ACID RAIN

Unit - VI

The term "acid rain" was first used by Robert Angus Smith in 1872.

→ The term acid rain is used to describe all precipitation and deposition, which is more acidic than normal.

→ NO_x, SO_2, VOCs produced during combustion of coal and petrolium oxidize in air to produce H_2SO_4 & HNO_3 etc. which are quickly dissolve & washout to ground as ACID RAIN.

$SO_x + O_2 + H_2O \longrightarrow H_2SO_3$ or H_2SO_4

$NO_x + O_2 + H_2O \longrightarrow HNO_2$ or HNO_3

→ If these compounds deposited in form of particulate and aerosols then called as Dry deposition. and if these precipitate out on earth in raindrops, snow, fog form then called wet deposition.

imp. Normal rain is acidic having pH 5.6 — 6.5.

→ Due to dissolution of CO_2 due to formation of carbonic acid,

$\because H_2O + CO_2 \longrightarrow H_2CO_3$

the Acid rain would be declared if the pH of rain water is less than 5.6.

$$SO_2 + OH \longrightarrow SO_2OH$$

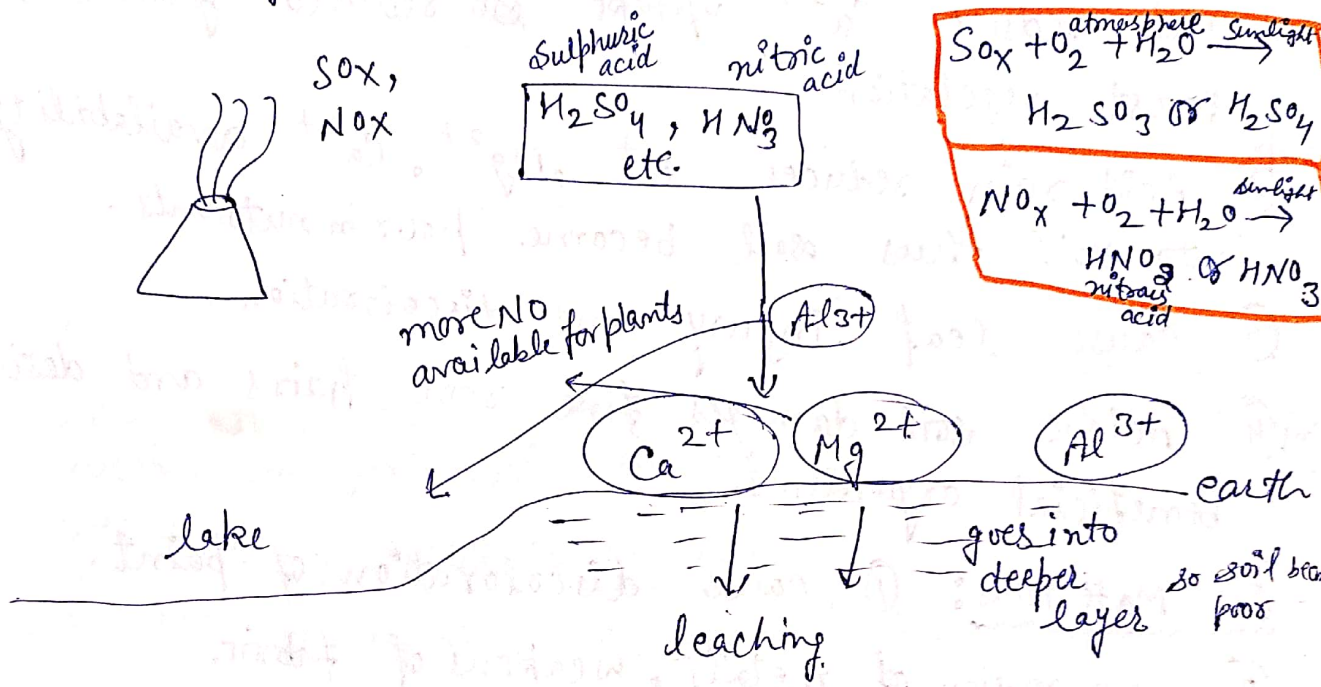
$$SO_2OH + O_2 \longrightarrow SO_3 + HO_2$$ intermediate ion

imp $\boxed{SO_3 + H_2O \longrightarrow H_2SO_4}$

The formation of SO_2 to SO_4 particle is gradual and takes days. During this time Sulphur

pollution may deposited on land & water in the form of SO_2 & SO_4. In either forms wet or dry.

⇒ Alkalinity is due to HCO_3^- (bicarbonate), CO_3^{2-} (carbonate ions).



- conc. of Al^{3+} increases now they became too mobile
- Acidity of lake increases
- crystal clear water due to floculation of Al^{3+} but lake physiologically dead.
- Al^{3+} toxic for fishes bcoz damage gills tissue.
- pH of lake water 6–8.

Sea water 8.3

As the pH of lake water drops to about 6, the acid sensitive organism die & as pH lower to 5, virtually all fishes die. Although acidify lakes will have crystal clear water, such lakes are considered as physiologically dead, for all aquatic flora and fauna except than few algae, masses & other tolerent organism.

Effects: On forest: ① Ca^{2+} deficiency in soil while Al^{3+} excess in soil results in lowering of Ca/Al ratio below than 1. and it considered as Al toxicity and reduce Ca^{2+} uptake so reduced growth of forest vegetation.

② Acid rain reduces K^+, Mg^{2+}, Ca^{2+} availability into soil thus soil become poor in nutrients.

③ cause leaf injury and discoloration.

④ Acidic soil damages fine root hairs and destroys beneficial organisms.

On Materials: ① cause discoloration of paint.

② corrosion of metals, weakens of fabric

③ H_2SO_4 cause damage to marble building by formation of $CaSO_4$ which is more soluble and thus leaves a pitted appearance on marble.

$$\underset{\text{insoluble}}{CaCO_3} + H_2SO_4 \longrightarrow \underset{\text{soluble}}{CaSO_4} + H_2O + CO_2$$

However in normal rain which has H_2CO_3, weathering of $CaCO_3$ do not occurs upto a great extent as it is minised by production of bicarbonate ions which neutralizes acid.

$$CaCO_3 + \underset{\text{carbonic acid}}{H_2CO_3} \longrightarrow Ca^{2+} + HCO_3^-$$

Control: ① neutralize acid with lime but expensive.

② reduce emissions of SO_x, NO_x.

→ Acid rain less in india beoz. Indian soil rich in Ca^{2+} ions.

One of the newcomers, called the *Indian Ocean Dipole* was first noticed in early 1980s. The dipole is a twin system of a warmer than average band of water between North Australia and Java (Indonesia), and an unusually cold band of water running northwest into the Indian Ocean from Australia's west coast.

The other newcomers operate from the tropical Atlantic. The tropical Atlantic blows hot and cold between January and May. When the sea in the southern tropics becomes warmer than usual and water to the north of the equator cools, it rains cats and dogs in north-east Brazil. When the pattern is reversed, the season is drier.

6.8 ACID RAIN

The term 'acid rain' was first used by Robern A. Smith in 1872. Since then numerous western investigators added insight to this emerging environmental challenge.

The term *acid rain* is used to describe all precipitation and/or deposition, which is more acidic than normal. It results, when gaseous emissions of particularly SO_x and NO_x interact with water vapour and sunlight, and are chemically converted to strong acidic compounds such as sulphuric, sulphurous, nitric and nitrous acids. When these compounds (acid gases or their precursors or acid particles) along with other organic and inorganic chemicals are deposited on the earth as aerosols and particulate, the deposition is called as *Dry deposition* ; and when these are carried to the earth's surface by precipitation (raindrops, snow, fog or dew), the deposition is called as *wet deposition*. However, dry deposition is estimated to be a small fraction of total acid deposition.

Generally, *clean rain* is slightly acidic as it dissolves varying amounts of naturally occurring carbon dioxide from the atmosphere. The lowest pH level which can be produced by carbonic acid (or CO_2) is 5.6. Therefore, the precipitation or rain is said to be clean rain upto a pH of 5.6, which is the natural background pH of rain water.

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

Hence, *acid rain*, on precipitation, is defined as the one which has a pH less than 5.6.

The principal species associated with dry-acid deposition are $SO_2(g)$, acid sulphate particles (H_2SO_4 and NH_4HSO_4), and $HNO_3(g)$, while the principal dissolved acids are H_2SO_4 and HNO_3. Other acids, such as hydrochloric acid (HCl) and organic acids, usually account for only a minor part of the acidity. Although organic acids can be significant contributors in remote areas.

Both acid particles and gases can be incorporated into cloud droplets. Particles are incorporated into droplets by nucleation,

impaction, Brownian movement, diffusiophoresis (transport into the droplet induced by the flux of water vapour to the same surface), thermophoresis (thermally induced transport to a cooler surface), and electrostatic transport. Advective and diffusive attachment dominate all other mechanisms for pollutant gas uptake by cloud droplets. Most of the H_2SO_4 in precipitation is due to the diffusion of SO_2 into the cloud droplets, where it is oxidized to H_2SO_4 by one of the several mechanisms; while most of the NHO_3 in precipitation is due to the diffusion of $HNO_3(g)$ into the droplets. The following equations summarize the reactions for sulphuric acid and nitric acid formation :

$$\underset{\text{present in atmosphere}}{SO_x + O_2 + H_2O} \longrightarrow \underset{\text{sulphurous acid}}{H_2SO_3} \text{ and/or } \underset{\text{sulphuric acid}}{H_2SO_4}$$

$$\underset{\text{present in atmosphere}}{NO_x + O_2 + H_2O} \longrightarrow \underset{\text{Nitrous acid}}{HNO_2} \text{ and/or } \underset{\text{Nitric acid}}{HNO_3}$$

Effect

The ecological impact of acid rain is quite serious. It is likely to produce irreversible changes. The acidification of streams and lakes affects aquatic animals and plants. High acidity results in reduced fish population. Green algae and many forms of bacteria, which are essential to aquatic systems, will be killed due to acidity. Also at low pH the rate of decomposition of organic matter in water bodies is reduced, which increases the degree of water pollution. Acid rains can affect vegetation and soil in many ways. It adversely affects the growth of trees, and hence affects the forests that results in consequent vanishing of greenery. Due to acid rains, the plant nutrients, such as potassium, are gradually leached out of the soil ; and the population of earth worms is reduced, thus affecting the fertility of soil. Acidic air pollutants have also been responsible for many other damaging effects like corrosion of metals, weakening or disintegration of textiles, paper and marble, and works of art and architecture. The building and sculptural materials (*e.g.* marble, limestone, etc.) become pitted and weakened mechanically as the soluble sulphates are leached out by acid rain.

$$CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + H_2O + CO_2$$

Acid deposition, in fact, shows a correlation with the prior movement of the air mass over major sources of SO_x and NO_x emissions. The acidity in Swedish lakes and rivers is due to emissions from highly industrialized areas of UK and central Europe. The British parliament

building has suffered serious damage from the presence of sulphuric acid in rainfalls. The Taj Mahal is seriously affected due to pollutants released, particularly, from Mathura refinery. Similarly, in Canada trees and aquatic life in lakes are being killed by acid rain, 60% of which originates from USA.

Control

One of the simplest solutions to the problem is to neutralize the acid with lime. But it is quite expensive, especially when large areas of water-bodies have to be limed. Further, large scale liming may create its own ecological problems. Probably, the best way to overcome this problem is—reduced emissions of SO_x and NO_x from anthropogenic sources. Effective air pollution prevention and control measures are required for both stationary and mobile sources of air pollution.

6.8.1 The Taj Mahal : A Case Study

The Taj Mahal—one of the eight wonders of world—has withstood the onslaught of natural elements for centuries, but now it is in the increasing danger of being destroyed by the constituents of a polluted atmosphere, especially due to the pollutants released from the nearby Mathura Refinery. The Refinery, inspite of using low sulphur fuels, emits about 25 to 30 tonnes of sulphur dioxide daily. The emitted SO_2 results in acidic precipitation (dry and/or wet), under conditions of low wind speeds combined with humidity, in the surrounding areas. The other sources of pollutants, which also contribute to acidic precipitation, are two thermal power stations at Agra (now shut-down) and heavy traffic. The acid deposition reacts with calcium carbonate ($CaCO_3$) in the marble to form calcium sulphate ($CaSO_4$), which causes deterioration. Some of the visible signs of deterioration of the Taj Mahal include discolouration of the white marble surface *i.e.* appearance of yellowish or yellow-grey or brown rust like stains, especially in the niches and arches ; chipping and breaking of the edges of the marble slabs ; and formation/appearance of cracks in marble.

To save this magnificient historical monument, the Government has taken many steps, such as development of a green belt of 1 to 5 km around the Taj, ordered the close down of two thermal power plants at Agra, asking for cleaning of emissions from stacks of the Mathura Oil Refinery, providing an outer road to restrict traffic, and establishment of pollution monitoring stations inside the Taj and between Mathura and Agra.

6.9 OZONE LAYER DEPLETION (OZONE HOLE)

In stratosphere, ozone is found in a concentrated thick layer at varying heights from 16 km to about 40 km at different latitudes. Its concentration, in ppmv (parts per million by volume), at tropopause is less than 1.0 and then starts increasing to reach a maximum value of about 8.0 at about 30 km, and then again starts decreasing to a value of 2.0 at 40 km. Its value reaches to zero at about 100 km. In the stratosphere, O_3 is formed naturally when oxygen is dissociated by ultraviolet solar radiations in the wave-length region of 80 to 240 nm.

$$O_2 + h\nu \longrightarrow O + O$$
$$O + O_2 + M \longrightarrow O_3 + M$$

where M is any third body molecule (most likely N_2 or O_2 in the atmosphere) that remains unchanged in the reaction. The ultraviolet radiations in the region of 200 to 300 nm can also dissociate the ozone :

$$O_3 + h\nu \longrightarrow O_2 + O$$

In this (above) reaction, ozone portrays the absorption of ultraviolet-B radiations and hence is responsible for the removal of UV-B radiations (λ = 280 to 320 nm) that would otherwise reach the earth's surface. The concern is that, any process that depletes stratospheric ozone will increase the UV-B radiations reaching the earth's surface. Increased UV-B will lead to increased incidence of skin cancer and could have deleterious effects on certain ecosystems.

The three important areas, where human activity can influence the ozone cycle, have been the direct emission of NO_x by supersonic transport flying above the tropopause, additional transport of nitrous oxide (N_2O) as a result of increased use of nitrogenous fertilizers, and the formation of atomic chlorine in the stratosphere from chloro-fluoro carbons (CFCs) (used as refrigerant, aerosol propellant and industrial solvent) released in the troposphere. Another class of compounds, halons, are also ozone depleting compounds. Halons are bromo-chloro-fluorocarbons or bromo-fluorocarbons that are widely used in fire extinguishers. Although the emissions of halons and thus their atmospheric concentrations are much lower than the most common chloro-fluorocarbons (CFCs), but they are 3 to 10 times more destructive than the CFCs.

The NO_x emission from supersonic transport in stratosphere or the diffusion of NO_x in stratorphere from the lower atmosphere, cause ozone depletion in the following way :

$$NO + O_3 \longrightarrow NO_2 + O_2$$
$$NO_2 + O \longrightarrow NO + O_2$$

The net effect on this sequence is the destruction of two molecules of ozone, since the oxygen atom (O) would have combined with oxygen molecule (O_2) to form ozone. Most significantly, the NO acts as a catalyst because it is not consumed, and therefore can participate in the reaction sequence many times.

(3) The CFCs (like chloro-fluoro methane or freon) are inert in normal and physical reactions, but they get accumulated in greater amounts at high altitudes, and there in stratosphere, they release chlorine atoms under the influence of UV radiations (< 240 nm). For example, CFC-12 would photolyze forming Cl and ClO radicals :

$$CF_2Cl_2 + h\nu \longrightarrow Cl + CF_2Cl$$
$$CF_2Cl + O_2 \longrightarrow CF_2O + ClO$$

The following reactions would then occur :

$$Cl + O_3 \longrightarrow ClO + O_2$$
$$ClO + O \longrightarrow Cl + O_2$$

In this sequence the chlorine atom acts as a catalyst, and two O_3 molecules are destroyed. Before the Cl is finally removed from the atmosphere (in 1-2 years) by precipitation, each Cl atom will have destroyed thousands of ozone molecules.

The first evidence that stratospheric ozone depletion is occurring comes from the discovery of the Antarctic ozone hole that could have been caused by human produced pollutants. This hole formation or the level of ozone depletion is increasing yearly. In the vertical profile, the most affected zones are around 40 to 50 km and the lower stratosphere below 20 km. The various studies carried out show that globally, stratospheric ozone concentrations have declined during the winter, spring and summer in both the northern and southern hemispheres at middle and high latitudes. The declines are most evident during winter months. In north Europe and America, during late winter and early spring, ozone is getting depleted and it is feared that in near future more ozone holes may develop. The studies carried out in India show that a good part of the country has low ozone belt, and further depletion could cause serious problems.

Effects

The thick shield (layer) of ozone present in the stratosphere is extremely useful as it prevents the UV-B radiations coming from sun to reach the earth's surface ; and thus the plants, animals and human beings escape from the hazardous UV-B radiations. Increase in UV-B radiations have damaging effects on the DNA of exposed cells of organisms and can cause mutation and skin cancer. Other effects are climatic changes

due to global warming, non-formation of stratospheric winds, and deleterious effect on certain ecosystems.

Control

The only practical solution to this problem is to accelerate the phaseout and complete elimination of the production of CFCs halons, carbon tetrachloride and methychloroform. Though, such steps will stop the increase of CFCs in the atmosphere ; but, because of their long life-times, the already emitted CFCs will remain in the atmosphere for centuries.

6.9.1 Ozone Hole Over Antarctica : A Case Study

The creation of ozone hole over Antarctica may be explained as follows :

In the stratosphere, the CFCs are broken down by UV radiations and release chlorine atom. Using CFC-12, the reaction is

$$CF_2Cl_2 + h\nu \longrightarrow Cl + CF_2Cl$$

The chlorine atom will then react with ozone and produce ClO :

$$Cl + O_3 \longrightarrow ClO + O_2$$

The product ClO when reacts with NO_2, it forms chlorine nitrate :

$$ClO + NO_2 \longrightarrow ClONO_2$$

Chlorine nitrate thus formed is an inert compound that can do no damage to the ozone. Thus, at this state, Cl is effectively trapped in $ClONO_2$. Over Antractica, however, a phenomenon of atmospheric circulation called the *circumpolar* or *polar vortex* forms. The formation of the circumpolar vortex blocks the warmer midlatitude air from mixing with the air above the pole. Thus the polar air is trapped with no connections to the outside warmer air. This condition cools the air in the stratosphere, which can go down to $-90°C$. Even though the stratospheric air is very dry, still ice crystals can form at this very low temperature, providing reaction surfaces for chlorine nitrate to react with water to form HOCl and HNO_3 :

$$ClONO_2 + H_2O \longrightarrow HOCl + HNO_3$$

As long as this polar vortex exists (during winter), the above reaction continues to operate, *i.e.* the accumulation of HOCl. This accumulation of HOCl is simply waiting for the Antarctic spring. As the sun first rises in the Antarctic spring (of August or September), HOCl photolyzes— forming Cl and the hydroxyperoxyl radical, which destroys the ozone. The reactions sequence is as under :

$$HOCl + h\nu \longrightarrow Cl + OH$$

$$Cl + O_3 \longrightarrow ClO + O_2$$

$$OH^{\circ} + O_3 \longrightarrow HO_2^{\circ} + O_2$$
$$ClO + HO_2^{\circ} \longrightarrow HOCl + O_2$$

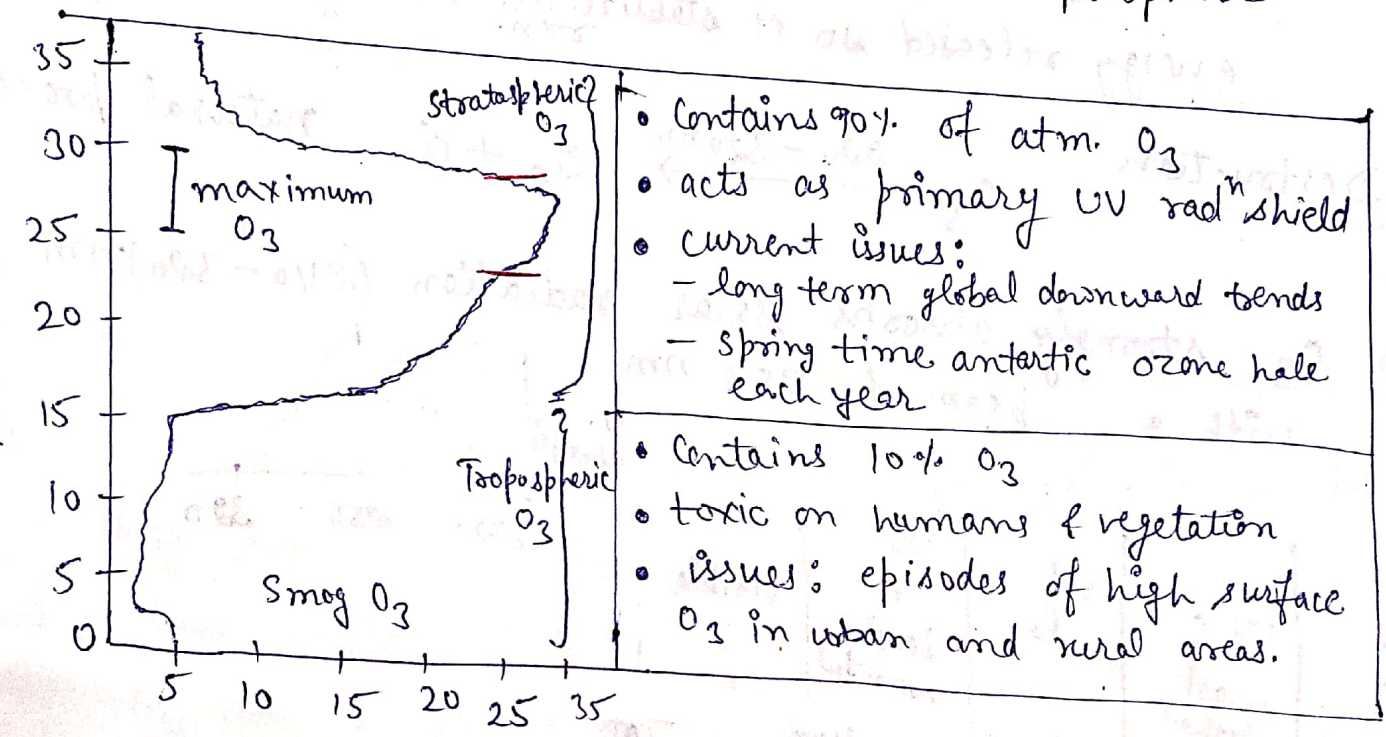
With this formation of HOCl, the cycle starts all over again. Each atom of chlorine chain then reacts with thousands of molecules of ozone, thus converting ozone to oxygen.

Ozone & depletion

Unit-II, X

→ Ozone is a bluish gas with pungent odour.

→ O_3 is a life saviour if present in stratosphere but a pollutant, if present in troposphere.



1 DU = .01 mm of O_3 or 100 DU = 1 mm

Dobson Unit

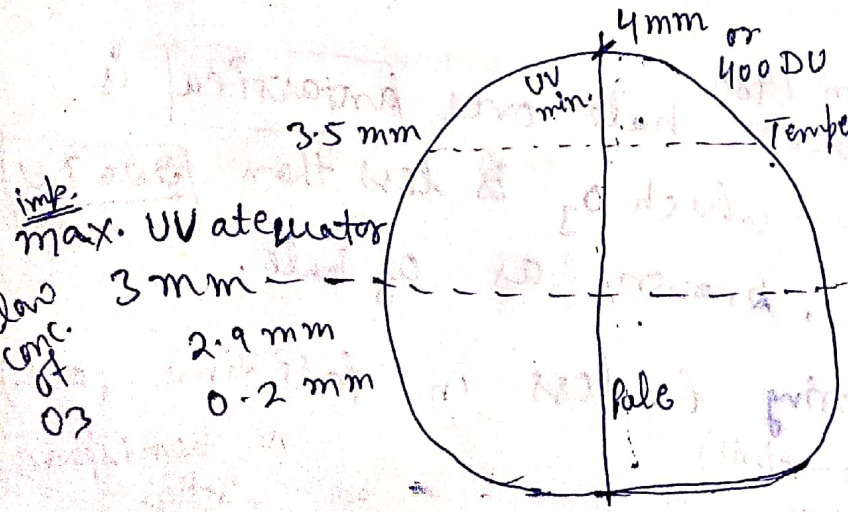
1 DU = 1 Dobson unit equivalent to a layer of O_3 0.01 mm thick at stratosphere.

P = 1 atm.

T = 0°C

1 DU = 1 ppb of O_3

$= 2.7 \times 10^{16}$ O_3 molecules/cm^3



Conc. of O_3 ↑es from equator to poles

Ozone formation : (Stratosphere):

$$O_2 \xrightarrow{242\,nm} O^{\cdot} + O^{\cdot}$$

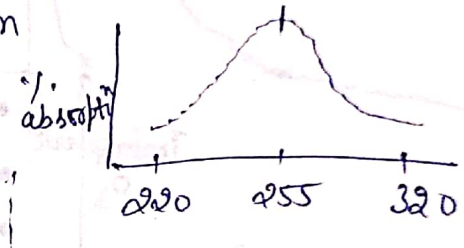
$$O^{\cdot} + O_2 \xrightarrow{M} O_3 + M$$

(this rxn. occur both in tropo & strato)

energy released so M stablize the rxn. M = N_2 / O_2 molecule

Destruction: $O_3 \xrightarrow{220-320\,nm} O_2 + O^{\cdot}$ natural process

$\Rightarrow$ O_3 strongly absorbs solar radiation (240 – 320) nm with a peak of 255 nm



far UV	UV C (most lethal)	UV B	UV A (least harmful)	visible
220	280	320	400	700

Energy content ~~000~~ UV C > UV B > UV A

becoz $E \propto \frac{1}{\lambda}$ λ max, E min; λ min, E max

Amount reached to Earth

UV A > UV B > UV-C

99 %. 1 %.

Ozone Hole: 1st in 1980 The ozone hole over antartica is defined as an area which O_3 is less than 220 DU decline in spring time, known as O_3 hole.

→ O_3 conc. more in spring & less in fall time (oct.)
(feb – April) Southern hemi. N hemisphere. early winter

Sources: ① Small amt. produced by lighting & forest fires.

② direct emission of NO_x by transport

③ N_2O from nitrogenous fertilizers

④ halones are O_3 depleting compounds (Cl, Br, F) used in fire extinguishers.

⑤ emission of CO, HC from vehicles

Effects:

⇒ early morning inversion, atm. stable, no dispersion imp.

⇒ due to inversion, stratospheric pollutants has long life than troposphere.

⇒ long residence time of pollutants in strato. O_3 absorb UV so temp. ↑es in strato. which cause temp. inversion hence stable condition.

⇒ Paul Crutzen et. al get nobel prize in 1995 for ozone destruction mechanism.

① O_3 reaches deeper into lungs than SO_x, it cause coughing, shortening of breath, headache, chest tightness, altered red blood cells, eye, nose and throat irritation.

② premature aging, bleaching and collapse of leaf.

P.T.O

UV-A effects: also called black light (invisible) & causes tanning of skin, photoaging, skin cancer, induce Vit-D (synthesis in body).

UV-B: Cause cataract (मोतियाबिंद), melanoma (skin cancer), damage to DNA, RNA & reduction in photosynthesis
- redness of skin
- snow blindness

SPF (Sun Protect^{n} factor) : rating of sun screens to block U.V-B rays

UV-C:
- most damaging
- used in water treatment due to penetrating power.
- doesnot reach to earth surface

V. imp. In Chemotherapy Co-60 used no UV used.

Control:
- reduce NO_x, VOCs, CO emissions.
- elimination of CFCs

- **Montero Protocal:** called for CFC prod^{n} reduced back to 5% of 1986, 1987 में लागू हुआ

→ levels by 1998. but amended in 1990, 1992. this time 140 nations agreed to phase ODS by 1995.

→ developing countries can till 2010 and HCFC not restricted. Class I [CFC, Halons, CCl$_4$ (Carbon tetra chloride)]

V. imp. HCFC restricted in 2030. use by 2000.

HFC (Class II) alternative to freon which has high GWP.

So researchers will find chemical efficient.

1992, Copenhagen Protocal for CFC banned by 1996 but HCFC by 2030.

Unit=X

Global Warming and Green house effect

Once the earth absorb solar radiation it must radiate on the average, some amount of energy in order to maintain the energy balance, The earth does it by emitting Infra red (I.R) radiation. However, a considerable amount of I.R radiation it does not escape into space but is reabsorbed by the gases called GHG or green house gases. then re-radiate back to earth. *The warming effect caused by absorption & reradiating of I.R radiation by GHG is commonly called as Green house effect.

However the excessive increase in the GHG's would retain more & more of I.R resulting in inhanced GHE effect. This concept is known as Global Warming.

Global Warming can occurs in 3 ways.

1. Change in solar radiation resulting upto earth surface.
2. Change in the fraction of solar radiation that is reflected (called albido). As increase in most Pinatubo case in fresh snow albido ≈ 1. or 100%.
3. Change in the I.R that is radiated back to space.

* conc. of aerosols also affect the global warming.
* Global warming is excessive green house effect.

$$\lambda_{max} \text{ in nm} = \frac{2897}{T(K)}$$

ecosystems, increased incidences of skin cancer, crop failures, famines, etc. Evidence suggests that abuse of environment may enhance the likelihood of these catastrophes. This has led national and international policy-makers to call for immediate action to stabilize or reduce the growth in greenhouse gas emissions.

6.6.1 River Nile : A Case Study

One of the best proxy measures of tropical climate over recent centuries is the discharge of river Nile in Egypt. The records of annual high and low water levels at the Roda Nilometer at Cairo were collected together by Tousson (1925). The series is practically complete from 641 A.D. to 1451 A.D., but patchy thereafter until the 19th century. It is generally accepted that the early summer or low flood level reflects precipitation falling over the Equatorial Lakes Plateaus (*i.e.* around Lake Victoria) ; whereas the late summer or high flood level responds to precipitation supply over the Ethiopia Highlands. Hassan (1981) has performed a detailed analysis on this time series and demonstrates generally high late summer floods in 1351 – 1470, 1737 – 1770, 1850 – 1900 and 1950 – 1964, which corresponds roughly with periods of glacial advance in Northwest Europe.

6.7 GLOBAL WARMING (GREENHOUSE EFFECT)

Incident solar energy as short-wave radiations, mostly in the form of visible light, is absorbed by the earth's surface and emitted into space as long-wave infrared (heat) radiations. There are several gases in the earth's atmosphere, primarily water vapour and CO_2, that are transparent to the incoming short-wave radiations but are nearly opaque to the reflected long-wave radiations. Thus much of the earth's heat is retained, which causes a warming effect. This phenomenon is known as *green-house effect*, and the gases that have the ability to absorb reflected long-wave radiations and produce this effect are called green-house gases. It is due to the natural occurrence of the green-house effect (*i.e.* presence of water vapour and CO_2) that there is a higher atmosphere equilibrium temperature ; otherwise the earth's mean surface temperature would have been – 18°C instead of the present + 17°C. There is concern that increasing concentrations of carbon dioxide and other trace greenhouse gases due to human activities will enhance the green-house effect and cause *'global warming'*.

The greenhouse gases which cause greenhouse warming of the global climate (excluding water vapour) are carbon dioxide, methane and a number of other trace gases like nitrous oxide (N_2O), tropospheric ozone, chloro-fluoro carbons (CFCs), hydro-chloro-fluoro carbons (HCFCs), methychloroform (CH_3CCl_3), carbon tetrachloride (CCl_4),

sulphur dioxide, fluorine, bromine, iodine, and compounds of nitrogen and sulphur. The principal sources of greenhouse gases are summarized in Table 6.1 ; while Fig. 6.2 shows the estimated contributions of greenhouse gases to global warming.

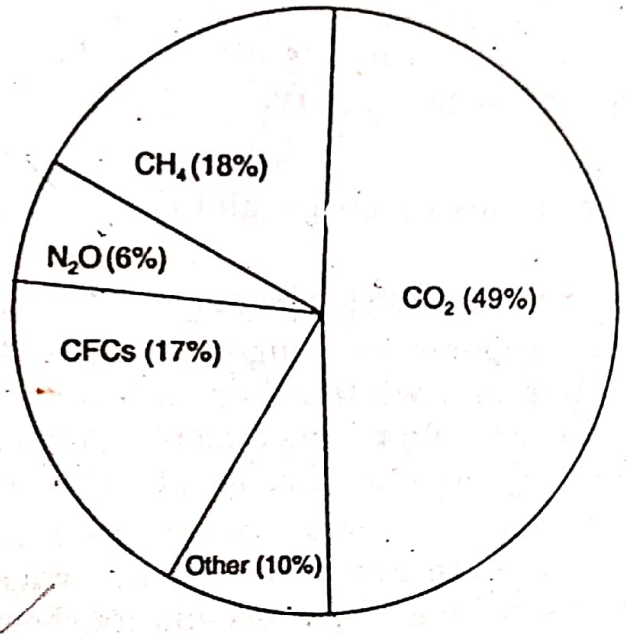


Fig. 6.2. Estimated contributions of greenhouse gases to global warming in 1980s.

Table 6.1. Major sources of greenhouse gases

S. No.	*Gases*	*Major sources*
1.	CO_2	Fossil fuel combustion, deforestation, respiration.
2.	CH_4	Wetlands, anaerobic decomposition of organic wastes, termites.
3.	N_2O	Natural soils, fertilizers, fossil fuel combustion.
4.	O_3	Photochemical reactions in troposphere, transport (diffusion) from stratosphere.
5.	CFC-11	Manufacturing of foams, aerosol propellant.
6.	CFC-12	Refrigerant, aerosol propellant, manufacturing of foams.
7.	CFC-113	Electronics solvent.
8.	HCFC-22	Refrigerant, production of fluoropolymers.
9.	CH_3CCl_3	Industrial degreasing solvent.
10.	CCl_4	Intermediate in production of CFC-11, CFC-12, solvent.

The greenhouse effect at its natural level is very essential for life to exist on this planet (earth) ; but its increase (*i.e. enhanced greenhouse effect*), as is actually taking place, is feared to cause global climatic changes of irreversible and highly destructive type. The concentrations of CO_2 and other greenhouse gases in the atmosphere are rising alarmingly, and making it clear that we are going to experience a general warming-up of the atmosphere. In fact, some warming-up from 0.3 to 0.7°C has already taken place during the last one century.

Effects

Speculated scenarios based on global warmings include the following :

(*i*) Increase in global mean temperature at about 0.3°C per decade.

(*ii*) There may be more warming-up in higher latitudes during late autumn and winter, than in tropics. In tropics, the expected rise would be less than the global average ; and in temperate regions, more than the global average.

(*iii*) Flooding of many coastal areas (lands and islands) due to rising sea levels resulting from the thermal expansion of the oceans, the melting of glaciers and ice sheet, and probably, from the melting of polar ice caps. One set of response predicted for average global temperature and sea-level rise is shown in Table 6.2. Rises in sea-level of this magnitude would be disastrous for low-lying areas of Netherlands, Maldives and other such areas.

Table 6.2. Prediction of a sea-level rise

Year	*1990*	*2030*	*2060*	*2100*
CO_2 Conc. (ppm)	354	470	600	850
Temp. rise (°C)		1.1	2.0	3.3
Sea-level rise (cm)		18	38	65

(*iv*) An increase in global average temperature is predicted to increase the amount of water vapour in the atmosphere (because saturated vapour pressure increases with temperature), thereby increasing the long-wave optical depth, trapping more long-wave radiation and increasing the temperature further.

(*v*) Increase in global average temperature will lead to dislocation of suitable land for agriculture, and thus may adversely affect the world food production. For instance, the wheat growing areas in the northern latitude will shift towards poles, *i.e.* from fertile lands (in USA, Canada and Russia) to poor soils

(in the north pole). In case of India, it is predicted that the wheat production will drop in the fertile northern belt.

(*vi*) The dislocation and possible extinction of certain biological species and ecosystems cannot be ruled out.

(*vii*) Increase in the severity of storms.

(*viii*) Other effects include more evapotranspiration in tropics, alteration in existing precipitation patterns, effect on hydrological cycle, effect on human health (like heat strokes), etc.

Control

Since, CO_2 accounts for about half of the greenhouse gases and there is a strong evidence linking temperature and CO_2 changes, therefore, the best way to solve this problem of global warming due to increasing concentration of CO_2 is to use sources of energy that do not produce carbon dioxide—such as wind, hydroelectric, geothermal, solar, tidal and nuclear energy. Similarly, the emissions of other greenhouse gases in the atmosphere should also be stopped to prevent the enhanced greenhouse effect.

6.7.1 El-Nino Phenomenon and its Effects : A Case Study

The El-Nino (*the infant* or *the Christ child*) is a climatic phenomenon of the pacific ocean that has appeared many times in the past. It usually begins around Christmas and generally affects the western coast of South America. The benign name for this phenomenon comes from its nearness to Christmas, and also because the ocean currents bear *gifts* in the form of exotic tropical species to the normally cold waters of the shore of South America. However, this benevolence is misleading as El-Nino brings death and destruction.

Under normal circumstances, the waters of the Eastern Pacific ocean along the western coast of South America are surprisingly cold, as much as 10°C cooler than the waters of the western pacific. This is due to the fact that Humboldt current, which carries cool waters from Antarctica almost as far north as the equator, washes the western coast of South America. This cold current is responsible for the desert-like character of Peru's coastal plain. The Humboldt current, however, supports one of the world's great fisheries, since here cold waters are rich in nutrients. But once every five years (on an average) from December to March, the waters of the Eastern Pacific warm up by 4 to 6°C than normal which disrupts the upwelling of the nutrient-rich, cold water. This phenomenon is called *El-Nino*.

In fact, there are two related events that occur during one of these episodes. One is the *Southern Oscillation*, a change in the atmosphere ;

6.3.1 Water Conservation

Water conservation is the careful use and protection of water resources and involves both the quantity and quality of water used. Water is indispensable resource for the sustenance of all life and is the basic need for all activities right from domestic use to agriculture and industry. With the ever-increasing pressure of human population, there has been a severe stress on water resources. Neglect of traditional water bodies like tanks and ponds, indiscriminate exploitation of ground water, improper maintenance of surface water systems has aggravated the problem still further and is likely to increase in the years to come.

The objective of water conservation can be achieved through concrete efforts on the conservation and utilization of water on sustainable basis with a focus on holistic planning and sustainable development of sources of water.

Domestic Conservation

As much as half of the water used for domestic purposes can be saved without great sacrifice or serious changes in the lifestyles by implementing the following measures :

- Take shorter showers.
- Repair all leaks quickly.
- Turn-off water when not absolutely needed for washing, brushing teeth, shaving, and so on.
- Use conserving appliances, such as low-volume shower heads, efficient dishwashers and washing machines, etc.
- In arid and semi-arid regions, replace lush green lawns with decorative rock garden.
- Use low-flow toilets, and flush the toilet only when really necessary.
- Use gray water from washing machines to water vegetation.
- Water lawns and plants in the early morning, late afternoon or at night so as to reduce evaporation.
- Use drip or sprinkle irrigation and place water-holding mulch around garden plants.
- In arid and semi-arid regions, plant drought-resistant vegetation that needs less water.
- Local bodies should install water-meter and encourage water pricing policies in which water is much more expensive beyond some baseline amount.

Industrial Conservation

Water conservation measures that can be taken by industries and manufacturing units include :

- Using dry cooling systems or cooling towers that use less water.
- Reuse the cooling water for irrigation or other purposes.
- Industries and manufacturing units should curb water withdrawals, wherever possible, by increasing in-plant treatment and recycling of water or by developing new equipment and processes that require less water.
- Recycled water should be used for floor-washing, and other such purposes.

Agricultural Conservation

Agriculture is the biggest water user and perhaps half of all the agricultural water used is lost to leaks in irrigation canals, application to areas where plants do not grow, runoff and evaporation. Improved agricultural irrigation could reduce withdrawals by between 20 to 30%. Tremendous saving may be achieved by implementing following agricultural conservation measures :

- Use lined or covered canals that reduce seepage and evaporation.
- Use improved irrigation techniques, such as sprinklers or drip irrigation.
- Irrigate fields in the early morning or at night when evaporation is minimal.
- Adopt better farming techniques, such as minimum tillage, leaving crop residue on fields and ground cover on drainage ways, intercropping, etc.
- Use mulch to help retain water around plants.
- Price agricultural water to encourage conservation.
- Integrate the use of surface and ground water so as to have a more effective use of the total resources. For instance, irrigate with surplus surface water when it is abundant and also use surplus surface water to recharge groundwater aquifers ; and when surface water is in short supply, use more ground water for irrigation.
- In arid and semi-arid regions, encourage the development of crops that require less water and are drought resistant.

6.3.2 Strategies to Support Water Conservation

Some of the strategies that can support water conservation activities and tackle the water scarcity problem include :

- Rainwater harvesting
  - roof top rainwater harvesting
  - revival of traditional water harvesting structures
  - micro-catchment water harvesting
  - macro-catchment water harvesting
  - recharge structures for wells and borewells.
- Sustainable water utilization
  - minimize domestic water consumption
  - recycling of waste water
  - improved irrigation methods.
- Encourage natural regeneration of vegetation and supplementing with artificial regeneration.
- Maintain and improve quality of water.
  - Collection and treatment of waste water effluents
  - Pollution check.
- Awareness building on water conservation

6.3.3 Rainwater Harvesting

For centuries, people have relied on rainwater harvesting to supply water for household, landscape, livestock, and agricultural uses. Before large centralized water supply systems were developed, rainwater was collected from roofs and stored on site in tanks known as *cisterns*. With the development of large, reliable water treatment and distribution systems and more affordable well drilling equipment, rain harvesting systems have been all but forgotten, even though they offer a source of pure, soft water. A renewed interest in this time-honoured technique/ approach emerged in recent decades due to following reasons :

- the problem of water shortage in arid and semi-arid regions ;
- the escalating environmental and economic costs of providing water by centralized water systems or by well drilling ;
- health benefits of rainwater ;
- potential cost savings associated with rainwater collection systems.

Rainwater harvesting is defined as a method for inducing, collecting, storing and conserving local surface runoff for later use. Three types of water harvesting are covered by rainwater harvesting :

(*i*) Water collected from roof tops, courtyards and similar compacted or treated surfaces is used for domestic purpose or garden crops, or for groundwater recharge.

(*ii*) Micro-catchment water harvesting is a method of collecting surface runoff from a small catchment area and storing it in the root zone of an adjacent infiltration basin. The basin is planted with trees, bushes or with annual crops.

(*iii*) Macro-catchment water harvesting, also called harvesting from external catchments, is the case where runoff from hill-slope catchments is conveyed to the cropping area located at hill foot on flat terrain.

The most common harvesting of rainwater involves water collected from the roofs of buildings and storing in rainwater tanks. The collection of rainwater from the roofs of buildings can easily take place in cities and towns. All that is necessary to capture this water is to direct the flow of rainwater from roof gutters to a rainwater storage tank. By doing this, water can be collected and used for various uses. If people are reliant on collected rainwater and are not connected to a town's water supply, then the water collected will be especially important to them. If people are from the city, then it is possible to replace all or at least a substantial portion of their fresh water requirements by the capture and storage of rainwater from their roofs.

A century-old tradition of conserving water helps residents of Dwarka to keep the crisis at bay. Almost every house in the city has an underground tank, which is used to collect rainwater every year. Sealed from all sides, drainpipes from rooftops and terraces are connected to the tank. A small opening at the top allows periodical cleaning of the tank with bags of lime (a disinfectant). If the rainfall is good, some tanks which are as large as 25 m^2 can collect ample amount of water. Since it is used strictly for drinking and cooking, it could last up to two years. Such a conservation measure in this region is making a difference with other severely affected parts of Saurashtra in Gujarat.

Trapping of rainwater either in small ponds or pumping them onto the ground directly from many collection localities is in use in some places even today. Collection in open areas may lead to substantial loss of evaporation. Some of the traditional deep ponds or storage wells in Gujarat and Rajasthan are engineering wonders but we may not be able to practise these methods today without suitable modifications required for specific local conditions due to changing land use. With urbanization

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* ENVIRONMENTAL ACTS

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→ THE ENVIRONMENTAL PROTECTION ACT, 1986
This act provides for the protection and improvement of environment. The Environmental act establishes the frame-work for Studing, planning and implementating long-term requirements of environmental safety and laying down a system of speedy and adequate response to Situation threatening the environment.

→ HAZARDOUS WASTES MANAGEMENT REGULATION
Hazardous waste means any waste which, by reason of any of its physical, chemical, reacting

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toxic, flammable, explosive or corrosive characteristics, causes danger or is likely to cause danger to health or environment, whether alone or when in contact with other wastes or substances.

→ THE NATIONAL GREEN TRIBUNAL ACT, 2010

This act has been enacted with the objectives to provide for establishment of a National Green Tribunal (NGT) for the enacted with the objectives to provide for establishment of NGT cases relating to environment protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensa for damages to persons and property and for matters connected therewith or incidental thereto.

* ROLE OF IT IN WATER CONSERVATION

Water Saving Technologies:-

1. WaterSense Labeled Irigation Controllers :-

water sense lables weather-based irigation controlle a type of "smart" irigation control technology that uses local weather data to determine when and

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how much to water.

2. Soil Moisture Sensors:
Soil moisture-based control tech. water plants based on their needs by measuring the amount of moisture in the soil and tailoring the irrigation schedule accordingly.

3. Rainfall Shutoff Devices:
Rain-fall shutoff device turn off your system in rainy weather and help compensate for natural rainfall. This in expensive device can be retrofitted to almost any system.

4. Rain Sensor
Rain Sensor can help decrease water wasted in the landscape by turning off the irrigation system when it is raining.

5. Sprinkler heads
Certain types of sprinkler heads apply water more efficiently than others. Rotary spray heads deliver water in a thicker stream than mist spray heads, ensuring more water reaches plants and less is lost to evaporation and wind.

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Drugs :-

Drugs affects the ways our body and mind function; they can change how we feel, think and behave. People take drugs for different reasons and in different ways.

Drugs are substances that change a person's mental & physical state. They can affect the way our brain works, how we feel or behave, our understanding and our senses. This make them unpredictable and dangerous, especially for young people.

Effects

(i) Mental health :- Use of drugs increase our risk of mental health issues such as anxiety, depression and psychosis. People with mental health issues also have a higher rate of drugs use problems.

(ii) Financial issues :- Some drugs can be very expensive - the street price of illicit drugs depends on availability and demand. If we have become dependent on a drugs, we end up in financial trouble.

(iii) Relationships :→ Drugs can change our behaviour, they can affect ~~yo~~ our relationship with family and friends. There is increased risk of injury and/or assault to both yourself and other people.

(iv) Legal issues :→ Many drugs are illegal and we can be fined, or sent to prison, for having them. If convicted of a drug offence, we could end up with a criminal record - this can make it harder to get a job, apply for a loan, or travel overseas.

(v) Drugs in sport :→ sports people and professional athletes who use illegal substances risk damaging not only their physical health, but also their reputation and the integrity of their sport.

Useful drugs

(i) Penicillin (1942) :→ It was first developed in 1928 but started to use in 1942. It marked a turning point in human history and lead the way in the treatment of numerous bacterial diseases. It also has been used to treat plethora of condition such as pneumonia and scarlet fever, as well as ear, skin, and throat infections.

(ii) Insulin (1922) :→ Individuals with advanced diabetes are unable to produce sufficient amount of insulin, a hormone involved in the conversion of sugar to energy.

(iii) Polio vaccine (1955):→ Although vaccines are not technically drugs, thy are a form of preventative medicine. Polio, a disease caused by a virus living in the throat and intestinal tract, was once one of the leading causes of disability in the world and was the source of widespread fear & panic. Since the virus is still in existence, children are still given the vaccine before starting school.

(iv) Smallpox vaccine (1798):→ Smallpox has been known as one of the worst threats humanity has ever faced. In today's terms, it was as deadly as cancer or heart diseases, killing well over 10% of population with figures being up to 20% in higher populated towns & cities. Thanks to the development of the vaccine in the 19th century, it was one of the first diseases to be wiped off the planet.

(v) HIV protease inhibitors (1990s):→ HIV infection was first document in San Francisco and New York City in 1981, then four year later it was identified as the causative agent of the acquired immune deficiency syndrome (AIDS). Although not the first HIV drugs. protease inhibitors, combined with other types of AIDS drugs, meant that patients never developed AIDS.

Harmful drugs:

(i) Alcohol:→ Alcohol includes all types of beer, wine and malt liquor. Alcohol ranks second on this list due to extensive health problems and injuries associated with use. 88,000 people die from alcohol-related causes. It causing health issues such as cancer, liver damage, hypertension, heart disease, suicide and motor accidents.

(ii) Cocaine :→ Cocaine also known as "Blow", "Coke", and "Crack", is a strong stimulant that is used as a recreating drug. Cocaine is long-term health risks that can occur from use, including heart disease, hypertension, organ failure.

(iii) Heroin :→ Heroin is a drug that come from a flower, the opium poppy, which usually grows in Mexico, Asia, and south America. It's very addictive and has bun illegal in the United ~~states~~ states since 1924. It can look like a white or brown powder, or a stickly black "tar". It's also called horse, smack, junk & brown sugar, among other names.

(iv) Nicotine (Tabacoo) :→ It is an extremely lethal substance according to the centers for disease control and the most dangerous drug. Smoking cigarettes "is the leading preventable cause of death." Person who do not smoke but live with a smoker risk lung-related illness & death through smoke It remain legal & has become popular with young users who used cigarettes. Tabacco users will note the difficulty in quitting cold turkey, and often time, nicotine patches and other methods are necessary to quit.

(v) Methadone :→ It is a schedule II synthetic Narcatic. It was first used during WWII treat pain because of a Morphine shortage. The symptoms of Methadone abuse aside cravings include sweating, itchiness, or feeling drowsy. Advanced use of Methadone can lead to constricted pupils, high blood pressure, and loss of consciousness.

Uses of drugs

(i) Penicillin :- It is first antibiotic, it pointed the way to the treatment of microbial disease. Without penicillin, 75% of the people now alive would not be alive because their parents or grandparents would have succumbed to infections. The effects of a drugs like this are absolutely mind-boggling.

(ii) Insulin: (The first hormone therapy) :- Patients with advanced diabetes can't use the energy stored in their body. The only treatment was to give patients a near starvation diet. They got as much food as they could metabolize or they soon wasted away and died. It completely change the lives of diabetes patients. Insulin proved to be hormone. As such it's the grandfather of all other hormone-replacement therapies.

(iii) Birth control pills :- Oral contraceptives changed the world, Benet says. Other experts agree. By giving women control over their reproductive system, these drugs had far-reaching medical & social impact.

(iv) Aspirin: (More than a headache pill) :- "Aspirin was the first drugs to show we can treat simple pain." In terms of the number of people who use it, it is more or less crucial for quality of life. Most people in the world have some kind of peripheral pain, muscle pain or headache. As an analgesic aspirin is very important.

Abuse of drugs

(i) Alcohol :- It is legal to use, obtain & possis, alchol is another commonly abused drugs with the potential for serious consequencis. It abuse manifests as drinking bcomes increasingly important and takes priority over everthing else of importante including job, friends & family. It can present a danger to ones: self and others as alcohol abuses.

(ii) Cocaine :- It is an illicit or illegal commonly abused drugs. It can lead to addiction, sivere health problems and death. Many cocaine abuses reports tobe trapped in vicious cycle of increased cocaine abuse in failed attempts to recreate the pleasurable sensations of their first cocaine.

(iii) Heroin :- It is a illegal commonly abused drugs which is extremely harmful to the use and to society. It often leads to heroin addiction ~~to~~ which one the hardest drugs addition to beat. It is the one of the worst drug additions and one of the hardest to break, causing the most damage both physically and mentally.

Stimulants drugs

(i) Ritalin :- It is a prescription drugs that comes in small tablets. Although it is often used by professionals as well as athletes, it is classified as a schedule II drug. It highly addictive contents mixed with its ability to heighten alertness make it a very popular drug to abuse among teenagers and young adults.

(ii) Cocaine :- Cocaine comes in a white powder, usually snorted, injected, or placed in the gums to create heightened feelings of excitement, and rapidly increased energy.

(iii) Anabolic steroids :- It is man-made drugs similar to testosterone. Usually athletes or anyone looking to build muscle fast abuse this drug. It can be prescribed however, possession or use of it without a prescription is illegal and can have fine upto $1,000.

(iv) concerta :- It is a prescription medication typically used to treat lack of focus and hyperactivity. It is in the same class as Ritalin, but its makeup is similar to cocaine. Taking the drugs produces intense craving similar to those cocaine users experience, thus making it a highly addictive drug.

Depression drugs :-

These type of drugs are used in medical for recovery of patent who is affected by the depression because of any mental problem.

Drug de-addiction :-

De-addiction means a treatment for addiction towards drugs, alcohol or tobacco. It is intended to remove the physicological effects of the addictive substance and also neutralize the toxic properties which affects the functioning of the human body.

Legal position on drug :-

Under the NDPS Act, it is illegal for a person for to produce, manufacture, cultivate, posses, sell, purchase, transport, store, and/or consume any narcotic drug or psychotropic substance. Under one of the provisions of the act, the narcotic control Bureau was set up with effects from March 1986.

The laws related to drugs are :-

(i) The poison Act, 1919

(ii) The drug Act, 1940

(iii) The drug and cosmetics Act, 1940.

(iv) The drug and cosmetic Rules, 1945.

(v) The pharmacy Act, 1948

(vi) The drugs and Magic ~~Red~~ Remedies Act, 1954.

(vii) The Marcotics drugs and Psychotropic substance Act, 1985

(viii) The Indian penal code (IPC), 1860

(ix) The criminal producer code (CrPC), 1973.

(x) The Indian evidence Act (IEA), 1872.