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**MAINS HARVEST™**



**ENVIRONMENT**

OFFICERS' IAS ACADEMY

GS-III

ENVIRONMENT

**Mains Harvest**

**ISO 9001:2015  
CERTIFIED ACADEMY**

**OFFICERS IAS ACADEMY**  
(IAS Academy by IAS Officers)

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## MESSAGE FROM THE DIRECTOR

**Dear Aspirant,**

This book is dedicated to YOU, the untiring civil service aspirant who has the drive and commitment to persevere towards clearing this exam which is considered as one of the toughest exams in the world.

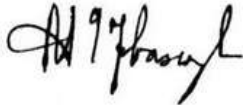
We congratulate you on choosing this book for “**Environment**”. Our attempt here is to simplify important concepts without losing the key points. Hence, we hope you will find this book useful in your civil services journey.

### **About this book**

This book is a distillation of the expertise of the faculty at Officers IAS academy, explained in simple and easy to understand language. What you get to study in this book has been painstakingly collated by our faculty through their years of teaching and mentoring thousands of aspirants.

A strong zeal from you to clear this exam combined with our coaching and textbook will, I am sure help you scale great heights.

I wish you the very best in the most important endeavour of your life.



R. A. Israel Jebasingh

(IAS, 2004 Batch All India Rank 59)

Director of Officers IAS Academy

## HOW TO USE THIS BOOK?

### **Hello Aspirant!**

There is a subtle difference between putting in effort and putting in the right and focussed effort. That difference could determine whether you get into the civil services or not! This statement becomes highly relevant during the UPSC Main Examination stage.

Aspirants know that every mark scored or missed in the Main examination determines their presence as well as their place in the All-India Rank list. Unlike the Preliminary examination, Main exams are fairly predictable. But with Mains, completing the examination on time becomes the biggest challenge.

Even with persistent efforts, aspirants generally tend to struggle in completing the Mains Syllabus. And even when the syllabus is covered, there is a struggle in recollecting appropriate points during the examination.

Such challenges are faced by all UPSC Mains Candidates. This is because of the sheer mindboggling number of topics, dimensions, and links with current affairs that aspirants have to sift through in their mind before writing an answer – something that is indeed a herculean task.

We in the R&D team of the Officers IAS Academy, have been pondering over this challenge, and have found a solution.

Our R&D team spent a year meticulously combing through the *past 47 years'* Mains General Studies question papers, to identify all possible topics and dimensions ever covered for each subject in an UPSC Main examination. Our researchers, then set out to prepare a series of books for each of the 'Main exam subjects' (pertaining to GS1, GS2, & GS3) where all relevant content is covered in a scientific and precise manner. Aspirants can confidently use these books to 'complete' the UPSC Main Exam syllabus effectively and efficiently.

Please note, we do not advocate the use of these 'Mains Harvest' books as 'Standard' sources. However, instead of reading endless number of books for the UPSC preparation, aspirants can focus on the standard books (NCERTs) for foundational knowledge and then devote the rest of their time in studying the Officers IAS Academy's Mains Harvest books.

For you, dear aspirants, we have practically 'harvested' the 'essence' of the UPSC main examination to produce the 'Mains Harvest' book series. Use them well!

Thanking and wishing you all the very best in your preparations,

**R&D Team,**

Officers IAS Academy, Chennai.

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## **POLLUTION**

- Pollution is any undesirable change in physical, chemical or biological characteristics of air, land, water, or soil.
- Agents that bring about such an undesirable change are called pollutants.
- Pollutants can be solid, liquid, or gaseous substances present in greater concentration than in natural abundance and are produced due to human activities or due to natural happenings.

### **1) Air Pollution**

- It occurs due to the presence of undesirable solid or gaseous particles in the air.
- The following are the major gaseous and particulate pollutants present in the troposphere:

#### **1. Gaseous air pollutants:**

- These are oxides of sulphur, nitrogen and carbon, hydrogen sulphide, hydrocarbons, ozone and other oxidants.

#### **2. Particulate pollutants:**

- These are dust, mist, fumes, smoke and smog.

| <b>Name of pollutant</b>            | <b>About pollutant</b>                        | <b>Sources</b>   | <b>Health and environmental effects</b>  |
|-------------------------------------|---|--|--|
| 1.Sulphur Oxides (SO <sub>2</sub> ) | It's a colourless with a pungent odor gas.    | Thermal power plants and Industries.   | <ul style="list-style-type: none"> <li>▪ Eye and throat irritation, cough, allergies, impairs enzyme function in the respiratory system.</li> <li>▪ Reduces exchange of gases from lung surface.</li> </ul>  |
| 2.Nitrogen Oxides (Nox)             | colourless, flammable gas with a slight odor. | Thermal power plant, Industries and burning fuels including petrol, Diesel and coal in vehicles.   | <ul style="list-style-type: none"> <li>▪ Irritation and inflammation of lungs, Breathlessness, Impairs enzyme function in respiratory system and causes Bronchitis and asthma.</li> <li>▪ Major contributor of smog and acid rain.</li> </ul>  |
| 3.Carbon Monoxide (CO)              | It is a colourless, odourless gas             | Vehicular emissions and Incomplete<br>Burning of carbon-based fuels like petrol, diesel and wood.<br>It is also produced from the combustion of natural and Synthetic products such as cigarettes. | <ul style="list-style-type: none"> <li>▪ Difficulty in breathing, severe headaches, Irritation to mucous membrane, unconsciousness and may cause death.</li> <li>▪ It lowers the amount of oxygen that enters our blood.</li> <li>▪ It can slow our reflexes and make us confused and sleepy.</li> </ul> |
| 4.Carbon Dioxide                    | It is the principal                           | Burning of coal, oil and natural gases.  | <ul style="list-style-type: none"> <li>▪ Impairs reflexes, judgment and vision, severe headaches and heart strain.</li> </ul>  |



|                    |  |  |  |
|--------------------|--|--|--|
| (CO <sub>2</sub> ) | greenhouse gas emitted as a result of human activities |  |  |
|--------------------|--|--|--|

### **Air Pollution and its Control**

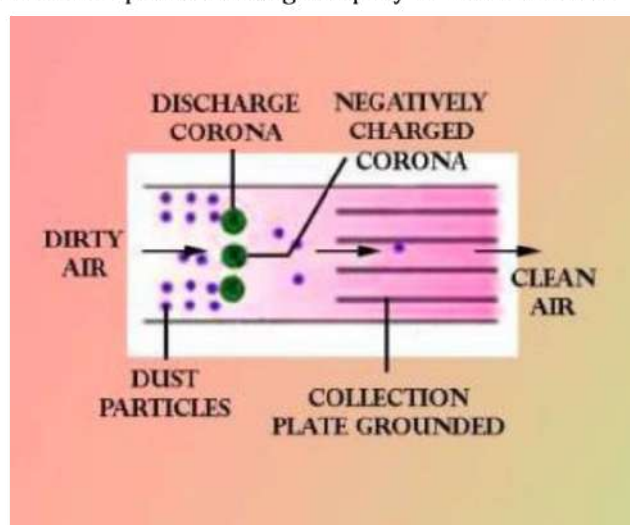
- Smokestacks of thermal power plants, smelters and other industries release particulate and gaseous air pollutants together with harmless gases, such as nitrogen, oxygen, etc.
- These pollutants must be separated/ filtered out before releasing the harmless gases into the atmosphere.

### **Electrostatic Precipitator**

- There are several ways of removing particulate matter; the most widely used of which is the electrostatic precipitator.
- It can remove over 99 percent particulate matter present in the exhaust from a thermal power plant.
- It has electrode wires that are maintained at several thousand volts, which produce a corona that releases electrons.
- These electrons attach to dust particles giving them a net negative charge. The collecting plates are grounded and attract the charged dust particles.
- The velocity of air between the plates must be low enough to allow the dust to fall.

### **Scrubber**

- A scrubber can remove gases like sulphur dioxide.
- In a scrubber, the exhaust is passed through a spray of water or lime.



### **Catalytic Converter**

- Catalytic converters, having expensive metals namely platinum-palladium and rhodium as the catalysts, are fitted into automobiles for reducing emission of poisonous gases.

- As the exhaust passes through the catalytic converter, unburnt hydrocarbons are converted into carbon dioxide and water, and carbon monoxide and nitric oxide are changed to carbon dioxide and nitrogen gas, respectively.
- Motor vehicles equipped with catalytic converters should use unleaded petrol because lead in the petrol inactivates the catalyst.

### **Burning of Crop Residue**

- Most farmers in Punjab and Haryana burned the agriculture field after harvesting in order to remove the residues for the next sowing.
- Due to lack of awareness in technology farmers burned the residues for cleaning the field fast and cheap.
- It release large amount of greenhouse gases such as Methane (CH<sub>4</sub>), Carbon Monoxide (CO), Sulphur dioxide (SO<sub>2</sub>), Ozone (O<sub>3</sub>), Carbon Dioxide (CO<sub>2</sub>), Black Carbon (BC), Volatile Organic Compound (VOC) etc.
- Emitted toxic gases affect human health and enter the soil and affect its moisture and microbes.

### **Alternatives**

- a) Use of Bio decomposers, zero tiller mechanic and Turbo Happy seeder mechanism.
- b) Changing of cropping patterns.
- c) Feed the field residues (Rice Straw) to cattles.

### **National Initiatives/ Legislations/ Organisations**

#### **1) National Green Tribunal**

- The Preamble of the act provides for the establishment of a National Green Tribunal for the effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources, including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto (The National Green Tribunal Act, 2010).
- The Chairperson of the National Green Tribunal (NGT) is appointed by the **Central Government** of India in accordance with the **Chief Justice of India**.
- With the establishment of the NGT, India has joined the distinguished league of countries that have a dedicated adjudicatory forum to address environmental disputes.
- India is the third **country** in the world to have a full-fledged green tribunal followed by New Zealand and Australia.
- The specialized architecture of the NGT will facilitate fast track resolution of environmental cases and provide a boost to the implementation of many sustainable development measures.
- NGT is mandated to dispose of the cases **within six months** of their respective appeals.
- NGT sitting in five places, they are New Delhi, Bhopal, Pune, Kolkata, and Chennai.
- Not bound to the code of civil procedure 1908 but guided by natural justice.

#### **2) Central Pollution Control Board**

- It's a statutory organisation, was constituted in September, 1974 under the Water (Prevention and Control of Pollution) Act, 1974.

- Further, CPCB was entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981.

**Functions**

- Advise the Central Government on any matter concerning prevention and control of water and air pollution and improvement of the quality of air.
- Plan and cause to be executed a nation-wide program for the prevention, control or abatement of water and air pollution.
- Coordinate the activities of the State Board and resolve disputes among them.
- Provide technical assistance and guidance to the State Boards, carry out and sponsor investigation and research relating to problems of water and air pollution, and for their prevention, control or abatement.
- Plan and organise training of persons engaged in programmes on the prevention, control or abatement of water and air pollution.
- Organise through mass media, a comprehensive mass awareness programme on the prevention, control or abatement of water and air pollution.
- Collect, compile and publish technical and statistical data relating to water and air pollution and the measures devised for their effective prevention, control or abatement.
- Prepare manuals, codes and guidelines relating to treatment and disposal of sewage and trade effluents as well as for stack gas cleaning devices, stacks and ducts.
- Disseminate information in respect of matters relating to water and air pollution and their prevention and control.
- Lay down, modify or annul, in consultation with the State Governments concerned, the standards for stream or well, and lay down standards for the quality of air.
- Perform such other functions as may be prescribed by the Government of India.

| <b>National Green Tribunal (NGT)</b>   | <b>Central Polluting Control Board (CPCB)</b>  |
|--|--|
| <ul style="list-style-type: none"> <li>▪ It's a specialised environmental tribunal in India and it was tasked with providing remedies in cases relating to environmental issues.</li> <li>▪ It's a statutory and Quasi-judicial body</li> <li>▪ Enforcement of any legal right relating to Conservation of forests and other natural resources.</li> </ul> | <ul style="list-style-type: none"> <li>▪ It's an apex body in the field of pollution control in India.</li> <li>▪ It's only a statutory body.</li> <li>▪ It promotes to clean wells and Stream around the country and improves the air quality.</li> </ul> |

**3) NAMP (National Air Quality Monitoring Program)**

- Central Pollution Control Board is executing a nationwide programme on ambient air quality monitoring known as NAMP
- The objectives of the N.A.M.P. are
  - To determine the status and trends of ambient air quality;
  - To ascertain whether the prescribed ambient air quality standards are violated;

- To obtain the knowledge and understanding necessary for developing preventive and corrective measures.
- To understand the natural cleansing process undergoing in the environment to assess the extent of corrective measures required
- Under N.A.M.P., four air pollutants viz., Sulphur Dioxide (SO<sub>2</sub>), Oxides of Nitrogen, Respirable Suspended Particulate Matter (RSPM / PM<sub>10</sub>) and Fine Particulate Matter (PM<sub>2.5</sub>) have been identified.

#### 4) Air Quality Index

- The National Air Quality Index was launched in 2015 starting with 14 cities to disseminate air quality information.
- The AQI has **six categories** of air quality, viz **Good, Satisfactory, Moderately Polluted, Poor, Very Poor and Severe.**
- Each of these categories leads to health impacts. AQI considers eight pollutants (PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>2</sub>, SO<sub>2</sub>, CO, O<sub>3</sub>, NH<sub>3</sub> and Pb) for which (up to 24-hourly averaging period) National Ambient Air Quality Standards are prescribed.

#### 5) Environment Protection Act, 1986

- The Environment (Protection) Act was enacted in 1986 for the conservation and development for the environment.
- Compared with previous laws, the Environment (Protection) Act, 1986 is more effective.
- It empowers the Central Government to establish authorities under section 3(3) of this act for taking appropriate measures to prevent and control environmental pollution. The Act was last amended in 1991.
- **Article 48A** (Directive Principles of State Policy) and **Article 51A (g)** (Fundamental Duties) of Indian Constitution are the genesis of the Environmental (Protection) Act, 1986.
- The Act prescribes a special procedure for handling hazardous substances.
- The Environment (Protection) Act, 1986 has relaxed the rule of "Locus Standi" and because of such relaxation even a common citizen can approach the Court provided he has given a notice of sixty days of the alleged offence and his intention to make a complaint to the Central Government or any other competent authority.
- This Act also empowers and authorises the Central Government to issue directions for the operation or process, prohibition, closure, or regulation of any industry. The Central Government is also authorised to stop, regulate the supply of electricity or water or any other service directly without obtaining the order of the Court in this regard.

#### Ambient Air quality standards in respect of Noise for different zones

- The ambient air quality standards in respect of noise for different areas / zones shall be such as specified in the Schedule annexed to these rules.
- The State Government shall categorize the areas into industrial, commercial, residential or silence areas/zones for the purpose of implementation of noise standards for different areas.
- The State Government shall take measures for abatement of noise including noise emanating from vehicular movements and ensure that the existing noise levels do not exceed the ambient air quality standards specified under these rules.

- All development authorities, local bodies and other concerned authorities while planning developmental activity or carrying out functions relating to town and country planning shall take into consideration all aspects of noise pollution as a parameter of quality of life to avoid noise menace and to achieve the objective of maintaining the ambient air quality standards in respect of noise.
- An area comprising not less than 100 meters around hospitals, educational institutions and courts may be declared as a silence area / zone for the purpose of these rules.

## 2) Water Pollution

### Sources of Water Pollution

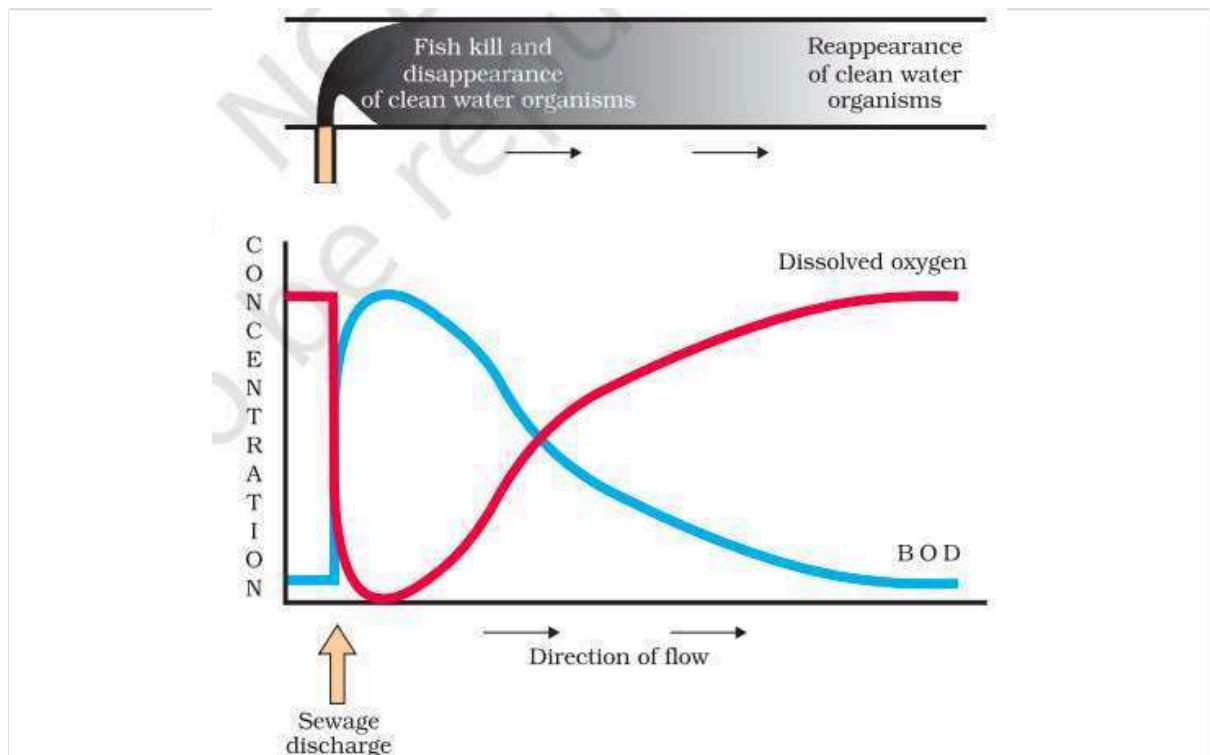
#### 1. Point Sources –

- When Harmful substances are directly emitted into water bodies.
- For Example,
  - Discharge of domestic or industrial effluents.
  - Application of insecticides to destroy niche of mosquito larvae.

#### 2. Non point Sources –

- While point sources can be easily regulated, non-pointed sources vary spatially from various diffuse sources and hence are difficult to regulate.
- For Example,
  - Eutrophication of water bodies, caused due to pesticide runoff from agricultural fields.

### Biological Oxygen Demand



- Biochemical oxygen demand (BOD) refers to the amount of oxygen consumed by bacteria and other microorganisms while decomposing organic matter under aerobic (using oxygen) conditions.
- At the sewage discharge site, a large amount of microorganisms use available oxygen for decomposition of organic matter in the form of sewage wastes, salts.
- This results in a sharp decline in dissolved oxygen levels as the sewage discharge site leads to mortality of fish.
- As the water flows downstream there is replenishment in dissolved oxygen levels.

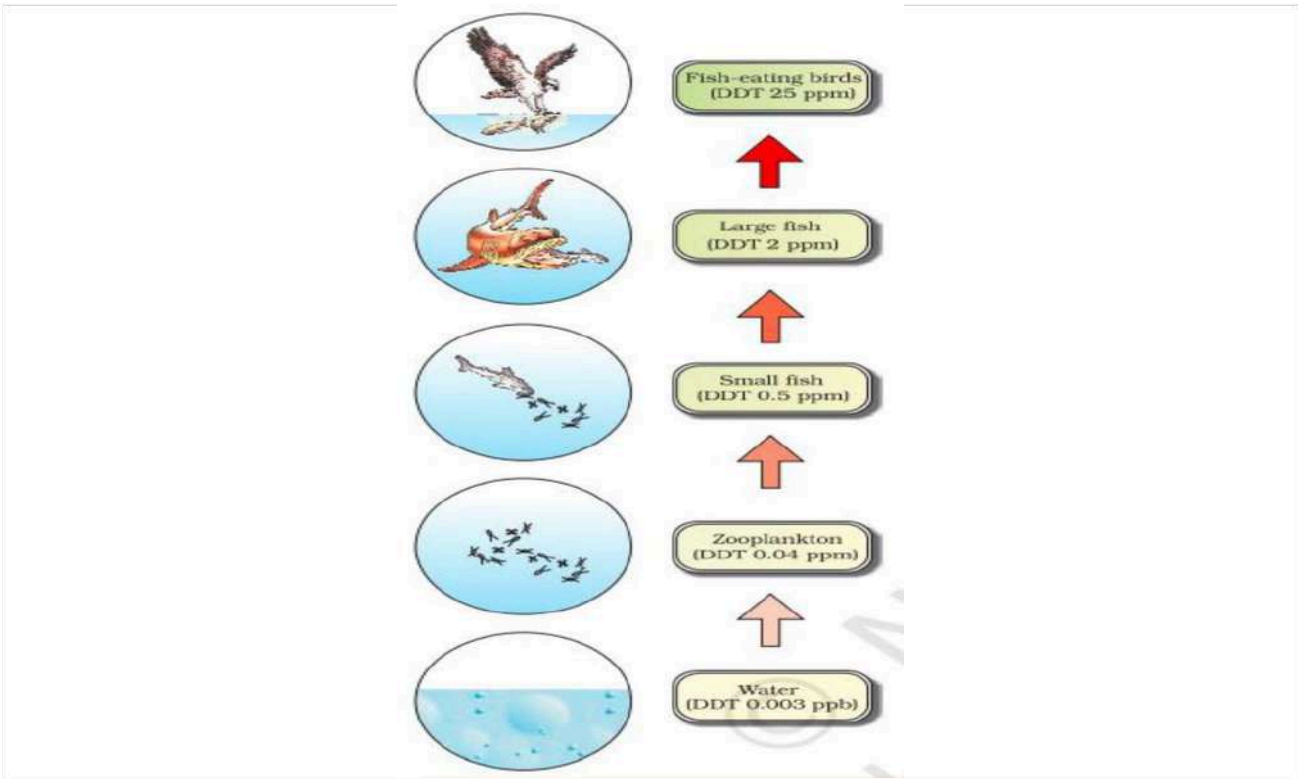
### Consequences of water pollution

#### Eutrophication

- It is defined as the process of natural ageing of a lake by nutrient enrichment of its waters.
- Excessive use of NPK fertilisers causes nitrate and phosphate build up in water bodies.
- Eutrophication can further result in the following-
  - Harmful Algal Blooms – Ex – Introduction of Water Hyacinth into Indian waters by the British , came to be known as “ Terror of Bengal “ as it multiplies largely in eutrophic bodies leading to fish mortality.
  - Dead Zones – Marine Regions devoid of oxygen . Ex – The Bay of Bengal (BoB) hosts a 'dead zone' of around 60,000 square kilometers almost devoid of oxygen.
  - Fish Kills - Occurred in Salim Ali lake , Maharashtra , due to lower levels of Dissolved Oxygen.

#### Biomagnification

- It refers to increase in the concentration of a toxicant from lower trophic levels to higher trophic levels.
- The apex predator remains most affected.
- Ex- DDT sprayed on water bodies can have a direct impact on birds feeding on fish in water. It interferes with calcium metabolism of birds, resulting in thinning of eggshells eventually leading to decline in bird populations.



**Waterborne diseases**

| Toxicant | Disease            |
|----------|--------------------|
| Fluorine | Fluorosis          |
| Arsenic  | Black foot disease |
| Cadmium  | Itai Itai          |
| Mercury  | Mina Mata          |
| Nitrates | Blue Baby Syndrome |

- Other disease includes- **Typhoid, Diarrhoea, Cholera.**

**3) Thermal Pollution**

- Discharge of untreated, hot water effluents from industries may increase the temperature of the receiving water by 10 – 15 ' C above ambient temperature . This is called thermal pollution.
- It is caused due to release of effluents from thermal power plants, desalination plants , etc
- Consequences include - It results in lowered Dissolved oxygen levels , Thermal shocks ( sudden rise and fall of temperature ) leading to fish mortality.
- Remediation includes,**
  - 1. Cooling Ponds** – The effluent water is made to pass through a cooling pond where heat dissipation occurs and cooled water is then discharged into rivers.

2. **Cooling Towers-** Through this process hot water is taken from the water source for cooling purposes and then returned to the water body after passing through a condenser.
3. **Sprayer** – Through air nozzles, overheated water is made to pass into air coolers before discharge into lakes.

### **Bioremediation**

- It refers to the use of living organisms, like microbes and bacteria, in the removal of contaminants, pollutants, and toxins from soil, water, and other environments.
- These techniques have been successfully used to remediate soils/sludges & groundwater contaminated by petroleum hydrocarbons, solvents, pesticides, wood preservatives, and other organic chemicals.
- Micro-organisms can be adapted to degrade specific contaminants or enhance the process.

### **In situ**

It involves treatment of the contaminated material at the site.

- **Bioventing:** supply of air and nutrients through wells to contaminated soil to stimulate the growth of indigenous bacteria. It is used for simple hydrocarbons and can be used where the contamination is deep under the surface.
- **Biosparging:** Injection of air under pressure below the water table to increase groundwater oxygen concentrations and enhance the rate of biological degradation of contaminants by naturally occurring bacteria.
- **Bio augmentation:** Microorganisms are imported to a contaminated site to enhance the degradation process.
- **Bioleaching:** It is the extraction of metals from their ores through the use of living organisms. This is much cleaner than the traditional heap leaching using cyanide.

### **Ex- situ**

- **Bioreactors:** These are large vessels where the contaminated material can be monitored and conditions for bioremediation can be controlled
- **Land farming:** It involves spreading contaminated soil into a lined bed (to prevent leaching) and periodically applying nutrients and mixing the soil to boost biological activity.
- **Bio piling:** It places the contaminated soil into piles that are well aerated and nutrients are added to speed up bioremediation.

### **Use of Genetically engineered organisms**

- These techniques are generally known as recombinant DNA technology. Genetically engineered microorganisms (GEMs) have shown potential for bioremediation of soil, groundwater, and activated sludge, exhibiting the enhanced degrading capabilities of a wide range of chemical contaminants.
- Example: *Pseudomonas putida* to clear oil spills



### **Micro Beads**

- Micro beads are small plastic particles – typically between one micrometre and one millimetre in diameter – that can be added to bathroom products, such as hand wash, exfoliating scrubs and even toothpaste.
- They're most commonly made from polyethylene or other plastics such as polypropylene or polystyrene, and are employed as exfoliating agents (tiny skin scrubbers) or used to give lotions that silky smooth feeling.
- The Bureau of Indian Standards (BIS) issued a notification in 2017 and added 'non-biodegradable polymeric micro beads' to the 'List of raw materials generally not recognised as safe for use in cosmetics.'

### **Ingredients of Micro beads**

1. Polyethylene (PE)
2. Polyethylene terephthalate (PET)
3. Nylon (PA)
4. Polypropylene (PP)
5. Polymethyl methacrylate (PMMA)

### **Harmful effects of Micro beads on Environment**

- Accumulation of plastic debris in the environment.
- Increase in micro plastics polluting the planet's oceans and lakes, researchers say.
- Unfortunately, most wastewater treatment systems do not capture microbeads.
- Damaging effect on marine life, the environment and human health. ability to absorb toxins
- Potential to transfer up the marine food chain.

### **National Initiatives**

#### **1) National Water Mission**

- The main objective of the National Water Mission (NWM) is "conservation of water, minimizing wastage and ensuring its more equitable distribution both across and within States through integrated water resources development and management".
- The five identified goals of the Mission are:
  - a) Comprehensive water data base in the public domain and assessment of the impact of climate change on water resource.
  - b) Promotion of citizen and state action for water conservation, augmentation and preservation.
  - c) Focused attention to vulnerable areas including over-exploited areas.
  - d) Increasing water use efficiency by 20%.
  - e) Promotion of basin level integrated water resources management.

#### **2) The Water (Prevention And Control Of Pollution) Act ,1974.**

- The Act vests regulatory authority in State Pollution Control Board and empowers these Boards to establish and enforce effluent standards for factories discharging pollutants into water bodies.
- The 1988 amendment strengthened the Act's implementation the pollution provisions as follows:
- Board may close a defaulting industrial plant or withdraw its supply of power or water by an administrative order.

- Stringent penalties
- Citizen's suit provision supports the enforcement machinery

### 3) Central Ground Water Authority

- It's a statutory body, constituted under the **Environment (Protection) Act 1986**.
- It's the **National Apex body** responding to monitoring, managing, exploring, augmenting, assessing and regulating groundwater.
- India has the **world's largest groundwater** irrigation system. It consists of **39 Million hectares** (67% of total irrigation system).
- District magistrates/deputy commissioners of revenue are the authorized officers for granting permission to extract groundwater for drinking/domestic purposes.
- It framed guidelines for granting NoC to abstract groundwater by industries and projects.

### 4) National Ganga River Basin Authority

- A statutory body.
- Established in 2009 under the **Environment Protection Act 1986**.
- It is the financing, planning, implementing, monitoring, and coordinating authority for Ganga under Jal Shakti Ministry.
- The **Prime Minister** is the chairperson of the authority.
- In 2016, the authority was changed to **National Ganga Council (NGC)**.

### National Mission for Clean Ganga (NMCG)

- It is the executive/implementation wing of NGC under River Ganga Authority Order 2016.
- Established in 2011 as a registered society.
- It has a two-tier management structure: **Governing Council, & Executive Committee**.
- **Functions:** To ensure effective control of pollution and rejuvenation of river Ganga by adopting a **river basin approach** to promote inter-sectoral coordination for comprehensive planning and management + To maintain **minimum ecological flows** in the Ganga river with the aim of ensuring water quality and environmentally sustainable development.

### Namami Gange Program

- It is an umbrella scheme implemented by NGC through its executive wing, NMCG.
- The main focus areas of the programme: **Wastewater Management, Solid waste Management, Industrial Pollution, River Front Development, River-Surface Cleaning, Afforestation, Industrial Effluent Monitoring, Biodiversity, Public Awareness, and Ganga Gram**.

### 4) Marine Pollution

- Marine pollution, also referred to as ocean pollution, refers to the spread of harmful substances, such as oil, plastics, chemicals into the ocean.

### Causes

- Sewage or polluting substances that flow into oceans
- Untreated Effluents from industries, agricultural runoff (account for 80 % of the total marine pollution)

- Oil spills in Oceans
- Ocean mining for cobalt, zinc , gold results in increased Sulphide depositions
- Ocean Acidification due to increased CO2 absorption hastened by climate change
- Coastal tourism and harbor development projects
- Formation of Plastic gyres
- Issue of microplastics in oceans

### Effects

- It affects the Niche of marine species , hampering reproduction activities.
- Oil spills in oceans can affect , photosynthesis of Corals , Phytoplanktons , etc
- It results in creation of dead zones , devoid of dissolved oxygen due to hypoxic conditions.
- It promotes Eutrophication , resulting in harmful algal blooms.
- Biomagnification occurs due to entry of toxicants, microplastics in the food chain.

### Typology

#### 1. Plastic pollution

- It includes accumulation of plastic in the seas (waste , abandoned ghost nets) entry of microplastics into food chains and deposition of plasticrust on rocks.

#### 2. Light Pollution

- Artificial light used to illuminate cities can penetrate the waves and can be used to affect the circadian rhythm of fish and other marine organisms.

#### 3. Noise Pollution

- The increased presence of loud and persistent sounds from ships, SONAR Devices , can affect communication (echolocation of whales), migration, hunting and reproduction patterns of marine fauna.

#### 4. Chemical Pollution

- It includes Untreated effluents, fertiliser and herbicide run offs, which can cause Eutrophication, Algal blooms resulting in Fish kills.

### Oil spills

- Oil spills refer to the accidental or intentional release of liquid petroleum hydrocarbons into the environment.
- These spills can have detrimental effects on ecosystems, wildlife, and human communities.
- Oil spills can occur through various means
  - **Accidents:** Accidental spills can happen during the extraction, transportation, and refining of oil. For example, pipeline ruptures, tanker accidents, or drilling mishaps can lead to oil being released into the environment.
  - **Leakage:** Aging infrastructure, corrosion, or technical failures in oil pipelines and storage facilities can result in leaks, leading to oil spills.
  - **Shipwrecks:** Maritime accidents, such as collisions, groundings, or sinking of oil tankers, can cause significant oil spills in marine environments.

### Impacts of oil spills

- Oil is toxic to many marine organisms. Fish, shellfish, and other aquatic organisms may suffer direct mortality when exposed to oil.
- Birds that come into contact with oil can experience feather contamination, making it difficult for them to fly.

- Oil spills can contaminate coastal habitats, including marshes, mangroves, and estuaries.
- Oil spills can have cascading effects on plankton and small organisms, disrupting the base of the marine food chain.

#### Measures to mitigate oil spills

- **Booms and barriers** are physical structures deployed on the water's surface to contain and control the spread of spilled oil. They act as barriers, preventing the oil from spreading further and protecting sensitive areas such as shorelines, marshes, and estuaries.
- **Skimmers** are devices used to remove oil from the water's surface. They work by physically separating the oil from the water, allowing for the recovery of the spilled oil.
- **Oilzapper technology** is an eco-friendly technology for the remediation of oil spills. It makes use of five bacterial strains for the treatment of oil spills.
- **Advanced Technologies** can be used for oil drilling, transportation, and storage to minimize the risk of spills. This includes the use of double-hulled tankers, blowout preventers, and safety equipment.

#### International Conventions and Treaties

##### London Convention on Dumping waste at sea (1972)

- The definition of dumping in this convention relates to the deliberate disposal at sea of wastes or other materials from vessels, aircraft, platforms and other manmade structures.
- It was amended in 1993 to ban the disposal of low-level radioactive waste into the sea.

##### Marpol Convention (1973)

- It covers pollution of the marine environment by ships due to operational and accidental causes. It lists various forms of marine pollution caused by oil, liquid substances and sewage garbage from ships.

##### Bunker Convention (2008)

- It is an International Convention that aims to determine questions on compensation and liability available to persons who suffer from damage caused by oil spills. It requires signatories to the convention to have their ships insured against oil leakages. India hasn't ratified this convention yet.

##### Hong Kong Convention (2009)

- It aimed to provide for safe recycling of ships once they have reached the end of their operational lives.

#### 5) Radiation Pollution

- **Radioactive pollution** is defined as a form of physical, nuclear pollution to living organisms and the environment (hydrosphere, lithosphere, and atmosphere) arising from exposure to the release of ionizing radiation from radioactive elements such as **uranium**.
- Such releases occur as a result of radioactive decay of radioactive elements during,
  - Nuclear explosions and testing,
  - Disposal of nuclear waste,
  - Mining radioactive ores,
  - Accidents at nuclear power plants.
- Radiations are of two types ionizing and non-ionizing radiations.
- Non-ionizing radiations affect only those components which absorb them and have low penetrability.
- Ionising radiations have high penetration power and cause breakage of macromolecules. They include UV, X-rays, and Gamma rays.

### **Radiation Damage**

- Radiation damage can be divided into two types,

#### **1. Somatic damage**

- Refers to damage to cells that are not associated with reproduction.
- Effects of somatic radiation damage include loss of hair, fibrosis of the lungs, and reduction of white blood cells. This damage can also result in cancer and death.

#### **2. Genetic damage**

- Refers to damage to cells associated with reproduction.
- This damage can subsequently cause genetic damage from gene mutation resulting in abnormalities

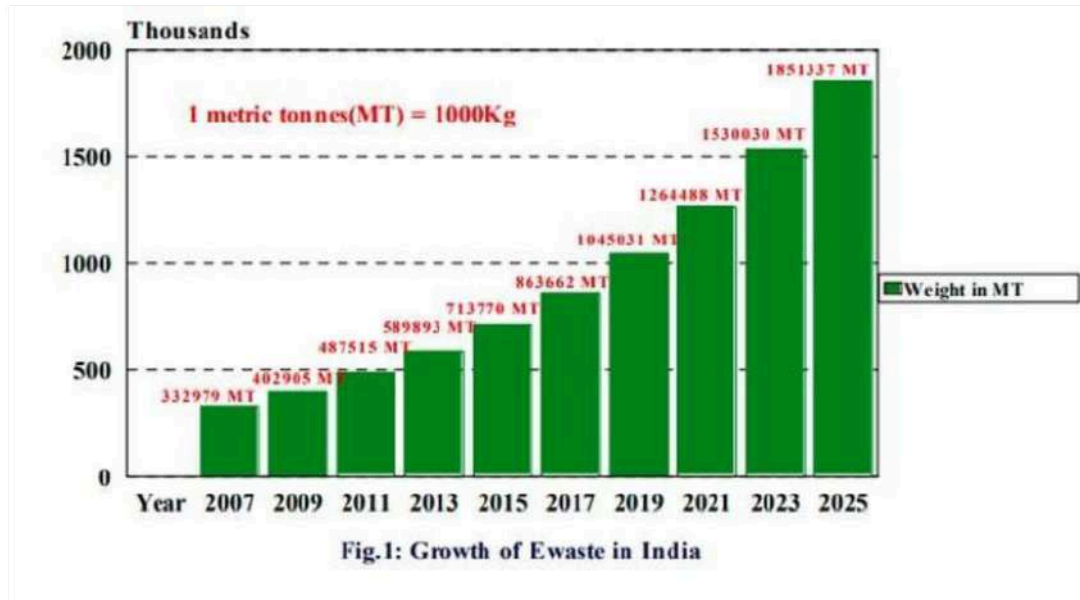
### **Effects**

- Exposure to very high levels of radiation can cause acute health effects such as skin burns and acute radiation syndrome ("Radiation Sickness").
- It can also result in long-term health effects such as cancer and cardiovascular disease.
- The radioactive contaminants in the soil react together with the various nutrients that cause the nutrients to be lost, making the soil highly toxic and infertile.
- Radioactive contamination has been shown to alter current cells, resulting in irreversible tissue and organ damage.

### 6) E-Waste

- In India about **1.2 million tons** of –waste is generated every year, as per a study conducted by the **Central Pollution Control Board (CPCB)**.
- Electronic waste is generated when electrical equipment becomes unfit for their originally intended use or has crossed the expiry date.
- The E-waste consists of many compounds which include organic and in-organic compounds.
- Organic compounds include **flame retardants, dioxins, chlorinated benzenes and phenols, nonylphenol etc.** In-organic compounds include **arsenic, barium, asbestos, cadmium, copper, mercury, lead, nickel, chromium, selenium, zinc, tin.**

### Growth of E-Waste in India



### E-Waste (Management and Handling) rules, 2016

- The management of e-waste in the Country is regulated under the E-Waste (Management) Rules, 2016 and amendments thereof.
- Extended Responsibility to producers to manage a system of E-waste collection, storage, transportation and environmentally sound dismantling and recycling through Extended Producer Responsibility (EPR) Authorization.

### Objectives

1. To promote and encourage establishment of an efficient e-waste collection mechanism.
2. To promote environmentally safe and sound recycling through authorized dismantlers and recyclers of e-waste.
3. To minimize illegal recycling / recovery operations.
4. Reduce hazardous substances in Electrical and Electronic Equipment (EEE).
5. As per E-Waste (Management) Rules, 2016, the producer of electrical and electronic equipment (EEE) as listed in Schedule I shall implement e-waste collection targets under Extended Producers Responsibility (EPR) as per Schedule III which are as below,

### Definition of Extended Producer Responsibility

- Extended Producers Responsibility is the use of financial incentives to encourage manufacturers to design eco-friendly products by making producers accountable for their product management during end-stage consumption.



### **E-Waste (Management) Amendment Rules, 2018**

- It revised the collection targets under the provision of EPR. The phase-wise collection targets for e-waste in weight shall be 10% of the quantity of waste generation during 2017-18, with a 10% increase every year until 2023.
- From 2023 onwards, the target has been made 70% of the quantity of waste generated.
- The responsibility of producers is not confined to waste collection alone, but also to ensure that the waste reaches the authorized recycler/dismantler.
- Under the amended Rules, PROs are required to apply to the Central Pollution Control Board (CPCB) for registration to undertake their activities.

### **Effects of E-Waste**

- Contamination in the air occurs when e-waste is informally disposed of, releasing toxins, such as dioxins, into the environment that cause air pollution.
- Heavy metals from e-waste, such as mercury, lithium, lead, and barium, then leak through the earth and pollute groundwater.
- It can also considerably affect the nervous and reproductive systems of the human body, leading to disease and birth defects.

### **7) Biomedical Waste**

- Biomedical waste comprises human and animal anatomical waste, treatment apparatus like needles, syringes and other materials used in health care facilities in the process of treatment and research.
- This waste is generated during diagnosis, treatment or immunization in hospitals, nursing homes, pathological laboratories, blood banks.

**Biomedical Waste Management Rules, 2016**

- These rules shall apply to all persons who generate, collect, receive, store, transport, treat, dispose of, or handle bio-medical waste in any form.
- According to it, a Common Bio-medical Waste Treatment and Disposal Facility (CBWTF) is set up where biomedical waste is generated.
- The member health care facilities imparted necessary treatment to reduce adverse effects that this waste may pose on human health and the environment.
- It calls for the Phase-out of the use of chlorinated plastic bags, gloves, and blood bags within two years.
- It calls for Pre-treatment of the laboratory waste, microbiological waste, blood samples and blood bags through disinfection or sterilization on-site.
- It seeks to establish a Bar-Code System for bags or containers containing bio-medical waste for disposal.
- As per the rules, Bio-medical waste has been classified into 4 categories to improve the technology options available for 'treatment'.

**BIOMEDICAL WASTE IS CLASSIFIED INTO 4 CATEGORIES TO IMPROVE SEGREGATION AT SOURCE...**

|   |  |  |   |
|---|--|--|---|
| <br><b>Yellow</b><br>Human/animal anatomical waste, soiled waste, expired medicines, chemical waste, body fluids                               | <br><b>Orange</b><br>Contaminated plastic bag, bottles, pipes or containers | <br><b>White</b><br>Scalpels, blades, needles, syringes and sharp metal items   | <br><b>Blue</b><br>Broken glassware or metallic body implant |
| <b>Vaccination, blood donation and surgical camps are also governed by Biomedical Waste Management Rules, 2016</b>  |  |  |   |
| <b>1</b> The norms stipulate that a provision needs to be made within the premises of a healthcare facility for a safe, ventilated and secured location for storage of segregated biomedical waste in coloured bags or containers |  | <b>2</b> It is the duty of the operator of a biomedical waste treatment and disposal facility to ensure timely collection of such waste and take all steps to ensure it is transported, handled, stored and disposed of without any adverse effect to human health and the environment |   |

**Treatment of Biomedical Waste**

- **Chemical process,**
  - In these processes, chemicals act as disinfectants.
  - Sodium hypochlorite, dissolved chlorine dioxide, peracetic acid, hydrogen peroxide, dry inorganic chemicals and ozone are examples of such chemicals.
- **Thermal process,**
  - Here, heat is utilized to disinfect and they operate depending on the temperature.



- **Mechanical process,**
  - It's used to change the physical form or characteristics of the waste to facilitate waste handling or to process the waste in conjunction with other treatment steps.
- **In Irradiation process,**
  - In this process, wastes are exposed to ultraviolet or ionizing radiation in an enclosed chamber. These systems require post-shredding to render the waste unrecognizable.
- **Biological process,**
  - Here, enzymes are used for treating medical waste.

#### **Biomedical Waste Management (Amendment) Rules, 2018**

- Bio-medical waste generators will have to phase out chlorinated plastic bags (excluding blood bags) and gloves by March 27, 2019.
- Operators of common bio-medical waste treatment and disposal facilities shall establish barcoding and global positioning system for handling bio-medical waste in accordance with guidelines issued by the Central Pollution Control Board.
- Every occupier, i.e. a person having administrative control over the institution and the premises generating biomedical waste shall pre-treat the laboratory waste, microbiological waste, blood samples, and blood bags through disinfection or sterilization on-site in the manner as prescribed by the World Health Organization (WHO).

#### **8) Solid Waste Management**

- Solid waste means any garbage or refuse, sludge, and other discarded material, resulting from industrial, commercial, mining, and agricultural operations, and from community activities.
- Solid-waste management means collecting, treating, and disposing of solid material that is discarded because it has served its purpose or is no longer useful.
- **Municipal solid waste** includes commercial and domestic wastes generated in municipal or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes.

#### **Issues related to solid waste**

- Improper disposal of municipal solid waste can create unsanitary conditions, leading to pollution and outbreaks of vector-borne disease that is, diseases spread by rodents and insects.
- Urban India alone generates nearly 0.15 million tonnes per day of MSW. The volume of waste is projected to reach 165 million tonnes by 2031 and 436 million tonnes by 2050.
- The informal sector is largely engaged in the handling and management of solid wastes, which affects their health.

#### **Solid Waste Management Rules, 2016**

- The Government has revamped the Municipal Solid Wastes (Management and Handling) Rules 2000 and notified the new Solid Waste Management Rules, 2016.
- They expanded the scope of application of MSW rules by including places of pilgrims, airports, special economic zones, ports and harbors, defense establishments, and every domestic, institutional, commercial, and any other non-residential solid waste generator under its ambit.
- The Rules for the first time prescribe the duty of MSW generators.

- A Central Monitoring Committee is to be constituted to monitor the implementation. Criteria for landfilling and waste-to-energy plants are also provided.
- The Central Pollution Control Board will have to coordinate with the State Pollution Control Board, review environmental standards, monitor implementation, publish guidelines, and prepare an annual report on implementation.

### **Previous Year Questions**

1. Indicate the sources of atmospheric pollution in the major urban centers in India and the steps to be taken to minimize the problem.
2. The environmental pollution poses serious health hazards in developing and developed countries. Describe the various human activities that cause environmental pollution. Suggest ways and means for containing environmental pollution in India.
3. State the types of environmental pollution and some of the places where it has occurred due to the progress industrialisation in India.
4. Give examples of some serious problems associated with the operation of chemical industries in India and other countries. What technical steps can be taken to achieve maximum safety in chemical factories?
5. What do you understand by Environmental Pollution? Mention the various kinds of pollution and their effect on human health in India.
6. Plastic hazards - Discuss.
7. Describe the sources of ionizing and non-ionizing radiations and their effects on the biotic components of the atmosphere.
8. Justify with necessary logic "Biological clean-up methods can be cheaper than the conventional physical and chemical pollution treatments
9. Bring out the salient features of the evolution and the current status of the Bharat Stage' vehicle emission norms.
10. What are the impediments in disposing the huge quantities of discarded solid wastes which are continuously being generated? How do we remove safely the toxic wastes that have been accumulating in our habitable environment?
11. Do you think India will meet 50 percent of its energy needs from renewable energy by 2030 ? Justify your answer. How will the shift of subsidies from fossil fuels to renewables help achieve the above objective
12. Enumerate the National Water Policy of India. Taking river Ganges as an example, discuss the strategies which may be adopted for river water pollution control and management. What are the legal provisions of waste
13. What is oil pollution? What are its impacts on the marine ecosystem? In what way is oil pollution particularly harmful for a country like India?

## ***CLIMATE CHANGE***

### **1) What is Climate Change?**

- Climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural, but since the 1800s, human activities have been the main driver of climate change, primarily due to the burning of fossil fuels (like coal, oil and gas) which produce heat-trapping gases.

### **Causes for climate change**

- The causes of climate change can be divided into two categories - Natural and man made

#### **1) Natural causes**

- There are a number of natural factors responsible for climate change. Some of the important factors are continental drift, volcanoes, ocean currents and the earth's tilt.
- **Continental drift**
  - The continents we see today were formed when the landmass began gradually drifting apart, millions of years back. This drift changed the position of water bodies of the landmass and the flow of ocean currents and winds. These changes affect the climate. This drift of the continents continues even today.
- **Volcanoes**
  - When a volcano erupts it throws out large volumes of sulfur dioxide (SO<sub>2</sub>), water vapor, dust, and ash into the atmosphere. Although the volcanic activity may last only a few days, the large volumes of gases and ash can influence climatic patterns for years. The gases and dust particles partially block the incoming rays of the sun, leading to cooling.
- **The Earth's tilt**
  - The Earth is tilted at an angle of 23.5° to the perpendicular plane of its orbital path. Changes in the tilt of the earth affect the severity of the seasons. More tilt means warmer summers and colder winters; less tilt means cooler summers and milder winters.
- **Ocean currents**
  - The oceans are a major component of the climate system. They cover about 71% of the Earth. The oceans absorb the sun's radiation about twice as much as the atmosphere

#### **2) Human causes**

- **Greenhouse effect**
  - The earth receives energy from the sun, which warms the earth's surface. As this energy passes through the atmosphere, a certain percentage (about 30) gets scattered.
  - Some part of this energy is reflected back into the atmosphere from the land and ocean surface. Certain gases in the atmosphere form a sort of blanket around the earth and absorb some of this energy.
  - These gases like carbon dioxide, methane, and nitrous oxide, along with water vapour, comprise less than one percent of the atmosphere.
  - They are called '**Greenhouse Gases**'.



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