M.Sc Semester-I, Paper: AECC-1

Unit-2 Development & its effect on environment

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Acid rain:

Acid rain is a broad term that includes any form of precipitation with acidic components such as sulphuric acid (H_2SO_4) or nitric acid (HNO_3) that fall to the ground from the atmosphere in wet or dry forms. It also defined as "All precipitations rain, snow, fog, dew, hail or even dust which is more acidic than normal (pH: 5.6-3.5) is called acidic rain or acid deposition.

* **Chemistry of Acid rain:** Natural processes such as volcanic eruptions, forest fires, bacterial decomposition of organic matter etc and human activities such as fossil fuel burning power plants, vehicles, oil refineries etc. release SO_2 & NO_x into the atmosphere (air). When they (SO_2 & NO_2) mix and react with H_2O, O_2 & other chemical (Oxidants) in presence of sunlight, more acidic pollutants (H_2SO_4 & HNO_3) formed as mist. These condense at low temperature, mixed with rain, fog or snow and fall to the ground as acid rain.

$$SO_2 + H_2O \longrightarrow H_2SO_3 \text{ (Sulphurous acid)} \quad ; \quad SO_2 + O_3 \longrightarrow SO_3 + O_2 \quad ; \quad SO_3 + H_2O \longrightarrow H_2SO_4 \text{ (Sulphuric acid)} \quad ; \quad O_2 + O \longrightarrow O_3$$

$$2NO + O_2 \longrightarrow 2NO_2 \text{ (Nitrogen dioxide)} \quad ; \quad 2NO_2 + H_2O \longrightarrow HNO_2 + HNO_3 \text{ (Nitrous acid) (Nitric acid)} \quad ; \quad 3HNO_2 \longrightarrow 2HNO_3 + NO$$

* **Effects:** 1. **Ecological effects** – The ecological effects of acid rain are most clearly seen in aquatic environments such as streams, lakes & marshes where it can be harmful to fish, and other wild life. As it flows through the soil, acidic rain water can leach Al from soil clay particles and then flow into streams & lakes. It can be extremely harmful to water bodies as it can kill individual fish, reduce fish population, completely eliminate fish species from a water body and decrease biodiversity.

2. **Vegetation & Forests:** It can extremely harmful to forest. It seeps into the ground and dissolve nutrients e.g. Mg, Ca that trees or plants need to be healthy. It also causes Al to be released into the soil, which makes it difficult to trees/plants to take up water.

3. **Materials:** H_2SO_4 mist (acid rain) causes serious damage to structural materials such as marble, limestone, slate. Shinning of buildings, statues etc. made of such materials lost and decayed by acid rain.

4. **Human health:** It can cause health problems in human. It can cause repiratory diseases, or can make these diseases worse. Respiratory diseases like asthma or chronic bronchitis make it hard for human to breathe.

* **Control:** A great way to reduce acid rain is to produce energy without using fossil fuels. Instead, we can use renewable energy sources such as solar and wind power. Renewable energy sources help in reducing acid rain because they produce less air pollution. Dispersal methods have been used/proposed for reduction of emiss of exhaust gases from power plants, oil refineries, industries and automobiles.

⟹ Ozone layer & its depletion

The presence of ozone (O_3) blanket in the upper atmosphere/earth's stratosphere at an altitude of about 10 km, called ozone layer or ozonosphere, prevents the harmful ultra-violet (UV) radiations from reaching the earth. UV-radiations are very harmful particularly to the animal life. Ozone (O_3) is formed in the upper atmosphere by following reactions:

$$\underset{(Air)}{O_2} \longrightarrow 2O \; ; \; O_2 + O \longrightarrow \underset{(Ozone)}{O_3}$$

Ozone depleting substances e.g. CFCs (Chlorofluoro carbons), NO_x (nitrogen oxides) CCl_4 etc. are being released in the atmosphere by refrigerators, high flying jets, rockets etc. These are converting ozone (O_3) into oxygen (O_2) as follows:

$$O_3 + NO_2 \longrightarrow NO + 2O_2 \; ; \; \underset{(1)}{2O_3 + CCl_2F_2 \xrightarrow{Light} 3O_2} \; (2)$$

Mechanism of the reaction (2) is: $CCl_2F_2 \longrightarrow Cl\cdot + \cdot CClF_2$; $\underset{(CFCs\ acts\ as\ catalyst)}{Cl\cdot + O_3 \longrightarrow ClO\cdot + O_2}$; $ClO\cdot + O_3 \longrightarrow Cl\cdot + O_2$

Due to the destruction of ozone in the atmosphere, its concentration has fallen down. This is called ozone layer depletion or ozone hole.

*__Effects of Depletion of ozone layer__: High radiation ultra violet (UV) rays will be in a position to pass through the ozone hole and will have a direct assess to our planet, i.e., earth. The UV-rays produce green house effect, and hence global warming on the earth. They will also lead to health hazards. Some of diseases likely to be caused as a result of the depletion of ozone layer are (i) UV rays cause skin cancer in middle aged persons and more in old persons (ii) They are likely to result in weaking of eyesight and ultimately to blindness (iii) They are also likely to suppress immune system. The immunity against certain diseases is likely to decrease.

Efforts are being made all over the world to check the release of CFCs and other ozone depleting substances in the atmosphere. These are being replaced by hydrofluorocarbons (HFCs) which do not contain chlorine.

⟹ Green house effect

Green house effect is a natural process that occurs when gases in Earth's atmosphere trap the sun's heat and warms the Earth's surface and troposphere (the lowest layer of the atmosphere). The gases: CO_2, CH_4, N_2O, O_3, CFCs, $H_2O_{(g)}$ etc. are called green house gases.

When the sun's energy (heat) reaches the Earth's atmosphere (troposphere), some of it (75%) is reflected back to space and the rest (25%) is absorbed and re-radiated by green house gases. The absorbed energy (heat) warms the atmosphere and the surface of the Earth. The gradual increase in the overall temp. of the earth is called global warming.

This process makes the Earth much warmer than it would be without an atmosphere. This is one of the things makes the Earth a confortable to live.

__Causes__: (i) Some green house gases like methane (CH_4) are produced through agricultural practices, including live stock manure (ii) CO_2 largly result from natural processes like respiration and from the burning of fossil fuels e.g. coke/coal & oil.

(iii) Thermal power plants where coal burns, release large amount of CO & CO_2 gases.
(iv) Deforestation: Plants take up CO_2 from the atmosphere, an imbalance is this is being created and so concentration of CO_2 gas increase in the atmosphere by deforestation.
(v) Marshy lands, paddy fields and organic wastes release methane (CH_4) into atmosphere.
(vi) Refrigerators, rockets etc. release Chlorofluorocarbons ($CFCs$) into atmosphere.
(vii) Use of excess nitrogenous fertilizers is responsible for NO_x in the atmosphere.

* Effects: The global warming results by green house effect which has profound impact on human health, Climate, vegetation, soil etc.
* Controls: (i) The use of fossil fuels (e.g. Coal, wood, petrol etc.) should be minimised.
(ii) Electricity must be generated from sun, wind, Nuclear reactors etc; i.e, renewable energy such as solar, wind, nuclear and geothermal power must be used.
(iii) Deforestation & fossil fuel burning must be totally banned (iv) Man made/anthropogenic components of the green house effect produced by man activities must be controlled.

⟹ Global warming

"Global warming is the unusually rapid increase in Earth's average surface temperature over the past century primarily due to green house gases released as people burn fossil fuels." It is a major aspect of Climate change which, in addition to rising global surface temperatures, also includes its effects such as changes in precipitation. In short, "Global warming is the ongoing rise of the temperature (average) of the Earth's Climate System"

Charney used word "global warming" when referring to surface temp. Change, and "Climate change" when discussing the many other changes that would be induced by increasing CO_2 gas in the atmosphere. It occurs mostly in troposphere which extends up to 6-11 miles from earth's surface, where earth's cloud, living things & their habitats/weather present.

* Causes: (i) It occurs when CO_2 gas, other air pollutants and green house gases collect in the atmosphere and absorb sunlight/solar radiation that have bounced off the earth surface.
(ii) It is associated with increase in the incidence of severe and extreme weather, heavy flooding and wild fires phenomena that threaten homes, dams, transportation network and other facets of human infrastructures.

* Effects/Consequences: (i) Glaciers/ice sheets will melt at a higher rate and this will lead to rise in the sea level resulting in floods & loss of soil particularly in Coastal areas.
(ii) Warming of ocean surface, leading to increased temp. stratification and change in Ocean Circulation.
(iii) It increases the cases of malaria, dengue, yellow fever etc.
(iv) This leads to forest fires which release more gases into the atmosphere.

* Controls: Global warming can be checked only if we check the release of green house gases into the atmosphere. So, all control measures of green house effect must be used. Other control measures are — (i) Power your home with renewable energy (ii) Invest in energy efficient appliances (iii) Reduce wastes of water/water wastes.
(iv) Buy better bulbs and pull the plug(s).

* Largest global warming in China (9.3 GT CO_2 emission rate). In India, CO_2 emission rate is 2.2 GT.

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