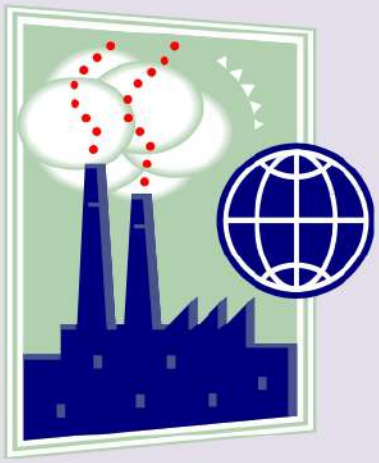
ENVIRONMENTAL POLLUTION



ENVIRONMENTAL SCIENCE (AECC-1) PROJECT

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DEFINITION OF ENVIRONMENTAL POLLUTION

Pollution is the effect of undesirable changes in our surroundings that have harmful effects on plants, animals and human beings. This occurs when only short-term economic gains are made at the cost of the long-term ecological benefits for humanity.

TYPES OF POLLUTION

Air Pollution
Water Pollution
Soil Pollution
Sound / Noise Pollution
Thermal Pollution

(1) AIR POLLUTION

Definition :- It can be defined as addition of any contaminant to the air which causes harm to the health of living organisms.

Causes of Air Pollution

Air may get polluted by natural causes such as volcanoes which release ash, dust, sulphur and other gases, or by forest fires that are occasionally naturally caused by lightning. However, unlike pollutants from human activity, naturally occurring pollutants tend to remain in the atmosphere for a short time and do not lead to permanent atmospheric change.

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Some common causes that contribute to air pollution are :-

- Burning fossil fuels
- Mining operations
- Exhaust gases from industries and factories
- Exhaust gases from vehicles like cars, rails, aircrafts, etc.

Effects of Air Pollution

The impact of air pollution ranges from :

- Increased risk of respiratory illness and cardiovascular problems
- Increased risk of skin diseases
- May increase the risk of cancer
- Global warming
- Acid rain
- Ozone depletion
- Hazards to wildlife

(1) EFFECTS OF AIR POLLUTION ON LIVING ORGANISMS :-

- When the upper respiratory system is irritated by pollutants sneezing and coughing expel contaminated air and mucus.
- Prolonged smoking or exposure to air pollutants can overload or breakdown these natural defenses causing or contributing to diseases such as lung cancer, asthma, chronic bronchitis and emphysema. Cigarette smoking is responsible for the greatest exposure to carbon monoxide.

- Sulphur dioxide irritates respiratory tissues. Chronic exposure causes a condition similar to bronchitis.
- Nitrogen oxides especially NO_2 can irritate the lungs, aggravate asthma or chronic bronchitis.
- Irritation of eyes, throat, nose and respiratory system.

(II) EFFECTS ON PLANTS :-

When some gaseous pollutants enter leaf pores they damage the leaves of crop plants. Chronic exposure of the 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. Such exposure interferes with photosynthesis and plant growth, reduces nutrient uptake and causes leaves to turn yellow, brown or drop off altogether.
At a higher concentration of sulphur dioxide majority of the flower buds become stiff and hard. They eventually fall from the plants as they are unable to flower.

(III) EFFECTS OF AIR POLLUTION ON MATERIALS :-

Every year air pollutants cause damage worth billions of rupees. Air pollutants break down exterior paint on cars and houses.

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All around the world air pollutants have discoloured irreplaceable monuments, historic buildings, marble statues, etc.

(IV) **EFFECT ON CLIMATE :-**

Carbon cycle is broken (as forests are cut consumption of CO_2) CO_2 is heavy gas and has capacity to absorb the heat. Rise of CO_2 has caused the global warming. The release of CFC gases have made an impact on ozone layer due to the ozone depletion, cosmic rays reaches to earth increasing temperature of earth.

Control Measures for Air Pollution

Air pollution can be controlled by two fundamental approaches: preventive techniques and effluent control. There are various air pollution control technologies and land use planning strategies available to reduce air pollution.

Following are the commonly used pollution control devices by industry or transportation devices. They can either destroy contaminants or remove them from an exhaust stream before it is emitted into the atmosphere.

(4) **VOC (Volatile Organic Compounds) ABATEMENT :-**

- Adsorption systems, such as activated carbon
- Flares
- Thermal oxidizers
- Catalytic converters
- Biofilteres
- Absorption (scrubbing)
- Cryogenic condensers
- Vapor recovery systems

(2) **WATER POLLUTION**

Water is the essential element that makes life on earth possible. Without water there would be no life. We usually take water for granted.

Definition :- When the physical, chemical or biological composition of freshwater, ground-water or saline water changes directly or indirectly as a result of anthropological activities such that it becomes unfit for any purpose and may pose threat to humans or aquatic life, it is said to be polluted.

■ **Causes of Water Pollution**

- The disease causing agents (pathogens) which include bacteria, viruses, protozoa and parasitic worms that enter water from domestic sewage and untreated human and animal wastes. Large populations of bacteria use up the oxygen present in water to degrade these wastes. In the process this degrades

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(1) PARTICULATE CONTROL :-

- Mechanical collectors (dust cyclones, multicyclones) - electrostatic precipitators or elestrostatic air cleaner is a particulate collection device that remones particles from a flowing air/gas using force of an induced electrostatic charge.
- It is highly efficient filtration devices which can easily remone fine particulate matter such as dust and smoke form the air stream.
- Particulate scrubber / wet scrubber is a form of pollution control technology in which polluted gas stream is brought in contact with the scrubbing liquid by spraying it with the liquid by forcing it through a pool of liquid or by some other contact method so as to remone the pollutants.

(2) NOx (Nitric Oxide) CONTROL :-

- Low NOx burner
- Selective catalytic reduction (SCR)
- Selective non-catalytic reduction (SNCR)
- NOx scrubbers Exhaust gas recirculation (EGR)
- Catalytic converter (also for VOC control)

(3) ACID GAS / SO_2 CONTROL :-

- Wet scrubbers
- Dry scrubbers
- Flue-gas desulfurization

water quality. The amount of oxygen required to break down a certain amount of organic matter is called the biological oxygen demand (BOD). The amount of BOD in the water is an indicator of the level of pollution.

- The water soluble inorganic chemicals which are acids, salts and compounds of toxic metals such as mercury and lead. High levels of these chemicals can make the water unfit to drink, harm fish and other aquatic life, reduce crop yields and accelerate corrosion of equipment that uses this water.

Some common causes of water pollution are:-

- Dumping solid wastes in water bodies
- Disposing untreated industrial sewage into water bodies
- Human and animal wastes
- Agricultural runoff containing pesticides and fertilisers
- Spillage from oil rigs, pipelines and tankers

Groundwater Pollution

Groundwater flows slowly, hence the contaminants are not effectively diluted and dispersed as compared to surface water. Moreover, pumping groundwater and treating it is very slow and costly. Hence it is extremely essential to prevent the pollution of groundwater in the first place.

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Groundwater pollution is caused due to :-

- seepage of industrial and municipal wastewater.
- application of large amounts of fertilisers and pesticides
- leakage from underground storage tanks containing chemicals
- poorly designed and inadequately maintained septic tanks
- contamination due to mining operations

Effects of Water Pollution

- The toxic chemicals can bioaccumulate in living beings and these chemicals can travel their way up the food chain, ultimately reaching humans.
- Excess of nitrates in drinking water leads to formation of compounds in the body that change haemoglobin to methaemoglobin, decreasing the ability of blood to carry oxygen. In infants, the condition can be fatal. Methaemoglobinemia is a condition caused by elevated levels of methaemoglobin in the blood. This condition is also known as the Blue Baby Syndrome.
- Excess fluorides cause deformations of teeth, hardened bones and stiff joints and this condition is called skeletal fluorosis.
- Water pollution changes the physical, chemical and biological state of aquatic ecosystems. It increases the rate of decomposition of organic matter in the water.
- Demand for oxygen (Dissolved Oxygen - DO) is directly

related to increasing input of organic waste and is expressed as Biochemical Oxygen Demand (BOD). It is a measure of oxygen required by aerobic decomposers for the biochemical degradation of organic matter present in the water. Higher the BOD, lower would be the DO.

- Chemical Oxygen Demand (COD) is another measure of pollution load in the water. It is the measure of oxygen equivalent to the requirements for oxidation of total organic matter (biodegradable + non-biodegradable) present in the water.
- Contamination of water bodies will reduce the levels of DO and aquatic flora and fauna will die off. Some tolerant species might be able to survive and are known as indicator species (like helminths).
- Rapid Test can be used to quickly assess the pH, TDS and DO levels in a given sample. Polluted water has DO < 8.0 mg/L whereas heavily polluted water has DO < 4.0 mg/L.

Control Measures for Water Pollution

- While the foremost necessity is prevention, setting up effluent treatment plants (ETPs) and treating waste through these can reduce the pollution load in the recipient waters. The treated effluent can be reused for either gardening or cooling purposes wherever possible.
  - ⊙ Primary Treatment :- physical process to separate large detritus, followed by sedimentation in sedimentation or clarification tanks.

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⊙ Secondary Treatment :- biological process to decompose organic matter (using microorganisms and algae) which settles down as sludge which is aerated continuously.

⊙ Tertiary Treatment :- biochemical process to remove turbidity of water caused due to nitrogenous compounds by strong oxidizing agents like Cl_2, ozone and UV rays.

- Using organic fertilizers in crop fields
- Industrial waste management.

(3) SOIL POLLUTION

Definition :- Soil pollution refers to the alteration in the composition of the soil by certain pollutants that cause contamination of soil and degrade the soil quality. It occurs when the pollutants causing the pollution reduce the quality of the soil and convert the soil inhabitable for microorganisms and other organisms living in the soil.

▲ Causes of Soil degradation

- **SOIL EROSION**

Erosion of soil can be defined as the movement of surface litter and top soil from one place to another. While erosion is a natural process often caused by wind and flowing water it is generally accelerated by human

activities such as farming, construction, overgrazing by livestock, burning of grass cover and deforestation. Loss of the topsoil makes a soil less fertile and reduces its water holding capacity. The topsoil, which is washed away also contributes to water pollution clogging lakes, increasing turbidity of the water and also leads to loss of acquatic life. For one inch of topsoil to be formed it normally requires 200 - 1000 years depending upon the climate and soil type. Thus if the topsoil erodes faster than it is formed the soil becomes a non-renewable resource.

- **EXCESS USE OF FERTILIZERS**

Approximately 25 percent of the world's crop yield is estimated to be directly attributed to the use of chemical fertilizers. The use of chemical fertilizers has increased significantly over the last few decades and is expected to rise even higher. Fertilizers are very valuable as they replace the soil nutrients used up by plants. The three primary soil nutrients often in short supply are potassium, phosphorus and nitrogen compounds. These are commonly referred to as macronutrients. Certain other elements like boron, zinc and manganese are necessary in extremely small amounts and are known as micronutrients. When crops are harvested a large amount of macronutrients and a small amount of micronutrients are removed with the crops. If the same crop is grown again depleted levels of these nutrients can result in

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decreased yields.

- **PROBLEMS WITH PESTICIDE USE**

Pesticides not only kill the pests but also a large variety of living things including humans and destroy the soil quality. However more and more farmers are increasingly opting to replace chemical fertilizers and use different methods of controlling pests without affecting their yield.

- **EXCESS SALTS AND WATER**

Irrigation water contains dissolved salts and in dry climates much of the water in the saline solution evaporates leaving its salts such as sodium chloride in the topsoil. The accumulation of these salts is called salinization, which can stunt plant growth, lower yields and eventually kill the crop and render the land useless for agriculture. These salts can be flushed out of the soil by using more water.

Another problem with irrigation is water logging. This occurs when large amounts of water is used to leach the salts deeper into the soil. However if the drainage is poor this water accumulates underground gradually raising the water table. The roots of the plants then get enveloped in this saline water and eventually die.

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Effects of soil pollution

- Loss of soil nutrients which renders the soil unfit for agriculture.
- Impacts the natural flora and fauna residing in the soil.
- Degrades vegetation due to the increase of salinity of the soil.
- Toxic dust (such as silica dust) can cause respiratory problems or even lung cancer.

Control Measures for Soil Pollution

Some of the most commonly employed methods include the following types of treatment that are generally used :-

- Area treatment which involves treating the land
- Drainage line treatment which involves treating the natural water courses (nalas).
- Continuous contour trenches can be used to enhance infiltration of water, reduce the runoff and check soil erosion. These are actually shallow trenches dug across the slope of the land and along the contour lines basically for the purposes of soil and water conservation. They are most effective on gentle slopes.
- Live check dams which barriers created by planting grass, shrubs and trees across the gullies can be used for this purpose.

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- By reducing the use of pesticides and chemical fertilizers.
- Develop necessary legislation on soil pollution control and proper management of agricultural land and the practice of organic farming.

(4) NOISE POLLUTION

Noise is an undesirable and unwanted sound. Not all sound is noise. What may be considered as music to one person may be noise to another. It is not a substance that can accumulate in the environment like most other pollutants. Sound is measured in a unit called the 'DECIBEL'. Measurement of intensity of sound :-

- The unit is dB (decibel), the range extends between 1 to 140 dB. When it is less than 1dB we can not hear it and when it is more than 140 dB we can not stand to it.
- Normal talk sound intensity is 40 dB and shouting 60 dB and whispering 30 dB.
- Industrial machines 90 dB, traffic busy road with high speed vehicles 70 dB.
- Thunderstorm with lightning 120 dB, near Airports it is 150 dB, Rocket engines 190 dB.

Definition :- Noise is unpleasant, high intensity sound which pollutes the calmness of society is called noise pollution.
Our ears can hear ordinary conversation between 30-60 dB. A decibel value greater

than 80 dB causes noise pollution. Noise pollution becomes troublesome above 140 dB.

Causes of Noise Pollution

- Industrial activities :- pneumatic industries, textile industries, steel rolling industries, wood cutting mills.
- Transport activities :- automobiles, railways, aeroplanes
- Domestic activities :- T.V., radio, tape recorder, mixers, grinders
- Cultural activities :- festivals, religious programmes, marriage functions, public speeches.
- Agricultural activity :- tractors, threshers
- Defence activity :- tanks, gunfire, aeroplanes, bombs, army exercises
- Mining activities :- blasting
- Other activities :- stone crushing, construction of dams, tunnels, roads, landslides and earthquakes are the natural sources of noise pollution.

Effects of Noise Pollution

The noise pollution creates temporary as well as permanent problems to the human beings, the noise pollution can have physical, physiological and psychological effects

- Physical effects :- temporary hearing problems, permanent deafness, damage to tympanic

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membrane.

- Physiological effects :- headache, pains in the heart, reduction in the vision, rise in blood pressure, loss of memory.
- Psychological effects :- depression, fatigue, emotional disturbance, frustration irritation
- Loud and sudden noise affects the brain. Intermittent noise leads to a higher incidence of psychiatric illness and also a danger to health of pregnant mothers and small infants.
- Noise has harmful effects on non-living materials too, eg.- cracks develop under the stress of explosive sounds.
- Tinnitus, sleeping disorders, hypertension (high BP) are some other common effects of noise pollution.

Control measures for Noise Pollution

- Using earplugs, ear muffs, noise helmets, headphones
- Reducing the noise pollution at source
- Heavy vehicles should not be allowed into narrow streets
- Heavy traffic on the residential streets must be reduced.
- Use of air pressure horns should be prohibited
- Laws regarding noise pollution must be followed
- Areas like schools, hospitals must be kept silence zone.
- Social awareness program should be taken up to educate the public about the causes

and effects of noise pollution
- Planting bushes; trees in and around sound generating source is an effective solution for noise pollution.
- Regular servicing and tuning of vehicles can effectively reduces noise pollution.
- Buildings can be designed with suitable noise absorbing materials for walls, windows and ceilings.
- Soundproof doors and windows can be installed to block unwanted sound
- Factories and industries should be located far from the residential area

(5) THERMAL POLLUTION

Definition :- The discharge of warm water into a river is usually called a thermal pollution. It occurs when an industry removes water from a source, uses the water for cooling purposes and then returns the heated water to its sources.

▲ Causes of Thermal Pollution

- The single biggest cause of thermal pollution is probably cooling for industrial machinery and power plants. Water is an excellent and free, cooling agent. This is why many industrial operations pull in relatively cool water to cool their machinery and let the relatively warm water flow back into the

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river or lake or sea.

- Thermal pollution also has some natural causes. Geothermal vents and hot springs introduce excess heat into bodies of water. Soil erosion, deforestation, and runoff from paved areas are other artificial sources of hot water. Deforestation eliminates shade, which exposes the water to sunlight. Water on hot paved surfaces gets hot, then runs off into nearby bodies of water, raising the water temperature. Retention ponds can also be a source of thermal shock because the relatively small and shallow bodies of water can absorb quite a bit of heat energy from the sun. Pumping that water directly into a river, lake or bay causes a significant temperature increase, just like pouring a hot pitcher of water into a bathtub full of water causes the water to jump a few degrees Fahrenheit.

▲ Effects of Thermal Pollution

- The warmer temperature decreases the solubility of oxygen and increases the metabolism of fish. This changes the ecological balance of the river. Within certain limits thermal additions can promote the growth of certain fish and the fish catch may be high in the vicinity of a power plant. However sudden changes in temperature caused by periodic plant shutdowns both planned and unintentional can change results in death of these fish that

are acclimatized to living in warmer waters.

- Tropical marine animals are generally unable to withstand a temperature increase of 2 to 3°C, this results in a change in the diversity of fauna as only those species that can live in warmer water survive.

Control Measures for Thermal Pollution

- Thermal pollution can be controlled by passing the heated water through a cooling pond or a cooling tower after it leaves the condenser. The heat is dissipated into the air and the water can then be discharged into the river or pumped back to the plant for reuse as cooling water.
- One method is to construct a large shallow pond. Hot water is pumped into one end of the pond and cooler water is removed from the other end. The heat gets dissipated from the pond into the atmosphere.
- Another method is to use a cooling tower. These structures take up less land area than the ponds. Here most of the heat transfer occurs through evaporation. Here warm water coming from the condenser is sprayed downwards over vertical sheets or baffles where the water flows in thin films. Cool air enters the tower through the water inlet that encircles the base of the towers and rises upwards causing evaporative cooling. The disadvantages in both these methods is that large amounts of water are lost by evaporation

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POLLUTANTS

Definition :- Pollutants include solid, liquid or gaseous substances present in greater than natural abundance produced due to human activity, which have a detrimental effect on our environment. The nature and concentration of a pollutant determines the severity of detrimental effects on human health.

CLASSIFICATION / TYPES OF POLLUTANTS

From an ECOLOGICAL PERSPECTIVE pollutants can be classified as follows :

- **DEGRADABLE OR NON-PERSISTENT POLLUTANTS**

These can be rapidly broken down by natural processes. For example :- domestic sewage, discarded vegetables, etc.

- **SLOWLY DEGRADABLE OR PERSISTENT POLLUTANTS**

Pollutants that remain in the environment for many years in an unchanged condition and take decades or longer to degrade. For example :- DDT and most plastics.

- **NON-DEGRADABLE POLLUTANTS**

These cannot be degraded by natural processes. Once they are released into the environment they are difficult to eradicate and continue to accumulate. For example :- toxic elements like

lead or mercury.

From a SOURCE PERSPECTIVE pollutants can be classified as follows :-

- **POINT - SOURCE OF POLLUTION**

It is readily identified as it has a definite source and place. As the name suggests, it comes from a single source.
The United States Environmental Protection Agency (EPA) defines point source pollution as any contaminant that enters the environment from an easily identified and confined place.
Examples include Municipal and Industrial Discharge Pipes, smokes stacks

- **NON - POINT - SOURCE OF POLLUTION**

It is the opposite of point source of pollution, as it cannot be readily identified like pollutants released in a wild area.
Examples include agricultural runoff, acid rain, during a thunderstorm and rain runoff water is a big problem in cities because of all the hard surfaces, including streets and roofs, etc.

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On the basis of the form in which they persist after being released into the NATURE POLLUTANTS can be classified as follows :-

- **PRIMARY POLLUTANTS**

These are directly emitted from the identifiable source and persist in the form in which they were added to the environment.
Typical examples of this type of pollutants include natural events (like dust storms and volcanic eruptions) and human activities (like emission from vehicles, industries, etc.)
There are five primary pollutants that together contribute about 90 percent of the global air pollution. These are carbon oxides (CO and CO_2), nitrogen oxides, sulphur oxides, volatile organic compounds (mostly hydrocarbons) and suspended particulate matter.

- **SECONDARY POLLUTANTS**

These are formed from primary pollutants by chemical interactions with some constituents present in the atmosphere.
Examples are sulphur trioxide, sulphuric acid, nitric acid, aldehydes, ketones, ozone, etc

AIR QUALITY INDEX (AQI)

* What is Air Quality Index (AQI)?

The air quality index (AQI) is an index for reporting air quality on a daily basis. It is a measure of how air pollution affects one's health within a short time period. The purpose of the AQI is to help people know how the local air quality impacts their health. The Environmental Protection Agency (EPA) calculates the AQI for five major air pollutants, for which national air quality standards have been established to safeguard public health.

1. Ground-level ozone
2. Particle pollution / particulate matter (PM2.5/pm 10)
3. Carbon Monoxide
4. Sulphur dioxide
5. Nitrogen dioxide

The higher the AQI value, the greater the level of air pollution and the greater the health concerns. The concept of AQI has been widely used in many developed countries for over the last three decades. AQI quickly disseminates air quality information in real-time.

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How is AQI calculated?

Different countries use different point scales to report air quality. For instance, the United States uses a 500 point scale, wherein rating between 0 and 50 is considered good. Rating between 301 to 500 range is deemed hazardous. India too follows that the 500 point scale. Every day monitors record concentrations of the major pollutants. These raw measurements are converted into a separate AQI value for each pollutant (ground-level ozone, particle pollution, carbon monoxide, and sulphur dioxide) using standard formulae developed by EPA. The highest of these AQI values are reported as the AQI value for that day.

AIR QUALITY INDEX CATEGORIES

- Good (0-50) - Minimal Impact
- Satisfactory (51-100) - May cause minor breathing difficulties in sensitive people.
- Moderately polluted (101-200) - May cause breathing difficulties in people with lung disease like asthma and discomfort to people with heart disease, children and older adults.
- Poor (201-300) - May cause breathing difficulties in people on prolonged exposure and discomfort to people with heart disease.
- Very Poor (301-400) - May cause respiratory illness in people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases.

- Severe (401-500) - May cause respiratory issues in healthy people and serious health issues in people with lung / heart disease. Difficulties may be experienced even during light physical activity.

Why is AQI important?

Awareness of daily levels of air pollution is important, especially for those suffering from illnesses caused by exposure to air pollution.

Objectives of Air Quality Index (AQI)

- Comparing air quality conditions at different locations / cities.
- It also helps in identifying faulty standards and inadequate monitoring programmes.
- AQI helps in analysing the change in air quality (improvement or degradation).
- AQI informs the public about environmental conditions. It is especially useful for people suffering from illnesses aggravated or caused by air pollution.

Who is most at risk from air pollution?

- People with lung diseases such as asthma, chronic bronchitis and emphysema
- Children including teenagers
- Active people of all ages who exercise or work extensively outdoors
- Some healthy people are more sensitive to Ozone

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DELHI IN A CHOKEHOLD: AIR POLLUTION AS A PUBLIC HEALTH EMERGENCY

Delhi is in pollution's ever tightening chokehold, causing catastrophic health harms. India ranks as the second most populated country in the world and the first in air pollution. Of the World Health Organisation's (WHO's) top 10 most polluted cities. Consider the sheer number of people breathing toxic air.

On November 1, 2019, Delhi's Environment Pollution (Prevention and Control) Authority (EPCA) declared air pollution a public health emergency. The declaration acknowledged the severe impact of pollution on health. Although it provided for specific measures to ameliorate pollutant levels and to prevent undue human exposure, it did not specifically define "public health emergency," specify duration or provide for long-term systematic changes.

* Air Pollution and Health

- Ambient air pollution is a key risk factor for preventable non-communicable diseases (NCDs) It kills more than four million people every year globally. Worldwide, air pollution is responsible for 29 percent of all deaths and disease from lung cancer, 17 percent from acute lower respiratory infection,

25 percent from ischaemic heart disease, 43 percent from chronic obstructive pulmonary disease and 24 percent of all deaths from stroke.

- In addition to these direct impacts on individual health outcomes, air pollution causes indirect health harms on other key determinants of individual health. For example - with dangerously high levels of air pollution, people cannot go outside to exercise or cannot perform work during business hours. Every aspect of an individual's health is affected.
In Delhi, NCDs attributable to ambient air pollution far exceed the global average, with hundreds of thousands of premature deaths resulting annually across India. The major factors contributing to Delhi's particulate matter (PM) levels include unpaved roads, ill-regulated industry, an ever-increasing number of road vehicles, the burning of stubble (an unwanted but burdensome remainder of harvest) in the adjacent states of Punjab and Haryana and firecracker use accompanying annual Diwali celebrations. These activities release PM, the most harmful form of pollutant, in its two major forms: PM10 (the largest, albeit still microscopic) and PM2.5 (smaller but harmful when inhaled).

- To give a sense of the catastrophe that gripped Delhi in early November, ambient PM was recorded in excess not only of what may be considered

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safe for inhalation but also, at times the very scale used to record its presence. PM 10 has been measured at 999 out of a maximum possible 999 micrograms per cubic meter (mpcm) in parts of Delhi metropolis with for example - 24 hour averages hovering at 693 mpcm and 288 mpcm for PM10 and PM2.5 on November 2. (In United States and many other countries, the scale ends at 500). Per the WHO, safe levels of mean PM 10 and PM 2.5 exposure over 24 hours are, respectively, 50 mpcm, and 25 mpcm.

* EPCA's Declaration

- In response to Delhi's decades long escalation in air pollution levels, the EPCA was constituted in 1998 pursuant to an India Supreme Court order for preventing excess ambient air pollution in the city. Its recent November 2019 declaration came after a 48 hour period of levels exceeding the most severe tier in the Air Quality Index: five times the standard considered acceptable in India and nearly ten times the standard deemed safe by the WHO.

- The EPCA used the November declaration to set out a brief factual summary attributing the high PM levels to firecracker use, stubble burning and adverse weather. Accompanying the declaration, the EPCA advised schools to minimise outdoor activity and specifically required all construction activities in the

city to cease for a week. It also put a temporary stop on certain forms of dirty industry operations and prohibited all firecracker use. All this, came after the EPCA's earlier declaration in October that provided for a raft of other measures in Delhi and set out a strongly worded demand that Punjab and Haryana states curb stubble burning.

- An immediate response by the government of Delhi to the declaration came in the form of school closures across the capital. This was followed by the government's previous implementation of an "odd-even rule" preventing vehicle use on alternate days, depending on whether the last digit of one's license place is odd or even. The ability and willingness of Delhi's government to implement other measures provided for by the EPCA remains an open question, but pressure for action has increased. More doubtful still is whether Punjab and Haryana states can solve the complex quandary of stubble burning anytime soon.

- While an important step was taken by the EPCA in making the declaration and in ordering specific actions, these were temporary solutions that did not address systematic sources of pollution and arguably placed undue burdens on individuals. The declaration focused on seasonal and transient sources, omitting relatively constant pollutants from vehicle and industry emissions. For example-

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overuse of private car transportation and quality of road paving are together much greater sources of pollutants than the declaration's targets. In any emergency, short-term solutions are necessary, but they are insufficient over the long haul.

* Public Health Emergency

The public health emergency declaration, while necessary to address immediate issues and provide impetus for further action, is not sufficient on its own to address this environmental and health catastrophe. First, the full potential of the law is released only with considered legislative and executive action, taken on the basis of detailed scientific advice and extensive public consultation. EPCA actions are, by contrast, reactive and aimed at sources most susceptible to prevention for the immediate protection of public health. For example, the EPCA's recommendation that people stay indoors and the subsequent closure of schools benefit those middle-class people who live in homes with well-maintained air purifiers. Similarly, an India Supreme Court Order, issued in response to the declaration, aimed at causing stubble burning's immediate cessation was admirable but did not address the economic burden such as ban would impose on farmers or provide for their compensation.

Conclusion

The actions taken in Delhi were reactive antipollution measures that do not protect the poorest and do not enact structural change. This focus on treatment over cures, and cures over prevention while necessary during a period of emergency is shortsighted. With air pollution in Delhi reaching new peaks, solutions must include unconventional and unpopular measures that tackle short and long term causes and benefit all residents of the city. Bold governments, a unified center-State front and an independent truly empowered agency focused on long-term measures - all are required to respond to a public health emergency.

GANGA WATER POLLUTION AND GANGA ACTION PLAN

Ganga, the largest river in India, poses significant threats to human health and the larger environment. Severely polluted with human waste and industrial contaminants, the river provides water to about 40% of India's population across 11 states, serving an estimated population of 500 million people which is more than any other river in the world.
Today, the Ganges is considered to be the fifth-most polluted river in the world.

GANGA ACTION PLAN

The Ganges Action Plan (GAP) was launched by Rajiv Gandhi, the then Prime Minister of India on June 1986 with covering 25 class I towns (6 in Uttar Pradesh, 4 in Bihar and 15 in West Bengal); Rs. 862.59 crore were spent. Its main objective was to improve the water quality by the interception, diversion and treatment of domestic sewage and to prevent toxic and industrial chemical wastes from identified polluting units from entering the rivers. The other objectives of the GAP are as follows:-

- Control of non-point pollution from agricultural

run off, human defecation, cattle wallowing and the disposal of human remains in the river.

- Research and development to conserve the biotic diversity of the river to augment its productivity.

- Development of sewage treatment technology such as Up-flow Anaerobic Sludge Blanket (UASB) and sewage treatment through afforestation.

- Rehabilitation of soft-shelled turtles for pollution abatement.

- Resource recovery options such as methane production for energy generation and use of aquaculture for revenue generation.

- To act as trend setter for taking up similar action plans in other grossly polluted stretches in other rivers.

- The ultimate objectives of the GAP is to have an approach of integrated river basin management considering the various dynamic interactions between abiotic and biotic eco-system.

Not withstanding some delay in the completion of the first phase of the GAP it has generated considerable interest and set the scene for

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evolving a national approach towards replicating this program for the other polluted rivers of the country. The Government of India proposed to extend this model with suitable modifications to the national level through a National River Action Plan (NRAP). The NRAP mainly draws upon the lessons learnt and the experience gained from the GAP besides seeking the views of the State Governments and the other concerned Departments / Agencies. Under NRCP scheme the CPCB had conducted river basin studies and had identified 19 gross polluted stretches and 14 less polluted stretches along 19 rivers which include 11 stretches situated along 7 rivers of M.P. It was much more effective as compared to the previous launched programs.

Phase II covered 59 towns in five states, Rs. 505.31 crore were spent.

* Other programmes to Clean Ganga are :-

National River Ganga Basin Authority (NRGBA)
2010 Government clean-up campaign
Namami Gange Programme.
↳ The main pillars of Namami Gange Programme are :-
1. Sewerage Treatment Infrastructure
2. River-Front Development
3. River-Surface Cleaning
4. Bio-Diversity

5. Afforestation
6. Public Awareness
7. Industrial Effluent Monitoring
8. Ganga Gram

Ganga Manthan

* Clean Ganga Fund

The Union Cabinet gave its approval for setting up of Clean Ganga Fund in September 2014 with the aim of using the collection for various activities under the Namami Gange programme for cleaning the Ganges.

Utilisation of funds

- Cleaning up of the Ganges
- Setting up of waste treatment plants
- Conservation of biotic diversity of the river
- Development of public amenities
- Activities such as Ghat redevelopment and Research and Development and innovative projects.

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YAMUNA RIVER POLLUTION AND SUSTAINABLE SOLUTIONS FOR THE FUTURE

About 57 million people depend on Yamuna waters as it accounts for more than 70% of Delhi's water supplies but today it is also referred to as 'Delhi's dying holy river'.

Yamuna is the second largest tributary of River Ganga and the longest tributary of India, it originates from Yamunotri glacier in Uttarakhand and flows across seven states and merges with the river Ganga at Sangam in Prayagraj, Uttar Pradesh.

Long ago, the water of Yamuna were pristine blue but today the Yamuna is considered to be one of the severely polluted rivers in the world. The Yamuna is particularly polluted downstream of New Delhi, the capital of India which dumps about 58% of its waste into the river. The most pollution comes from Wazirabad from where Yamuna enters Delhi.

Main Sources of Pollution

Domestic Sources :-

According to a report submitted by the Delhi Pollution Control Committee and the Central Pollution Control Board (CPCB) to the Yamuna Pollution Control Committee at least 90% of domestic wastewater in the city flows into the Yamuna.
The wastewater mainly comes from household activities hence the presence of high content of detergent, laundry chemicals and phosphate compounds.

Industrial heavy metal contamination :-

The catchment area of river Yamuna in Delhi is highly urbanized and is networked with several drains. Rapid urbanization and population growth results in industrialisation pose a major threat of heavy metal pollution nearby water bodies. Among the heavy metals investigated in the River Yamuna water, Iron (Fe) was found to be most abundant and even exceeding the limit.
High amounts of heavy metals in water can cause several health effects such as reduced growth and development, cancer, organ damage, nervous system damage, etc.

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Untreated Sewage :-

More than 800 million litres of largely untreated sewage is pumped in the Yamuna each day. Sewage that is treated before being released into the River accounts for only 35% of the total estimated sewage discharge.

Although Sewage treatment plants (STPs) have been constructed in various parts of Delhi, the treated or partially treated sewage from these STPs is continuously being discharged directly or through the carrier drains into the river.

Many times untreated sewage goes directly into the river at few locations due to non-operational STPs caused by power failures, mechanical problems or maintenance issues, which further deteriorate water quality issues.

Idol immersion leading to increased toxicity :-

Immersion of idols during festivals with cheap lead and chrome paints and plaster of paris and puja articles such as polythene bags, foam cut-outs, flowers, food offerings, decorations, metal polish, plastic sheets, cosmetic items all are a cause for concern for the river's quality.

If the water is not treated, it will increase the chance of toxins entering the food chain through vegetables grown on the floodplains. The toxicity of heavy metals can damage the brain, lungs, kidneys, liver, other vital organs functions and alter blood composition.

Plastic Pollution :-

In Agra, the Yamuna has been choked by intense plastic pollution. After the 2017 ban on single-use plastics, there has still been rampant use of plastics which is evident by the production of plastic.
According to records, Delhi produces 2,51,674 tonnes of plastic each year - 50% of which is single use. The environment department said plastics enter the river mostly through open drains in which people dispose of their waste.

PROJECTS AND PLANS FOR YAMUNA

1. Yamuna Action Plan

It is one of the largest river restoration projects in India which is bilateral project between the Government of India and Japan. It is being executed by the National River Conservation Directorate and the Ministry of Environment and Forests and the Government of India.

The project is divided into 3 parts :-

(a) Yamuna Action Plan I (YAP-I) - [1993 - 2002, 2002 - 2003 (Extended Phase)]

The plans were carried out by the National River Conservation Directorate (NRCD), Ministry of Environment in collaboration with various State Department. The plan focused on two types of actions which are Sewerage and Non-Sewerage

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facilities

(i) Sewerage :- construction of 29 STPs 58 pumping stations and 179 km of sewers was proposed.

(ii) Non-Sewerage :- 1282 public toilet complexes, 96 crematoria, Riverfront development, plantation and public awareness and participation were proposed. A study on river pollution to estimate future pollution loads of the river Yamuna from different sources. The total sewage treatment capacity created under YAP-I was 750 MLD.

(b) Yamuna Action Plan II (YAP-II) -[2004-2011]

YAP II was mostly to undertake non-sewerage part of the objectives.

The total STP capacity sanctioned under YAP II was 189 MLD. The total budget sanctioned : INR 6.24 billion. There was an emphasis on Public Participation and Awareness, Public Relations and Institutional Strengthening and Capacity Building of MCD. A Master Plan and Feasibility Study was also carried out.

Various Pilot projects included Dairy Farm Waste Management, Dhobighat Sudhar Yojna, Slaughterhouse Modernisation and Waste Management, Antim Niwas Sudhar Yojna and Slum Rehabilitation Study.

(c) Yamuna Action Plan III - [2018 onwards]
11 projects under National Mission for Clean Ganga (NMCG) have been planned to conserve river Yamuna in Delhi including rehabilitation of sewers, rehabilitation of Rising mains, Tertiary Treatment Plants and Sewerage projects in four packages of Kondli (K1, K2, K3, K4), three packages of Rithala (R1, R2, R3) and Okhla Zone (O).

2. **Yamuna Purification Drive, 2018**
Organised by the Public Health Department and covers 15 towns including Gurgaon, Faridabad, Yamuna Nagar, Karnal, Panipat and Sonipat. Its objectives are to control the discharge of raw sewage into the river. Initiative that has been done are:-

- Eleven treatment plants are being installed along the 83 km long sewer line.
- A treatment plant that can treat 30 million litres a day has been installed in Gurgaon which will help reduce the level of pollution from 200 mg a liter to 30 mg a liter, before it enters the Yamuna.
- A 5.8 km long sewer line has been laid in the city to collect the polluted water at the treatment plant.

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SUSTAINABLE SOLUTIONS (SOCIO, ECONOMIC, ENVIRONMENTAL)

Creating a project that balances the social, environmental and economic interests of a community is important to achieve sustainability

What can be done at the administration level

- Develop more public toilets and crematoria to reduce the sewage waste into the rivers.
- Educational programs to increase awareness encouraging people to use biodegradable paints for painting idols and stop dumping wastes in the rivers is needed.
- Stringent implementation of regulation for industries and hospitals not to dump waste in the rivers.
- Upgradation of existing sewage treatment plants (STPs) that don't comply with standards.
- New strategies for the existing water treatment such as automated river quality monitoring
- Develop parks with fountains or grassy lands, pools, plantations, etc., along the rivers banks to provide opportunities for water to undergo artificial aeration that leads to self-purification of the river.

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What can be done at the Community level

- The locals can report ground results and activities on a regular basis to help authorities keep check on the effluent disposal by the industries.
- Train and educate people about ensuring proper maintenance of the sewage system and waste disposal methods.
- Create a waste management system that can help the community make a livelihood for themselves in the form of recycling the wastes.
- Apply rainwater harvesting to meet requirements throughout the year that is uncontaminated for domestic and other needs.
- Improving the community's literacy rate (taken as proxy for awareness). A study has shown that a significant positive relationship is found between the rate of increase in literacy level in a district and the water quality in rivers flowing through the district.
- Community can use more environmentally friendly ideals alternatives that use organic materials.

WATER QUALITY STANDARDS

Water Quality Standards (WQS) are provisions of state, territorial, authorised tribal or federal law approved of EPA that describe the desired condition of water bodies and the means by which that condition will be protected or achieved

Water bodies can be used for purposes such as recreation (example - swimming and boating), scenic enjoyment, and fishing and are the home to many aquatic organisms. To protect human health and aquatic life in these waters, states, territories and authorised tribes establish WQS. WQS form a legal basis of controlling pollutants entering the waters of the United States.

Core Components of WQS

Water Quality standards consist of three core components that are :-

- Designated uses of a water body
- Criteria to protect designated uses
- Antidegradation Requirements to protect existing uses and high quality / high value waters.

Additional Components of WQS

States, territories and authorised tribes also have the choice of including additional components in their water quality standards such as:-

- General Policies
- WQS Variances

Designated Uses

The WQS regulation requires states, territories and authorised tribes to specify goals and expectations for how each water body is used. Typical designated uses include :-

1. Protection and propagation of fish, shellfish and wildlife.
2. Recreation
3. Public drinking water supply
4. Agricultural, industrial, navigational and other purposes.

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BHOPAL GAS TRAGEDY

* Introduction

Bhopal disaster, chemical leak in 1984 in the city of Bhopal, Madhya Pradesh state, India. At the time, it was called the worst industrial accident in history. On December 3, 1984, about 45 tons of the dangerous gas methyl isocyanate escaped from an insecticide plant that was owned by the Indian subsidiary of the American firm Union Carbide Corporation. The gas drifted over the densely populated neighbourhoods around the plant, killing thousands of people immediately and creating a panic as tens of thousands of others attempted to flee Bhopal. The final death toll was estimated to be between 15,000 and 20,000.

Some half a million survivors suffered respiratory problems, eye irritation or blindness and other maladies resulting from exposure to the toxic gas, many were awarded compensation of a few hundreds dollars. Investigations later established that substandard operating and safety procedures at the under-staffed plant had led to the catastrophe. In 1998 the former factory site was turned over to the state of Madhya Pradesh.

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Causes for Disaster

There are two main lines of argument involving the disaster:

1. Corporate Negligence
2. Worker Sabotage

The '**Corporate Negligence**' point of view argues that the disaster was caused by a potent combination of under-maintained and decaying facilities, a weak attitude towards safety and an under trained workforce, culminating in worker actions that inadvertently enabled water to penetrate the MIC tanks in the absence of properly working safeguards.

- This point of view also argues that management (and to some extent, local government) under-invested in safety which allowed for a dangerous working environment to develop.
- Factors cited include the filling of the MIC tanks beyond recommended levels, poor maintenance after the plant ceased MIC production at the end of 1984, allowing several safety systems to be inoperable due to poor maintenance and
- Switching off safety systems to save money - including the MIC tank refrigeration system which could have mitigated the disaster severity and non-existent catastrophe management plans.
- Other factors identified by government inquiries included undersized safety devices and the dependence on manual operations. Specific plant management deficiencies that were

identified include the lack of skilled operators, reduction of safety management, insufficient maintenance and inadequate emergency action plans.

- The **'Worker Sabotage'** point of view argues that it was not physically possible for the water to enter the tank without concerted human effort and that extensive testimony and engineering analysis leads to a conclusion that water entered the tank when a rogue individual employee hooked a water hose directly to an empty valve on the side of the tank. This point of view further argues that the Indian government took extensive actions to hide this possibility in order to attach blame to UCC.

- Theories differ as to how the water entered the tank. At the time, workers were cleaning out a clogged pipe with water about 400 feet from the tank. They claimed that they were not told to isolate the tank with a pipe slip-blind plate. The operators assumed that owing to bad maintenance and leaking valves, it was possible for the water to leak into the tank.

- Methyl isocyanate from chemical plant was advertently released into the air killing as many as 2,500 people and injuring thousands of others.

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Short Term Effects

The short term effects of the exposure were

- coughing
- severe eye irritation
- a feeling of suffocation
- burning in the respiratory tract
- blepharospasm, breathlessness
- stomach pains and vomiting
- People awakened by these symptoms fled away from the plant. Those who ran inhaled more than those who had a vehicle to ride. Owing to their height, children and other residents of shorter stature inhaled higher concentrations as methyl isocyanate gas is approximately twice as dense as air and therefore in an open environment has a tendency to fall toward the ground.
- Thousands of people had died by the following morning. Primary causes of deaths were choking, reflexogenic circulatory collapse and pulmonary oedema. Findings during autopsies revealed changes not only in the lungs but also cerebral oedema, tubular necrosis of the kidneys, fatty degeneration of the liver and necrotising enteritis. The stillbirth rate increased by up to 300% and neonatal mortality rate by around 200%.

* **Long-term Effects**

Studied and reported long-term health effects are :-

- **Eyes** :- Chronic conjunctivitis, scars on cornea, corneal opacity, early cataracts, blindness
- **Respiratory tracts** :- Obstructive and/or restrictive disease, pulmonary fibrosis, aggravation of TB and chronic bronchitis
- **Neurological System** :- Impairment of memory, finer motor skills, numbness etc
- **Psychological problems** :- Post traumatic stress disorder (PTSD)
- **Children's health** :- Peri- and neonatal death rates increased. Failure to grow, intellectual impairment, etc.
- Cancer
- Immune deficiency
- Soil and water contamination in the area was blamed for chronic health problems and high instances of birth defects in the area's inhabitants.

– A 2014 report in Mother Jones quotes 'spokesperson for the Bhopal Medical Appeal, which runs free health clinics for survivors' saying "An estimated 120,000 to 150,000 survivors still struggle with serious medical conditions including nerve damage, growth problems, gynecological disorders, respiratory issues, birth defects and elevated rates of cancer and tuberculosis

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- In 2004 the Indian Supreme Court ordered the state to supply clean drinking water to the residents of Bhopal because of groundwater contamination. In 2010 several former executives of Unions Carbide's India subsidiary - all Indian citizens - were convicted by a Bhopal court of negligence in the disaster.

* **Conclusion** :- Union Carbide's pesticide plant in Bhopal, India was the scene of one of the worst industrial accidents in history when methyl isocyanate gas leaked from the plant and spread over a populated area, killing at least 2,000 people at the time of the accident and causing an estimated 15,000 to 20,000 subsequent deaths. Many thousands more sustained lifelong injuries.