**Advances in Bioresearch**
Adv. Biores., Vol 8 (2) March 2017: 42-50
©2017 Society of Education, India
Print ISSN 0976-4585; Online ISSN 2277-1573
Journal's URL:http://www.soeagra.com/abr.html
CODEN: ABRDC3
DOI: 10.15515/abr.0976-4585.8.2.4250

Advances in Bioresearch

## REVIEW ARTICLE

# A Review on Air Pollution, Polluting Agents and its Possible Effects in 21st Century

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**ABSTRACT**
*Our atmosphere (air) is vital for survival of man as well as existence of other creatures too. Without the atmosphere, life would be impossible. It is the atmosphere which is the source of Oxygen (essential for life) and Carbon dioxide (essential for photosynthesis). Through ages, man has always strived to define a better living condition for himself. As a result of man's quest for comfort, many anthropogenic activities lead to the pollution of air. This review paper deals with the pollution of air as the effect of mixed/added pollutants (solid, liquid or gas) which enters into natural air as a result of anthropogenic activities. A pollutant can enter in air through many sources, which sometimes make it difficult to attribute contamination to specific activity. Apart from the various activities that lead to the pollution of fresh air, the paper also focus on the need for an urgent action on a global, regional and national level in order to monitor and protect our atmosphere. Likewise, increased awareness, education and implementation of legislations are recommended.*
***Keywords:*** *air pollution, greenhouse gases, ozone, particulate matter, pollutants*

Received 20/12/2016 Revised 09/01/2017 Accepted 21/02/2017

**How to cite this article:**
N Saxena, R Bhargava. A Review on Air Pollution, Polluting Agents and its Possible Effects in 21st Century. Adv. Biores., Vol 8 [2] March 2017: 42-50.

## INTRODUCTION

Air is a fundamental element for survival of each creature on this planet; it may be either a small microbe or we, the *Homo sapiens.* Without the atmosphere (air), life would be impossible. It is the atmosphere which is the source of oxygen and other essential gases for our survival and production of food for us. Further, without atmosphere, there would be no clouds, winds or storms – hence no weather. Among its other functions, the atmosphere acts as a great canopy to protect the Earth's surface from the full range of solar effects by day and prevents excessive loss of heat by night. That is, it helps in maintaining habitable temperature on this marvellous planet by maintaining the heat balance of the earth. Therefore, it is essential for everything on our planet to grow and prosper. Although, as we humans recognize this fact, we disregard it by polluting our surroundings. Subsequently, we are slowly but surely harming our planet to the point where organisms are dying at a very alarming rate. In order to combat air pollution, we must understand the problems and become part of the solution. According to WHO, 2006 [1] Air pollution is one of the world's biggest killers. It leads to the premature death of close to 7 million people annually, largely from heart diseases and strokes, respiratory diseases and cancers. Recently in the month of January, 2017 heavy smog is seen in parts of Beijing, Tianjin, Hebei and various parts of China and an orange alert has been declared for those areas. Many Chinese cities have suffered from frequent winter smog in recent years, triggering widespread public concern. Frequent outbreaks of smog have become increasingly common in winter in northern China. Data from Beijing Municipal Environmental Centre showed that the density of particulate matter ($PM_{2.5}$) associated with hazardous smog, stood at 391 micrograms per cubic meter at the noon in the city proper, indicating that the air is heavily polluted. In the month of December, 2016 Delhi's air quality entered in the severe zone. Ministry of Earth Sciences Agency SAFAR recorded the average levels of $PM_{2.5}$ and $PM_{10}$ at 197 and 304 micrograms per cubic meter respectively as against the prescribed standards of 60 and 100. A person may develop respiratory

illness on prolonged exposure to very poor quality air while severe may affect healthy people and seriously impact those with existing respiratory diseases, CPCB [2] says.

Anthropogenic air pollution has been a way of life for almost 500 years now. The industrial revolution introduced great strides in technology, society and services; however, it also initiated the production of huge quantities of pollutants emitted into the air with no notion of how they might affect health. At the time, smoke from burning coal was the major pollutant, but this was only the beginning of countless air pollutants which have since proven harmful to human health [3]. Since that time, many episodes have been recorded where elevated levels of pollutants have caused serious health effects in different populations.

Concern over massive anthropogenic change in the composition of air and its quality has been on the increase since last 2-3 decades. In Stockholm (1972), the UN held the first conference on human environment. In 1992, UN Conference of Environment and Development was held in Rio de Janeiro, Brazil. It was also named as 'Rio Earth Summit'. After 10 years, in 2002 in Johannesburg another UN Earth summit was held. In 2012, UN Conference on Sustainable Development was held in Rio de Janeiro. The outcomes of Rio Earth Summit, 1992 were 'Climate change convention' which in turn led to the 'Kyoto Protocol, 'Rio declaration on Environment and Development' and the 'Agenda 21'. The primary result of 2012 UN Conference on Sustainable Development was the nonbinding document "The Future we want". Recently the Paris Climate conference held in Paris, France, from 30 November to 12 December, 2015. It was the 21$^{st}$ yearly session of the conference of the parties to the 1992 United Nations Framework Convention on climate change (UNFCCC) and the 11$^{th}$ session of the conference of the parties to the 1997 Kyoto Protocol. The goal of the 2015 Paris climate conference was to achieve a legally binding, international agreement to keep average global temperature no more than 2$^0$C above pre-industrial temperatures. The agreement calls for zero net anthropogenic greenhouse gas emissions to be reached during the second half of the 21$^{st}$ century [4]. In India, the Central Pollution Control Board (CPCB) set up under the Air Act of 1981 (MoEF,1981) [5], is mandated with setting and reviewing the National Ambient Air Quality Standards (NAAQS).

## CONCEPT OF POLLUTION

Pollution is the contamination of the earth's environment with materials that interfere with human health, the quality of life, or the natural functioning of the ecosystem. Less technically, it is the act of making the state or conditions of an environment unhealthy and unbearable. Pollution can be of three types – Air, Water and Land. But for the purpose of this discussion, the focus shall be on air pollution. Air Pollution is basically the presence of foreign substances in air in excessive concentration which disturb the actual profile and composition of atmospheric gases, further this adversely affects the well being of the individual or any other organism in the ecosystem or causes damage to property. Wherever we live, the air is contaminated to some degree. The earliest pollutants noted in the atmosphere were of natural origin; like smoke, fumes, ash and gases from volcanoes and forest fires, sand storms or windstorms, or any other natural source. But the real problems of air pollution came on the scene when human induced or anthropogenic sources started emitting pollutants. There are two main categories of pollutants – Primary pollutants and Secondary pollutants. Primary air pollutants are those which are emitted directly into the atmosphere and are found there in the form in which they are emitted. For example, Particulates, Carbon monoxide, Hydrocarbons, oxides of Sulphur, oxides of Nitrogen, etc. Secondary air pollutants are those which are produced in the air by the interaction among two or more primary air pollutants, or by reactions with normal atmospheric constituents, with or without photo activation. For Example, ozone ($O_3$), Peroxy-acetyl nitrate (PAN), formaldehyde, etc.

### Contributing agents of air pollution

Actually, the contributing agents or sources of air pollution may be natural or anthropogenic (man-made); but the pollution due to natural sources such as Volcanic eruptions, sandstorms, forest fires, etc. is balanced or compensated by nature itself. Thus, the main factors behind air pollution are anthropogenic sources which include emissions from industries, automobile exhaust, rapid industrialization, agricultural activities and many more. But in this discussion, we are not interested in identifying the sources but we have worked upon identifying the pollutants, their effects and check and control.

## COMMON AIR POLLUTANTS

The common air pollutants (also known as 'criteria pollutants') are found all over the globe. They are particle pollution (often referred to as particulate matter), ground-level ozone, carbon monoxide, sulphur oxides, nitrogen oxides, lead, and cadmium. These pollutants can harm our health, environment and cause

property damage. Of these air pollutants, particulate matter and ground level ozone are the most widespread health threats. Now let's see why these pollutants are of concern.

**A. Ozone: How ground level Ozone is bad for us**

A key component of photochemical smog, Ozone is formed by a complex reaction of nitrogen dioxide, hydrocarbon and volatile organic compounds (VOCs) in the presence of sunlight. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, Gasoline vapours and Chemical solvents are some of the major sources of $NO_x$, hydrocarbon and VOCs.

**Ozone and our health:**

Ozone in the air we breathe can harm our health – typically on hot, sunny days when ozone can reach unhealthy levels. Even relatively low levels of ozone can cause health effects. People with lung diseases, children, older adults, and people who are active outdoors may be particularly sensitive to ozone. Children are at greater risk from the exposure to ozone because their lungs are still developing and they are more likely to be active outdoors when ozone levels are high, which increases their exposure. Children are more likely than adults to have Asthma. About 25 million people, including 7 million children, have asthma and over 12 million people report having an asthma attack in the past year (UNEPA) [6].

Breathing ozone can trigger a variety of health problems including chest pains, coughing, throat irritation and congestion. It can worsen bronchitis, emphysema, and asthma. Ground level ozone can also reduce lung functions and inflame the linings of the lungs. Repeated exposure may permanently scar lung tissues. Air pollution claims more than 2 million lives worldwide every year and roughly 4,70,000 deaths occur each year due to increase in ground level ozone [7]. That inhalation produces toxicity in large airways is supported by evidence of ciliated cell loss and increased epithelial mitotic index in small animals, netrophilic inflammation in humans, increased bronchial artery blood flow in sheep and by the symptoms of cough and of substernal pain exacerbated by deep inspiration in humans [8].

**Ozone and ecosystems:**

Ground level ozone can have harmful effects on sensitive vegetation and ecosystems. Plant species that are sensitive to ozone and potentially at an increased risk from exposure include trees such as black cherry, quaking aspen, ponderosa pine and cottonwood [6]. These effects can also have adverse impacts on ecosystems, including loss of species diversity and changes to habitat quality and water and nutrient cycles. The long term exposure to ground level ozone has various effects on plants and vegetation including premature aging, suppressed growth, necrosis (killing of plant tissues), bleaching and collapse of leaf.

**Ozone and property:**

As ozone is an extremely active and oxidizing compound, it readily oxidizes paints, textile fibres, dye and elastomers (such as rubber). Due to this, buildings and monuments lose their shine and lustre very soon and need more paints and varnish. In fact, the cracking of rubber tyres and insulation on wires has become a serious economic problem. Though, technology is available to protect elastomers but only at significantly high cost.

**B. Particulates, quite destructive:**

Particulate matter (PM), also known as particle pollution, is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of number of components, including acids (such as nitrates and sulphates), organic chemicals, metals and soil or dust particles. The size of particles is directly linked to their potential for causing health problems. We are concerned about the particles that are 10 micrometers in diameter or smaller because those are the particles that generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and can cause serious health effects. Particle pollution includes inhalable coarse particles, with diameters larger than 2.5 micrometers and smaller than 10 micrometers and fine particles, with diameters that are 2.5 micrometers and smaller. Among the different PM10 and PM2.5 components are organic compounds, such as benzene, 1-3 butadiene, polycyclic aromatic hydrocarbons, dioxins, etc., inorganic compounds, such as carbon, sulphates, nitrates, chlorides and even some metals [9]. The particles produce toxic effects according to their chemical and physical properties, as described above. However, they primarily affect susceptible individuals, where their effects are much more severe than those produced in normal individuals [10].Sources of particulate matter is shown in diagram 1.

**Effects on human health:**

Particle pollution, especially fine particles contains microscopic solids or liquid droplets that are so small that they can get deep into the lungs and cause serious health problems. Numerous scientific studies have linked particle pollution exposure to a variety of problems, including: premature death due to heart or

lung disease**,** nonfatal heart attacks, irregular heartbeat, aggravated asthma, decreased lung function, and increased respiratory symptoms, such as irritation of the respiratory airways, coughing or difficulty breathing. Researchers from University of North Carolina estimated that about 2.1 million people die as a result of surge in fine particulate matter air pollution. They also claimed that many of these deaths are estimated to occur in East Asia and South Asia where population is high and air pollution is severe [7].

**Effects on environment and vegetation:**

Particles can be carried over long distances by wind and then settle on ground or water. The effects of this settling include: making lakes and streams acidic, changing the nutrient balance in coastal waters and large river basins, depleting the nutrients in soil, damaging sensitive forests and farm crops and affecting the diversity of ecosystems. Fine particles ($PM_{2.5}$) are the main cause of reduced visibility (haze) in many parts of the world, including many of our treasured national parks and wilderness areas.Particle pollution can stain and damage stone and other materials, including culturally important objects such as statues and monuments (deterioration of Taj Mahal, due to smoke and acid rain).

**C. Carbon monoxide:**

Carbon monoxide (CO) is a colorless, odorless and tasteless gas emitted from incomplete combustion processes or substances containing carbon in them. The natural sources are volcanic eruptions, natural gas emissions; oxidation of methane gas from decaying vegetation, electric discharge during storms, etc. from natural sources, the estimated annual emission of CO on a global is about 75 million tonnes (UNEP). Yet this production is still a great deal less than the estimated 275 million tonnes produced from anthropogenic sources on a global scale. The anthropogenic sources are motor vehicles, industries including iron and steel, petroleum, etc. Almost $2/3^{rd}$ of the CO emitted comes from internal combustion engines and overwhelming bulk (about 60%) of this comes from the Gasoline – powered IC engines of motor vehicles. It is anticipated that the annual input of CO into the atmosphere by anthropogenic sources is expected to be double every five years [11].

**Effects of Carbon monoxide:**

According to the studies and researches carried out by USEPA, 2012 [12], at present CO global ambient levels has little if any effect on property, vegetation or materials. However, at higher concentrations it can seriously affect human health. Due to its high affinity for haemoglobin (Hb), it reacts with the haemoglobin of blood and displaces oxygen to form carboxy – haemoglobin (COHb), thus reducing the capability of blood to carry oxygen.

$$O_2Hb + CO \rightleftharpoons COHb + O_2$$

Since the affinity of haemoglobin for CO is about 200 times more than for oxygen, therefore, carbon monoxide can seriously impair the transport of oxygen even when present at low concentrations. As COHb levels increase, effects become more and more severe. The effects on human health on the basis of CO concentration, exposure duration and the activity being performed are given in the table no. 2.

**D. OXIDES OF NITROGEN ($NO_X$):**

In ambient air, only two oxides of nitrogen (NO and $NO_2$) are primarily involved in air pollution. Nitric Oxide is emitted to the atmosphere in much larger quantities than Nitrogen dioxide. Bacterial decomposition of organic matter releases $NO_x$ into the air, mainly in the form nitric oxide. Small concentrations of $NO_x$ produced in the upper atmosphere by solar radiation reach the lower atmosphere through downward diffusion. $NO_x$ are also produced by lightening and forest fires. In fact, naturally occurring sources of $NO_x$ produce 10 times as much as $NO_x$ as do the anthropogenic sources. Primary origins of human induced $NO_x$ are from fuel combustion and in stationary sources (power and heating), industrial processes in which nitric acid is used, emission from electric utilities, mining and electric arc welding. Typical background levels of NO are about 2-3 ppb and for $NO_2$ about 4-5 ppb (USEPA).

**Effects on human health:**

Nitrogen dioxide has more harmful effects on human health as compared to nitric oxide. Exposure to $NO_2$ even at low concentrations, can lead to increased resistance of the lung's airways to air movement, increased frequency of acute bronchitis among infants and older persons, increased incidence of respiratory illness, and irritation to the alveoli of the lungs. Nitric oxide is a relatively inert gas and moderately toxic. Nitric oxide, like CO, can combine with haemoglobin to reduce oxygen carrying capacity of the blood. NO concentrations are generally less than 1 ppm in the ambient air and are, thus not considered health hazards (UNEP).

**Effects of vegetation and environment:**

On plants and vegetation, $NO_x$ has no considerable effects below $850\mu g/m^3$. $NO_2$ cooperates with $NH^{4+}$ to form acids and under these acidic conditions soil loses $Mg^{2+}$ and $Ca^{2+}$ ions, thus disturbing the ecological equilibrium due to altered competitive behaviour. $NO_x$ mainly affects the plants indirectly rather than due to direct exposure, as the secondary pollutants produced during photochemical reactions involving $NO_x$

such as PAN (Peroxy Acetyl Nitrate) and $O_3$, are far more likely to be damaging to plants. Exposure of plants to these pollutants leads to suppressed growth, silvering of lower leaf surface, premature ageing, necrosis, bleaching and ultimately collapse of leaf and even death of plants at concentrations above 850µg/$m^3$ exposed for about half an hour in highly industrialized area or urban areas [13].

**Effects on material:**

The oxides of Nitrogen adversely affect the life and texture of materials and property. Effects on material include fading of textile dyes, yellowing of white fabrics and oxidation of white fabrics and oxidation of metals when exposed to high levels of $NO_2$.

**Oxides of Sulphur ($SO_x$):**

The oxides of Sulphur are acrid, corrosive and poisonous. The major natural sources are volcanoes and dimethyl sulphides (DMS), which is produced by marine phytoplankton and oxidised to $SO_2$ in the atmosphere. Natural sources contribute about 67% of $SO_x$ pollution which is evenly distributed all over the world. The anthropogenic sources contribute 33% of $SO_x$ pollution which is, however localized in some urban areas. In the $SO_x$ pollution, $SO_2$ is the most prevalent gas. The largest sources of $SO_2$ emissions are from fossil fuel combustion at power plants and other industrial facilities. Smaller sources of $SO_2$ emissions include industrial processes such as extracting metal from ore and the burning of high sulphur containing fuels by locomotive, large ships and non-road equipment.

**Effects of human health:**

Current scientific evidences link short term exposures to $SO_2$, ranging from 5min to 24hours, with an array of adverse respiratory affects including bronchoconstriction and increased asthma symptoms. $SO_x$ can react with other compounds in the atmosphere to form small particles. These particles penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory disease, such as emphysema and bronchitis and can aggravate existing heart disease. The secondary product $H_2SO_4$ primarily influences respiratory systems. Its compound polynuclear ammonium salts or organo sulphates, act mechanically in alveoli and as easily soluble chemicals, they pass across the mucous membranes of the respiratory tract into the organism [14]. The most widespread disaster due to $SO_2$ occurs when it is accompanied by smoke. The $SO_2$ particulate combination has been cited as cause of death in several air pollution tragedies, like Meuse valley episode (1930), Donora Pennsylvanian tragedy (1942), London episode (1952), and many more.

**Effects on plants:**

Effects on plants can be chronic or acute. The $SO_2$ concentration in acute exposure is high for a short period, resulting in the damage characterized by clearly marked dead tissues between the veins or on the margins of the leaves, chronic injury comes from exposure to low concentrations for long periods of time, which causes brownish red or bleached white areas on the blade of the leafs. The pant injury threshold for $SO_2$ is about 0.3ppm to 0.4ppm exposure to 8 hours. Plants are particularly sensitive to $SO_2$ during day periods of intense light, high relative humidity, adequate moisture and moderate temperature. They are generally more sensitive during growing seasons, regardless of climatic conditions. Plants vary widely in their susceptibility to $SO_2$. Crops such as alfalfa, cotton and soyabeans, vegetables such as beans, spinache and lettuce and trees such as apple, mulberry and pine are particularly sensitive to $SO_2$ [15].

**Effects on materials and property:**

Sulphur dioxide's effects on material are quite significant. Paper absorbs $SO_2$, the sulphur dioxide is oxidised to $H_2SO_4$, and the paper yellows and becomes brittle. Similarly leather also weakens and disintegrates in the presence o $SO_2$. Excess exposures to $SO_2$ accelerates corrosion rates of many metals at relative humidity. The accelerated corrosion is particularly noticeable in winters when more fuel is burned. Sulphuric acid aerosols readily attack building materials, especially those containing carbonates (such as marble, limestone, slate and mortar).

**Hydrocarbon (HC):**

Hydrocarbons are generally not toxic at the concentrations normally found in the atmosphere, but they are the major pollutants because of their role in the formation of photochemical smog. Aliphatic hydrocarbon concentrations of 500 ppm produce no harmful effects, but polynuclear group of aromatic hydrocarbons from automotive exhaust emissions are carcinogenic in nature. Ehylene produced in automobile exhaust, is one of the very few hydrocarbon that can cause damage to plants at even low concentrations. Plants may severely damaged, if they are exposed to ethylene (0.01 to 0.03 ppm) for longer duration.

**HAZARDOUS AIR POLLUTANTS**

These are either deadly or have severe health risks in small amounts. Almost 200 are regulated by law, some of the most common are benzene, polycyclic aromatic hydrocarbon, mercury, lead, cadmium and dioxins.

**Benzene:**

Benzene has low acute toxicity, but repeated exposure to vey high concentrations can cause severe effects on the blood and blood forming organs in humans. It is classified as a carcinogen by EPA, can cause eye, skin and lung irritation in the short term and blood disorders in the long term. The most convincing relationship is found between benzene exposure and the development of acute non-lymphocytic leukaemia [16].

**Polycyclic Aromatic Hydrocarbons (PAH):**

Polycyclic aromatic hydrocarbons (PAH) are complex mixtures of hundreds of chemicals, including derivatives of PAH, such as PAH with $NO_2$ group (nitro-PAH) and oxygenated products, and also heterocyclic aromatic compounds [17]. PAH are toxic components of traffic exhaust and wildfire smoke. In large amounts, they have been linked to eye and lung irritation, blood and liver issues, and even cancer. In one recent study, the children of mothers who had higher PAH exposure during pregnancy had slower brain processing speeds and worse symptoms of attention deficit hyperactivity disorder (ADHD). Biological properties of most PAH are still unknown. Nevertheless, the available data, mostly from animal studies, indicate that several PAH may induce a number of adverse effects, such as immunenotoxicity, genotoxicity, carcinogenicity and reproductive toxicity (affecting both male and female offspring). PAH may also influence the development of artherosclerosis [18].

**Mercury:**

Mercury exists in various forms: elemental (or metallic) and inorganic (to which people may be exposed through their occupation); and organic (e.g., methylmercury, to which people may be exposed through their diet). These forms of mercury differ in their degree of toxicity and in their effects on the nervous, digestive and immune systems, and on lungs, kidneys, skin and eyes. It is released into the environment from volcanic activity, weathering of rocks and as a result of human activity. Human activity is the main cause of mercury releases, particularly coal-fired power stations, and residential coal burning for heating and cooking, industrial processes, waste incinerators and as a result of mining for mercury, gold and other metals. All humans are exposed to some level of mercury. Generally, fetus are most susceptible to developmental effects due to mercury. Methylmercury exposure in the womb can result from a mother's consumption of fish and shellfish. It can adversely affect a baby's growing brain and nervous system. The primary health effect of methylmercury is impaired neurological development. Therefore, cognitive thinking, memory, attention, language, and fine motor and visual spatial skills may be affected in children who were exposed to methylmercury as fetuses [19].

**Lead:**

Lead is a metal and a primary element-Pb on the periodic table. It serves a number of essential purposes, for instance, lead-acid batteries to start our vehicles and the lead in our computer monitors that shields from the cathode ray tubes harmful radiation. For many years, lead was used in gasoline as a performance enhancer. But that meant many tons of lead pollution was being spewed into the air, and once the serious effects of lead contamination became apparent, the world began phasing out leaded gasoline. In the two decades since the phase in of the ban began, airborne lead levels have dropped more than 90%. Unfortunately, there are still some sources of lead, primarily industrial activities like lead smelting, metal processing and lead acid battery manufacturing, waste incineration and power generation.

Lead toxicity can be explained by interactions with different enzymes, and that is why almost all organs can be considered as target organs for lead. A wide range of biological effects has been evidenced experimentally, including effects on haem synthesis, the nervous system, the kidney, the reproductive organs, the cardio vascular system, the immune system, the liver, the endocrine system and the gastrointestinal tract [20]. Lead in large amounts can affect children's IQ, behavioural disorders, memory problems and ability to learn.

**Cadmium:**

Cadmium (Cd) whether absorbed by inhalation or via contaminated food, may alter kidney functioning in various ways. There is also sufficient evidence that cadmium can produce lung cancer in humans and animals exposed by inhalation, and the international agency for research on cancer has classified cadmium as a class-1 human carcinogen [21].

**Pollen and Mold:**

Mold and allergens from trees, weeds and grass are also carried in the air, are exacerbated by climate change, and can be hazardous to health. They are not regulated by the government and are less directly

connected to human actions, but can be considered air pollution. Mold exposure can precipitate asthma attacks or an allergic response and some molds can even produce toxins that would be dangerous for anyone to inhale. Pollen allergies are worsening because of climate change. It also extends the pollen production season, and is becoming a more potent allergen. That means more people suffer runny noses, fevers, itchy eyes and other symptoms.

**WAYS TO HELP KEEP THE AIR CLEANER**

**1. Use public mode of transportation:** Encourage people to use more and more public modes of transportation to reduce pollution. Also, try to make use of car pooling, if come from the same locality.

**2. Conserve energy:** Switch off fans and lights when you are going out. Large amount of fossil fuels are burnt to produce electricity. We can save the environment from degradation by reducing the amount of fossil fuels to be burned.

**3. Understand the concept of Reduce, Reuse and Recycle:** Do not throw away items that are of no use to you. In fact reuse them for some other purpose.

**4. Emphasis on clean energy resources:** Clean energy technologies like solar, wind and geothermal are on high these days. Governments of various countries have been providing grants to consumers who are interested in installing solar panels for their home. This will go a long way to curb air pollution.

**5. Use energy efficient devices:** LED lights consume less electricity as against their counterparts. They live longer, consume less electricity, lower electricity bills and also help you to reduce pollution by consuming less energy.

Several attempts are being made worldwide on personal, industrial and governmental levels to curb the intensity at which Air Pollution is rising and regain a balance as far as the proportions of the foundation gases are concerned. Air Pollution is one of the larger mirrors of man's follies, and a challenge we need to overcome to see a tomorrow.

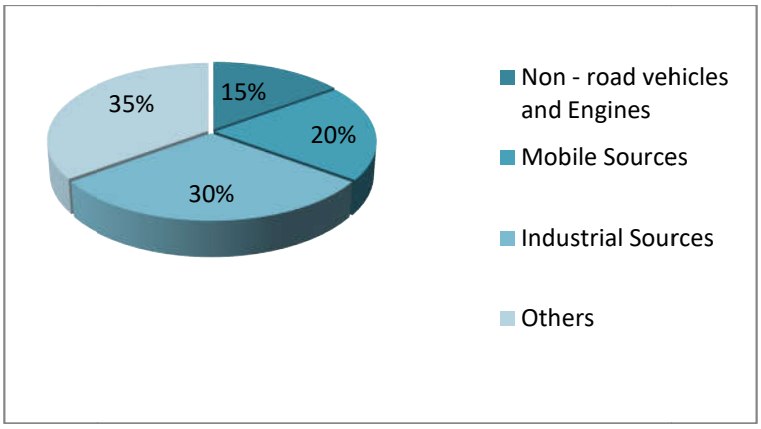
Table 1: Effects of ground level ozone (Source: USEPA)

| Concentration | | Exposure | Effects |
|---|---|---|---|
| Ppm | µg/m$^3$ | | |
| 0.02 | 40 | 1hour | cracked, stretched rubber |
| 0.03 | 60 | 8 hours | vegetation damage |
| 0.10 | 200 | 1 hour | increased airway resistance |
| 0.30 | 590 | continuous working hours | nose and throat irritation, chest constriction |
| 2.00 | 3900 | 2 hours | severe cough |

Table 2: Health effects of COHb at various levels in the blood (Source: WHO)

| COHb level (%) | CO level (ppm) | Effects |
|---|---|---|
| **< 1.0** | < 5 | No apparent effect |
| **1 to 2** | 5 - 10 | Some evidence of effect on behavioral performance |
| **2 to 5** | 10 - 30 | Central Nervous System affects impairment of time interval discrimination, visual perception, brightness discrimination, and psychomotor functions. |
| **> 5** | > 30 | Cardiac and pulmonary functional changes. |
| **10 - 25** | 30 - 200 | Headaches and dizziness. |
| **25 – 40** | 200 - 400 | Loss of consciousness. |
| **40 – 60** | 400 -750 | Respiratory failure, coma, death after several hours. |
| **> 65** | > 1000 | Rapid death. |

Diagram: 1 Sources of particulate matter




## CONCLUSION

Air if polluted, can be made unfit for survival. It is also evident that air pollution related problems have the potentials to disrupt life on our planet in a more devastating manner. At global, continental, regional and national level UN itself has passed laws to try to combat air pollution. Thus acknowledging the fact that air pollution is, indeed, a serious issue and call for urgent attention. But the government and authorities alone cannot solve this enormous problem of air pollution. It is ultimately up to us, as individuals, as a people and as corporate body, to be informed, responsible and involved when it comes to the problems we face with our environment. We must become familiar with our localities and learn about ways of disposing harmful household and industrial wastes so that they don't induce harmful fumes and gases in atmosphere.

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