



**ENVIRONMENT AND HEALTH**

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Article Received on 10/06/2019

Article Revised on 29/06/2019

Article Accepted on 20/07/2019

**ABSTRACT**

Several factors affect the environment such as topographic or physiographic factors, climatic factors, edaphic factors and biotic factors. Life of organisms is affected by the combination of all these ecological factors. The ecological factors operate under natural conditions. When natural conditions are disturbed due to man's intervention, there are several repercussions. Several problems like ecological imbalance, disruption of earth's natural ecosystems, environmental degradation, depletion of protective ozone umbrella, chlorofluorocarbons, ozone hole and global warming are affecting the health of human beings which is now at stake. Man-made sources of pollution such as increase in population, deforestation, burning of fossil fuels and fires, emissions from vehicles, rapid industrialization, agricultural activity, war are causing air pollution and affecting the health of people. New frontiers are being developed to reduce or eliminate the use of hazardous chemical substances and promote the use of bio-resources which are more feasible, economical and environment friendly and thus contributing to the development of green society which helps in protecting the health of human beings.

**KEYWORDS:** Environment, Health, Pollution.

**As B.K. Sharma quotes in his book "Environmental Chemistry", environment is defined as follows**

1. "Environment is the sum of all social, economic, biological, physical or chemical factors which constitute the surroundings of man".
2. "Environment refers to the sum total of conditions which surround man at a given point in space and time".
3. "Environment is the representative of physical components of the earth wherein man is the important factor influencing his environment".
4. "Environment is a holistic view of the world as it functions at any time with a multitude of special elemental and socio economic systems distinguished by quality and attributes of space and mode of behaviour of biotic and abiotic factors".

**Environment consists of the following two components**

1. Abiotic or Non-living component
2. Biotic or living component

**The abiotic or physical environment is subdivided into three components**

- 1) Lithosphere
- 2) Hydrosphere
- 3) Atmosphere

Biotic component includes plants and animals.

Several factors affect the environment such as topographic or physiographic factors, climatic factors, edaphic factors and biotic factors. Life of organisms is affected by the combination of all these ecological factors. The ecological factors operate under natural conditions. When natural conditions are disturbed due to man's intervention, there are several repercussions. Several problems like ecological imbalance, disruption of earth's natural ecosystems, environmental degradation, depletion of protective ozone umbrella, chlorofluorocarbons, ozone hole and global warming are affecting the health of human beings which is now at stake.

The Government of India in the sixth Five Year Plan (1980-1985) stated that "It is imperative that we use our renewable resources of water, soil, air and vegetation to sustain our economic development. Over exploitation of these is visible in soil erosion, floods, deforestation, siltation, floral and wild life resources. The depletion of these resources tends to be irreversible and since the whole population depend on these natural resources to meet their basic needs i.e. fuel, fodder and land. It has meant a deterioration in their standard of life".

Not only standard of life but health is affected severely. Let us view some of the deleterious effects caused due to environmental degradation:

Man-made sources of pollution such as increase in population, deforestation, burning of fossil fuels and fires, emissions from vehicles, rapid industrialization, agricultural activity, war are causing air pollution and affecting the health of people. The major effect of air pollution is greenhouse effect or global warming.

#### Global warming (Greenhouse effect)

Greenhouse means a building made mainly of glass with heat and humidity regulation for growing plants. The atmosphere acts like a glass in a greenhouse. Atmosphere like glass, absorbs some of the long wave radiation emitted by earth and radiates energy back to the earth. In this way, temperature of the earth is maintained. Atmosphere surrounding the earth also in this manner, maintains an even temperature on the earth's surface.

In a greenhouse light passes through the glass and heats up the soil warming the plants. The warm soil emits radiation in longer wavelengths particularly in the infrared. Because glass is opaque to longer wavelength of infrared radiation it partly reflects and partly absorbs infrared radiation. This mechanism keeps the greenhouse warmer than the outer atmosphere.

The four major greenhouse gases which cause adverse effects on health are CO<sub>2</sub>, Methane (18%), Nitrous Oxide (N<sub>2</sub>O), and Chlorofluorocarbons (CFC) (14%). Among these most important is CO<sub>2</sub>. O<sub>3</sub> is also a greenhouse gas.

#### Sources of CO<sub>2</sub>, oxides of Nitrogen

- 1) Burning of coal, oil and natural gases
- 2) Automobiles, burning of fire wood, forest fires, reduction of forest cover, halogenated gases such as CFC used as coolants and propellants.

Power stations of coal are major source of CO<sub>2</sub>. Second major source is vehicle exhaust and third source is cement industry. For example, In Brazil, clearing of rainforests led to 42% increase in greenhouse effect. Loss of trees means less absorption of CO<sub>2</sub>.

The major source of oxides of nitrogen is spraying chemical fertilizers and burning fossil fuels. The N<sub>2</sub>O is generated when nitrogen compounds are converted by the process of nitrification and denitrification.

The reaction of O<sub>2</sub> with nitrogen compounds to form nitrates is known as nitrification. The conversion of nitrites and nitrates into free nitrogen is known as denitrification. In this process N<sub>2</sub>O is also generated. It takes place in the presence of chemosynthetic bacteria such as Nitrosomonas and Nitrospora etc. Some fungi also release N<sub>2</sub>O as by-product during anaerobic respiration.

#### Effects of oxides of Nitrogen and Greenhouse gases on the health of human beings

1. NO<sub>2</sub> has irritating effects on mucous membrane.
2. Higher doses of NO<sub>2</sub> cause bronchitis and respiratory problems. Exposure towards 150 to 200 ppm of NO<sub>2</sub> results in Bronchiolitis fibrosa obliterans. It is a dangerous disease and occurs within 3 to 5 weeks after the exposure.
3. NO<sub>2</sub> causes irritation of alveoli leading to symptoms resembling emphysema on prolonged exposure to 1 or 2 ppm level.
4. NO<sub>2</sub> being most toxic is also known to be transformed in the lungs to nitrosamines which are carcinogenic. It is also transformed to methaemoglobin in the blood.
5. Acute exposure to NO<sub>2</sub> decreases gas exchange in blood.
6. NO<sub>2</sub> poisoning results in a dangerous silo filler's disease in man.
7. NO gets attached to haemoglobin and reduces oxygen transport efficiency of blood.
8. Higher levels of NO<sub>x</sub> cause gum inflammation, internal bleeding, pneumonia, oxygen deficiency and lung cancer.
9. Due to increase in greenhouse gases, there are more deaths due to thermal extremes, more draughts and floods, deterioration of sanitation, food shortage, famine, population migration and stress related diseases.
10. We have longer summers nowadays.
11. Higher temperature in surface water in tropics and subtropics means more heat is released into the atmosphere. So, more storms occur which are more intensive and disastrous.
12. Shrinking sea ice in the arctic due to global warming will cause reduction in ice algae which is food for arctic animals like fish, seals and polar bears. People who depend for their food on these animals will be severely affected as these animals die due to lack of food.

#### Ozone depletion

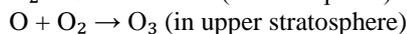
Second major problem is Ozone depletion. Ozone depletion is mainly caused due to use of air conditioners, refrigerators, aerosols, cleaning solvents and fire extinguishers.

Ozone layer is present between 20km and 40km in stratosphere. It absorbs UV rays and prevents them from reaching earth. The biological furnace will turn to blast furnace if ozone is depleted. The thickness of O<sub>3</sub> is measured in Dobson units.

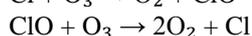
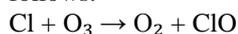
Ozone hole was first noticed in 1979 in Antarctica (South Pole). Scientists confirmed that ozone layer was depleted by CFC. US satellite photos showed that ozone hole above Antarctica has increased over past decade. Its area is increasing every year. It was now found to cover South Australia and New Zealand too.

### Mechanism of Ozone depletion

Atmospheric oxygen absorbs UV radiation shorter than 240nm and photo dissociates into two oxygen atoms. These unite with other O<sub>2</sub> molecules to form O<sub>3</sub>.



This is natural process but due to CFC□, chlorine destroys ozone layer by acting as a catalyst. It reacts as follows:



In the above reactions, Chlorine combines with ozone forming oxides of chlorine which in turn unite with more of ozone to form oxygen and chlorine. The liberated chlorine continues to deplete more and more ozone converting it to O<sub>2</sub>.

### Effects on the health of human beings

- 1) They cause skin cancers. They cause 3 types of cancers- basal cell carcinoma, squamous cell carcinoma and melanoma.
- 2) UV rays cause cataracts.
- 3) They cause Emphysema, a destructive lung disease and lung cancers.
- 4) Asthma is also caused due to UV rays.
- 5) Cells in the epidermis of human skin are key players in immune surveillance. UV radiations break down the defences in the skin. UV radiations cause blood vessels near the skin surface to carry more blood making the skin hot swollen or red causing skin burns.
- 6) UV radiation causes leukaemia and breast cancer.
- 7) UV radiation is also absorbed by cornea and lens in the eye leading to photo keratitis and cataracts.
- 8) Ozone at low concentration is also known to cause accumulation of inflammatory cells at the site of lung injury causing severe damage to the lung.
- 9) Emphysema a destructive lung disease and chronic obstructive lung disease such as chronic bronchitis and development of asthma are due to chronic ozone exposure.
- 10) Ozone exposure has also been implicated in dizziness and visual impairment.
- 11) Another major problem is photochemical smog.

### Photochemical Smog

The word smog is derived from smoke and fog. It was first recognized in 1944 in Los Angeles. It contains primary pollutants as NO<sub>x</sub> and hydrocarbons as well as secondary pollutants as O<sub>3</sub>, PAN, HNO<sub>3</sub>, particulate nitrate, aerosol particles and sulphates. Hot climate (>24°C) with low humidity is favourable for the formation of photochemical smog.

### Effects on the health of humans

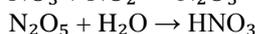
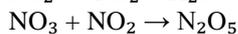
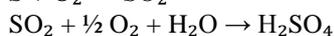
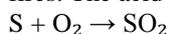
- 1) Peroxy Acyl Nitrate (PAN) cause irritation of the eyes causing lachrymation and effect severely the respiratory tract of human beings.

- 2) Primary photochemical pollutant i.e. NO<sub>2</sub> produces brownish haze causing nose and eye irritation and pulmonary discomfort.
- 3) In higher concentration causes headache, cough, dryness of throat, chest pain, difficulty in breathing, etc.
- 4) Exposure to ozone which is part of smog for a period of 2 hours produces extreme fatigue and lack of coordination in central nervous system.

### Acid rains

Acid rains is another major problem. Normally rain water is slightly acidic because it has CO<sub>2</sub> and forms carbonic acid. But when oxides of Sulphur and Nitrogen dissolve the PH decreases to 2.4 and this is called Acid rain.

The sources of acid rain are combustion of fossil fuels from power plants, automobile exhausts and domestic fires. The acid rain increased due to industrialization.



SO<sub>2</sub> and NO<sub>3</sub> combine with rain water and fall as acid rain in the form of H<sub>2</sub>SO<sub>4</sub> and HNO<sub>3</sub>.

### Effect of Acid rain on the health of human beings

1. Acid rain affects human nervous system respiratory system and digestive system by making the person an easy prey to neurological diseases. This happens because these acids produce highly toxic compounds which contaminate the portable water and enter man's body.
2. Man loses forest cover as it is destroyed.
3. As crops are destroyed by acid rain there is low productivity and high prices.
4. Variety of species in the food chain are killed due to acid rains thus altering ecosystems.

### Effect of Pesticides

Human beings are exposed to pesticide during their production, formulations, packaging, transportation and application to vegetation. These give opportunity for contact, inhalation and even ingestion of these toxic agents. Farmers out of their eagerness to get better yield spray large amounts of pesticides. Only some of it is taken up by plants. The remaining finds its way into the surface run off which ultimately is drained into nearby water bodies polluting them. When people drink this water, they are severely affected.

### Effects on the health of human beings

- 1) Organo-Chlorine pesticides are more dangerous as they show persistence and biological magnification. They are non-biodegradable and remain in the soil for several years.
- 2) Organo-Phosphates like Parathion, Melathion damage nervous system.

- 3) Organo-Chlorine pesticides like DDT are accumulated in lower organisms and increase in concentration successively up the food chain until toxic concentrations are consumed by higher animals (birds and humans). This increase up the food chain is called biological magnification.

Example: Estuary DDT level- 0.00005 ppm

Plankton- 0.04ppm

Minnow- 0.94ppm

Fish- 4-6ppm

Fish eating birds, Gulls- 75.5ppm

Man- 100ppm

- 4) Chronic accumulation of pesticides plays a major role in liver and kidney malfunctioning.
- 5) Organo-Phosphates like Ethion, Felthion, Monocrotophos, etc. inhibit the production of cholinesterase at the junction between adjoining nerve cells with the result that cholinesterase breaks down acetyl chlorine and interferes with nerve impulse transmission.
- 6) Bhopal industrial disaster was the worst ever pesticide MIC accident in history taking an unprecedented and still unaccounted death toll leaving no fewer than 50,000 effected. This carbaryl leakage caused an increased risk of sleeping, digestive problems, vision problems, sterility, kidney and liver infections as well as brain damage.

#### Industrial effluents

Industrial wastes include wastes from coal washeries, China clay works, tanneries, dairies, electroplating industry, modern industrial wastes may also contain radioactive substances, grease, oil and explosives, highly offensive and odorous substances.

Heavy metals cause a number of diseases according to B.K Sarma.

#### Environmental Impact Assessment Study

Every industry has to prepare and submit an Environmental Impact Assessment Statement on the basis of Environmental Impact Assessment Study as per the guidelines of the Ministry of Environment and Forests, Government of India. It is mandatory for all industries.

#### EIAS covers the following aspects

1. Any possible chance of land degradation due to the project or industry and loss of biodiversity.
2. Extent of forest clearances or tree felling and measures of their regeneration.
3. Types of pollution and health hazards expected due to project or industry and measures of its abatement.
4. Extent of risks and problems of displacement of local inhabitants of that area and measures for their rehabilitation.

To reduce the health hazards and risks to man and his co-existence, we need to adopt certain strategies that will

reduce pollution, prevent environmental degradation and ruining of the earth's most valuable resources. We need to adopt eco-friendly technologies to save humans and our planet as a whole. Some of the environmental friendly technologies are as follows:

#### Efficient and Environment friendly technologies

- 1) **Combustion:** Gases are changed by burning them with the help of suitable chemicals to become less harmful or harmless.
- 2) **Absorption:** Gases are passed through absorbers that contain specific liquids. Thus, the harmful parts of gaseous pollutants are absorbed by those liquids and harmless gas is released out.
- 3) **Adsorption:** Gases containing pollutants are passed through specific porous equipment which contain specific chemicals as adsorbents when gases containing organic and inorganic pollutants are passed through adsorbents, their pollutants are caught by chemical filled in them. Thus harmless gas is released out.
- 4) **Use of Bio-fertilizers instead of chemical fertilizers:** Chemical fertilizers destroy microbes which enrich humus and enhance plant growth and thus cause soil degradation fertilisers increase crop yield but at the expense of protein loss. It is reported that there occurs a 20 – 25% decline in protein content. So, people suffer protein deficiency.

Hence the safer option is to develop bio fertilizers which are eco-friendly and beneficial.

#### They have the following benefits

- 1) Bio-fertilizers add nutrients through the natural process of nitrogen fixation. solubilizing phosphorus and stimulating plant growth through the synthesis of growth promoting substances.
- 2) The micro organisms in fertilizers restore the soil's natural nutrient cycle and build soil organic matter. Through the use of bio-fertilizers healthy plants can be grown while enhancing the sustainability and health of the soil.
- 3) They are more cost effective than chemical fertilizers and provide eco-friendly organic agro input.
- 4) Since bio-fertilizer is technically living it can symbiotically associate with roots.
- 5) The involved micro organisms can safely and readily convert complex organic material into simpler compounds so that plants can easily take up.

Rhizobium, Azotobacter, Azospirillum and Blue green algae (BGA) are good bio-fertilizers. Rhizobium inoculant is used for leguminous crops. Azotobacter can be used with crops like wheat maize, mustard, cotton, potato and other vegetable crops. Azospirillum inoculations are recommended mainly for sorghum, millets, maize, sugarcane and wheat. Blue green algae such as Nostoc, Anabaena or Tolypothrix or Aulosira fix

atmospheric nitrogen and are used as inoculations for paddy crop growth.

Anabaena in association with water fern Azolla contributes nitrogen upto 60kg/ha/season and also enriches soils with organic matter. Phosphate solubilizing bacteria such as Pantotheraagglomerans strain P<sub>5</sub> or Pseudomonas putida strain P<sub>13</sub> are able to solubilize the insoluble phosphate from organic and inorganic phosphate sources.

Resources such as fossil fuels are limited and non renewable. Continuous use and misuse of resources by cumulative rise in population will finally lead to shortage which in turn may lead to collapse of economy and natural systems. Hence here is every need to search for some renewable and eco-friendly resources that can replace the existing non renewable resources. Here we shall discuss a few of the bio-resources that are used for energy generation.

### 5) Use of Bio-fuels instead of fossil fuels

Bio-fuels are fuels produced from living organisms. They are formed by biomass conversion and have increased in popularity because of rising oil prices and the need for energy conservation.

#### Biogas

Biogas is produced by the anaerobic digestion with anaerobic bacteria or fermentation of biodegradable materials such as manure, sewage, municipal waste, green waste, plant material and crops.

Biogas comprises primarily of methane and CO<sub>2</sub> and may have small amounts of H<sub>2</sub>S, moisture and siloxanes. It can be used for cooking and also in anaerobic digesters where it is used in gas engines to convert the energy in the gas into electricity and heat. Biogas can be compressed in the same way as natural gas is compressed to CNG and used to power motor vehicles. Biogas is renewable and qualifies for renewable energy subsidies in some parts of the world.

Normally manure if left to decompose releases nitrogen dioxide and methane NO<sub>2</sub> warms the atmosphere 310 times more than CO<sub>2</sub>. Thus by converting manure to methane and using methane to generate energy, global warming gases can be reduced by ninety nine million metric tonnes or 4%. One cow can produce enough manure in one day to generate 3 kilowatt hours of electricity. Only 2.4 kilowatt hours of electricity is needed to power 100W single bulb for 1 day.

Compressed biogas is becoming widely used in Sweden, Switzerland and Germany. A biogas powered train named Biogastaget Amanda near Linköping station. This has been in service in Sweden since 2005 about 12000 vehicles are being fuelled with upgraded biogas world wide mostly in Europe.

#### Bio-ethanol

Bio-ethanol is an alcohol made by fermentation mostly from carbohydrates produced in sugar or starch crops such as corn or sugar cane. Bio-ethanol is widely used in USA and Brazil. Ethanol can be used in petrol engines as a replacement for gasoline.

#### The advantages of ethanol are

1. It has a high octane rating than ethanol free gasoline available at road side gas stations which allows an increase of an engine's compression ratio for increased thermal efficiency.
2. In high altitude (thin air locations) some states mandate a mix of gasoline and 15% ethanol as a winter oxidizer to reduce atmospheric pollution emissions.
3. Ethanol is also used to fuel fire places. As they do not require a chimney and are flue less, bio-ethanol fires are extremely useful for newly built homes and apartments.

#### Bio-diesel

Bio-diesel is the most common biofuel in Europe. It is produced from vegetable oils or animal fats using transesterification and is a liquid similar in composition to fossil/ mineral diesel. Feed stocks for bio-diesel include animal fats, vegetable oils such as rapeseed, jatropha, mahua, mustard, flax, safflower, palm oil, hemp, Pongamiapinnata and algae.

In many European countries 5% bio-diesel blend is widely used and is available at thousands of gas stations.

#### The benefits of bio-diesel are

1. It contains reduced amount of carbon and higher hydrogen and oxygen content than fossil diesel. This improves the combustion of bio-diesel and reduces particulate emissions from unburnt carbon.
2. It is safe to handle and transport because it is as biodegradable as sugar and one tenth as toxic as table salt.
3. It has a high flash point of about 300<sup>0</sup> (148<sup>0</sup> C) as compared to petroleum diesel fuel which has a flash point of 125<sup>0</sup> F (52<sup>0</sup> C).

#### Green Diesel

Green diesel is produced through hydro cracking of vegetable oils and animal fats. Hydro cracking is a refinery method that uses elevated temperatures and pressure in the presence of a catalyst to break down larger molecules such as those found in vegetable oils into shorter hydrocarbon chains used in diesel engines. It is renewable diesel and is being developed in Singapore.

#### Biofuel gasoline

In 2013 researchers developed a GM strain of Escherichia coli which could transform glucose into bio-fuel gasoline that does not need to be blended.

**Bio-ethers**

Bio-ethers also referred to as fuel ethers are cost effective compounds that act as octane rating enhancers. They also enhance engine performance whilst significantly reducing engine wear and toxic exhaust emissions greatly reducing the amount of ground level ozone, they contribute to air quality.

**Algal bio-fuels**

By using algae that have natural oil content greater than 50% which Michael Briggs suggests can be grown on algae ponds at waste water treatment plants. These oil rich algae can then be extracted from the system and processed into bio-fuels with the dried remainder further reprocessed to create ethanol. The benefit is it does not need farmland or fresh water unlike crop based bio-fuels.

As pollution is increasing various technologies have been developed to remove pollutants.

**6) Bioremediation**

One method to remove pollutants is Bioremediation. Some examples are phytoremediation, bio-venting, bioleaching, land farming, bioreactor composting, bio-augmentation, rhizofiltration and bio stimulation. Bone char has been shown to bio-remediate small amounts of cadmium, copper and zinc. The use of genetic engineering approaches to create organisms specifically designed for bioremediation has great potential. The bacterium *Deinococcus radiodurans* has been modified to consume and digest toluene and ionic mercury from highly radio active nuclear waste.

**7) Myco-remediation**

Myco-remediation is a form of bioremediation in which fungi are used to decontaminate the area. Two species of the Ecuadorian fungus *Pestalotiopsis* are capable of consuming polyurethane in aerobic and anaerobic conditions such as found at the bottom of land fills.

**8) Myco-filtration**

It is a similar process using fungal mycelia to filter toxic waste and micro organisms from water in soil.

**9) Biodegradable plastic**

Bio-degradable plastic is plastic that has been treated to be easily broken down by micro organisms and returned to nature. Biodegradable technology is especially utilized in biomedical community. Biomedical applications include the use of biodegradable implant materials. As a result implants can now fit in though small incisions, doctors can easily perform complex deformations and sutures and other material aides can naturally biodegrade after a completed surgery.

**10) Bio-pharmaceuticals**

Some examples of biopharmaceutical drugs include Infliximab, a monoclonal antibody and Etanercept, a fusion protein used in the treatment of auto immune diseases. Rituximab is used in treatment of cancer.

**11) Bio-pesticides**

Substances used to kill or repel pest are called as pesticides. The ladybird or *Coccinellaseptempunctata* and praying mantis called *Mantis religiosa* are used in biological control of insect pests.

**12) Vermiculture**

Rearing of earth worms and using earthworms to increase soil fertility is called vermiculture. A major advantage of earthworm activity is that they work as living ploughs, open the soil for greater aeration, retention and root development and hence promote water and nutrient absorption.

Thus new frontiers are being developed to reduce or eliminate the use of hazardous chemical substances and promote the use of bio-resources which are more feasible, economical and environment friendly and thus contributing to the development of green society which helps in protecting the health of human beings.

**REFERENCE BOOKS**

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