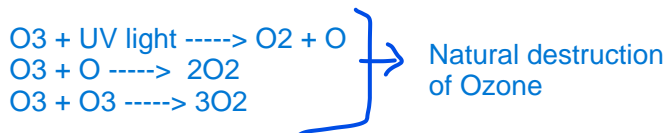


Environment Class 13

12th March, 2024 at 9:00 AM

OZONE LAYER DEPLETION (09:11 AM)

- Tropospheric ozone is an air pollutant, a key ingredient of **photochemical smog**, and also greenhouse gas.
- However, stratospheric ozone (ozone layer) is beneficial as it filters out dangerous high-energy UVs.
- UV can be further divided into **UV-A, UV-B and UV-C** with increasing frequency.
- The ozone layers filter out dangerous UV-C and a large part of UV-B.
- The ^{reason} ozone layer is in the **stratosphere** because there is plenty of oxygen and ^{plenty of} UV light, which leads to an equilibrium between the formation and destruction of ozone.
- If this equilibrium gets disturbed because of anthropogenic factors more towards ozone destruction, it will lead to ozone depletion.
- More exposure to UV light can cause **skin cancer, cataracts, genetic defects, and damage to a lot of materials.**
 ^{weakening of immune system, adverse impact on photosynthesis, adverse impact on growth of aquatic species.}
- **Dobson Unit:**
- It is a unit of measurement of the ozone layer.
- 1 dobson unit is ^{number of} several ozone molecules, that would be required to **create a layer of pure ozone 0.01 mm thick at zero degrees Celsius at 1 ATM.** Pressure.
- In terms of dobson units, the ozone layer's average thickness is about 300 dobson units (3mm thick).
- The term **ozone hole** signifies the reduction of the ozone layer to **less than 100 dobson unit**



MECHANISM OF OZONE DESTRUCTION (09:37 AM)

- **Ozone Depleting Substances:**
- Human activities add substances to the atmosphere, that can potentially reduce ozone concentration in the ozone layer.
- E.g. **Oxides of Nitrogen** (Mostly due to Jet Engine Exhaust), and CFCs.
- **CFC** Originally thought to be an ideal industrial chemical, because of stability, non-toxicity, very less reactivity and longer atmospheric lifetime.
- But it became a leading cause of ozone destruction.
- **One** The chlorine of CFC can go on to destroy more than 100,000 ozone molecules before being removed from the air.
- **Interference Reactions:** There are reactions which mitigate the destructive impact of Chlorine.
- **Thus while** Nitrogen oxide can act as a catalyst in ozone destruction and at the same time, they can **reduce produce** the destructive capacity of chlorine. **troposphere and**
- **Polar Stratospheric Clouds:** These clouds are formed in the higher stratosphere at less than minus 80 degrees Celsius.
- They provide a surface which converts, benign forms of Chlorine into ozone-destroying forms.
- It also interferes with interference reactions. $\text{H}_2\text{O}(\text{in ice form}) + \text{ClNO}_2 \rightarrow \text{HOCl} + \text{HNO}_3$
- **Thus throughout the winter** Chlorinated molecules accumulate in the stratosphere and when the first sunlight of the season reaches all of this chlorine becomes available for ozone destruction.
- **Role of Polar Vortex:**
- The polar vortex is a large area of low pressure and cold air surrounding both the earth's poles.
- It exists throughout the year but strengthens in winter.
- This vortex creates some sort of barrier isolating the upper atmosphere from the rest of the atmosphere for some time.
- Thus, Chlorine can remain in the stratosphere for a longer duration. **their**

OZONE-DEPLETING SUBSTANCES AND THE SOURCES (10:07 AM)

Ozone Depleting Potential (ODP):-

- It is a measure of how much damage chemicals can cause to the ozone layer compared to similar mass Trichlorofluoro methane.
- We assign an Ozone destruction potential of 1 to this molecule.
- **a. CFCs:** Used in refrigeration, air conditioning, foam blowing, cleaning of electronic components, solvents, and insulation. **-> HCFC (Hydro Chlorofluoro Carbon):** ODP = 0.01: It replaces CFCs, hydrogen makes them less stable therefore less damaging to Ozone layer.
- **b. Halons:** Used in fire extinguishers,
- **c. Bromochloromethane:** ODP of 6
- **d. Carbontetra Chloride:** Used as raw material in the production of CFC and HCFCs. ODP is 1.1.
- **e. Methyl bromide:** Used in fumigation of soil and food production facilities. ODP is 0.7.
- **f. Methyl Chloroform:** Used as a solvent in cleaners, and adhesives. ODP is 0.1.

Since Polar Vortex of Antarctica is much stronger than Polar Vortex of Arctic so in Antarctica Polar Stratospheric cloud can remain trapped for longer duration which can convert non-reactive Chlorine into Chlorine which can react and when first sunlight of Spring comes then this will lead to more Ozone layer depletion.

Because of weakening of polar vortex in summer polar vortex meandering happens which will lead to cause colder air comes into hotter area for some day for example Texas and Florida etc. but this happens once in 4-5 years.

So Polar vortex meandering is good in context to ozone layer depletion but this is not good for areas in polar region and this also lead to intense cold condition in lower atmosphere.

GLOBAL INITIATIVES TO TACKLE OZONE DEPLETION (10:17 AM)

- **Vienna Convention (1985):**
- For the protection of the ozone layer.
- It paved the way for the Montreal Protocol.
- **Montreal Protocol (1987):** (Imp.)
- It became a **legally binding** agreement to reduce the production and consumption of ozone-depleting substances.
- It is considered one of the **most successful environmental agreements**.
- Recent studies suggest that the ozone layer is ~~being~~ ^{getting} repaired and in a few decades will be restored.
- The protocol has become successful because of many reasons:
 1. There were **trade restrictions** which limited signatories to trade only with other signatories for CFCs and other substances.
- Thus many countries ratified the protocol, there was an **approach of cooperation**, and a **multilateral fund was set up to support developing countries**.
- New scientific information was accommodated and incentives were given to the ~~industry~~ ^{industries} to find alternatives to **ODS**.
- **Kigali Agreement 2016:**
- Montreal Protocol was amended under Kigali Agreement and **signatories have to phase out HFCs** which ~~were~~ ^{is} not ozone-depleting but have very high Global Warming potential.
- India is a signatory to all of the above. Under **EPA-1986**, govt. notified the Ozone-depleting substances (Regulation and Control) Rules, 2000.
- As of now, India has phased out CFCs and is phasing out HCFCs.
- India will start phasing down HFCs in four steps from 2032 onwards:
 - 10 percent reduction by 2032.
 - 20 percent by 2037
 - 30 percent by 2042
 - 85 percent by 2047
- The main replacement of HFCs is a group of refrigerants known as ~~Hydrofluoro~~ ^{Hydrofluoro} **Olefines** which has much lower **GWP**.
- Some companies are also exploring Ammonia, CO₂, and Hydrocarbon as refrigerants.

LAND DEGRADATION AND DESERTIFICATION (10:56 AM)

- Land degradation can be defined as a negative trend in land conditions which leads to the reduction or loss of at least one of the following:
 1. Biological Productivity
 2. **Ecological Integrity**
 3. **Value to Humans**
- Land degradation within **dry land regions such as arid, semi-arid areas** is termed as desertification **which can turn fertile land** into desert-like conditions.
- There can be both natural and anthropogenic factors.
- Natural factors ~~swind~~ ^{can be} erosion, Water Erosion, **Water logging** and Wildfire.
- Anthropogenic factors: **Agriculture and related activities**, excessive agricultural inputs, Use of pesticides, intensive livestock farming.
- **Land Use Changes:** -> **Climate Change**.
- Mining, Industrial Development, Deforestation, Municipal Solid and Plastic Waste.

Q: Both climate change and land degradation are part of a +ve feedback loop. Examine.

Climate change contribute to Land degradation -

-> More rainfall leads to soil erosion.

-> Rising level leads to soil erosion in coastal areas and saline water intrusion.

-> More natural disasters like wildfire, floods etc.

Land degradation lead to Climate change -

-> Because of land degradation primary production will decrease and this will lead to less carbon sequestration.

-> Land degradation means high use of Nitrogen based pesticides which will lead to climate change.

-> Albedo change will lead to climate change.

-> Permafrost thawing will release methane and CO₂.

IMPACT OF LAND DEGRADATION (11:28 AM)

- The **environmental impact includes** biodiversity loss, extreme weather events, further contribution to climate change, and disruption of ecosystem services.
- **Socio-economic impact includes** Food Security Issues, Water Scarcity, Environmental Migration, and **Zoonotic diseases**.

Result of

GLOBAL INITIATIVES to tackle Land Degradation -

- **United Nations Convention to Combat Desertification (UNCCD)**
- Rio Summit: Entered in Force in 1994. It is the only legally binding agreement at the International level which looks into the issue of sustainable land management.
- The convention is working towards **land degradation neutrality (LDN)**.
- This includes the restoration of productivity of degraded land.
- Enhancing the livelihood of people, ^{dependent on them} and mitigating the impact of droughts on vulnerable populations.
- The convention can support countries with the LDN Fund.
- **LDN will be measured by:**
- 1. Land Cover and Land Cover Change
- 2. Land Productivity
- 3. Soil Organic Carbon
- India is a signatory to UNCCD.
- **Bonn Challenge:**
- Launched by govt. of **Germany and IUCN**.
- It is a non-binding challenge to restore 350 million hectares of land by 2030.
- **India is part of this challenge and has pledged to restore 21 million hectares.**
- United Nations has declared the current decade as a **decade for ecosystem restoration**.
- 'Namami Gange' was one of the projects selected for this purpose.

Topic for the Next Class: Pollution and Waste Management

Q: The process of desertification does not have climatic boundaries. Justify with examples.