

Air pollution and undergraduate courses assignment

[Environment](#), [Air](#)



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. An average human requires about 12 goof air each day, which is nearly 12 10th times greater than the amount of food we eat. Thus even a small concentration of pollutants in the air becomes more significant in comparison to the similar levels present in food.

Pollutants that enter water have the ability to spread to distant places especially in the urine ecosystem. From an ecological perspective pollutants can be classified as follows: Degradable or non-persistent pollutants: These can be rapidly broken down by natural processes. Egg: 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.

Hippocrates has mentioned air pollution in 400 BC. With the discovery and increasing use of coal, air pollution became more pronounced especially in urban areas. It was recognized as a problem 700 years ago in London in the form of smoke pollution, which prompted King Edward I to make the first antipollution law to restrict people from using coal or domestic heating in the year 1273. In the year 1300 another Act banning the use of coal was passed. Defying the law led to imposition of capital punishment.

In spite of this air pollution became a serious problem in London during the industrial revolution due to the use Of coal in industries. The earliest

recorded major disaster was the ' London Smog' that occurred in 1952 that resulted in more than 4000 deaths due to the accumulation of air pollutants over the city for five days. In Europe, around the middle of the 19th century, a black form of the Peppered moth was noticed in industrial areas. Usually the normal Peppered moth is well camouflaged on a clean lichen covered tree.

However the peppered pattern was easily spotted and picked up by birds on the smoke blackened bark of trees in the industrial area, while the black form remained well camouflaged. Thus while the peppered patterned moths were successful in surviving in clean non-industrial areas, the black colored moths were successful in industrial areas. With the spread of industrialization, it has been observed that the black forms are not only seen in Peppered moth, but also in many other moths. This is a classic case of evolution leading to adaptation.

Pollution 113 Chapters. Air pollution began to increase in the beginning of the twentieth century with the development of the transportation systems and large-scale use of petrol and diesel. The severe air quality problems due to the formation of photochemical smog from the combustion residues of diesel and petrol engines were felt for the first time in Los Angeles. Pollution due to auto- exhaust remains a serious environmental issue in many developed and developing countries including India.

The Air Pollution Control Act in India was passed in 1981 and the Motor Vehicle Act for controlling the air pollution, very recently. These laws are

intended to prevent air from being polluted. The greatest industrial disaster leading to serious air pollution took place in Bhopal where extremely poisonous methyl cyanide gas was accidentally released from the union Carbide's pesticide manufacturing plant on the night of December 3rd 1984. The effects of this disaster on human health and the soil are felt even today.

Temperature declines with altitude in the troposphere. At the top of the troposphere temperatures abruptly begin to rise. This boundary where this temperature reversal occurs is called the tropopause. The tropopause marks the end of the troposphere and the beginning of the stratosphere, the second layer of the atmosphere. The stratosphere extends from 17 to 48 kilometers above the earth's surface. While the composition of the stratosphere is similar to that of the troposphere it has two major differences.

The volume of water vapor here is about 1000 times less while the volume of ozone is about 1 000 times greater. The presence of ozone in the stratosphere prevents about 99 percent of the sun's harmful ultraviolet radiation from reaching the earth's surface thus protecting humans from cancer and damage to the immune system. This layer does not have clouds and hence airplanes fly in this layer as it creates less turbulence.

Temperature rises with altitude in the stratosphere until there is another reversal.

This point is called the stratopause and it marks the end of the stratosphere and the beginning of the atmosphere's next layer, the mesosphere. In the

mesosphere the temperature decreases with altitude falling up to -1 10 co at the top. Above this is a layer where unionization of the gases is a major phenomenon, thus increasing the temperature. This layer is called the troposphere. Only the lower troposphere is routinely involved in our weather and hence air pollution. The other layers are not significant in determining the level of air pollution.

Structure of the atmosphere The atmosphere is normally composed of 79 percent nitrogen, 20 percent oxygen and one percent as a mixture of carbon dioxide, water vapor and trace amounts of several other gases such as neon, helium, methane, krypton, hydrogen and xenon. The general structure of the atmosphere has several important features that have relevance to environmental problems. The atmosphere is divided into several layers. The innermost layer the troposphere extends 17 kilometers above sea level at the equator and about 8 kilometers over the poles. It contains about 75 percent of the mass of the earth's air.

The fragility of this layer is obvious from the fact that if the earth were an apple this particular layer would be no thicker than an apple's skin. 114

Types and sources of Air Pollution What is air pollution? Air pollution occurs due to the presence of undesirable solid or gaseous particles in the air in quantities that are harmful to human health and the environment. Air may et polluted by intergovernmental Studies for Undergraduate Courses 114 4/9/2004, 5109 PM oral causes such as volcanoes, which release ash, dust, sulfur 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. Pollutants that are emitted directly from identifiable sources are produced both by natural events (for example, dust storms and volcanic eruptions) and human activities (emission from vehicles, industries, etc.). These are called primary pollutants. There are five primary pollutants that together contribute about 90 percent of the global air pollution.

These are carbon oxides (CO and CA), nitrogen oxides, sulfur oxides, volatile organic compounds (mostly hydrocarbons) and suspended particulate matter. Pollutants that are produced in the atmosphere when certain chemical reactions take place among the primary pollutants are called secondary pollutants. Egg: sulfuric acid, nitric acid, carbonic acid, etc.

Nitrogen oxides are found in vehicular exhausts. Nitrogen oxides are significant, as they are involved in the production of secondary air pollutants such as ozone. Hydrocarbons are a group of compounds consisting of carbon and hydrogen atoms.

They either evaporate from fuel supplies or are remnants of fuel that did not burn completely. Hydrocarbons are washed out Of the air when it rains and run into surface Water. They Cause an oily film on the surface and do not as such cause a serious issue until they react to form secondary pollutants.

Using higher oxygen concentrations in the fuel-air mixture and using valves to prevent the escape of gases, fitting of catalytic nonvoters in automobiles,

are some of the modifications that can reduce the release of hydrocarbons into the atmosphere.

Particulates are small pieces of solid material (for example, smoke particles from fires, bits of asbestos, dust particles and ash from industries) dispersed into the atmosphere. The effects of particulates range from soot to the carcinogenic (cancer causing) effects of asbestos, dust particles and ash from industrial plants that are dispersed into the atmosphere. Repeated exposure to particulates can cause them to accumulate in the lungs and interfere with the ability of the lungs to exchange gases. Lead is a major air pollutant that remains largely unmonitored and is emitted by vehicles.

High lead levels have been reported in the ambient air in metropolitan cities. Leaded petrol is the primary source of airborne lead emissions in Indian cities. Pollutants are also found indoors from infiltration of polluted outside air and from various chemicals used or produced inside buildings. Both indoor and outdoor air pollution are equally harmful. Carbon monoxide is a colorless, odorless and toxic gas produced when organic materials such as natural gas, coal or wood are incompletely burnt. Vehicular exhausts are the single largest source of carbon monoxide.

The number of vehicles has been increasing over the years all over the world. Vehicles are also poorly maintained and several have inadequate pollution control equipment resulting in release of greater amounts of carbon monoxide. Carbon monoxide is however not a persistent pollutant. Natural processes can convert carbon monoxide to other compounds that are not

harmful. Therefore the air can be cleared of its carbon monoxide if no new carbon monoxide is introduced into the atmosphere. Sulfur oxides are produced when sulfur containing fossil fuels are burnt.

Pollution 115 Types of particulates Term Aerosol Mist Dust Meaning General term for particles suspended in air Aerosol consisting of liquid droplets Aerosol consisting of solid particles that are blown into the air or are produced from larger particles by grinding them down Aerosol consisting Of solid particles or a mixture of solid and liquid particles produced by chemical reaction such as fires Generally means the same as smoke but often applies specifically to aerosols produced by condensation of hot vapors of metals.

Geometrical shape or form of the smoke coming out of a chimney Aerosol consisting of eater droplets Term used to describe a mixture of smoke and fog. Examples Sprays from pressurized cans Sulfuric acid mist Dust storm Smoke Cigarette smoke, smoke from burning garbage Fume Zinc/lead fumes Plume Fog Smog What happens to pollutants in the atmosphere?

Once pollutants enter the troposphere they are transported downwind, diluted by the large volume of air, transformed through either physical or chemical changes or are removed from the atmosphere by rain during which they are attached to water vapor that subsequently forms rain or snow that falls to the earth's surface. The atmosphere normally disperses pollutants by mixing them in the very large volume of air that covers the earth. This dilutes the pollutants to acceptable levels.

The rate of dispersion however varies in relation to the following aspects:

Topography Normally as the earth's surface becomes warmed by sunlight the layer of air in contact with the ground is also heated by convection. This warmer air is less dense than the cold air above it, so it rises. Thus pollutants produced in the surface layer are effectively dispersed. However on a still evening, the process is reversed. An hour or two before sunset after a sunny day, the ground starts to lose heat and the air near the ground begins to cool rapidly.

Due to the absence of wind, a static layer of cold air is produced as the ground cools. This in turn induces condensation of fog. The morning sun cannot initially penetrate this fog layer. The Environmental Studies for Undergraduate Courses 116 cold air being dense cannot rise and is trapped by the warm air above. It cannot move out of the area due to the surrounding hills. The topographic features resemble a closed chemical reactor in which the pollutants are trapped. This condition often continues through the cool night and reaches its maximum intensity before sunrise.

When the morning sun warms the ground the air near the ground also warms up and rises within an hour or two. This may be broken up by strong winds. In cold regions this situation can persist for several days. Such a situation is known as smog (smoke + fog). Other industrial establishments. This used to lead to the generation of high levels of smoke containing sulfur oxides. Due to a sudden adverse meteorological condition air pollutants like smoke and sulfur oxides started to build-up in the atmosphere.

The white fog accumulated over the city turned black forming a 'pea-soup' smog with almost zero visibility. Within two days of the formation of this smog, people started suffering from acute pulmonary disorders which caused irritation of bronchi, cough, nasal discharges, sore throat, vomiting and burning sensations in the eyes. This event led to several deaths.

Meteorological conditions The velocity of the wind affects the dispersal of pollutants. Strong winds mix polluted air more rapidly with the surrounding air diluting the pollutants rapidly.

When wind velocity is low mixing takes place and the concentration of pollutants remains high. The most well known example is that of the 'London Smog' that occurred in 1952. The city used large quantities of sulfur containing coal for domestic heating that released smoke, along with smoke from thermal power plants and Pollution 117 When sulfur dioxide and nitrogen oxides are transported by prevailing winds they form secondary pollutants such as nitric acid vapor, droplets of sulfuric acid and particles of sulfate and nitrate salts.

These chemicals descend on the earth's surface in two forms: wet (as acidic rain, snow, fog and cloud vapor) and dry (as acidic particles). The resulting mixture is called acid deposition, commonly called acid rain. Acid deposition has many harmful effects especially when the pH falls below 5.1 for terrestrial systems and below 5.5 for aquatic systems. It contributes to human respiratory diseases such as bronchitis and asthma, which can cause premature death. It also damages statues, buildings, metals and car finishes.

Acid deposition can damage tree foliage directly but the most serious effect is weakening of trees so they become more susceptible to other types of damage. The nitric acid and the nitrate salts in acid deposition can lead to excessive soil nitrogen levels. This can over stimulate growth of other plants and intensify depletion of other important soil nutrients such as calcium and magnesium, which in turn can reduce tree growth and vigor. Predatory diseases are especially vulnerable to air pollution. Cigarette smoking is responsible for the greatest exposure to carbon monoxide.

Exposure to air containing even 0.001 percent of carbon monoxide for several hours can cause collapse, coma and even death. As carbon monoxide remains attached to hemoglobin in blood for a long time, it accumulates and reduces the oxygen carrying capacity of blood. This impairs perception and thinking, slows reflexes and causes headaches, drowsiness, dizziness and nausea. Carbon monoxide in heavy traffic causes headaches, drowsiness and blurred vision. Sulfur dioxide irritates respiratory tissues. Chronic exposure causes a condition similar to bronchitis.

It also reacts with water, oxygen and other material in the air to form sulfur-containing acids. The acids can become attached to particles which when inhaled are very corrosive to the lung. Nitrogen oxides especially NO₂ can irritate the lungs, aggravate asthma or chronic bronchitis and also increase susceptibility to respiratory infections such as influenza or common colds. Suspended particles aggravate bronchitis and asthma. Exposure to these particles over a long period of time damages lung tissue and contributes to the development of chronic respiratory disease and cancer.

Many volatile organic compounds such as (benzene and formaldehyde) and toxic particulates (such as lead, cadmium) can cause mutations, reproductive problems or cancer. Inhaling ozone, a component of hydrothermal smog causes coughing, chest pain, breathlessness and irritation of the eye, nose and the throat. Effects of air pollution on living organisms Our respiratory system has a number of mechanisms that help in protecting us from air pollution. The hair in our nose filters out large particles. The sticky mucus in the lining of the upper respiratory tract captures smaller particles and dissolves some gaseous pollutants.

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 Hess natural defenses causing or contributing to diseases such as lung cancer, asthma, chronic bronchitis and emphysema. Elderly people, infants, pregnant women and people with heart disease, asthma or other rest 18 118 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 sulfur dioxide majority of the flower buds become stiff and hard. They eventually fall from the plants, as they are unable to flower. Reloaded exposure to high levels Of several air pollutants from smelters, coal burning

power plants and industrial units as well as from cars and trucks can damage trees and other plants. Concentration can produce dramatic effects on life on earth. The total amount of ozone in a 'column' of air from the earth's surface up to an altitude of 50 km is the total column ozone. This is recorded in Dobson Units (DU), a measure of the thickness of the ozone layer by an equivalent layer of pure ozone gas at normal temperature and pressure at sea level.

This means that 1 DU = 1 mm of pure ozone gas at normal temperature and pressure at sea level. Ozone is a form of oxygen with three atoms instead of two. It is produced naturally from the photolysis of oxygen gas molecules in the atmosphere. The ozone thus formed is constantly broken down by naturally occurring processes that maintain its balance in the ozone layer. In the absence of pollutants the creation and breakdown of ozone are purely governed by natural forces, but the presence of certain pollutants can accelerate the breakdown of ozone.

Though it was known earlier that ozone shows fluctuations in its concentrations which may be accompanied sometimes with a little ozone depletion, it was only in 1985 that the large scale destruction of the ozone also called the Ozone Hole came into limelight when some British researchers published measurements about the ozone layer. Soon after these findings a greater impetus was given to research on the ozone layer, which convincingly established that CFCs were leading to its depletion. These CFCs (chloro-fluorocarbons) are extremely stable, non-flammable, non-toxic and harmless to handle.

This makes them ideal for many industrial applications like aerosols, air conditioners, refrigerators and fire extinguishers. Many cans, which give out foams and sprays, use CIFS. (egg: perfumes, room fresheners, etc.) CIFS are also used in making foams for mattresses and cushions, disposable Styrofoam cups, glasses, packaging material for insulation, cold storage etc. However their stall 19 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.

All around the world air pollutants have disclosure irreplaceable monuments, historic buildings, marble statues, etc. Effects of air pollution on the stratosphere The upper stratosphere consists of considerable amounts of ozone, which works as an effective screen for ultraviolet light. This region called the ozone layer extends up to 60 SMS above the surface of the earth. Though the ozone is present Upton 60 SMS its greatest density remains in the region between 20 to 25 SMS.