFAL:** SAFAL has minimal usage of aluminium (only in flash powder for initiation) with consequent significant reduction in particulate matter (35-40%) compared to commercial crackers. It has a matching sound intensity with commercial crackers in the range of 110-115 dBA.
- **Flower Pots for Substitution of  $\text{BaNO}_3$  (Barium Nitrate):** Flower pots by using “eco-friendly materials”, has been developed by CSIR-CECRI that can potentially reduce particulate matter by 30-35%.
- **E-crackers:** They are a string of pods connected to each other using wires, along with flashing LEDs. Each pod contains a high-voltage generator, which sparks itself internally at random intervals. These high-voltage sparks create a cracking sound to mimic firecrackers. LEDs are just to create flashing lights.
  - **E-ladi:** It is based on high-voltage electrostatic discharge to generate light/sound effect. It is triggered by providing heat to the thermal switch which will give the excitement of firing the conventional cracker. The E-Ladi is also programmable to give various light/sound effect. A functional prototype has been developed by CSIR-CEERI Pilanihas.
- **Post Combustion Control System and Devices:** CSIR-NEERI is planning to use area source control through the development of new systems called PURE-WAYU as also the photo chip material for local dust control.
- **Reduced Emission Crackers:** CSIR-CECRI, Karaikudi has developed reduced emission crackers through the replacement of commonly used Aluminium with Magnesium and Magnesium based compounds in flash powder.





- **Flower Pot:** This category of fire cracker essentially comprises of alkali nitrates, aluminium powders of different grain sizes and in some cases the binder to enhance luminescence. Aluminium has been used as a primary heat source and to produce flash.
  - To reduce the ignition temperature and subsequently to minimize the particulate matter, Magnesium could be a viable alternative to Aluminium.
  - Alternate chemical formulations for flower pots were prepared by replacing Aluminium with Magnesium chips and Magnesium based compounds.
  - **Jil Jil and Atom Bomb:** These are chemically modified formulation for flower pots developed by CSIR-CECRI along with Krishna Fireworks, Sivakasi. These flower pots are developed by using eco-friendly materials with consequent implications on particulate matter (PM) reduction by 25-30%.
- **Bijli Cracker:** It is modified form of cracker being developed by CSIR-NEERI by eliminating the use of ash as desiccants for reduction of particulate matter by 20%.

## Indoor Air Pollution

It refers to the physical, chemical, and biological characteristics of air in the indoor environment within a home, building, or an institution or commercial facility. Different conditions are responsible for indoor air pollution in the rural areas and the urban areas.

Poor ventilation due to faulty design of buildings leads to pollution of the confined space.

In congested areas, slums and rural areas, the burning of firewood and biomass results in lot of smoke.

### Major Indoor Air Pollutants

- **Volatile Organic Compounds:** They originate mainly from solvents and chemicals. Perfumes, hair sprays, furniture polish, glues, air fresheners, moth repellents, wood preservatives, etc., are the main indoor sources. The main health effect is the irritation of the eye, nose and throat. In more severe cases there may be headaches, nausea and loss of coordination.
- **Tobacco Smoke:** It generates a wide range of harmful chemicals and is known to cause cancer. They cause a wide range of problems to the passive smokers from burning eyes, nose, and throat irritation to cancer, bronchitis, severe asthma, and a decrease in lung function.
- **Pesticides:** This is also a harmful chemical which, if used carefully and the manufacturers, instructions followed carefully they do not cause too much harm to the indoor air.
- **Biological Pollutants:** They include pollen from plants, mite, hair from pets, fungi, parasites, and some bacteria. Most of them are allergens and can cause asthma, hay fever, and other allergic diseases.
- **Formaldehyde:** It is a gas that comes mainly from carpets, particle boards, and insulation foam. It causes irritation to the eyes and nose and may cause allergies in some people.
- **Asbestos:** It is mainly a concern because it is suspected to cause cancer.
- **Radon:** It is a gas that is emitted naturally by the soil. Due to modern houses having poor ventilation, it is confined inside the house causing harm to the dwellers.

### Prevention and Control of Indoor Air pollution

- Use of wood and dung cakes should be replaced by cleaner fuels such as biogas, kerosene or electricity.



- Improved stoves for looking like smokeless chullahs have high thermal efficiency and reduced emission of pollutants including smoke.
- The house designs should incorporate a well ventilated kitchen. The use of biogas and CNG need to be encouraged.
- Those species of trees such as baval (*Acacia nilotica*) which are least smoky should be planted and used.

#### **National Biomass Cook Stoves Initiatives (NBCI)**

National Biomass Cook Stoves Initiative (NBCI) was launched on 2<sup>nd</sup> December 2009 at New Delhi with the primary aim to enhance the use of improved biomass cook stoves. As follow up to the National Biomass Cook-stove Initiative (NBCI), the Ministry initiated a new proposal for promoting the development and deployment of Unnat Chulhas (Biomass Cookstoves) in the country during the 12<sup>th</sup> Plan Period.

#### **Lightening a Billion Lives**

Lighting a Billion Lives is a global initiative led by TERI (The energy and Resources Institute, Delhi) to facilitate clean energy access and the delivery of last mile energy services for basic and productive use. The initiative enables energy poor communities to transition from traditional and inefficient energy sources to modern, more efficient and sustainable energy solutions.

The interventions focused their efforts towards the achievement of three main objectives:

- To replace inefficient and harmful lighting and cooking methods with efficient, affordable and reliable clean energy alternatives.
- To enable the productive use of clean energy for enhanced education, better health and improved livelihood opportunities – thereby empowering the poor to escape the poverty trap.
- To facilitate access and adoption of demand responsive solutions at the last mile through capacity building and enterprise development.

#### **Pradhan Mantri Ujjwala Yojana (PMUY)**

Pradhan Mantri Ujjwala Yojana was launched by Ministry of Petroleum and Natural Gas. Under this scheme LPG connections will be provided to BPL families with a support of ₹1600 per connection.

- It aims to safeguard the health of women & children by providing them with a clean cooking fuel – LPG, so that they don't have to compromise their health in smoky kitchens or wander into unsafe areas collecting firewood.
- Ensuring women's empowerment, especially in rural India, the connections will be issued in the name of the women of the households. Identification of the BPL families will be done through Socio Economic Caste Census Data.

## **Initiatives of Indian Government**

### **National Air Quality Monitoring Programme (NAMP)**

The Central Pollution Control Board is executing a nationwide programme of ambient air quality monitoring known as National Air Quality Monitoring Programme (NAMP). The network consists of Six hundred and Eighty Three (683) operating stations covering Three Hundred (300) cities/towns in twenty nine (29) states and seven (7) Union Territories of the country.