Auditing Course Material

Part 58 of 61 (Chapters 5701-5800)

6. National Action Plan on Climate Change

The **National Action Plan on Climate Change (NAPCC)** is a comprehensive strategy introduced by the Government of India in 2008 to address the challenges posed by climate change. It outlines a set of eight national missions, each focusing on a specific area of climate action.

NAPCC is guided by the principles as discussed below.

(i) Protecting the poor and vulnerable sections of society through an inclusive and sustainable development strategy, sensitive to climate change

(ii) achieving national growth through ecological sustainability,

(iii) devising efficient and cost-effective strategies for end use Demand Side Management,

(iv) deploying appropriate technologies for both adaptation and mitigation of greenhouse gases emissions,

(v) engineering new and innovative forms of market, regulatory and voluntary mechanisms to promote sustainable development,

(vi) effecting implementation of programmes by including civil society and local government institutions and through public-private partnership, and

(vii) welcoming international cooperation for research, development, sharing and transfer of technologies.

The 8 national missions are given below:

1. *National Solar Mission (NSM)*: Launched in 2010, it aims to promote the development and deployment of solar energy technologies to achieve a significant share of solar power in the country's energy mix.
2. *National Mission for Enhanced Energy Efficiency (NMEEE)*: Launched in 2010, it aims to improve energy efficiency in various sectors like industry, transportation, and agriculture, with the goal of reducing emissions and conserving resources.
3. *National Water Mission (NWM)*: Launched in 2011, it aims to improve water use efficiency and promote sustainable management of water resources, recognizing the critical link between water and climate change impacts.
4. *National Mission for Sustainable Agriculture (NMSA)*: Launched in 2012, it focuses on adopting climate-resilient agricultural practices, improving soil health, and promoting sustainable water management in agriculture.
5. *National Mission for Sustaining the Himalayan Ecosystem (NMSHE)*: Launched in 2010, it aims to safeguard the fragile Himalayan ecosystem, which is particularly vulnerable to climate change impacts, by addressing issues related to biodiversity, forests, and livelihoods.
6. *National Mission for a Green India (GIM)*: Launched in 2014, it focuses on afforestation, reforestation, and conservation of biodiversity to enhance carbon sequestration and ecosystem resilience.
7. *National Mission for Sustainable Habitat (NMSH)*: Launched in 2010, it aims to promote energy efficiency, sustainable urban planning, and waste management practices in urban areas to reduce emissions and enhance urban resilience.
8. *National Mission for Strategic Knowledge for Climate Change (NMSKCC)*: Launched in 2014, it focuses on research, capacity building, and knowledge generation to better understand and address climate change challenges.

1. How many national missions are there in the National Action Plan on climate change? **(UGC NET 24th Mar 202 Shift)**

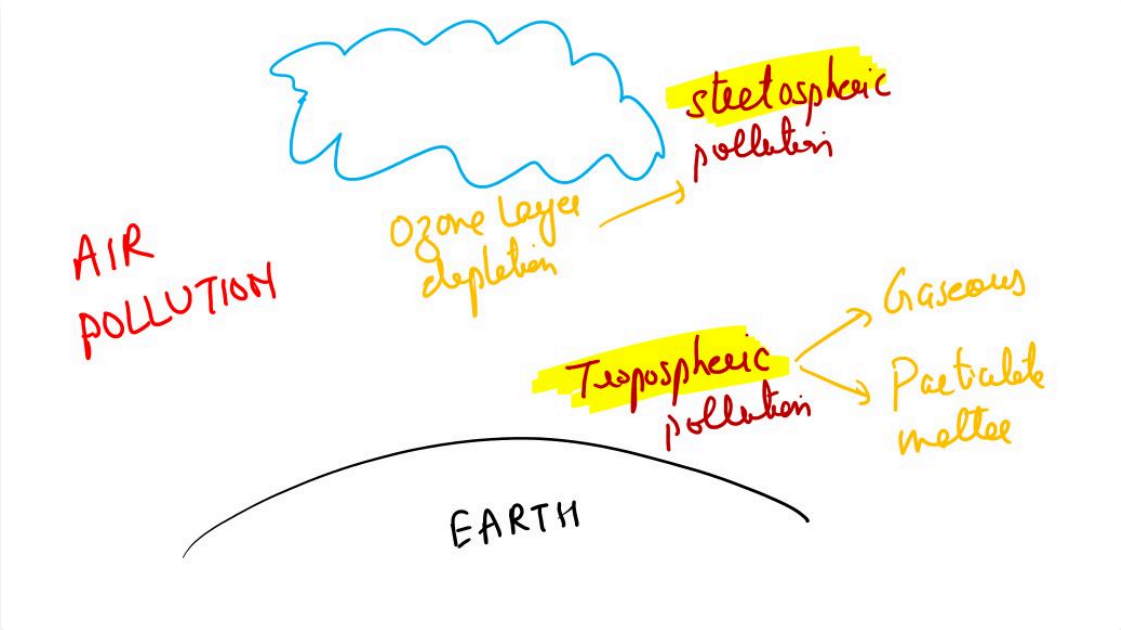
- 9
- 8
- 6
- 7

Check

Question: 1 of 3 questions

1. Introduction

Air Pollution is the contamination of the Earth's atmosphere by harmful or excessive substances, known as air pollutants. These pollutants can be of natural origin, like dust and volcanic emissions, or human-made, such as emissions from vehicles, industrial processes, and power plants. It poses significant health risks to humans, as it can lead to respiratory problems, cardiovascular diseases, and other illnesses. Additionally, it can harm the environment by causing acid rain, damaging ecosystems, and contributing to climate change.



Air Pollution is generally studied as stratospheric and tropospheric pollution.

The presence of **stratospheric pollution** correlates with the shielding effect the ozone layer offers against damaging UV radiation. This pollution interacts with the ozone layer, impacting its ability to protect against harmful UV rays, posing potential threats to the environment and human health.

Tropospheric pollution occurs due to the presence of undesirable solid or gaseous particles in the air. It can be sub-divided into:

- *Gaseous air pollutants:* These are oxides of sulphur, nitrogen and carbon, hydrogen sulphide, hydrocarbons, ozone and other oxidants.
- *Particulate pollutants:* These are dust, fly ash, aerosols, soot, smoke, smog etc.

> Air pollution is limited to situations in which the outdoor ambient atmosphere contains materials in concentration which are injurious to humans and their surrounding environment.
> World Health Organization

Let us discuss them one by one.

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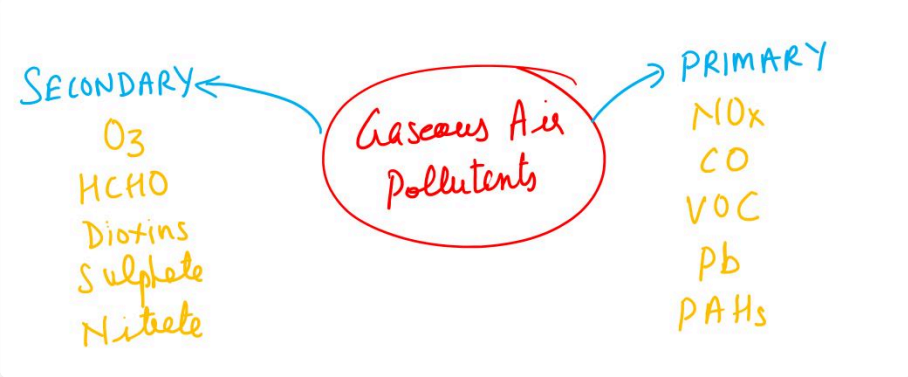
2. Gasesous Air Pollutants

Air pollutants are substances present in the Earth's atmosphere that can be harmful to human health, the environment, and the quality of the air we breathe. These pollutants can originate from natural sources or human activities.



Air pollutants can be classified into two main categories, primary pollutants and secondary pollutants. This classification distinguishes between pollutants that are directly emitted into the atmosphere.

These two types are discussed next.

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2. Gasesous Air Pollutants

Primary air pollutants are those substances that are directly emitted into the atmosphere. Some of them are discussed below.

1. Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic Aromatic Hydrocarbons (PAHs) are a class of chemicals that occur naturally in coal, crude oil, and gasoline. They are produced during the incomplete combustion of organic materials, such as fossil fuels, wood, and tobacco, and can also be found in the environment, including in soil, water, and the atmosphere. Some of its harmful effects are given below.

Effect:

- Large amounts of PAHs in air can irritate eyes and breathing passages.

2. Oxides of Nitrogen (NOx)

Nitrogen oxides, including nitric oxide (NO) and nitrogen dioxide (NO_2), are produced primarily from combustion processes, such as those in vehicles and power plants. In an automobile engine, (at high temperature) when fossil fuel is burnt, dinitrogen and dioxygen combine to yield significant quantities of nitric oxide (NO) and nitrogen dioxide (NO_2).

Effect:

- The irritant red haze in the traffic and congested places is due to oxides of nitrogen.
- Higher concentrations of NO_2 damage the leaves of plants and retard the rate of photosynthesis.
- Nitrogen dioxide is a lung irritant that can lead to an acute respiratory disease in children.
- Nitrogen dioxide is also harmful to various textile fibres and metals. It is toxic to living tissues also.
- They contribute to the formation of ground-level ozone, acid rain.
- These oxides of nitrogen play a major role in the chemical reactions that generate photochemical smog.

3. Oxides of Sulphur

Oxides of Sulphur are produced when Sulphur containing fossil fuel is burnt. The most common species is Sulphur dioxide (SO_2) which is poisonous to both animals and plants. SO_2 is formed and emitted by combustion of fossil fuels (mainly coal and oil) primarily for electricity generation. Natural processes like volcanic eruptions also releases Sulphur compounds. The high concentrations of SO_2 have been recorded in the vicinity of large industrial facilities.

Effect:

- Even a low concentration of Sulphur dioxide (SO_2) causes respiratory diseases e.g., asthma, bronchitis, emphysema in human beings.
- High concentration of SO_2 leads to stiffness of flower buds which eventually fall off from plants.
- Sulphur dioxide (SO_2) causes irritation to the eyes, resulting in tears and redness.
- It contribute to the formation of acid rain.
- Hydrogen Sulphide (H_2S) is somewhat soluble in water, resulting in formation of sulfhydryl acid, which is corrosive to metals, and contributes to acidic deposition to soil and water.

4. Carbon Monoxide (CO)

Carbon Monoxide is generated during the incomplete combustion of carbon-containing fuels, such as gasoline and natural gas. It is produced naturally by oxidation of methane, in the oceans and air, produced from organic decomposition.

Effect:

- High levels of CO can be harmful as it reduces the blood's ability to carry oxygen.
- It binds to haemoglobin to form carboxyhaemoglobin.
- This oxygen deficiency, results into headache, weak eyesight, nervousness and cardiovascular disorder.

5. Volatile Organic Compounds (VOCs)

Volatile Organic Compounds (VOCs) are a group of organic chemicals that easily evaporate into the air at room temperature. While they are not inherently toxic, they can have harmful effects on the environment due to their role in air pollution and their ability to contribute to the formation of ground-level ozone and secondary organic aerosols. They are emitted from various

sources, including vehicle exhaust, industrial processes, and the use of solvents in products like paints and cleaning agents. Some of its examples include - Trichloroethylene, Benzene, Toluene, Xylene, Acetone among others.

Effect:

- VOCs contribute to the formation of ground-level ozone and smog.
- It causes eye, nose and throat irritation.

6. Lead (Pb)

Lead emissions were historically significant from the use of leaded gasoline. While leaded gasoline has been largely phased out, lead can still be emitted from industrial processes, especially in places where lead-acid batteries are produced.

Effect:

- Lead is a heavy metal, and when present in the body, it can impair brain function, especially in children.
- Depending upon the level of exposure, it can adversely effect kidney function, immune system, reproductive and developmental systems and the cardiovascular system.

7. Ammonia (NH_3)

Ammonia originates from both natural and anthropogenic sources, with the main source being agriculture, e.g. manures, slurries and fertiliser application.

Effect:

- It can contribute to fine particulate matter and can affect air quality in rural areas.
- Excess nitrogen can cause eutrophication and acidification effects on semi-natural ecosystems.
- It has a negative effects on vegetation occur via direct toxicity, when uptake exceeds detoxification capacity.

8. Methane (CH_4)

Methane is a powerful greenhouse gas and Short-Lived Climate Pollutant (SLCP) primarily emitted by human activities. It is emitted from natural sources (e.g., wetlands), agriculture (e.g., enteric fermentation in livestock), and man-made sources (e.g., fossil fuel production and transport).

Effect:

- Methane affects air quality because it can lead to ground level (tropospheric) ozone.
- Methane leaks can also pose explosion hazards.

1. Out of different oxides of nitrogen which of the following are considered as Air Pollutants and known as NO_x **(U 22nd Mar 2023 Evening Shift)**

A. NO (Nitric Oxide)
B. NO_2 (Nitrogen dioxide)
C. NO_2 (Nitrogen trioxide)
D. N_2O (Nitrous oxide)

- ○ C and D Only
- ○ A and B Only
- ○ B and C Only
- ○ A, B and D Only

Check

Question: 1 of 5 questions

2. Gasesous Air Pollutants

Secondary Air Pollutants are those that are formed through chemical reactions involving precursor pollutants. Some of them are discussed below.

1. Ground-Level Ozone (O_3)

It forms through reactions between Nitrogen Oxides (NO_x) and Volatile organic compounds (VOCs) in the presence of sunlight. Ozone can cause respiratory problems and other health issues and is a major component of smog.

2. Peroxyacetyl Nitrate (PAN)

Peroxyacetyl Nitrate (PAN) is a secondary air pollutant that forms in the atmosphere through chemical reactions involving two primary precursor pollutants: nitrogen oxides (NO_x) and volatile organic compounds (VOCs). These precursor gases are released into the atmosphere from various sources, including industrial processes, vehicle emissions, and natural sources. When NO_x and VOCs are present in the atmosphere, they can react to produce PAN through a series of photochemical reactions.

3. Formaldehyde (HCHO)

Formaldehyde is a secondary pollutant that forms in the atmosphere through the oxidation of volatile Organic Compounds (VOCs), such as methane and other hydrocarbons. Formaldehyde is used in a wide range of applications, including as a preservative, in the production of resins, for textile treatment, as a disinfectant, and in the manufacture of various plastics and building materials.

4. Dioxins

Dioxins are a group of chemically-related compounds that are persistent environmental pollutants (POPs), meaning they take a long time to break down once they are in the environment. They are found throughout the world in the environment and they accumulate in the food chain, mainly in the fatty tissue of animals. They are also emitted during combustion of biomass, plastics, chemical processing, and waste incineration. They are highly toxic and can cause reproductive and developmental problems, damage the immune system, interfere with hormones and also cause cancer.

5. Aerosols and Mists

They are very fine liquid droplets that cannot be effectively removed using traditional packed scrubbers. These droplets can be formed from gas phase hydrolysis of halogenated acids (HCl, HF, HBr), metal halides, organohalides, sulfur trioxide (SO_3), and phosphorous pentoxide (P_2O_5).

6. Sulfate Particles

Sulfate Particles are formed through the oxidation of sulfur dioxide (SO_2), a primary pollutant, in the presence of other atmospheric chemicals. These particles can contribute to the formation of fine particulate matter and can be harmful to respiratory health.

7. Nitrate Particles

Nitrate particles are produced through the reaction of nitrogen oxides (NO_x) with ammonia (NH_3) and other compounds in the atmosphere. They are a significant component of fine particulate matter and can affect air quality.

8. Smog

Smog is a complex mixture of secondary pollutants, including ground-level ozone, fine particulate matter, and other compounds resulting from chemical reactions between precursor pollutants in the presence of sunlight. It can have adverse effects on air quality and human health.

It is to be noted that Particulate Matter can be both a primary and secondary air pollutant, depending on its origin and composition.

- *Common Primary Pollutants:* combustion processes (such as vehicle emissions, industrial furnaces, and wood-burning stoves), dust from construction sites, and natural events like wildfires and volcanic eruptions.
- *Common Secondary Pollutants:* SO_2 and NOx can combine with other compounds and moisture to form sulfate and nitrate particles.

1. Dioxins are emitted during combustion of: **(UGC NET 14th Mar 2023 Morning Shift)**

- Natural gas
- Coal
- Biomass
- Nuclear

Check

Question: 1 of 4 questions

3. Particulate Pollutants

Particulate Pollutants consist of tiny solid particles or liquid droplets suspended in the air. They originate from various sources, including vehicle emissions, smoke from fires, dust particles, and ash produced by industrial activities.

Particulates in the atmosphere can be categorized as viable or non-viable.

- *Viable particulates* include microscopic living organisms such as bacteria, fungi, molds, and algae that are dispersed in the air. Some of these fungi can trigger allergies in humans and also have the potential to cause diseases in plants.
- *Non-Viable particulates* are formed either by breakdown of large materials or by the condensation of minutes particles and droplets.
  Particulate Matter

These are tiny solid or liquid particles suspended in the air, originating from sources like combustion processes (e.g., vehicle exhaust, industrial emissions), dust from construction and roads, and natural events like wildfires and volcanic eruptions. Particulate matter includes $PM_{2.5}$ and PM_{10}, with $PM_{2.5}$ being finer and more harmful to human health.

- PM_{10}: inhalable particles, with diameters that are generally 10 micrometers and smaller; and
- $PM_{2.5}$: fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller.

Soot, dust, mists, fumes are the some of the common examples of non-viable particulates. These are discussed next.

Soot

It is a type of fine particulate matter composed of tiny, solid carbon particles. It is typically produced during the incomplete combustion of carbon-containing fuels or materials. It is commonly associated with the exhaust emissions from vehicles, industrial processes, and the burning of wood or coal. It can also be found in indoor environments, particularly in homes with open flames or inefficient combustion devices.

Mist

It consists of tiny liquid droplets suspended in the air. These droplets are usually on the order of micrometers in size and can be water-based or contain other liquids. It is commonly associated with processes like spraying, atomization, and the use of liquid coolants in machining operations. It can also be found in natural environments, such as in the form of fog.

Fume

It refers to very fine, solid particles which are generally obtained by the condensation of vapours during sublimation, distillation, boiling and several other chemical reactions. Generally, organic solvents, metals and metallic oxides form fume particles.

Dust

It is composed of fine solid particles (over 1µm in diameter), produced during crushing, grinding and attribution of solid materials. Sand from sand blasting, saw dust from wood works, pulverized coal, cement and fly ash from factories, dust storms etc., are some typical examples of this type of particulate emission.

Note

Fume, Mist, and Soot are actually types of aerosols.

Aerosols

Aerosols are small particles suspended in the atmosphere. They are often not or barely visible to the human eye, yet their impact on climate, weather, health, and ecology are significant. They can be either primary or secondary depending upon the source of formation.

- *Primary Aerosol:* These are particles that are directly emitted into the atmosphere. These emissions can come from both natural and human-made sources. For example, natural sources of primary aerosols include sea spray, mineral dust from deserts,volacanic ash etc. Human-made sources include emissions from industrial processes, such as the release of soot and ash from combustion, as well as vehicle exhaust emissions.
- *Secondary Aerosols:* These are aerosols which were emitted in another form (e.g. gases), then become aerosol particles after going through chemical reactions in the atmosphere, such as sulfate aerosols from volcanoes or industrial emissions.

All aerosols can also undergo further chemical changes, referred to as ‘aging effects’.

1. Which of the following Particulate Matter (PM) type is also commonly known as Respirable Suspended Particul (RSPM)? **(UGC NET 13th Mar 2023 Morning Shift)**

- PM_1
- $PM_{2.5}$
- PM_5
- PM_{10}

Check

Question: 1 of 4 questions

4. Smog

Smog is a type of air pollution characterized by a mixture of smoke and fog, or other particulate matter and pollutants, which often results in a hazy and unhealthy atmospheric condition. Smog is typically formed when certain pollutants interact with sunlight and atmospheric conditions, leading to the production of a complex mixture of airborne particles and noxious gases. The term "smog" was first used in the early 1900s (originally coined in 1905 by Des Voeux) to describe a mix of smoke and fog.

There are 2 types of smog. These are discussed below.

1. Classical Smog (London Smog)

This type of smog is often associated with older industrial cities and occurs when sulfur dioxide (SO_2) and particulate matter from the burning of coal and other fossil fuels combine with atmospheric moisture. It results in a mixture of sulfuric acid (H_2SO_4) droplets and fine particles suspended in the air, leading to a thick, yellowish fog. It occurs in cool, damp climates where coal is a major source of energy. It was especially prevalent in cities like London during the 19th and early 20th centuries. Classical smog is characterized by a strong sulfur odor and can have harmful effects on respiratory health and visibility. This smog is known to cause respiratory problems and reduced visibility due to its high concentrations of sulfur dioxide and particulate matter.

2. Photochemical Smog (Los Angeles Smog or Oxidizing Smog)

This type of smog is primarily associated with sunny, urban areas with high levels of vehicle emissions. It forms when nitrogen oxides (NO_x) and volatile organic compounds (VOCs) from vehicle exhaust and industrial sources react with sunlight. These reactions produce ground-level ozone (O_3) and other secondary pollutants, creating a brownish haze. Photochemical smog is known to cause respiratory problems, eye irritation, and reduced lung function, among other health issues.

The major undesirable components of photochemical smog are nitrogen dioxide (NO_2), Ozone (O_3), PAN (peroxyacetyl nitrate), and chemical compounds that contain the –CHO group (aldehydes). PAN and aldehydes can cause eye irritation and plant damage if their concentrations are sufficiently high.

Some of the harmful effects of Photochemical Smog are given below.

- Both ozone and PAN act as powerful eye irritants.
- Ozone and nitric oxide irritate the nose and throat and their high concentration causes headache, chest pain, dryness of the throat, cough and difficulty in breathing.
- Photochemical smog leads to cracking of rubber and extensive damage to plant life.
- It also causes corrosion of metals, stones, building materials, rubber and painted surfaces.

Smog in India

The smog in cities in India mainly consists of Carbon monoxide and SPM having carbon monoxide concentration highest and ozone concentration lowest.

Winter Smog and Summer Smog

Smog is often categorized as being either summer smog or winter smog. Summer smog is primarily associated with the photochemical formation of ozone. During the summer season when the temperatures are warmer and there is more sunlight present, photochemical smog is the dominant type of smog formation. During the winter months when the temperatures are colder, and atmospheric inversions are common, there is an increase in coal and other fossil fuel usage to heat homes and buildings. These combustion emissions, together with the lack of pollutant dispersion under inversions, characterize winter smog formation. Winter Smog primarily consists of fine Particulate Matter (PM2.5), sulfur dioxide (SO_2), and, to a lesser extent, nitrogen dioxide (NO_x).

1. Which of the following play a role during formation of photochemical smog? **(UGC NET 24th Mar 2023 Mornin**

A. NO_2 (Nitrogen dioxide)
B. Black Carbon
C. Sunlight
D. VOCs (Volatile Organic Compounds)
E. CO (Carbon monoxide)

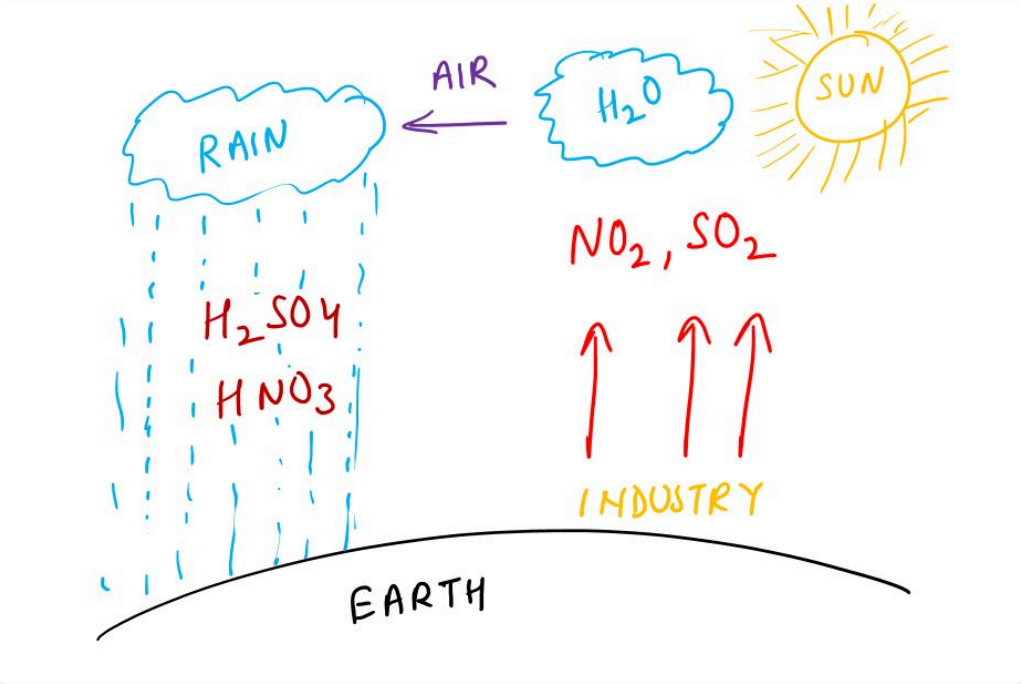
- A, C and D only
- A, D and E only
- A, B and C only
- B, C, D and E only

Check

Question: 1 of 3 questions

5. Acid Rain

Acid Rain occurs when rainwater has a pH value lower than 5.6, primarily due to the presence of pollutants like sulfur dioxide (SO_2). Other air pollutants, such as nitric oxide (NO) and nitrogen dioxide (NO_2), also contribute to the acidity of rainwater. These gases react with the water vapour present in the atmosphere to form Sulphuric acid and Nitric acid. The acids drop down with rain, making the rain acidic.



Acid rain is a byproduct of a variety of human activities that emit the oxides of sulphur and nitrogen in the atmosphere. Burning of fossil fuels (which contain sulphur and nitrogenous matter) such as coal and oil in power stations and furnaces or petrol and diesel in motor engines produce sulphur dioxide and nitrogen oxides. SO_2 and NO_2 after oxidation and reaction with water are major contributors to acid rain, because polluted air usually contains particulate matter that catalyse the oxidation.

Acid Rain effects on Taj Mahal

The Taj Mahal is particularly vulnerable to the harmful impacts of sulfur dioxide, which can accelerate its deterioration. Acid rain has corroded the marble of the Taj Mahal. This phenomenon is also called as “Marble cancer”. Additionally, suspended particulate matter, such as the soot particles, has contributed towards yellowing of the marble.

Mitigation of Acid Rain

A great way to reduce acid rain is to produce energy without using fossil fuels. Instead, people can use renewable energy sources, such as solar and wind power. Renewable energy sources help reduce acid rain because they produce much less pollution. These energy sources can be used to power machinery and produce electricity.

Some of the other key strategies for mitigating acid rain are discussed below:

- *Emissions Reduction:* For Sulfur Dioxide (SO_2), implementing technologies that reduce SO_2 emissions from industrial facilities and power plants is a primary approach. This can involve using low-sulfur fuels, installing scrubbers, and improving combustion processes to minimize SO_2 release. For Nitrogen Oxides (NO_x), reducing NO_x emissions from sources like vehicles and power plants is crucial. This can be achieved through the use of catalytic converters in automobiles and the adoption of Selective Catalytic Reduction (SCR) and Selective Non-Catalytic Reduction (SNCR) technologies in power plants.
- *Air Quality Regulations:* Implement and enforce strict air quality regulations and emission standards. These standards can set limits on the amount of sulfur and nitrogen compounds that industrial facilities and vehicles are allowed to release into the atmosphere.
- *Cap-and-Trade Programs:* Cap-and-trade programs can be effective in controlling emissions. They establish a cap on total emissions and allow companies to buy and sell emission allowances, providing an economic incentive to reduce pollution.
- *Catalytic Converters:* The use of catalytic converters in automobiles helps reduce nitrogen oxide emissions, contributing to lower NOx levels in the atmosphere.

- *Public Awareness and Education:* Educating the public about the causes and consequences of acid rain is essential. This can lead to more responsible energy consumption, reduced personal emissions, and support for policies aimed at reducing acid rain.
- *International Cooperation:* Agreements like the Convention on Long-Range Transboundary Air Pollution in Europe have been successful in reducing transboundary pollution.

1. Which one of the following pollutants is responsible for acid rain formation? **(UGC NET 23rd Mar 2023 Evening**

- CO (Carbon monoxide)
- SO_2 (Sulphur dioxide)
- $C_6 H_6$ (Benzene)
- CH_4 (Methane)

Check

Question: 1 of 3 questions

6. Diseases and health effects

Here is a list of diseases and health effects associated with air pollution:

- *Asthma:* Air pollution, particularly fine Particulate Matter (PM2.5) and ozone, can exacerbate asthma symptoms and lead to asthma attacks.
- *Dry Eye Syndrome:* Prolonged exposure to poor indoor air quality can contribute to dry eye syndrome, causing discomfort and irritation of the eyes.
- *Bronchitis:* Chronic exposure to air pollutants can increase the risk of developing bronchitis, which is characterized by inflammation of the bronchial tubes and persistent coughing.
- *Chronic Obstructive Pulmonary Diseases (COPD):* Long-term exposure to air pollution, especially fine particles, can worsen existing COPD conditions and contribute to the development of COPD in susceptible individuals.
- *Sick Building Syndrome (SBS):* SBS is associated with poor indoor air quality and can lead to a range of symptoms, including headaches, fatigue, respiratory problems, and irritation of the eyes, nose, and throat.
- *Wheezing:* Nitrogen dioxide (NO_2) exposure can lead to wheezing, which is a whistling sound produced during breathing and is a common symptom of respiratory distress.
- *Eye Irritation:* Surface ozone and other pollutants can irritate the eyes and respiratory tract of individuals exposed to polluted air.

Pollutant-specific Diseases

Specific air pollutants are associated with various diseases, and their effects on human health depend on the type and concentration of the pollutant, as well as the duration of exposure. Given below are some common air pollutants are their linked-specific diseases:

- *Carbon Monoxide:* It is known to be an asphyxiant and can lead to carbon monoxide poisoning, especially in enclosed spaces with poor ventilation. Carbon monoxide (CO) has a very strong affinity towards hemoglobin (Hb) in blood. Carbon monoxide pollution may cause loss of consciousness or death in the exposed individual. However in case of death, for such an event to occur, the likely minimum percentage saturation level of carboxyhemoglobin in the human blood would be approximately 60%.
- *Volatile Organic Compounds (VOCs):* These can include a variety of chemicals, some of which are known to be carcinogenic and can contribute to the development of cancer over prolonged exposures.
- *Ozone:* Ozone, while known to irritate the respiratory tract and worsen allergies in sensitive individuals, can also have a notable impact on eye irritation.
- *Asbestos Fibre:* Though not an air pollutant, asbestos fibers are known to be carcinogenic when inhaled and can lead to diseases such as mesothelioma.
- *Nitrogen Dioxide (NO_2):* Inhalation of NO_2 can lead to respiratory irritation, exacerbate conditions like asthma, and increase the risk of respiratory infections. Prolonged exposure may hinder lung development in children and is associated with cardiovascular issues. In areas with high levels of NO_2, there is an increased risk of premature mortality, particularly for vulnerable populations.
- *Particulate Matter (PM):* Fine particulate matter (PM2.5) and coarse particulate matter (PM10) are tiny solid or liquid particles suspended in the air. These particles can be inhaled deep into the respiratory system. Long-term exposure to PM2.5 is associated with respiratory conditions like bronchitis, aggravated asthma, and decreased lung function. It is also linked to cardiovascular diseases, including heart attacks and strokes.

1. Sick Building Syndrome (SBS) is associated with **(UGC NET 13th Mar 2023 Evening Shift)**

- ○ E-waste
- ○ Outdoor Air Quality
- ○ Indoor Air Quality
- ○ Water Quality

Check

Question: 1 of 3 questions

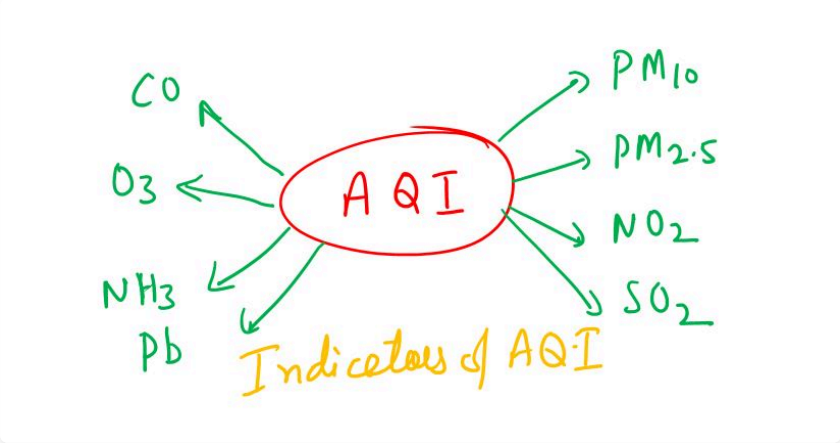
7. Air Quality Index

The Air Quality Index (AQI) is a standardized way of measuring and comparing the quality of air in different locations and at different times. It provides a numerical value that represents the overall air quality, taking into account various pollutants that can harm human health and the environment. In India, the AQI system was implemented to monitor and manage air quality.

India introduced the AQI system in 2014 under the National Air Quality Index (NAQI) initiative of 'Swachh Bharat Abhiyan'. It was launched by the Central Pollution Control Board (CPCB) in collaboration with the Ministry of Environment, Forests and Climate Change (MoEF&CC). IIT Kanpur was actively involved in the development of the National Air Quality Index (NAQI) for India.

Indian National Ambient Air Quality Standards

Indian National Ambient Air Quality standards, set in 2009, stipulate the maximum permissible limit of annual mean concentration as well as 24-hour mean. These are set by the Central Pollution Control Board. The CPCB has been conferred this power by the Air (Prevention and Control of Pollution) Act, 1981.



There are 6 AQI categories, namely Good, Satisfactory, Moderately polluted, Poor, Very Poor, and Severe. The AQI considers 8 pollutants, these are - PM10, PM2.5, NO_2, SO_2, CO, O_3, NH_3, and Pb. For this short-term (up to 24-hourly averaging period) National Ambient Air Quality Standards are prescribed.

AQI	Category	Health Impact
0-50	Good	Minimal impact
51-100	Satisfactory	Sensitive people might experience minor breathing discomfort
101-200	Moderately Polluted	Discomfort in breathing and risk of heart diseases
201-300	Poor	Breathing discomfort on prolonged exposure
301-400	Very poor	Might lead to serious respiratory disorders
401-500	Severe	Severe health impact

1. Which of the following pollutants is included in the Air Quality Index in India? **(UGC NET 25th June 2020 Morn**

- ○ Chlorofluoro carbons
- ○ Methane
- ○ Sulphur dioxide
- ○ Carbon Dioxide

Check

Question: 1 of 3 questions

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1. Introduction

Water Pollution is the contamination of water bodies, such as rivers, lakes, oceans, and groundwater, by substances that negatively affect the quality of the water and make it harmful to the environment and human health. This pollution can occur through various means, including natural processes, but it is primarily driven by human activities.

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2. Types of Water Pollution

Types of Water Pollution are discussed below.

1. Groundwater Pollution: Contamination of underground water sources, often caused by the percolation of pollutants from the surface. Leaking underground storage tanks, seepage from landfills, and agricultural runoff can contaminate groundwater with chemicals and toxins such as nitrates.

2. *Surface Water Pollution:* Contamination of water bodies like rivers, lakes, and oceans due to various pollutants. Discharge of industrial effluents, sewage, and agricultural runoff into rivers and lakes can lead to surface water pollution.

5. *Microbiological Pollution:* Presence of disease-causing microorganisms like bacteria, viruses, and parasites in water. Contaminated sewage discharges into water bodies can introduce harmful pathogens, leading to waterborne diseases.

6. *Chemical Water Pollution:* Contamination of water with various chemicals, including heavy metals, pesticides, and industrial compounds. Runoff from agricultural fields carrying pesticides and herbicides can result in chemical water pollution.

7. *Thermal Pollution:* Increase in water temperature, often from industrial processes, affecting aquatic ecosystems. Discharging warm water from power plants into rivers can harm fish and other aquatic organisms sensitive to temperature changes.

8. *Oxygen-Depletion Pollution:* Reduction of dissolved oxygen in water, often caused by excessive organic matter decomposition. Nutrient pollution from sewage and agricultural runoff can lead to oxygen depletion, causing "dead zones" in bodies of water.

Other notable forms of water pollution (cause-related) are mentioned below.

- *Suspended Matter:* Presence of solid particles, such as silt and sediment, suspended in water, leading to reduced water clarity. Construction site runoff can introduce sediment into rivers, clouding the water and harming aquatic habitats.
- *Oil Spillages:* Accidental or deliberate release of oil into water bodies, causing harm to the environment and aquatic life. Oil spills from tanker accidents or offshore drilling can have devastating effects on marine ecosystems.

1. Thermal Pollution **(UGC NET 13th Mar 2023 Morning Shift)**

- ○ is a pollution of hot springs
- ○ is a pollution of air.
- ○ is increase of temperature in urban environment in comparison to surrounding suburban environment.
- ○ is a pollution of water body

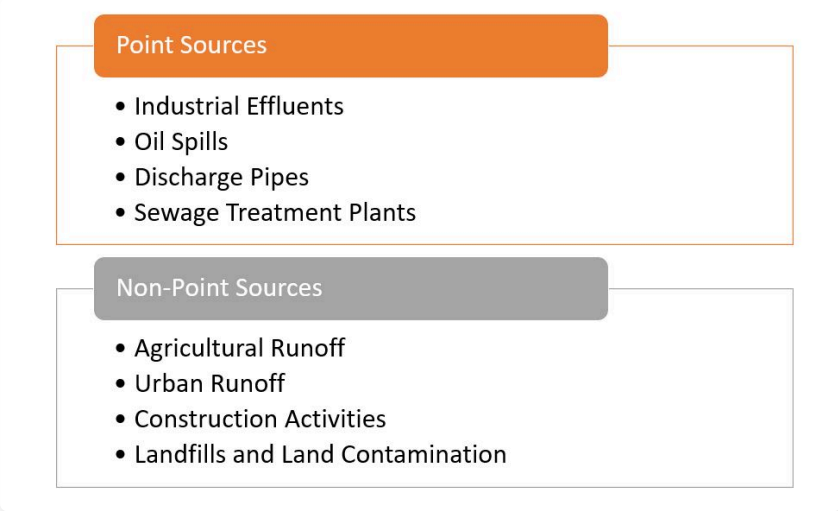
Check

Question: 1 of 2 questions

3. Sources and Prevention of Water Pollution

Sources of Water Pollution

Sources of water pollution can be divided into 2 types based on the discharge points into the water bodies.



1. Point Sources

These are specific, identifiable locations or discharges where pollutants enter a water body. Examples include:

- *Industrial Effluents*: Wastewater discharged from factories and manufacturing facilities, which may contain chemicals, heavy metals, and other contaminants.
- *Municipal Wastewater Treatment Plants*: Effluents from sewage treatment facilities, which may contain organic matter, nutrients, and pathogens.
- *Oil Spills*: Accidental or deliberate releases of oil into water bodies from ships, pipelines, or other sources.
- *Discharge Pipes*: Direct discharges of pollutants from pipes or outlets, such as those from power plants, refineries, or mining operations.

Note

The largest source of water pollution in India is untreated sewage.

2. Non-Point Sources

These are diffuse sources of pollution that are not confined to specific discharge points. Instead, they result from runoff or seepage from various land-based activities and can be challenging to trace back to a single source. These sources are often episodic, occurring during rain events or snowmelt. Examples include:

- *Agricultural Runoff*: Pesticides, herbicides, fertilizers, and animal waste can be carried into water bodies by rainwater runoff.
- *Urban Runoff*: This happens in cities and towns. Pollutants like oil, heavy metals, and litter can be washed into storm drains and eventually reach water bodies during rainfall events.
- *Construction Activities*: Sediments, cement, and other construction-related pollutants can be transported into water bodies during construction projects.
- *Landfills and Land Contamination*: Leachate from landfills or contaminated sites can percolate into groundwater and surface water.

Measures to Prevent Water Pollution

Preventing water pollution is crucial for safeguarding the environment, human health, and the availability of clean water resources. Some of the measures and strategies to help prevent water pollution:

- *Reduce Chemical Use:* Minimize the use of pesticides, herbicides, and fertilizers in agriculture and landscaping. Choose non-toxic alternatives or adopt organic farming practices.
- *Proper Waste Disposal:* Dispose of household hazardous waste, such as chemicals, paints, and batteries, at designated collection centers rather than throwing them in the trash or down the drain.
- *Sustainable Agriculture:* Implement farming practices that reduce runoff and soil erosion, such as no-till farming, crop rotation, and the use of cover crops.

- *Efficient Water Use:* Employ water-efficient technologies and practices in agriculture and industry to reduce the volume of water needed for production.
- *Wastewater Treatment:* Upgrade and maintain wastewater treatment facilities to ensure they adequately treat sewage and industrial effluents before releasing them into water bodies.
- *Stormwater Management:* Develop and implement effective stormwater management systems to capture and treat runoff from roads, parking lots, and urban areas.
- *Erosion Control:* Implement erosion control measures, such as vegetative buffers and silt fences, to prevent soil erosion and sediment runoff into water bodies.
- *Industrial Best Practices:* Industries should adopt clean production processes and technologies to minimize pollution. Properly store and dispose of hazardous materials.
- *Oil Spill Prevention:* Strictly enforce regulations for oil storage and transportation to prevent spills. Install containment systems and use best practices for spill response.
- *Reducing Plastic Pollution:* Minimize plastic waste by using reusable items, recycling, and supporting policies that reduce single-use plastics.
- *Protect Wetlands and Riparian Zones:* Preserve and restore wetlands and riparian areas, which act as natural filters and buffers, helping to absorb pollutants before they reach water bodies.
- *Community Education:* Raise awareness about water pollution and the importance of responsible water use through educational programs and campaigns.
- *Regulations and Enforcement:* Enforce environmental regulations and laws to hold polluters accountable and deter harmful practices.
- *International Cooperation:* Collaborate with neighboring countries on transboundary water issues and agreements to address pollution in shared water bodies.
- *Green Infrastructure:* Invest in green infrastructure solutions, such as vegetated swales and green roofs, to absorb and filter stormwater.

Note

The Government of India has passed the Water (Prevention and Control of Pollution) Act, 1974 to safeguard our water resources. The largest source of water pollution in India is untreated sewage. Also, the Water (Prevention and Control of Pollution) Cess Act was enacted in 1977, to provide for the levy and collection of a cess on water consumed by persons operating and carrying on certain types of industrial activities. This cess is collected with a view to augment the resources of the Central Board and the State Boards for the prevention and control of water pollution constituted under the Water (Prevention and Control of Pollution) Act, 1974.

1. Given below are two statements: **(UGC NET 21st Mar 2023 Morning Shift)**

Statement I: It is relatively easier to monitor and regulate water pollution caused by nonpoint sources than point s

Statement II: Nonpoint sources of water pollution may be fairly uniform and predictable throughout the year.

- ○ Both statement I and Statement II are true
- ○ Statement I is false but Statement II is true
- ○ Statement I is true but Statement II is false
- ○ Both Statement I and Statement II are false

Check

Question: 1 of 3 questions

4. Water Pollutants and its Types

Water Pollutants are substances or agents that contaminate water, making it impure, unsafe, or unsuitable for its intended use. Water pollutants can include various types of chemicals, biological contaminants, and physical impurities, based on their source and characteristics.

Some of the common types of water pollutants are given below:

Pollutant	Source
Micro-organisms	Domestic sewage
Organic wastes	Domestic sewage, animal excreta and waste, decaying animals and plants, discharge from food processing factories.
Plant nutrients	Chemcial fertilizers
Toxic heavy metals	Industries and chemical factories
Sediments	Erosion of soil by agriculture and strip mining
Pesticides	Chemicals used for killing insects, fungi and weeds
Radioactive substances	Mining of uranium containing minerals
Thermal	Water used for cooling in industries

1. Chemical Pollutants

It can be either because of inorganic or organic substances as well as presence of excessive nutrients.

- *Inorganic Pollutants:* These include heavy metals (e.g., lead, mercury, cadmium, arsenic), acids, and salts that can originate from industrial discharges and mining activities.
- *Organic Pollutants:* Such as pesticides, herbicides, and industrial chemicals like solvents and petrochemicals. They often come from agricultural runoff and industrial processes.
- *Nutrients:* Excessive nutrients like nitrogen and phosphorus from agricultural and sewage discharges can lead to water eutrophication, promoting algal blooms and oxygen depletion.

2. Biological Pollutants

Pathogens such as bacteria, viruses, and parasites from sewage and animal waste can cause waterborne diseases, such as cholera and hepatitis as well accelerated eutrophication.

3. Suspended Solids

Particulate Matter, silt, sediment, and soil eroded from construction sites and agricultural lands, leading to turbid water and habitat degradation.

4. Thermal Pollutants

Elevated water temperature from industrial discharges or power plant cooling water can harm aquatic ecosystems and reduce dissolved oxygen levels.

5. Radioactive Substances

Radioactive isotopes, such as radium and uranium, can enter water bodies from natural deposits or nuclear facilities, posing health risks.

6. Oil and Grease

Hydrocarbons from oil spills, urban runoff, and industrial discharges can form surface films, impacting aquatic life and water quality.

7. Toxic Substances

Hazardous chemicals like PCBs (polychlorinated biphenyls), dioxins, and heavy metals, which can accumulate in organisms and cause harm to the environment and human health.

8. Trash and Debris

Solid waste, including plastics, bottles, and other litter, can degrade water quality and harm aquatic life through entanglement and ingestion.

9. Acid Rain

Rainfall with acidic pH levels due to air pollution emissions, which can lower the pH of water bodies, harming aquatic life.

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5. Water Quality Indicators

Water Quality Indicators are specific characteristics or parameters used to assess the condition of water and to determine the suitability of water for various uses, including drinking, recreation, and supporting aquatic ecosystems. These indicators are measurable and help to gauge the presence of pollutants or the overall health of a water body.

Common water quality indicators are discussed below.

1. Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) in water are some organic and inorganic materials, which include minerals and ions that are dissolved in a particular quantity in water. When water passes through stones, pipes, or different surfaces, the particles are absorbed into the water. TDS in water can come from different sources such as minerals in chemicals used for treating water, runoff from the road salts, and chemicals or fertilizers from the farms. Calcium, Magnesium, Sodium, and Potassium cations, as well as Carbonate, Hydrogen Carbonate, Chloride, Sulfate, and Nitrate anions, are commonly the most prominent constituents.

Note

TDS is typically expressed in milligrams per liter (mg/L) or parts per million (ppm). Bureau of Indian Standards (BIS), recommends the TDS upper limit as 500 ppm.

2. Total Coliform Bacteria

The most basic test for bacterial contamination of a water supply is the test for total coliform bacteria. Coliform bacterial are commonly found in the intestines of warm-blooded animals, including humans. The presence of coliforms in water indicates faecal contamination, which can potentially include harmful pathogens. Total coliform counts give a general indication of the sanitary condition of a water supply.

3. Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD)

Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) are important water quality parameters that are used to assess the oxygen content and overall quality of water bodies, particularly in terms of their suitability for aquatic life and the health of ecosystems.

(i) Dissolved Oxygen

Dissolved Oxygen (DO) is a measure of the concentration of oxygen dissolved in water. It is crucial for the survival of aquatic organisms, including fish, insects, and microorganisms as they rely on dissolved oxygen for respiration. When DO levels drop below certain thresholds, it can lead to hypoxia or even anoxia, which can harm or kill aquatic life. The actual amount of dissolved oxygen (in mg/L) will vary depending on temperature, pressure, and salinity.

The amount of dissolved oxygen in water can vary based on different factors:

- *Effect of Temperature*: As water temperature increases, the solubility of oxygen in water decreases. In other words, warmer water is less capable of holding as much dissolved oxygen compared to colder water.
- *Effect of Salinity* (Salt Levels): The amount of dissolved oxygen in water is also affected by its salt content, or salinity. In general, as the salt levels in water increase, the amount of dissolved oxygen decreases.
- *Effect of Pressure*: An increase in pressure can lead to an increase in the amount of dissolved oxygen. The higher pressure at greater depths allows water to hold more dissolved gases, including oxygen.

(ii) Biochemical Oxygen Demand (BOD)

Biochemical Oxygen Demand (BOD) is a measure of the amount of dissolved oxygen consumed by microorganisms in the water as they decompose organic matter (e.g., sewage, organic pollutants). It provides an indication of the level of organic pollution in water. Higher BOD values indicate higher levels of organic pollution. BOD is typically measured over a specific period, such as 5 days (BOD5), and is expressed in milligrams of oxygen per liter (mg/L) or parts per million (ppm).

(iii) Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) is a measure of the amount of oxygen required to chemically oxidize both organic and inorganic substances in water. It provides a broader assessment of water quality than BOD because it includes the oxygen demand of both biodegradable and non-biodegradable substances. COD is often used when wastewater contains chemicals or

pollutants that may not be easily biodegradable. COD is typically measured in milligrams of oxygen per liter (mg/L) or parts per million (ppm).

4. Nitrates

Nitrogen provides the essential nutrients for all living organisms. However, large nitrate concentrations, often due to the flow of human and animal waste, industrial pollutants, and agricultural activity, can increase algae growth and reduce the amount of dissolved oxygen in the water, killing fish and other aquatic life.

5. Bioindicators

Bioindicators are organisms used to monitor the health of an ecosystem, for example, the quantity of microalgae present in water. They are organic and natural indicators of environmental pollution – living organisms such as plants, plankton, animals, and microbes – providing valuable information for assessing the quality of water as well as an important indicator of water pollution.

6. pH scale

pH illustrates how acidic or basic a body of water is according to a logarithmic scale, a measurement of alkalinity. The value for pH is expressed on a scale ranging from 0 to 14. Low numbers indicate the degree of acidity in the water; higher numbers how basic water is. A score of 7 is neutral. These levels affect the chemical reactions in water and the availability of nutrients for aquatic life.

7. Turbidity

Turbidity is a measure of how clean water is and its clarity. The measurement of turbidity levels depends upon the concentration of Total Suspended Solids (TSS). TSS are particles larger than 2 microns found in water, such as gravel, sand, silt, clay, and algae. When organic matter decays – for example from animals, plants, and algae – this becomes a suspended solid. Suspended sediments can also contain high amounts of pollutants including phosphorus, pesticides, or heavy metals. Lighter solids will settle at the bottom of a body of water; if there are a lot of solids present, the surface water becomes cloudy or less clear.

8. Trophic State Index (TSI)

The Trophic State Index (TSI) is a classification system designed to rate water bodies based on the amount of biological activity they sustain. The TSI of a body of water is rated on a scale from 0 to 100. Under the TSI scale, bodies of water may be defined as:

- *Oligotrophic*, (TSI 0–40), having the least amount of biological productivity, "good" water quality;
- *Mesoeutrophic*, (TSI 40–60), having a moderate level of biological activity, "fair" water quality; or
- *Eutrophic* to *Hypereutrophic*, (TSI 60–100), having the highest amount of biological activity, "poor" water quality.

The quantities of nitrogen, phosphorus, and other biologically useful nutrients are the primary determinants of a body of water's TSI.

International Standards of Drinking Water is given below.

Substance	Maximum Concentration
Fluoride	10 ppm
Lead (Pb)	50 ppb
Sulphate	500 ppm
Nitrate	50 ppm
Fe, Al	0.2 ppm
Mn	0.05 ppm
Cu	3 ppm
Zn	5 ppm
Cd	0.005 ppm

1. BOD (Biochemical Oxygen Demand) is the measure of: **(UGC NET 13th Mar 2023 Evening Shift)**

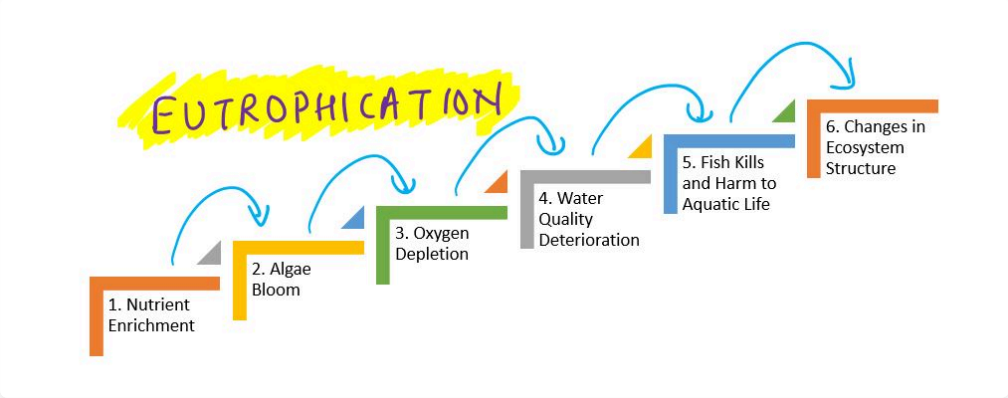
- soil contamination
- water contamination
- air pollution
- dissolved oxygen of river water

Check

Question: 1 of 4 questions

6. Eutrophication

Eutrophication is a natural process that occurs when a body of water, such as a lake or pond, becomes overly enriched with nutrients, primarily nitrogen and phosphorus. This enrichment of nutrients can result from both natural processes and human activities.



The phenomena of Eutrophication is described below.

1. *Nutrient Enrichment:* Eutrophication begins with the introduction of excess nutrients into the water. These nutrients often come from various sources, including agricultural runoff, sewage discharges, industrial activities, and atmospheric deposition. Fertilizers used in agriculture are a common source of nutrients, as they contain high levels of nitrogen and phosphorus.

2. *Algae Bloom:* Once the nutrients enter the water, they stimulate the growth of aquatic plants, particularly algae. Algae are tiny, plant-like organisms that thrive on nutrients and sunlight. When nutrients are abundant, algae populations can explode, leading to what is known as an "algal bloom." These blooms can turn the water green, brown, or red, depending on the types of algae involved.

3. *Oxygen Depletion:* As algae proliferate, they eventually die and sink to the bottom of the water body. Bacterial decomposition of dead algae consumes oxygen from the water. When the decomposition process consumes oxygen at a rapid rate, it depletes the dissolved oxygen levels in the water. Low oxygen levels can harm aquatic life, including fish, which may struggle to survive in oxygen-deprived water.

4. *Water Quality Deterioration:* Eutrophication leads to a decline in water quality as a result of the algal blooms, reduced oxygen levels, and the accumulation of organic matter on the water bottom. This can result in the water becoming murky, malodorous, and aesthetically unpleasing.

5. *Fish Kills and Harm to Aquatic Life:* The depletion of oxygen and the release of toxins by some types of algae can cause fish kills and harm other aquatic organisms. Fish and other animals that rely on dissolved oxygen in the water may die due to a lack of oxygen.

6. *Changes in Ecosystem Structure:* Over time, eutrophication can disrupt the natural balance of an aquatic ecosystem. Some species of algae, such as harmful cyanobacteria, may thrive, while others may decline. This can impact the entire food web, leading to shifts in species composition and abundance.

Efforts to mitigate eutrophication often involve reducing nutrient inputs through better agricultural practices, wastewater treatment, and regulatory measures. Monitoring and management of water bodies are essential to prevent or mitigate the adverse effects of eutrophication and maintain healthy aquatic ecosystems.

1. Eutrophication in a water body leads to which of the following? **(UGC NET 1st Dec 2021- Evening shift)**

A. Bloom of algae
B. Increase in the level of dissolved oxygen (DO)
C. Increase in turbidity and odor of the water body
D. Difficulty in sustaining normal aquatic life
E. Deficiency of nutrients

- C, D and E only
- B, C and D only
- A, B and C only
- A, C and D only

Check

Question: 1 of 2 questions

7. Water Borne Diseases

Water-borne diseases, also known as waterborne diseases, are illnesses caused by microorganisms (such as bacteria, viruses, and other pathogens) that are transmitted through contaminated water. These pathogens can enter the human body when people consume or come into contact with water that is contaminated with fecal matter, urine, or other sources of these microorganisms.

Common examples of waterborne diseases include:

1. Bacterial Waterborne Diseases

- *Cholera:* Caused by the bacterium Vibrio cholerae, cholera leads to severe diarrhea and dehydration, and it can be life-threatening if not treated promptly.
- *Typhoid fever:* This disease is caused by the bacterium Salmonella Typhi and is characterized by high fever, abdominal pain, and gastrointestinal symptoms.
- *Dysentery:* Dysentery can be caused by various pathogens, including Shigella species and Entamoeba histolytica. It leads to severe diarrhea with blood and mucus.
- *Coli infection:* Certain strains of Escherichia coli (E. coli) can cause gastrointestinal illness when consumed in contaminated water.

2. Protozoal Waterborne Diseases

- *Giardiasis:* Giardia lamblia is a protozoan parasite that causes giardiasis, leading to symptoms like diarrhea, abdominal cramps, and weight loss.
- *Amoebiasis:* Entamoeba histolytica is a protozoan parasite responsible for causing amoebiasis. This disease can lead to gastrointestinal symptoms, including diarrhea and abdominal pain. In severe cases, amoebiasis can result in the formation of abscesses in the liver and other complications.

3. Viral Waterborne Diseases

- *Hepatitis A:* The hepatitis A virus primarily spreads through contaminated water and food, leading to liver inflammation and related symptoms.
- *Rotavirus and norovirus:* These viruses can cause gastroenteritis with symptoms like diarrhea and vomiting, often in outbreaks in settings like cruise ships or crowded areas.

4. Helminthic (Parasitic Worm) Waterborne Disease

- *Schistosomiasis:* This disease is caused by parasitic flatworms of the Schistosoma species. It is commonly found in tropical and subtropical regions and cause various symptoms and long-term health issues, including damage to the liver, intestines, and urinary system.
- *Cryptosporidiosis:* Cryptosporidium parasites cause this disease, which results in diarrhea, stomach cramps, and vomiting.

5. Other Waterborne Diseases

- *Malaria*: Although malaria is primarily transmitted through mosquito bites, it can indirectly be associated with water bodies, as mosquitoes breed in stagnant water. It's not transmitted through water itself.
- *Methemoglobinemia:* It also known as *blue baby syndrome*: It is a condition that can result from consuming drinking water with high nitrate levels. It is characterized by a bluish discoloration of the skin and can be dangerous for infants.

1. Algal blooms in oligotrophic lakes are **(UGC NET 24th June 2019 Morning Paper)**

- widespread
- very frequent
- frequent
- very rare

Check

Question: 1 of 3 questions

8. Thermal Pollution

Thermal Pollution is a type of environmental pollution that occurs when there is a significant alteration in the natural temperature of a water body, such as a river, lake, or ocean, due to human activities. This alteration can have detrimental effects on aquatic ecosystems and the organisms that depend on them.

Causes of Thermal Pollution

Given below are some of the causes of Thermal Pollution:

- *Industrial Discharges:* Industries often use water for cooling processes and then release heated water back into rivers or lakes. This discharge can significantly raise the temperature of the receiving water body.
- *Power Plants:* Many power plants, especially those using fossil fuels or nuclear energy, rely on water for cooling purposes. The warm water is discharged into nearby rivers or lakes, leading to thermal pollution.
- *Deforestation and Urbanization:* The removal of vegetation and the increased construction of urban areas can reduce shade and increase runoff, which raises water temperatures in local water bodies.
- *Agricultural Practices:* Inefficient or excessive water use in agriculture, along with changes in land use patterns, can lead to increased water temperatures in rivers and streams.

Prevention of Thermal Pollution

Given below are some of the preventive measures:

- *Improved Cooling Technologies:* Industries and power plants can invest in more efficient cooling technologies that reduce the amount of heat transferred to water.
- *Regulatory Measures:* Government regulations and policies can set limits on the temperature of water discharges from industrial and power plant facilities. These regulations can encourage the adoption of more responsible cooling methods.
- *Eco-Friendly Urban Planning:* Urban planners can prioritize green spaces and vegetation in cities, helping to mitigate the urban heat island effect and reduce runoff that contributes to thermal pollution.
- *Conservation and Reforestation:* Protecting and restoring natural riparian areas along water bodies can help maintain cooler water temperatures. Reforestation efforts can reduce the amount of heat reaching the water.
- *Water Reuse and Recycling:* Industries and power plants can explore water reuse and recycling techniques to minimize their dependence on freshwater for cooling. This can reduce the need for large water withdrawals.
- *Public Awareness and Education:* Educating the public and industries about the impacts of thermal pollution and the importance of responsible water use can help drive behavioral changes and support prevention efforts.

1. Given below are two statements: **(UGC NET 24th Mar 2023 Morning Shift)**

Assertion-A: Rise in water temperature from normal levels, due to thermal pollution, can adversely affect water qu aquatic life.

Reason-R: Oxygen solubility in water increases as temperature increases.

- ○ A is not correct but R is correct.
- ○ Both A and R are correct and R is the correct explanation of A.
- ○ Both A and R are correct but R is NOT the correct explanation of A.
- ○ A is correct but R is not correct.

Check

Question: 1 of 2 questions

9. Arsenic Pollution

Arsenic is a naturally occurring element that can be found in the Earth's crust and is released into groundwater through geological processes. When the concentration of arsenic in groundwater exceeds safe levels, it can pose serious health risks to those who consume contaminated water.

Arsenic can cause various health disorders in humans such as:

- Respiratory distress, cardiac problems, gastrointestinal effects,anaemia and leucopenia.
- Skin disorders leading to hyperkeratosis, warts or corns on the palms and soles and areas of hyperpigmentation interspersed with small areas of hypopigmentation in the face, neck and back.
- Ingestion of inorganic arsenic can result in neural injury, skin cancer and lung cancer when exposure occurs through inhalation.

Standards

As per BIS Standards (IS 10500: 2012) the maximum permissible limit of Arsenic in drinking water is 0.01 mg/l (ppm) or 10 µg/L(ppb). Also as per WHO, the current recommended limit of arsenic in drinking-water is 10 µg/L.

Take note

8-9 districts in West Bengal and 40-42 districts in Bangladesh have arsenic levels in groundwater above the World Health Organization maximum permissible limit.

1. Arsenic pollution in ground water is due to **(UGC NET 14th Oct 2022 Morning shift)**

- ○ Sulphates of arsenic
- ○ Acids of arsenic
- ○ Nitrates of arsenic
- ○ Oxides of arsenic

Check

Question: 1 of 2 questions

10. Biomagnification

Biomagnification, also known as bioamplification or biological magnification, is a process in which the concentration of certain substances, particularly toxic chemicals, increases progressively along the food chain. This phenomenon occurs because the substances cannot be metabolized or excreted by organisms and accumulate in their tissues instead.

The phenomena of biomagnification is explain below.

- *Pollutants or Substances:* It starts with the introduction of certain pollutants or substances into an ecosystem. These substances can include pesticides, heavy metals (e.g., mercury, lead), industrial chemicals, and other environmental contaminants.
- *Uptake by Primary Producers:* Primary producers, such as algae and aquatic plants, absorb these substances from the surrounding environment. These organisms are typically at the lowest trophic level.
- *Ingestion by Herbivores:* Herbivores, which feed on primary producers, consume these contaminated plants or algae. They, in turn, accumulate some of the pollutants in their bodies.
- *Predation and Accumulation:* Predators, or animals that eat herbivores, ingest the pollutants along with their prey. As predators consume multiple prey items over time, the concentration of pollutants in their bodies continues to increase.
- *Higher Trophic Levels:* This process continues up the food chain, with each trophic level accumulating higher concentrations of the pollutants. Apex predators, at the top of the food chain, can have the highest concentrations of the harmful substances.

Minamata Disease in Japan

One notable example of Biomagnification is of Minamata disaster which refers to a severe case of industrial pollution that occurred in the mid-20th century in Minamata City, Japan from bioaccumulation of methymercury in the food chain. The consumption of contaminated fish and seafood by local residents led to a widespread outbreak of mercury poisoning, which came to be known as Minamata Disease.

One of the most common examples of biomagnification is the case of the pesticide DDT (dichlorodiphenyltrichloroethane) and its impact on birds like eagles and falcons.

1. What is the correct sequence of Biomagnification due to contaminated water body? **(UGC NET 2nd Mar 2023 I Shift)**

A. Humans
B. Zooplanktons
C. Bacteria
D. Fish

- ○ C, B, D, A
- ○ A, D, B, C
- ○ A, C, D, B
- ○ B, C, D, A

Check

Question: 1 of 2 questions

1. Introduction

Noise Pollution is the presence of excessive, disruptive, or unwanted sound in the environment that can have an adverse effect on human health, well-being, and the ecosystem. It occurs when sound levels in a particular area exceed the tolerable limits and disrupt the normal acoustic environment. The sources of noise can be both natural and anthropogenic (human-made), with human-made noise being the most prevalent source.

Factors influencing Noise Pollution

The impact of noise pollution on human health is influenced by various factors, including:

- *Intensity (Volume):* The loudness of noise is a crucial factor. Even brief exposure to very loud noises can have adverse effects.
- *Duration of Exposure:* Prolonged exposure to noise, even if it isn't extremely loud, can still have detrimental effects on health.
- *Sensitivity to Noise:* Individuals vary in their sensitivity to noise, and factors such as age can influence how people react to it.
- *Pitch of the Noise:* The tone or pitch of a noise is also significant. Even when two noises have equal loudness, their pitch can make them feel different, with high-pitched sounds often being more bothersome.
  Noise Pollution (Regulation and Control) Rules, 2000

Noise Pollution (Regulation and Control) Rules, 2000 is a set of rules formulated by the Ministry of Environment, Forests & Climate Change (MoEF&CC) in India to address the issue of noise pollution in the country. These rules provide guidelines and restrictions on various sources of noise to protect public health and the environment.

Effects on Health

Noise pollution can have various adverse effects on human health, including:

- *Hearing Damage:* Prolonged exposure to loud noise can lead to hearing loss or impairment. This is common in industries with high noise levels, such as construction sites and manufacturing plants.
- *Stress and Sleep Disturbance:* Noise pollution can cause stress and disrupt sleep patterns, leading to a variety of health issues. Lack of quality sleep can result in fatigue, decreased concentration, and irritability.
- *Cardiovascular Problems:* Long-term exposure to high noise levels has been linked to an increased risk of cardiovascular problems like hypertension and heart disease.
- *Cognitive Issues:* Noise pollution can impair cognitive functions, affecting memory, attention, and problem-solving abilities.
- *Developmental Problems:* Children exposed to noise pollution can suffer from delayed speech and language development and poor school performance.
- *Tinnitus:* Chronic exposure to loud noise may result in tinnitus, a persistent ringing, hissing, or buzzing in the ears.

In other words, prolonged exposure to elevated noise levels can have significant health implications, including disruptions in speech clarity, permanent hearing impairment, elevated blood pressure (hypertension), sleep disturbances leading to insomnia, and decreased productivity at work. Noise pollution's impact extends beyond just auditory discomfort, affecting both mental and physical well-being. It underscores the importance of effective noise control measures and heightened awareness of noise-related health risks in our urban and industrial environments.

1. Identify the health effects related to Noise Pollution **(UGC NET 11th Mar 2023 Morning Shift)**

A. Speech interference
B. Hearing loss
C. Hypertension
D. Respiratory disease
E. Insomnia

- A, B, C and E only
- A, B, C and D only
- A, B, C, D and E
- A, B and E only

Check

Question: 1 of 2 questions

2. Sound and Intensity

Sound is the result of vibrations or oscillations of particles in a medium, such as air. These vibrations create pressure waves that travel through the medium, and our ears interpret them as sound.

In the context of sound, **intensity** refers to the amount of sound energy transmitted per unit of time and area. It is commonly expressed in watts per square meter (W/m^2). Intensity indicates how much sound energy is transmitted through a given area.

The measurement of sound intensity, often referred to as Loudness also, is done in decibels (dB). It is evaluated in relation to a standard sound intensity of 1 pico watt per square meter (approximately 10^{-12} W/m^2).

The formula of Sound Intensity Level is expressed as:

$L = 10 \log_{10} (I / I_0)$

Where:

- L is the sound level in decibels (dB).
- I is the sound intensity being measured.
- I_0 is the reference intensity, typically the threshold of hearing

Noise Level and Intensity Relation

The loudness of a sound wave is measured in decibels (dB) and is based on logarithms with base 10. For every 10 dB increase in intensity level, the sound intensity will increase by a factor of 10.

Let's say you have a sound with an intensity level of 30 dB. This is your reference point.

If the sound intensity level increases to 40 dB, the actual intensity of the sound has increased by a factor of 10. In other words, the sound at 40 dB is 10 times more intense than the sound at 30 dB.

Now, if the intensity level goes from 40 dB to 50 dB, the sound intensity again increases by a factor of 10. So, the sound at 50 dB is 10 times more intense than at 40 dB. Relative to the original 30 dB sound, the sound at 50 dB is 10 × 10 = 100 times more intense.

Inverse Square Law

This law states that the intensity of a sound (or any form of energy) radiating from a point source decreases with the square of the distance from that source. In other words, if you double the distance from a sound source, the intensity of the sound decreases to one-fourth of its original value. Mathematically, the law can be expressed as:

$I \propto 1/r^2$

Where:

- I is the sound intensity.
- r is the distance from the sound source.

This law helps us understand how sound propagates in three-dimensional space.

1. If the intensity of a given noise increases two-fold, the noise level in decibels (dB) increases by **(UGC NET 17tl Morning paper)**

- ~3 dB
- ~10 dB
- ~6 dB
- ~2 dB

Check

Question: 1 of 2 questions

3. Measurement of Noise Pollution

Measurement of noise pollution involves assessing and quantifying the levels of unwanted and disruptive sound in the environment. This process helps in understanding the extent of noise pollution and its potential impact on human health and the ecosystem. Various tools and methods are employed for this purpose. One of the significant way to measure noise levels is the calculation of Ln values.

L_n values

In most cases the sounds we hear are not steady noises, instead the sound pressure level fluctuates over time as well as appearing to vary in tone and magnitude. To measure this fluctuating noise we use Ln values. Ln values are statistical noise levels (sometimes called percentiles) used to assess noise levels (sound pressure levels) from fluctuating noise sources over time. Any statistical value between 0.01% and 99.99% may be calculated where 'n' is the percent exceeded noise level over a timed measurement period (T).

The commonly used values of n for the n-percent exceeded level, Ln are 1, 10, 50, and 90. These are discussed below.

1. L_{10}

It is the level exceeded for 10% of the time (e.g., 1 hour). For 10% of the time, the sound or noise has a sound pressure level above L_{10}. For the rest of the time, the sound or noise has a sound pressure level at or below L_{10}. These higher sound pressure levels are probably due to sporadic or intermittent events. L_{10} is often used to describe the noisiest periods in a noise environment. It helps identify short-term noise spikes or events that may be particularly disruptive, such as traffic noise peaks during rush hours.

2. L_{50}

L_{50} is the level exceeded for 50% of the time. It is statistically the mid-point of the noise readings. It represents the median of the fluctuating noise levels. It provides an indication of the typical or normal noise level in the environment.

3. L_{90}

It is the level exceeded for 90% of the time. For 90% of the time, the noise level is above this level. It is generally considered to be representing the background or ambient level of a noise environment. It is used to describe the quietest periods in a noise environment, helping to identify background noise levels in assessments of noise pollution and nuisance noise from industrial sources.

4. L_1

This represents the highest noise level occurring during a specified period. It gives an indication of the peak or maximum noise level reached. For instance, if you're monitoring noise in a factory, would tell you the highest noise level experienced during the observation period.

1. Noise levels at a traffic site are recorded for one hour at a sampling interval of 1 second and percentile indices L_1, L_{10}, L_{60}, L_{90} are computed from the data. The indices are then arranged in increasing order in terms of their v starting from minimum to maximum. Which of the following options represents their correct order? **(UGC NET 5th Evening Paper)**

- ○ L_{60}, L_{90}, L_{10}, L_1
- ○ L_{10}, L_{60}, L_{90}, L_1
- ○ L_1, L_{10}, L_{60}, L_{90}
- ○ L_{90}, L_{60}, L_{10}, L_1

Check

Question: 1 of 2 questions

4. Noise Level Standards

The increasing ambient noise levels in public places, stemming from various sources such as industrial activity, construction work, firecrackers, sound-producing instruments, generator sets, loudspeakers, public address systems, music systems, vehicular horns, and other mechanical devices, have adverse effects on human health and psychological well-being. To maintain ambient air quality standards regarding noise, it is essential to regulate and control noise-producing and generating sources. With this view point, in 1999, the Government of India, in exercise of its powers under the Environment (Protection) Act, 1986, formulated the Noise Pollution (Regulation and Control) Rules, 2000 to regulate and control noise sources.

As per the rules, the noise levels in any area/zone shall not exceed the ambient air quality standards in respect of noise as specified in the categories given below.

Code	Category of Area	Limits in dB(A) L_{eq}*	
		Day	Night
A	Industrial area	75	70
B	Commercial area	65	55
C	Residential area	55	45
D	Silence Zone	50	40

where:

- Day time shall mean from 6.00 a.m. to 10.00 p.m.
- Night time shall mean from 10.00 p.m. to 6.00 a.m.
- *dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.
- A "decibel" is a unit in which noise is measured.
- "A", in dB(A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.
- Leq: It is an energy mean of the noise level, over a specified period.

Silence Zone

The Rules provides that an area comprising not less than 100 metres around hospitals, educational institutions and courts are declared as silence area/zone.

1. According to Noise Pollution (Regulation and Control) Rules, 2000, the night time Noise standard prescribed fo Educational Institutions is: **(UGC NET 30th Sept 2020 Morning paper)**

- ○ 50 dB A
- ○ 40 dB A
- ○ 45 dB A
- ○ 55 dB A

Check

Question: 1 of 2 questions

1. Introduction

Soil Pollution, also known as soil contamination, is the presence of harmful substances or contaminants in the soil environment, which can degrade soil quality, disrupt ecosystems, and pose risks to human health. Soil pollution occurs when natural soil components, such as minerals, organic matter, and soil organisms, are contaminated with hazardous substances. These contaminants can be introduced into the soil from various sources and activities.

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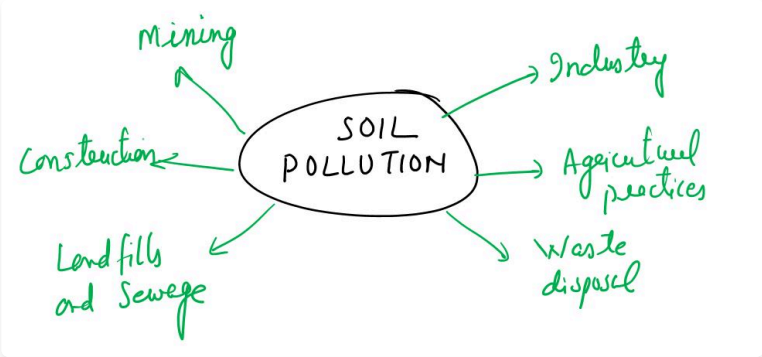
2. Sources of Soil Pollution



Major Sources of Soil Pollution are discussed below.

- *Industrial Activities:* Factories and manufacturing plants often release hazardous chemicals and pollutants into the soil. These can include heavy metals, solvents, and toxic organic compounds.
- *Agricultural Practices:* The use of chemical fertilizers, pesticides, and herbicides in agriculture can lead to soil contamination. Improper handling and disposal of agricultural chemicals can exacerbate the issue.
- *Waste Disposal:* Inadequate or improper disposal of household waste, solid waste, and hazardous waste in landfills or open dumping sites can result in the seepage of contaminants into the soil.
- *Mining Activities:* Mining operations can expose minerals and ores containing harmful substances, which can leach into the soil and nearby water bodies.
- *Construction and Urban Development:* Construction activities often involve the use of materials like concrete, which can introduce pollutants into the soil. Urbanization can also lead to soil pollution through increased waste generation and impervious surfaces.
- *Landfills and Sewage:* Improperly managed landfills and untreated sewage can contaminate the surrounding soil with a variety of pollutants.

1. Identify the sources of soil pollution from the following list: **(UGC NET 12th Nov 2020 Morning paper)**

i) Industrial effluents
ii) Eutrophication
iii) Unscientific disposal of nuclear waste
iv) Off-shore oil drilling
v) Improper management of septic systems

- ○ i, iii and v
- ○ ii, iii and iv
- ○ ii, iv and v
- ○ i, ii and iii

Check

Question: 1 of 2 questions

3. Effects of Soil Pollution

Environmental problems associated with soils are discussed below.

- *Reduced Crop Yields:* Polluted soil is often less fertile and less productive. Crop yields may decline, impacting food production and agricultural economies.
- *Nutrient Leaching:* It occurs when essential nutrients, such as nitrates and phosphates, are washed away from the soil through the percolation of water. This can happen due to excessive rainfall or over-irrigation. When these nutrients leach from the soil, they may enter groundwater or nearby surface water bodies, potentially causing groundwater pollution.
- *Groundwater Contamination:* Polluted soil can lead to the leaching of contaminants into groundwater, potentially affecting drinking water sources.
- *Ecosystem Disruption:* Soil pollution can harm soil organisms, including earthworms and beneficial microorganisms, disrupting the balance of ecosystems.
- *Crop Contamination:* Contaminated soil can lead to the uptake of pollutants by plants, potentially contaminating the food chain.
- *Human Health Risks:* Soil pollution can pose health risks to humans if they come into contact with contaminated soil or consume crops grown in polluted soil.
- *Salinity and alkalinity:* These are characterized by high levels of salt (salinity) and high pH levels (alkalinity) in the soil. These issues often occur due to natural processes but can be exacerbated by human activities, such as excessive irrigation and poor water management.

1. Environmental problems associated with soils are **(UGC NET 12th Oct 2022 Evening shift)**

A. Nutrient leaching
B. Metal contamination
C. Salinity and Alkalinity
D. Ozone depletion
E. Fine aerosols in ambient air

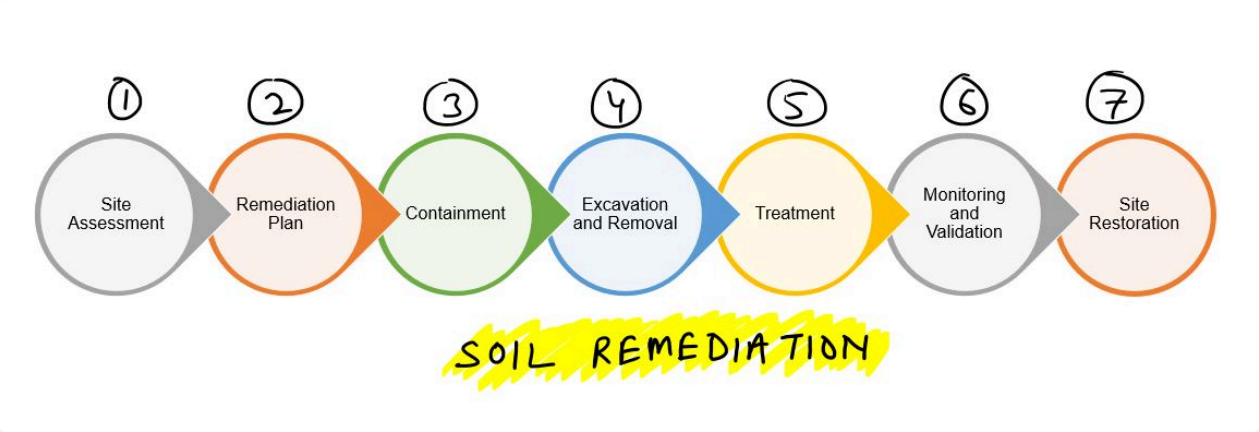
- ○ B, C, E
- ○ A, B, C, D
- ○ A, B, C, E
- ○ A, B, C

Check

Question: 1 of 1 questions

4. Soil Remediation

Soil Remediation is the process of cleaning, restoring, or improving soil quality in order to mitigate or eliminate contamination, pollution, or other undesirable factors that may affect its suitability for various uses, such as agriculture, construction, or recreation. This is crucial for environmental protection and human health, especially in areas where soil has been contaminated by industrial activities, chemical spills, or other pollutants.



Key steps involved in soil remediation:

1. **Site Assessment:** Before initiating any remediation efforts, a comprehensive site assessment is conducted to determine the extent and nature of soil contamination. This involves soil sampling, laboratory analysis, and the identification of contaminants, their sources, and potential risks to the environment and human health.

2. **Remediation Plan:** Based on the site assessment, a remediation plan is developed, outlining the objectives, methods, and technologies to be used. The plan also takes into consideration local regulations and guidelines.

3. **Containment:** In some cases, especially when immediate action is required, containment measures are employed to prevent the spread of contaminants. This may involve installing physical barriers or using chemical treatments to stabilize the contaminated area.

4. **Excavation and Removal:** For highly contaminated areas, excavating and removing the contaminated soil is a common approach. The removed soil is then treated or disposed of properly in accordance with local regulations.

5. **Treatment:** Various methods available for soil treatment are listed below:

- *Physical Treatment*: Physical methods, such as soil washing, air sparging, and soil vapor extraction, can be used to remove or separate contaminants from the soil. These methods are often used for treating soil contaminated with petroleum products, heavy metals, or volatile organic compounds.
- *Chemical Treatment*: Chemical methods include techniques like chemical oxidation, precipitation, and leaching. These methods use various chemicals to neutralize or transform contaminants into less harmful substances.
- *Biological Treatment*: Bioremediation is a biological approach that uses microorganisms like bacteria or fungi to degrade organic contaminants in the soil. It can be an effective and environmentally friendly method for treating oil spills, hydrocarbons, and other organic pollutants.
- *Phytoremediation*: Phytoremediation involves using plants to extract, absorb, and accumulate contaminants from the soil. Certain plants, known as hyperaccumulators, have the ability to absorb and concentrate metals in their tissues, making them a valuable tool in remediating metal-contaminated soils.

6. **Monitoring and Validation:** Regular monitoring of the soil and groundwater quality is essential to assess the progress of the remediation process. Validation testing ensures that the soil meets the predetermined cleanup goals and regulatory standards.

7. **Site Restoration**: Once the soil is successfully remediated, the final step involves site restoration, which may include re-vegetation, landscaping, and ensuring the site is safe for its intended use.

In Situ and Ex Situ Remediation

In situ remediation involves treating the contaminated soil at its original location without excavating or removing it.

Ex situ remediation involves physically excavating or removing contaminated soil from its original location for treatment at a separate facility.

1. Given below are two statements: **(UGC NET 8th Oct 2022- Morning shift)**

Statement I: Natural erosion of the soil is gradual removal of the top soil by natural processes.

Statement II: Accelerated erosion of the soil is caused due to manmade activities. The rate of accelerated erosion the rate of soil formation.

- ○ Statement I is true but II is false
- ○ Both Statement I and II are true
- ○ Both Statement I and II are false
- ○ Statement I is false but II is true

Check

Question: 1 of 1 questions

1. Introduction

Waste management is the process of collecting, transporting, processing, recycling, and disposing of waste materials in an environmentally responsible and efficient manner. It aims to ensure the proper handling of waste to minimize its negative impact on the environment and human health.

Key components of waste management include:

1. *Collection:* This involves the gathering of waste materials from various sources, such as households, businesses, and industrial facilities. Waste collection can be curbside pickup, drop-off centers, or scheduled collections for specific types of waste.
2. *Transportation:* After collection, waste is transported to appropriate facilities for further processing or disposal. This can involve the use of garbage trucks, transfer stations, and even rail or water transportation for long-distance movement of waste.
3. *Processing and sorting:* Waste materials are sorted and processed to separate recyclable materials from non-recyclables. This step may involve shredding, compacting, or other methods to reduce the volume of waste.
4. *Recycling:* Recyclable materials like paper, cardboard, glass, plastic, and metal are sent to recycling facilities where they are reprocessed into new products. Recycling helps conserve resources, reduce energy consumption, and decrease the environmental impact of waste.

Promoting waste reduction, recycling, and responsible disposal practices is an essential part of waste management. Public education and awareness campaigns encourage individuals and businesses to reduce waste generation and recycle properly.

The array of hazardous waste, including those with toxic, flammable, corrosive, or reactive properties, demands specialized attention to prevent potential risks. Further, the management of biomedical waste, electronic waste (e-waste), and the stringent regulations governing their handling underscores the need for comprehensive, responsible waste management strategies.

In this context, the following sections detail diverse waste management methods and the critical importance of proper management to address the impact on our ecosystems and communities.

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2. Solid Waste Management

Solid Waste Management (SWM) specifically focuses on the collection, handling, and disposal of solid waste, which includes all non-liquid, non-gaseous materials that are discarded from residential areas, institutional areas, and agriculture.

- In *Residential areas*, households generate waste through daily activities, resulting in a mix of materials.
- *Institutional areas* such as schools and offices produce waste from various sources, including paper waste, office supplies, and discarded equipment.
- *Agriculture* contributes to waste generation through crop residues, plastic packaging, and unused chemicals.

1. From the following list identify the sources of solid waste: **(UGC NET 12th Nov 2020 Morning paper)**

i) Residential areas
ii) Oceans
iii) Institutional areas
iv) Agriculture
v) Dust storms

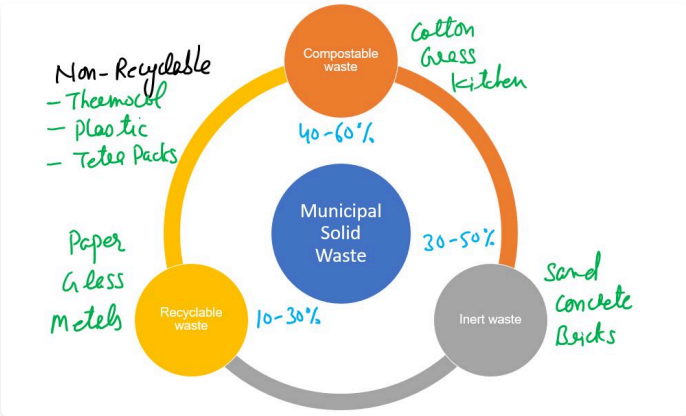
- ○ i, iii and iv
- ○ i, ii and iii
- ○ ii, iii and iv
- ○ iii, iv and v

Check

Question: 1 of 1 questions

2. Solid Waste Management

Municipal Solid Wastes are the residue or rubbish generated from household and commercial activities from municipalities. It includes a wide range of non-hazardous solid materials discarded in everyday life. It primarily encompasses garbage and rubbish.



Constituents of Municipal Solid Waste includes compostable organics, inert debris, paper, plastics, tin cans, leather, textile, glass, household hazardous and metals. However, it specifically excludes wastes generated from hospitals, industries and other electrical and electronic wastes.

Components of MSW

Municipal Solid Waste (MSW) in India has approximate 40–60% compostable, 30–50% inert waste and 10% to 30% recyclable.

- **Compostable waste**, also known as organic waste or biodegradable waste, includes materials that can naturally decompose and be turned into compost. This category primarily consists of food and kitchen waste, green waste (e.g., tree branches, grass etc.), and other organic materials like paper towels, napkins, and natural textiles (e.g., cotton).
- **Inert waste** is waste which is neither chemically nor biologically reactive and will not decompose or only very slowly. Examples include sand, concrete, metal, wood, bricks, and other building construction materials such as plaster, drywall, siding, shingles, insulation, and glass. It typically disposed of in landfills, as it doesn't readily decompose or pose significant environmental risks.
- **Recyclable waste** consists of materials that can be collected, processed, and reused to create new products. This category includes various materials, such as:
  - *Paper and cardboard:* Newspapers, magazines, cardboard boxes, and office paper.
  - *Plastics:* Plastic bottles, containers, and packaging.
  - *Glass:* Glass bottles and jars.
  - *Metals:* Aluminum and steel cans, as well as other metal objects like small appliances.

Solid Waste Management Rules 2016

In India, solid waste management is governed by the Solid Waste Management Rules 2016. It focuses on segregation of waste at source, responsibility on the manufacturer to dispose of sanitary and packaging wastes, user fees for collection, disposal and processing from the bulk generator.

Non-Recyclable waste

Among the components of municipal solid waste, certain items are **non-recyclable**. Thermocol, due to its low density and limited recycling options, poses challenges in recycling. Tetra packs, with their multilayered construction, are also difficult to recycle effectively. Proper disposal methods or alternative materials should be considered for these non-recyclable items.

Other examples of non-recyclable waste include Plastic Bags, Food-soiled papers and boxes (e.g., pizza box, used nepkins), Styrofoam (Expanded Polystyrene), Single-Use Coffee Cups, Broken or sharp objects among others.

1. Given below are two statements: **(UGC NET 22nd Mar 2023 Morning Shift)**

Statement I: Municipal solid waste includes Garbage and Rubbish.

Statement II: Garbage consists of both combustible and non-combustible materials.

- Both Statement I and Statement II are true.
- Statement I is false but Statement II is true.
- Statement I is true but Statement II is false.
- Both Statement I and Statement II are false.

Check

Question: 1 of 2 questions

2. Solid Waste Management

Solid Waste Management refers to the systematic collection, transportation, processing, recycling, and disposal of solid waste generated by households, businesses, industries, and institutions. The primary goal of solid waste management is to effectively and responsibly handle waste materials to protect the environment, public health, and conserve resources.

Here are some of the common approaches of solid waste management:

- **Pyrolysis:** Pyrolysis is a thermal decomposition process that converts organic materials in solid waste (municipal sold waste) into useful products like biofuels, syngas, and char. It helps in reducing the volume of waste and recovering energy or valuable materials.
- **Landfill:** Landfills are engineered sites designed for the controlled disposal of non-recyclable and non-compostable waste. Proper landfill management includes measures to prevent groundwater contamination and control methane emissions.
- **Incineration (Waste-to-Energy):** Incineration involves the controlled burning of waste at high temperatures. It can reduce the volume of waste and generate energy. However, it can produce toxic substances like dioxins and furans, necessitating advanced pollution control technologies.
- **Reuse:** Reuse involves extending the lifespan of items by using them multiple times before disposal. This method reduces the consumption of new resources and decreases waste generation.
- **Recycling:** Recycling is the process of collecting and processing materials like paper, glass, plastic, and metals to be used as raw materials for manufacturing new products. It conserves resources and reduces the need for virgin materials.
- **Composting:** Composting is a controlled, aerobic (oxygen-required) process that converts organic materials into a nutrient-rich soil amendment or mulch through natural decomposition. The end product is compost – a dark, crumbly, earthy-smelling material. Microorganisms feed on the materials added to the compost pile during the composting process. They use carbon and nitrogen to grow and reproduce, water to digest materials, and oxygen to breathe. Pit composting is a simple form of composting where organic waste is buried in pits or trenches. It is often used in rural areas and can be an effective way to recycle organic waste.
- **Extended Producer Responsibility (EPR):** EPR programs shift responsibility for waste management to the producers, encouraging them to design products that are easier to recycle and dispose of responsibly.
- **Pelletization:** In the context of RDF (Refuse-Derived Fuel) production, it refers to the process of compacting and shaping waste materials, typically non-recyclable and non-compostable solid waste, into small, dense, and cylindrical pellets or fuel blocks. These pellets are designed to be used as a source of energy, often as a substitute for traditional fossil fuels like coal, in industrial boilers, power plants, and other combustion processes.
  Vermicomposting

  Vermicomposting is a type of composting in which certain species of earthworms are used to enhance the process of organic waste conversion and produce a better end-product. Earthworms feed on the organic waste materials and passes it through their digestive system and gives out in a granular form (cocoons) which is known as vermicompost.

1. Pyrolysis helps in addressing the problem of **(UGC NET 14th Oct 2022 Evening shift)**

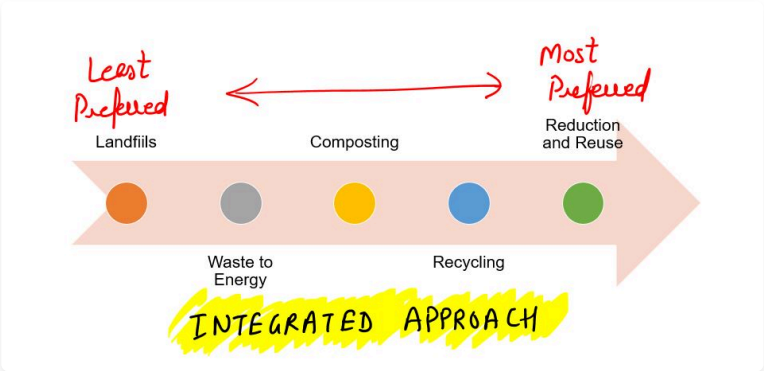
- Municipal Solid Wastes
- Water pollution
- Air Pollution
- Electronic wastes

Check

Question: 1 of 2 questions

2. Solid Waste Management

The Integrated Solid Waste Management (ISWM) approach presents a hierarchy for waste management, aiming to reduce waste disposal while optimizing resource conservation and efficiency. This hierarchy evaluates waste management methods based on their environmental, economic, and energy impacts.



At the top of the hierarchy (tier 1) is source reduction or waste prevention, including reuse, considered the most favorable approach. Recycling (tier 2) comes next, followed by tier 3, which involves composting organic waste to recover materials.

Materials that cannot be prevented or recycled may be considered for energy recovery (tier 4), while the least preferred option (tier 5) is the disposal of waste in sanitary landfills.

The selection of an appropriate waste management system and technology should be based on this hierarchy and local conditions. For instance, if there is a composting facility close to a residential area, biomethanation may be a preferred choice, even though it ranks lower and is costlier than composting in the ISWM hierarchy. The choice of technology should align with local circumstances and priorities.

1. Which of the following sequences of disposal options for low hazardous solid waste from industrial and urban s order of increasing desirability? **(UGC NET 6th Dec 2019 Evening Paper)**

- ○ Landfill< Composting < Reuse < Incineration
- ○ Incineration < Composting < Reuse < Landfill
- ○ Composting< Landfill < Reuse < Incineration
- ○ Indiscriminate dumping < Landfill < Incineration < Reuse

Check

Question: 1 of 1 questions

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3. Liquid Waste Management

Wastewater Management, also known as sewage or water reclamation, is the process of collecting, treating, and disposing of wastewater, which includes the water and pollutants that result from domestic, industrial, commercial, and agricultural activities.

Sources, environmental conerns and wastewater management are discussed next.

---

3. Liquid Waste Management

Some of prominent sources of Liquid Waste are listed below:

- *Domestic Sources:* Domestic wastewater includes sewage from households and residential areas, containing human waste, soapy water, and other contaminants.
- *Industrial Sources:* Industries generate various types of liquid waste, including process water, chemical effluents, and cooling water. These wastewaters can contain harmful chemicals and pollutants.
- *Agricultural Sources:* Agriculture contributes to liquid waste through the runoff of pesticides, fertilizers, and animal waste, which can contaminate surface water and groundwater.
- *Stormwater Runoff:* Rainwater runoff from streets, parking lots, and urban areas can carry pollutants such as oil, heavy metals, and debris into water bodies.
- *Commercial Wastewater:* Generated by businesses, restaurants, and commercial establishments. It may contain fats, oils, grease, detergents, and other pollutants.
  Leachate: Liquid waste produced from the decomposition of solid waste in landfills.

  Wastewater can also be generated from runoff from hospitals, laboratories, septic tank, food processing, dairy farm among others.

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3. Liquid Waste Management

Wastewater, if not managed and treated properly, can pose several environmental concerns that may negatively impact ecosystems, water quality, and public health. Some of the key environmental concerns associated with wastewater include:

- *Water Pollution:* Untreated or poorly treated wastewater can introduce a variety of pollutants into natural water bodies, including rivers, lakes, and oceans. These pollutants may include organic matter, nutrients (such as nitrogen and phosphorus), heavy metals, pathogens, chemicals, and pharmaceuticals. Water pollution can harm aquatic life and disrupt the balance of ecosystems.
- *Eutrophication:* Excessive nutrients, particularly nitrogen and phosphorus, in wastewater can lead to eutrophication. This is the overgrowth of algae and aquatic plants in water bodies, which depletes oxygen levels when the algae and plants decompose, leading to "dead zones" where aquatic life cannot survive.
- *Harmful Algal Blooms:* Nutrient-rich wastewater can trigger Harmful algal blooms, or HABs, which occur when colonies of algae — simple plants that live in the sea and freshwater — grow out of control and produce toxic or harmful effects on people, fish, shellfish, marine mammals and birds.
- *Disease Transmission:* Untreated wastewater may contain pathogens such as bacteria and viruses. Discharging untreated wastewater into water bodies can lead to the spread of waterborne diseases among both aquatic life and humans who come into contact with contaminated water.
- *Groundwater Contamination:* Poorly managed wastewater disposal, such as septic systems or land application, can lead to the contamination of groundwater. This can result in the spread of pollutants to drinking water sources and affect human health.
- *Chemical Contamination:* Industrial liquid waste may contain hazardous chemicals and heavy metals, which can persist in the environment and pose long-term risks.

---

3. Liquid Waste Management

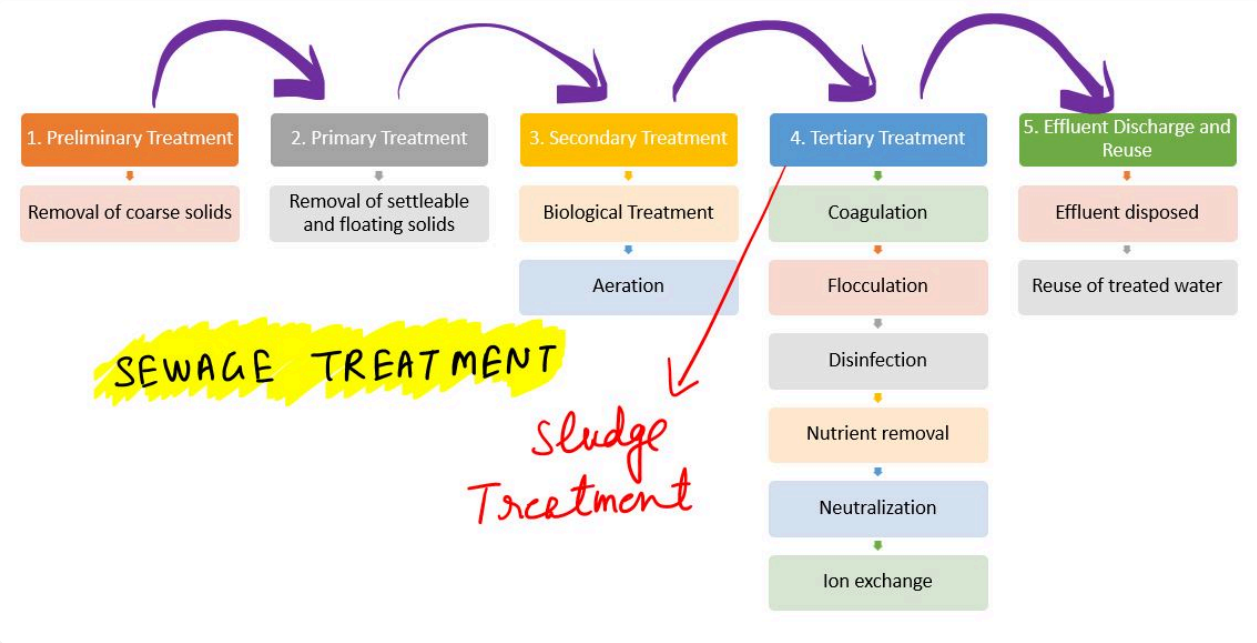
1. Aeration technique of water treatment is used for the removal of **(UGC NET 2nd Mar 2023 Evening Shift)**

- ○ Persistant Organic Pollutants (POPs)
- ○ Metals
- ○ Volatile Organic Compounds (VOCs)
- ○ Hardness

Check

Question: 1 of 5 questions

A Sewage Treatment Plant (STP) treats the sewage produced from various establishments to make it safe for disposal. It performs physical, chemical, and biological processes to remove contaminants and produce treated wastewater that is safe enough to dispose of into the environment. A by-product of sewage treatment is a semi-solid waste called sewage *sludge*. The sludge further undergoes treatment before being suitable for disposal or application to land.



Here is an overview of the typical steps involved in treating water at a sewage treatment plant:

1. Preliminary Treatment

Initially, the wastewater goes through the process where most coarse solids such as sticks, leaves, plastics etc., are removed by large filtering screens that help remove solid objects. Bar screens or fine screens are used to trap and remove these materials, preventing damage to downstream equipment. After screening, the wastewater may pass through a grit chamber, which helps remove abrasive particles like sand and grit that could damage equipment further downstream.

2. Primary Treatment

Primary treatment involves the removal of settleable and floating solids. Wastewater is held in a primary settling tank, where gravity allows solids to settle at the bottom, forming sludge, and oils and grease to float at the top. The relatively cleaner water in the middle is moved to the next treatment stage.

3. Secondary Treatment (Biological Treatment)

After primary treatment, the wastewater undergoes biological treatment. Microorganisms are introduced to the wastewater to break down and consume organic matter, including pathogens and nutrients (such as nitrogen and phosphorus). This process may take place in aeration tanks, activated sludge systems, or other biological reactors.

Aeration

Aeration is a process that involves the introduction of air or oxygen into water or wastewater to promote the growth of beneficial microorganisms or to remove undesirable gases, such as Volatile Organic Compounds. This technique is widely used in biological treatment processes (in ponds, reservoirs) and for maintaining dissolved oxygen levels in water bodies.

4. Tertiary Treatment

Tertiary treatment further polishes the water to remove nutrients (nitrogen and phosphorus), bacteria, and any remaining suspended solids. Some of the techniques are discussed below.

- *Filtration:* It is a physical separation process that involves passing wastewater through a porous medium, such as sand, gravel, or fabric, to remove suspended solids, particles, and impurities.
- *Coagulation:* It is the addition of chemicals, known as coagulants (e.g., aluminum sulfate or ferric chloride), to wastewater. These chemicals destabilize and neutralize the charges on suspended particles, allowing them to clump together. Coagulation helps in the removal of colloidal and fine particles that are too small to settle on their own. It initiates the formation of larger flocs for easier separation during subsequent processes.
- *Flocculation:* It follows coagulation and involves gentle mixing or agitation to encourage the collision and aggregation of destabilized particles into larger, settleable flocs. Flocculation enhances the formation of larger, denser flocs that can be more easily separated from the liquid phase through sedimentation or flotation.
- *Disinfection:* It is the treatment of wastewater to eliminate harmful microorganisms and pathogens, typically by using disinfectants like chlorine, ozone, or ultraviolet (UV) light. The primary aim of disinfection is to protect public health by ensuring that treated wastewater does not contain harmful bacteria, viruses, and other pathogens that could cause disease if released into the environment or reused for irrigation.
- *Nutrient removal:* It involves the removal of excess nutrients, such as nitrogen and phosphorus, from wastewater. This can be achieved through biological processes like nitrification-denitrification or chemical precipitation.
  Neutralization: To adjust and balance the pH (acidity or alkalinity) of wastewater by neutralizing it to a near-neutral or acceptable level. To raise the pH (neutralize acidity), an alkaline substance such as lime (calcium hydroxide) or sodium hydroxide (caustic soda) is added. Conversely, to lower the pH (neutralize alkalinity), an acid, like sulfuric acid, may be used.
- *Ion exchange:* It is a chemical process that involves the exchange of ions between solid ion-exchange resins and ions in the wastewater. Cations and anions in the water are exchanged with similarly charged ions on the resin. Ion exchange is used for selective removal of specific ions, such as heavy metals, from wastewater. It can also soften hard water by removing calcium and magnesium ions.

- *Chlorination:* It is a common and effective method for disinfecting water to make it safe for drinking and other uses. It involves the addition of chlorine or chlorine compounds to water to kill or deactivate harmful microorganisms, such as bacteria, viruses, and parasites. It also serves in odor treatment and aids in the removal of iron and manganese. However, the chlorination process can lead to the formation of certain carcinogens like chloroform.

5. Effluent Discharge and Reuse

After undergoing all treatment stages, the treated water, now referred to as effluent, is either safely discharged into receiving water bodies (rivers, lakes, oceans) in compliance with environmental regulations or used for non-potable purposes such as irrigation, industrial processes, or groundwater recharge.

Sludge Treatment

The solids separated during primary and secondary treatment, as well as excess biomass from biological treatment, are collectively known as sludge. Sludge treatment processes may include gravity thickening, dewatering, dissolved air floatation and further treatment (e.g., anaerobic digestion) to reduce its volume and stabilize its composition. The treated sludge can then be used for land application or disposed of in a responsible manner. Calcium is typically the most abundant in dried sewage sludge.

- *Gravity thickening:* It is a primary sludge treatment process where sludge is allowed to settle by gravity, resulting in the separation of water from solids. By allowing the sludge to settle, a significant portion of the water content is separated, creating a thicker, more concentrated sludge (often referred to as primary sludge) that is easier to handle and transport.
- *Dewatering:* It is the next step after gravity thickening, where mechanical methods, such as belt presses, centrifuges, or filter presses, are used to further separate water from the sludge. Dewatering significantly reduces the moisture content of the sludge, making it even more concentrated. This produces a semi-solid material with lower transportation and disposal costs. The treated sludge can be used as a soil conditioner or disposed of in an environmentally safe manner.
- *Anaerobic Digestion (AD):* It is a set of biochemical steps where microorganisms break down organic matter such as sewage sludge, manure, and food waste in the absence of oxygen (hence the word “anaerobic”), primarily producing gases such as

methane and carbon dioxide, as well as the organic wet mixture or residue called digestate.

- *Dissolved Air Floatation (DAF):* In DAF, air is dissolved under pressure into the wastewater, typically by using a recycle flow pressurized stream. Once the pressurized wastewater is released into a flotation tank or basin, the reduced pressure causes the dissolved air to come out of solution and form tiny bubbles (microbubbles). These microbubbles attach themselves to the suspended solids in the wastewater. The microbubbles and attached solids rise to the surface of the flotation tank due to their buoyancy. As they reach the surface, they form a layer of sludge, which can be skimmed off for further dewatering or disposal.

1. Aeration technique of water treatment is used for the removal of **(UGC NET 2nd Mar 2023 Evening Shift)**

- ○ Volatile Organic Compounds (VOCs)
- ○ Metals
- ○ Persistant Organic Pollutants (POPs)
- ○ Hardness

Check

Question: 1 of 5 questions

4. Biomedical Waste Management

Biomedical waste, also known as healthcare waste or medical waste, refers to any waste generated during medical or healthcare-related activities. This waste can pose potential hazards to human health and the environment due to its infectious, toxic, or otherwise harmful characteristics. Biomedical waste includes various types of waste materials generated in healthcare facilities, laboratories, and other medical settings.

Some common examples of biomedical waste include:

- *Infectious Waste:* This category includes materials that are contaminated with pathogens, such as blood, used needles, cultures, and swabs. It poses a significant risk of spreading infections.
- *Hazardous Waste:* Biomedical waste that contains hazardous chemicals or pharmaceuticals, such as expired medications, chemical reagents, and heavy metals. These substances can be toxic, flammable, or reactive.
- *Sharps:* Sharps waste consists of items with sharp edges or points, such as needles, scalpels, and broken glass. Sharps can cause injuries and transmit infections.
- *Pharmaceutical Waste:* Expired or unused medications, as well as pharmaceutical manufacturing byproducts, fall into this category. Proper disposal is crucial to prevent environmental contamination.
- *General Medical Waste:* This includes items like gloves, gowns, bandages, and tubing that may not be contaminated but are still considered medical waste.
- *Anatomical Waste:* Body parts, tissues, and organs removed during surgeries, autopsies, or other medical procedures are categorized as anatomical waste.
- *Chemical Waste:* Chemical waste generated during laboratory testing, research, or treatment processes can be hazardous and should be managed accordingly.
- *Radioactive Waste:* Materials contaminated with radioactive substances used in medical imaging and treatment must be handled and disposed of safely.

Biomedical waste management is a multi-step process ensuring safe handling and disposal of hazardous medical waste. It begins with waste segregation at the source, using color-coded bins and bags to prevent contamination. Collected waste is stored in leak-proof containers, properly labeled with biohazard symbols. Trained personnel and specialized vehicles ensure secure transport to treatment facilities. Treatment methods like incineration, autoclaving, or chemical disinfection render the waste safer, and compliant disposal follows local regulations.

The Government of India notified Bio-Medical Waste Management Rules, 2016 for ensuring proper handling and treatment of bio-medical waste.

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5. Hazardous Waste Management

Hazardous Waste refers to waste materials that, due to their toxic, corrosive, flammable, or reactive properties, pose significant risks to human health and the environment. Proper management of hazardous waste is essential to prevent contamination, minimize health hazards, and ensure the responsible disposal of these materials.

Hazardous waste can be classified into different types based on its characteristics and sources. The categorization of hazardous waste helps in its proper management, storage, transportation, treatment, and disposal. Here are some common types of hazardous waste:

- *Medical Wastes:* Generated by healthcare facilities and research institutions, these wastes may include infectious materials, sharps (needles and scalpels), pharmaceuticals, and radioactive materials.
- *Industrial Wastes:* Generated by manufacturing, industrial, and construction processes. These can include solvents, chemicals, and heavy metals.
  Toxic Chemical Wastes: Chemical manufacturing and research facilities generate toxic chemicals and byproducts that are classified as hazardous waste. Example include Pesticides, herbicides, certain industrial chemicals (e.g., formaldehyde, benzene), heavy metals (e.g., lead, mercury), and some pharmaceuticals.
- *e-Waste (Electronic Waste):* Discarded electronic equipment like computers, mobile phones, televisions, and batteries. Contains hazardous substances like lead, mercury, and cadmium.
- *Radioactive Waste:* Used nuclear fuel, contaminated laboratory equipment, and materials exposed to radiation in medical and industrial settings.
  Hazardous Household Waste: Products found in households, such as paint, cleaning chemicals, pesticides, batteries, and fluorescent bulbs.
- *Agricultural Waste:* Pesticides, herbicides, and fertilizers used in agriculture that can become hazardous if not managed properly.
  Construction and Demolition Waste: Materials like asbestos-containing products, lead-based paints, and other hazardous substances found in construction and demolition debris.
- *Pathological Waste:* Human tissues, organs, and body fluids generated from medical procedures and pathology labs.
- *Explosive Waste:* Materials that can explode under certain conditions, such as unstable chemicals and unused fireworks.
- *Hazardous Organic Compounds:* This category encompasses organic compounds that are hazardous due to their chemical properties, such as chlorinated solvents and Poly-Chlorinated Biphenyls (PCBs).
  Hazardous Waste Management Rules 2016

Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 are notified to ensure safe handling , generation, processing, treatment, package, storage, transportation, use reprocessing, collection, conversion, and offering for sale, destruction and disposal of Hazardous Waste.

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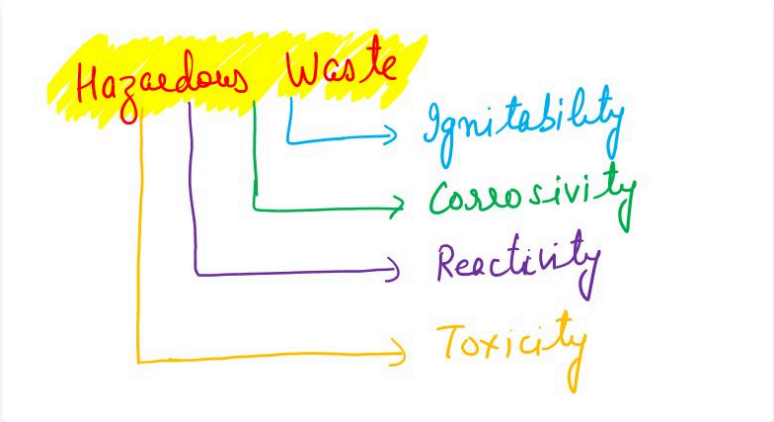
5. Hazardous Waste Management



Hazardous waste is characterized by specific traits that make it potentially harmful. These characteristics include:

- *Ignitability:* The waste's propensity to catch fire. Examples include solvents (e.g., acetone, methanol), gasoline, oil-based paints, and some industrial chemicals (e.g., diethyl ether).
- *Corrosivity:* The waste's ability to corrode containers or equipment. Examples include strong acids (e.g., sulfuric acid, hydrochloric acid), strong bases (e.g., sodium hydroxide), and battery acid.
- *Reactivity:* The waste's instability and potential to react violently with other substances. Examples include sodium, potassium, and some laboratory reagents.
- *Toxicity:* The waste's capacity to harm human health or the environment when released.

1. To characterize hazardous waste following characteristics are taken into account: **(UGC NET 5th Jan 2022- Ev shift)**

A. Conductivity
B. Ignitability
C. Corrosivity
D. Magnetic susceptibility
E. Reactivity

- ○ A, B, C and E only
- ○ B, C, D and E only
- ○ B, C and E only
- ○ A, C and D only

Check

Question: 1 of 1 questions

6. e-Waste Management

Electronic waste (e-waste) encompasses a diverse array of discarded electronic devices and equipment, including consumer electronics like computers, smartphones, and televisions, office equipment such as printers and photocopiers, large appliances like refrigerators and air conditioners, as well as communication equipment, audio-visual devices, lighting equipment, medical devices, industrial and laboratory equipment, consumer batteries, cables, printed circuit boards (PCBs), and various electronic components.

This waste stream poses several challenges for the environment and human health for the following reasons:

- *Hazardous Materials:* Electronic devices often contain hazardous materials like lead, mercury, cadmium, and various chemicals. When improperly disposed of or incinerated, these substances can leach into the environment, causing pollution and harm to living organisms.
- *Resource Depletion:* Electronics contain valuable resources, such as rare metals, which can be recovered and reused. Failing to recycle e-waste leads to the unnecessary depletion of natural resources.
- *Waste Accumulation:* Improper disposal of electronic devices contributes to landfill overflow and waste accumulation, as well as the inefficient use of valuable landfill space.
- *Data Security:* Many electronic devices store sensitive information. If not handled properly, discarded devices may expose personal or corporate data to unauthorized access.
- *Health Risks:* E-waste recycling and disposal, especially in informal or substandard facilities, may expose workers to hazardous materials and unsafe conditions, leading to health risks.

E-waste management involves the systematic collection, segregation, data erasure, reuse, recycling, and safe disposal of discarded electronic devices and equipment. This process aims to protect the environment, conserve valuable resources, and prevent health hazards associated with hazardous materials in electronics. It requires collaboration among governments, certified recycling companies, and manufacturers to ensure compliance with environmental regulations and promote responsible practices, such as extended producer responsibility (EPR) programs.

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6. e-Waste Management

Electronic waste (e-waste) comprises various components and materials, many of which can be recycled, refurbished, or reused. The specific components found in e-waste can vary depending on the type and age of the electronic devices.

Here are some common e-waste components and their potential uses after recycling:

- *Printed Circuit Boards (PCBs):* PCBs are often rich in precious metals like gold, silver, and palladium, as well as base metals like copper. These metals can be extracted and reused. PCBs can also be refurbished for use in other electronic devices.
- *Semiconductor Devices (Chips and Processors):* Integrated circuits and semiconductors can be reclaimed for use in new electronic devices, or they can be resold. Older chips may be suitable for retro gaming or niche applications.
- *Cathode Ray Tubes (CRTs):* CRT glass can be recycled into new CRTs or used in pavement, tiles, and fiberglass insulation.
- *LCD Panels:* Liquid crystal displays can sometimes be refurbished for use in other devices. Recycling may involve recovering metals, especially indium, from the panel.
- *Batteries:* Batteries contain valuable metals like lithium, cobalt, and nickel, which can be extracted and reused. Some old batteries can be refurbished or repurposed in other devices.
- *Plastics:* Plastic components can be melted down and reused for non-electronic products or new plastic parts. They can also be used in the construction of non-structural elements.
- *Copper and Aluminum Wiring:* Wires and cables contain valuable copper and aluminum that can be extracted and used in new products. Copper wiring can be melted down for recycling.
- *Housings and Casings:* The outer casings of electronic devices are often made of metal or plastic, which can be recycled. They can also be refurbished and reused for other devices.
- *Mercury-Containing Components:* Some electronic devices may contain small amounts of mercury, which must be safely extracted and processed. Fluorescent lamps and switches are common sources of mercury.
- Brominated flame retardants (BFRs) are added to electronic and electrical products to reduce their flammability and comply with safety standards.
- *Poly Vinyl Chloride (PVC):* PVC is a common type of plastic used in various electronic products, including cables, wire insulation, and some casings.
- *Poly Chlorinated Biphenyls (PCB):* PCBs were commonly used in electrical equipment, such as transformers and capacitors, as coolants and insulating fluids.

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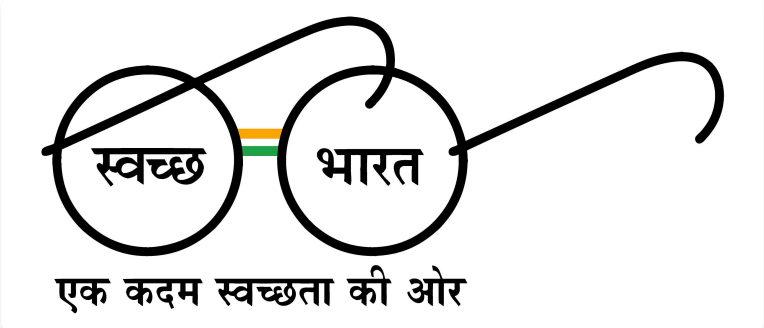
7. Swacch Bharat Mission



The Swachh Bharat Mission is a nationwide cleanliness campaign launched by the Government of India on 2nd October 2014. It aims to make India clean and free from open defecation, litter, and pollution. The mission covers all rural and urban areas.

The urban component of the mission is being implemented by the Ministry of Urban Development, and the rural component by the Ministry of Jal Shakti.

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7. Swacch Bharat Mission

SBM Grameen Phase I was launched on 2nd October 2014 for 5 years. After that, phase II was launched for the period of 2020-2021 to 2024-2025.

Under SBM-Grameen Phase I, all villages, Gram Panchayats, Districts, States and Union Territories in India needed to be declared themselves "Open-Defecation Free" (ODF) by 2nd October 2019, the 150th birth anniversary of Mahatma Gandhi, by constructing over 100 million toilets in rural India.

SBM-G Phase II was launched in 2020-21 with the objective of sustaining the ODF status and managing solid and liquid waste to bring about visual cleanliness by 2024-25 and transforming all the villages from ODF to ODF Plus.

To achieve the goal of ODF Plus villages, focus is given to the following interventions under the programme:

- Providing access to toilets to left-out households and newly emerged households by construction of Individual Household Latrines (IHHLs) and Community Sanitary Complexes (CSCs).
- Biodegradable Waste Management through Composting and Biogas plants.
  Collection, segregation setting up systems for and storage, facilities and Plastic Waste Management Units/Material Recovery Centres for Plastic Waste Management.
- Construction of Soak pits, Waste Stabilization Ponds, DEWATS, etc. for Greywater Management.
- Faecal Sludge Management through co-treatment in existing Sewage Treatment Plants/Faecal Sludge Treatment Plants (STPs/FSTPs) in peri-urban areas and setting up of FSTPs under the programme.
- Decentralized operation and maintenance of community sanitation assets in rural areas by Gram Panchayats.

The SLWM component of ODF Plus will be monitored on the basis of output-outcome indicators for 4 key areas:

1. Plastic waste management,
2. Biodegradable solid waste management (including animal waste management),
3. Greywater (Household Wastewater) management
4. Fecal sludge management.

GOBARdhan Scheme

GOBARdhan plays a crucial role in the second phase of the Swachh Bharat Mission (Grameen) in managing solid waste. This initiative aims to transform biodegradable waste, such as animal waste, kitchen scraps, and crop residue, into valuable resources. These resources include biogas, which can be used for cooking and lighting, and bio-slurry, a nutrient-rich organic fertilizer for agriculture. In areas with limited cattle dung availability, composting is the preferred method for managing biodegradable waste. However, for regions with ample cattle dung or animal waste resources, the GOBARdhan Compressed Biogas (CBG) plant is a more suitable choice. It allows for efficient utilization of these resources.

Financial support of up to Rs. 50 lakhs per district is provided to establish community or cluster-level biogas plants at the village, block, or district levels. This support helps in promoting sustainable waste management practices and the generation of valuable biogas and bio-slurry resources.

1. A key component in Swatchh Bharat Mission (Grameen), SLWM stands for **(UGC NET 9th July 2022- Evening**

- ○ Solid and Liquid Waste Management
- ○ State Level Waste Management
- ○ State Level Water Management
- ○ Sanitation and Liquid Waste management

Check

Question: 1 of 2 questions

7. Swacch Bharat Mission

Swachh Bharat Mission - Urban 1.0 was launched in 2014 in all Urban Local Bodies, to achieve 100% ODF (Open Defecation Free) status through construction of Individual Household Latrines (IHHLs) and Community/ Public Toilets (CT/PTs). The first phase of SBM-U focused on achieving the target of making urban India ODF by providing access to toilets and promoting behavioral change. SBM-U 1.0 was successful in achieving the target and 100% of urban India was declared ODF.

SBM Urban 2.0

In October 2021, SBM-U 2.0 (2021-22 to 2025-26) was launched with focus on sustaining sanitation and solid waste management outcomes achieved during SBM. The second phase of SBM-U aimed to go beyond ODF to ODF+, and ODF++, and focus on making urban India garbage-free. It emphasized sustainable sanitation practices, waste management, and the promotion of a circular economy.

Open Defecation Free (ODF) Status

ODF: An area can be notified or declared as ODF if at any point of the day, not even a single person is found defecating in the open.

ODF+: This status is given if at any point of the day, not a single person is found defecating and/or urinating in the open, and all community and public toilets are functional and well maintained.

ODF++: This status is given if the area is already ODF+ and the faecal sludge/septage and sewage are safely managed and treated, with no discharging or dumping of untreated faecal sludge and sewage into the open drains, water bodies or areas.

Key Highlights of SBM Urban 2.0 are listed below:

- To make all cities 100% 'garbage free' from current 70%.
- Ensure grey and black water management in all cities other than those covered under AMRUT.
- Make all urban local bodies as ODF+ and those with a population of less than 1 lakh as ODF++.
- Focus on source segregation of solid waste by utilizing the principles of 3Rs (Reduce, Reuse, Recycle).
- Scientific processing of all types of municipal solid waste and remediation of legacy dumpsites for effective solid waste management.

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1. Millennium Development Goals (MDGs)

The Millennium Development Goals (MDGs) were 8 international development goals for the year 2015 that were established following the “Millennium Summit of the United Nations” in 2000, held in New York, USA, following the adoption of the "United Nations Millennium Declaration".

All United Nations member states committed to help achieve the following Millennium Development Goals by 2015:

Goal 1 - *Eradicate Extreme Poverty and Hunger:* Targeted at reducing poverty and ensuring access to food for vulnerable populations.
Goal 2 - *Achieve Universal Primary Education:* Focused on ensuring that all children have access to and complete primary education.
Goal 3 - *Promote Gender Equality and Empower Women:* Aimed to eliminate gender disparities and empower women in all aspects of life.
Goal 4 - *Reduce Child Mortality:* Targeted at reducing child mortality rates through improved healthcare and disease prevention.
Goal 5 - *Improve Maternal Health:* Focused on reducing maternal mortality and providing access to maternal healthcare services.
Goal 6 - *Combat HIV/AIDS, Malaria, and Other Diseases:* Aimed at halting the spread of diseases and improving access to treatment.
Goal 7 - *Ensure Environmental Sustainability:* Focused on sustainable development, environmental conservation, and access to safe drinking water.
Goal 8 - *Develop a Global Partnership for Development:* Aimed to foster cooperation, trade, and aid to support the above goals.

India is a signatory to the Millennium Declaration adopted at the United Nations General Assembly in September 2000, and has consistently reaffirmed its commitment towards 8 development goals. The targets of the MDGs converge with India’s own development goals to reduce poverty and other areas of deprivation.

Each goal had specific targets, and dates for achieving those targets. The eight goals were measured by 21 targets. The eighth goal, developing a global partnership, has highest number of sub-targets (6).

In 2015, the MDGs were succeeded by the Sustainable Development Goals (SDGs), which expanded the scope and ambition of the global development agenda. The SDGs aim to address a wider range of social, economic, and environmental challenges and have a target date of 2030.

1. Reducing Child Mortality was one of the goals of: **(UGC NET 14th Mar 2023 Morning Shift)**

- Neither SDGs nor MDGs
- Millennium Development Goals (MDGs)
- Both SDGs and MDGs
- Sustainable Development Goals (SDGs)

Check

Question: 1 of 5 questions

2. Sustainable Development Goals (SDGs)

The Sustainable Development Goals (SDGs) (or Global Goals for Sustainable Development, also called Global Goals) are a collection of 17 global goals set by the United Nations General Assembly in 2015.

The SDGs are part of Resolution 70/1 of the United Nations General Assembly: "Transforming our World: the 2030 Agenda for Sustainable Development" that has been shortened to "2030 Agenda."

The goals are broad and interdependent, yet each has a separate list of targets to achieve. Achieving all 169 targets would signal accomplishing all 17 goals.

The SDGs cover social and economic development issues including poverty, hunger, health, education, global warming, gender equality, water, sanitation, energy, urbanization, environment and social justice.

The list of 17 SDGs, with important targets is given below.

Goal 1: *End poverty in all its forms everywhere*

- By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day
- By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions.

Goal 2: *End hunger, achieve food security and improved nutrition and promote sustainable agriculture*

- By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.
- By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons.

Goal 3: *Ensure healthy lives and promote well-being for all at all ages*

- By 2030, reduce the global maternal mortality ratio to less than 70 per 1,00,000 live births.
- By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births.
- By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases.
- By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being.
- By 2020, halve the number of global deaths and injuries from road traffic accidents.

Goal 4*: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*

- By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education.
- By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university.

Goal 5*: Achieve gender equality and empower all women and girls*

- Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation.
- Eliminate all harmful practices, such as child, early and forced marriage and female genital mutilation.

Goal 6: *Ensure availability and sustainable management of water and sanitation for all*

- By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations
- By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

Goal 7*: Ensure access to affordable, reliable, sustainable and modern energy for all*

- By 2030, double the global rate of improvement in energy efficiency.

Goal 8*: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all*

- Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries.

Goal 9*: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*

- Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.

Goal 10*: Reduce inequality within and among countries*

- By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average.
- By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status.
- By 2030, reduce to less than 3 per cent the transaction costs of migrant remittances and eliminate remittance corridors with costs higher than 5 %.

Goal 11*: Make cities and human settlements inclusive, safe, resilient and sustainable*

- By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.
- By 2030, provide access to safe, affordable, accessible and sustainable. transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.
- Strengthen efforts to protect and safeguard the world's cultural and natural heritage.

Goal 12*: Ensure sustainable consumption and production patterns*

- By 2030, achieve the sustainable management and efficient use of natural resources.
- By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.

Goal 13*: Take urgent action to combat climate change and its impacts**

- Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.
- Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible.

Goal 14*: Conserve and sustainably use the oceans, seas and marine resources for sustainable development*

- By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.
- By 2020, conserve at least 10 % of coastal and marine areas, consistent with national and international law and based on the best available scientific information.

Goal 15*: Protect, restore and promote sustainable use of terrestrial ecosystems*

- By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems, in particular forests, wetlands, mountains and drylands, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.
- By 2030, combat desertification, restore degraded land and soil, and ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development.
- Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources.

Goal 16*: Promote peaceful and inclusive societies for sustainable development*

- Significantly reduce all forms of violence and related death rates everywhere.
- End abuse, exploitation, trafficking and all forms of violence against and torture of children.
- Promote the rule of law at the national and international levels and ensure equal access to justice for all.

Goal 17*: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development*

- Strengthen domestic resource mobilization, including through international support to developing countries, to improve domestic capacity for tax and other revenue collection.
- Mobilize additional financial resources for developing countries from multiple sources.

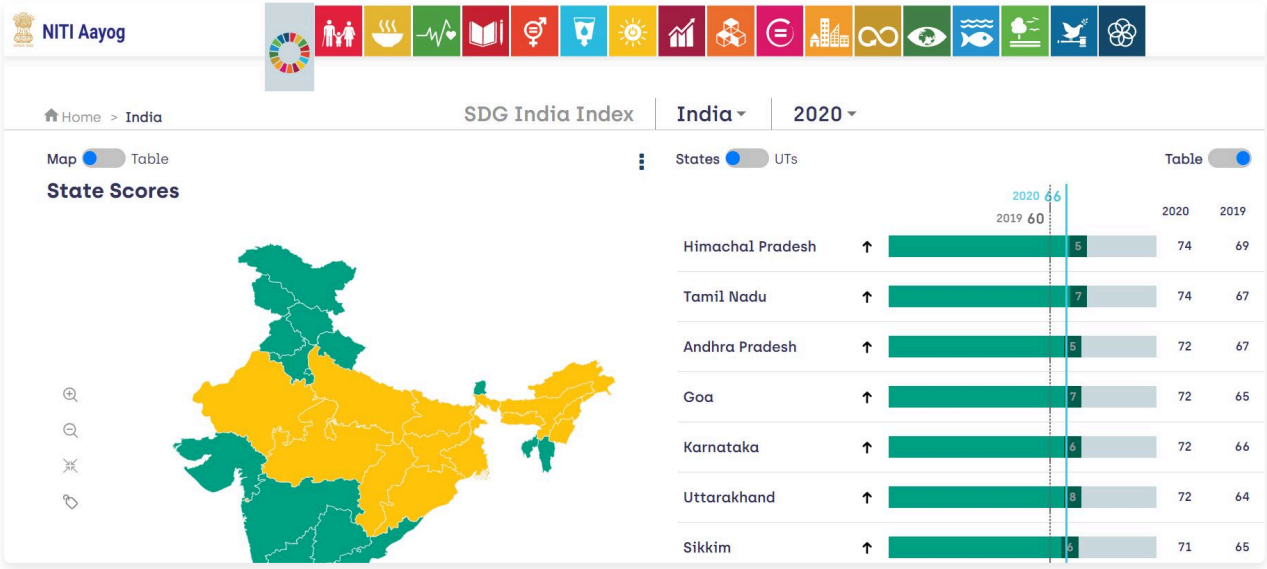
1. The Sustainable Development Goals (SDGs) are intended to be achieved by the year **(UGC NET 3rd Mar 2023 Shift)**

- ○ 2029
- ○ 2025
- ○ 2030
- ○ 2027

Check

Question: 1 of 5 questions

3. SDG India Index 2023-24



SDG India Index 2023-24, the 4th edition was released in July 2024. It measures and tracks national progress of all States and UTs on 113 indicators aligned to the Ministry of Statistics and Programme Implementation's (MoSPI) National Indicator Framework (NIF). The SDG India Index computes goal-wise scores on the 16 SDGs for each State and UT. Overall State and UT scores or Composite Scores are generated from goal-wise scores to measure the aggregate performance of the sub-national unit based on its performance across the 16 SDGs. These scores range between 0–100, and if a State/UT achieves a score of 100, it signifies it has achieved the targets. The higher the score of a State/UT, the greater the distance covered to the target. Classification Criteria based on SDG India Index Score is as follows:

- Aspirant: 0-49
- Performer: 50-64
- Front Runner: 65-99
- Achiever: 100

Key Highlights of the SDG India Index for 2023-24 are given below.

- India's overall SDG score improved to 71 in 2023-24 from 66 in 2020-21 and 57 in 2018. All states have shown improvement in overall scores.
- Top Performers: Kerala and Uttarakhand emerged as the best-performing states, each scoring 79 points.
- Lowest Performer: Bihar lagged behind with a score of 57 points, followed by Jharkhand at 62 points.
- Front-Runner States: 32 states and union territories (UTs) are in the front-runner category, with 10 new entrants including Arunachal Pradesh, Assam, Chhattisgarh, and Uttar Pradesh.
- Among goals, Goal 13 (Climate Action) has shown the most substantial improvement, with its score increasing from 54 to 67.

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4. UN Sustainable Development Report 2024

The 9th edition of the Sustainable Development Report was released by UN Sustainable Development Solutions Network (SDSN) in June 2024. It highlighted that the world is significantly behind schedule in achieving the Sustainable Development Goals (SDGs) set by the United Nations in 2015. The Report reviews progress made each year on the Sustainable Development Goals since their adoption by the 193 UN Member States in 2015. This year's edition also presents a new index of countries' support to UN-based multilateralism and discusses long-term pathways to attain sustainable food and land systems.

Key Highlights are given below.

- Nordic countries lead in SDG achievement, with Finland (score 86.4) ranked first, followed by Sweden (85.7), Denmark (85.0), Germany (83.4), and France.
- BRICS and BRICS+ countries (Egypt, Ethiopia, Iran, Saudi Arabia, UAE) have shown faster-than-average SDG progress since 2015.
- Bottom 3 Countries: South Sudan, Central African Republic and Chad.
- East and South Asia are the regions with the most SDG progress since 2015.
- India secured 109th rank with the overall score of 64.0.

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1. Introduction

In an increasingly interconnected world, addressing global challenges such as climate change, environmental degradation, and biodiversity loss requires concerted international efforts. International agreements and protocols serve as vital frameworks to foster collaboration among nations, setting guidelines and targets to mitigate the adverse impacts of human activities on the planet.

The collective response to environmental issues at an international level has led to the establishment of key agreements designed to address specific challenges.

From the United Nations Framework Convention on Climate Change (UNFCCC) and its landmark protocols like the Kyoto Protocol and the Paris Agreement, to agreements such as the Montreal Protocol and the Kigali Amendment, each international agreement serves as a testament to global commitment in confronting climate change and environmental degradation. Additionally, conventions like the Convention on Biological Diversity and the United Nations Convention to Combat Desertification, alongside initiatives like the International Solar Alliance, signify the global community's recognition of the interdependence between environmental sustainability, economic progress, and human well-being.

The examination of these international agreements and alliances is critical to understanding the collaborative mechanisms, goals, and strategies that underpin global efforts in safeguarding our planet for future generations.

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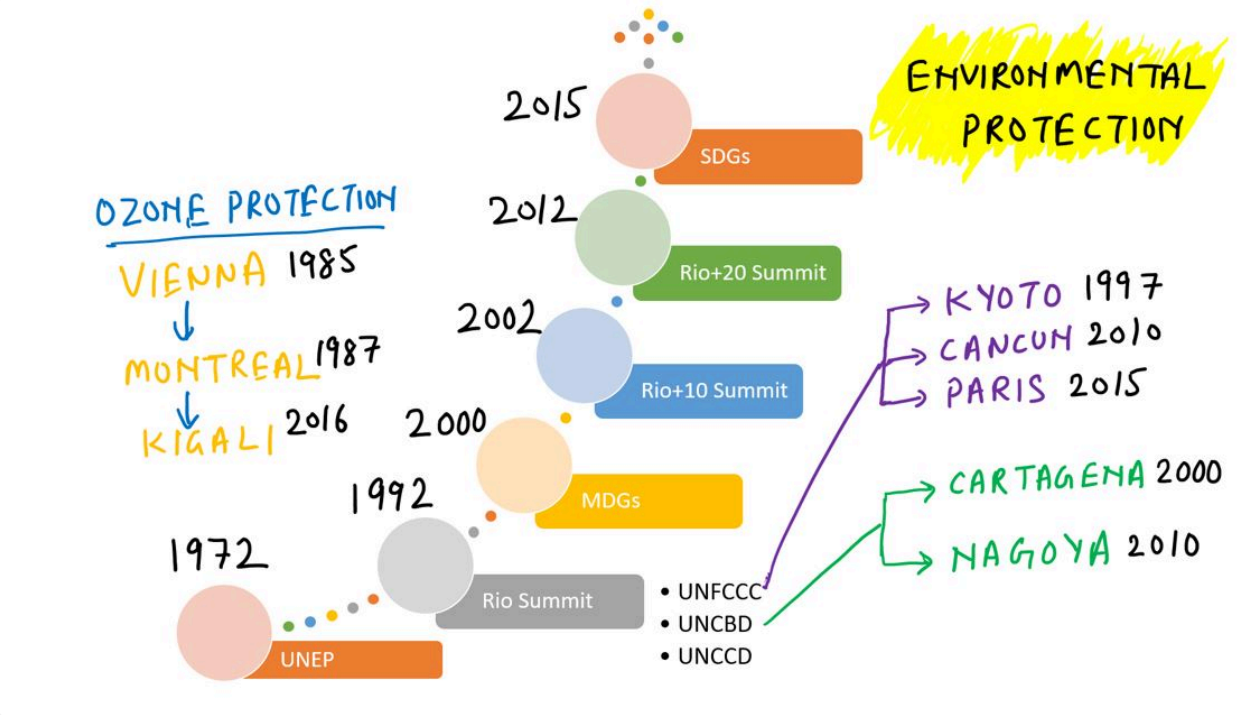
2. Overview of all Events

Stockholm Conference 1972

The 1972 United Nations Conference on the Human Environment in Stockholm was the first world conference to make the environment a major issue. The key outcome of the conference was the birth of United Nations Environment Programme (UNEP), founded in 1972.



Treaty for Ozone Layer Protection

In the early 1980s, through a combination of ground-based and satellite measurements, scientists began to realize that Earth's ozone layer was thinning dramatically over the South Pole each spring. This alarming discovery prompted global leaders to adopt the Vienna Convention for the Protection of the Ozone Layer in 1985, establishing a framework for international cooperation focused on safeguarding the ozone layer in the stratosphere. This initial treaty laid the groundwork for the subsequent Montreal Protocol in 1987, compelling countries to implement control measures for the protection of the ozone layer.

Rio Summit 1992

The United Nations Conference on Environment and Development (UNCED), also known as the 'Earth Summit', was held in Rio de Janeiro, Brazil, from 3-14 June 1992. It is also known as Earth Summit or the Rio Summit. The summit led to establishment of Rio Conventions which includes the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (UNCBD); and the Convention on Combat Desertification (UNCCD).

Millennium Summit 2000

At the Millennium Summit in September 2000, the largest gathering of world leaders in history adopted the United Nations Millennium Declaration, committing their nations to a new global partnership to reduce extreme poverty and setting out a series of targets, with a deadline of 2015. These have become known as the Millennium Development Goals (MDGs).

World Summit on Sustainable Development 2002

A decade after the establishment of the UNFCCC, the World Summit on Sustainable Development (WSSD), informally referred to as Earth Summit 2002 or Rio+10, was held in Johannesburg, South Africa. At Rio+10, sustainable development was acknowledged as a fundamental goal for institutions at the national, regional, and international levels. Key outcomes of this conference include the Johannesburg Declaration and nearly 300 international partnership initiatives designed to assist in achieving the Millennium Development Goals (MDGs).

United Nations Conference on Sustainable Development 2012

The United Nations Conference on Sustainable Development (UNCSD), also known as Rio 2012, Rio+20, or Earth Summit 2012, was the third international conference on sustainable development. Hosted by Brazil in Rio de Janeiro in 2012, it marked a 20-year follow-up to the 1992 United Nations Conference on Environment and Development (UNCED) held in the same city, and the 10th anniversary of the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg.

The outcome was the establishment of Sustainable Development Goals (SDGs) aimed at advancing sustainable development on a global scale. It is thought that the SDGs will pick up where the Millennium Development Goals leave off. Further, the nations agreed to explore alternatives to GDP as a measure of wealth that take environmental and social factors into account in an effort to assess and pay for 'environmental services' provided by nature, such as carbon sequestration and habitat protection.

United Nations Environment Assembly (UNEA)

United Nations Environment Assembly (UNEA) was created in 2012, as an outcome of the UN Conference on Sustainable Development (Rio+20), held in Brazil. Set up as a sort of 'world parliament on the environment', UNEA aims to define priorities for environmental policies and develop international legislation on the matter. Over the years, UNEA has approved important resolutions on topics such as combating illegal wildlife trafficking, protecting the environment in areas of armed conflict, sustainable urban mobility, among others. It is the world's highest-level decision-making body on the environment.

The sixth session of the United Nations Environment Assembly (UNEA-6) took place from in February 2024 at the United Nations Environment Programme (UNEP) headquarters in Nairobi, Kenya.

1. What is the correct chronological order of the following from older to newer? **(UGC NET 23rd Oct 2022 Mornin**

A. Paris Agreement
B. Convention on biodiversity
C. Kyoto protocol
D. Montreal protocol
E. Stockholm conference

- ○ E, D, B, C, A
- ○ B, D, C, E, A
- ○ B, C, D, E, A
- ○ E, D, C, B, A

Check

Question: 1 of 2 questions

2. Overview of all Events

The Intergovernmental Panel on Climate Change (IPCC) is an intergovernmental entity of the United Nations dedicated to providing the world with an impartial, scientific assessment of climate change and its socio-political and economic repercussions. The objective is to provide governments at all levels with scientific information that they can use to develop climate policies. It prepares comprehensive Assessment Reports about the state of scientific, technical and socio-economic knowledge on climate change, its impacts and future risks and options for reducing the rate at which climate change is taking place. So far, 6 assessment reports have been produced, the first one being released in 1990.

The Sixth Assessment Report is intended to assess scientific, technical, and socio-economic information concerning climate change. The first part of the report was released in August 2021. That one was centred around the scientific basis of climate change. The second part of the report is about climate change impacts, risks and vulnerabilities, and adaptation options released in March 2022. The third and final part, released in April 2022, of the report is focused on looking into the possibilities of reducing emissions.

IPCC was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). It was subsequently endorsed by the United Nations General Assembly.

1. Full form of IPCC, a nodal agency in the context of climate change, is: **(UGC NET 23rd Mar 2023 Morning Shi**

- ○ International Panel on Climate Change
- ○ International Policy on Climate Change
- ○ Intergovernmental Panel on Climate Change
- ○ Intergovernmental Policy on Climate change

Check

Question: 1 of 1 questions

3. Timeline of Events

1972

Stockholm Confernence 1972

First-ever Conference held on Environment

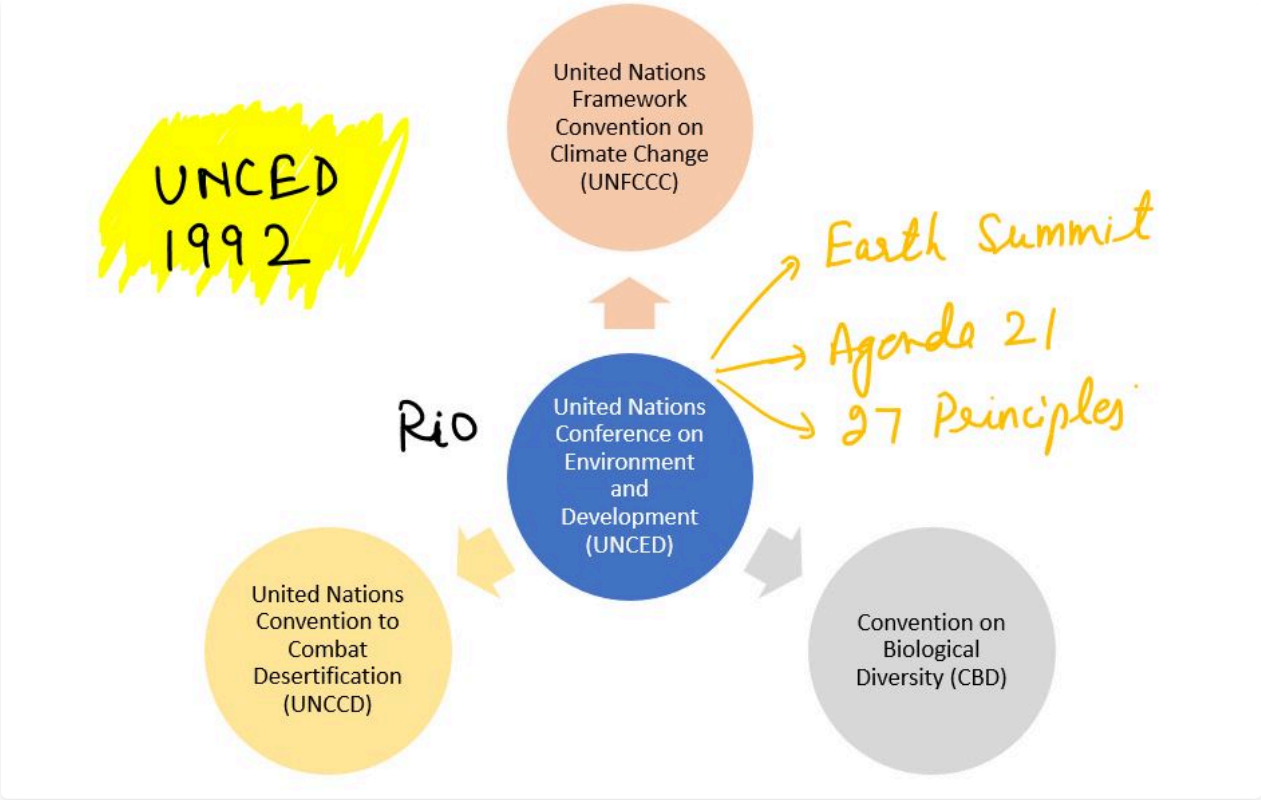
Key Outcome - foundation of United Nation Environment Programme (UNEP)

1985

Vienna Convention 1985

4. United Nations Conference on Environment and Development (UNCED)

The United Nations Conference on Environment and Development (UNCED), also known as the 'Earth Summit', was held in Rio de Janeiro, Brazil, from 3-14 June 1992. This global conference, held on the occasion of the 20th anniversary of the first Human Environment Conference in Stockholm, Sweden. The primary objective of the Rio 'Earth Summit' was to produce a broad agenda and a new blueprint for international action on environmental and development issues that would help guide international cooperation and development policy in the twenty-first century.



Key highlights of the Earth Summit are given below:

- It affirmed that sustainable development is achievable globally, emphasizing its importance at various levels.
- It acknowledged the need to balance economic, social, and environmental concerns for sustaining human life on Earth.
- The Conference recognized that the integrated approach required new perspectives on production, consumption, lifestyle, and decision-making.

Following are the key achievements of the Summit:

- The Rio Declaration and its 27 universal principles which provides a framework for addressing environmental and developmental challenges while promoting sustainable practices.
- Agenda 21 which outlines strategies for achieving sustainable development globally in the 21st century. The agenda encompasses a wide range of issues, including environmental conservation, social equity, economic development, and governance. It serves as a blueprint for integrating environmental and developmental goals to create a more sustainable and equitable future.
- The Summit led to the creation of 3 pivotal legally binding accords, collectively referred to as the Rio Convention.

1. *United Nations Framework Convention on Climate Change (UNFCCC)*: Its objective is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system caused by human activities.
2. *Convention on Biological Diversity (CBD)*: This treaty aims to conserve biological diversity, promote sustainable use of its components, and ensure fair and equitable sharing of benefits arising from the use of genetic resources.
3. *United Nations Convention to Combat Desertification (UNCCD)*: This convention addresses the problems of desertification, land degradation, and drought, with the aim of promoting sustainable development in affected areas.

These are discussed next one by one.

1. Convention on Biodiversity was signed during **(UGC NET 1st Dec 2021- Morning shift)**

- Earth Summit at Rio de Janeiro, 1992
- Montreal Protocol, 1987
- Human Environment Conference, Stockholm, 1972
- Kyoto Protocol, 1997

Check

Question: 1 of 4 questions

5. United Nations Framework Convention on Climate Change (UNFCCC)

The United Nations Framework Convention on Climate Change (UNFCCC) is an international treaty established in 1992 during the Earth Summit held in Rio de Janeiro, Brazil. The UNFCCC is a foundational framework for addressing global climate change and serves as the parent treaty for the subsequent Kyoto Protocol and the Paris Agreement. It officially came into force on 21st March 1994 after the 50th instrument of ratification, acceptance, approval or accession had been deposited.

Key Elements and Mechanisms of the UNFCCC:

- *Stabilize Greenhouse Gas Concentrations:* The UNFCCC aims to prevent dangerous human interference with the climate system. It focuses on reducing the concentration of greenhouse gases (GHGs) in the Earth's atmosphere to levels that would prevent such interference.
- *Promote Sustainable Development:* The convention recognizes that addressing climate change should be consistent with socio-economic development goals. It emphasizes that parties should promote sustainable development to address climate change effectively.
- *Conference of the Parties (COP):* The COP is the supreme body of the UNFCCC, and its meetings are held annually.
- *Financial Mechanisms:* The convention establishes financial mechanisms to support developing countries in their efforts to mitigate and adapt to climate change, including the Green Climate Fund.
- *Onus on the developed countries:* Developed countries are expected to take the lead due to their historical emissions. They are called Annex I countries and belong to the Organization for Economic Cooperation and Development (OECD). They were required to reduce emissions to 1990 levels by 2000.

Under the overarching framework of the UNFCCC, parties negotiated 3 significant climate agreements:

1. **Kyoto Protocol:** This agreement, adopted in December 1997 and entered into force on 16th February 2005, exclusively entailed developed countries committing to specific emission reduction targets.
2. **Cancun Agreement:** Both developed and developing nations pledged voluntary climate targets under this agreement in 2010.
3. **Paris Agreement:** This landmark accord, reached in 2015, aims to limit global warming to well below 2° Celsius above pre-industrial levels, with an aspirational goal of limiting it to 1.5° Celsius.

1. The Kyoto Protocol was adapted at which convention?

- ○ Third conference of the UNFCC in 1997
- ○ Convention on Biological Diversity
- ○ Convention on the Trans boundary Effects of Industrial Accidents
- ○ United Nations Framework Convention on Climate Change (UNFCCC), 1992

Check

Question: 1 of 1 questions

5. United Nations Framework Convention on Climate Change (UNFCCC)

The parties to the UNFCCC have convened annually since 1995 in Conferences of the Parties (COP) to evaluate progress in addressing climate change. COP serves as the highest decision-making body of the UNFCCC. Subsequently, COP1 was held in 1995 in Berlin, Germany.

Conference of the Parties (COP28)

28th Conference of the Parties (COP28) of the UNFCCC, was held in December 2023 in Dubai, UAE. It also marked the 18th session of the Conference of the Parties to the Kyoto Protocol (CMP 18) and 5th session of the Conference of the Parties to the Paris Agreement (CMA 5). The conference yielded a mix of positive outcomes and disappointments, marking a substantial step forward since the Paris Agreement. This was the first time when the countries (197 representatives) formally assessed their progress under the 2015 Paris climate agreement.

Key outcomes from COP 28 are discussed below.

Global Stocktake Text:

- The Global Stocktake is a periodic review mechanism from the Paris Agreement.
- Proposes eight steps to limit global temperature rise to 1.5°C.
- Calls for tripling renewable energy capacity and doubling energy efficiency improvements by 2030.
- Emphasizes significant reductions in non-CO_2 emissions, especially methane, by 2030.

Transitioning Away from Fossil Fuels:

- Advocates for a just, orderly, and equitable transition away from fossil fuels.
- Aims to accelerate action in this decade to achieve net zero by 2050.

Global Goal on Adaptation (GGA):

- Focuses on enhancing adaptive capabilities and minimizing vulnerability for sustainable development.
- Calls for doubling adaptation finance and establishing assessments for adaptation needs.
- Sets a 2030 target date for goals related to water security, ecosystem restoration, and health.

Climate Finance:

- Wealthy nations are estimated to owe developing countries USD 500 billion by 2025 for climate finance.
- Aims to establish a new collective quantified goal starting from USD 100 billion per year.
- Allocates funds for mitigation, adaptation, and loss and damage.

Loss and Damage Fund:

- Agreement to operationalize a fund to compensate countries impacted by climate change.
- A specific portion is allocated for Least Developed Countries and Small Island Developing States.
- The World Bank will initially oversee the fund.

Global Renewables and Energy Efficiency Pledge:

- Signatories commit to tripling global renewable energy capacity to at least 11,000 GW by 2030.
- Aims to double the global rate of energy efficiency improvements to over 4% annually by 2030.

Global Cooling Pledge:

- 66 national governments commit to reducing cooling-related emissions by at least 68% globally by 2050, compared to 2022 levels.

Declaration to Triple Nuclear Energy:

- Launched at COP28, this declaration aims to triple global nuclear energy capacity by 2050.

India introduced Green Credit Initiative at COP 28. The Green Credit Initiative has been conceptualized as a mechanism to incentivize voluntary pro-planet actions, as an effective response to the challenge of climate change. It envisions the issue of

Green Credits for plantations on waste/degraded lands and river catchment areas, to rejuvenate and revive natural ecosystems.

Indian Prime Minister also voiced the concerns of the Global South and reiterated the urgency of making climate finance available to the developing countries.

India's Panchamrit

CoP-26 was held in Glasgow, UK, in November 2021. Notable point was the India's submission in the form of 5 nectar elements (Panchamrit) of India's climate action, which were:

1. Reach 500 GW Non-fossil energy capacity by 2030.
2. 50% of energy requirements from renewable energy by 2030.
3. Reduction of total projected carbon emissions by one billion tonnes till 2030.
4. Reduction of the carbon intensity of the economy by 45% by 2030, over 2005 levels.
5. Achieving the target of net zero emissions by 2070.

1. The 'Loss and Damage' funding in the context of climate change impacts was agreed upon by the international at **(UGC NET 2nd Mar 2023 Morning Shift)**

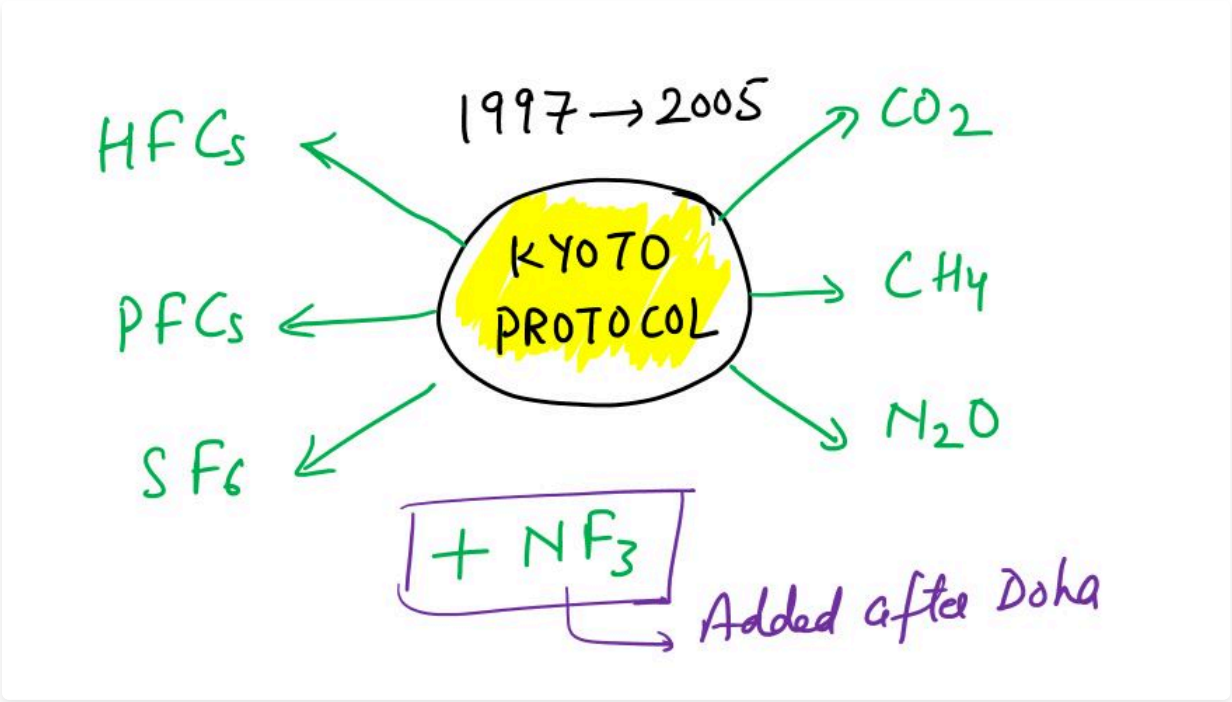
- COP 26
- COP 25
- COP 27
- COP 21

Check

Question: 1 of 1 questions

5. United Nations Framework Convention on Climate Change (UNFCCC)

The Kyoto Protocol is an international treaty which extends the 1992 UNFCCC that commits state parties to reduce greenhouse gas emissions. The Kyoto Protocol was adopted in Kyoto, Japan on 11th December 1997 and entered into force on 16th February 2005. There are currently 192 parties to the Protocol. In 1997, the Kyoto Protocol was concluded and established legally binding obligations for developed countries to reduce their greenhouse gas emissions in the period 2008–2012.



The Kyoto Protocol applies to the 6 greenhouse gases:

1. Carbon dioxide (CO_2),
2. Methane (CH_4),
3. Nitrous oxide (N_2O),
4. Hydrofluorocarbons (HFCs),
5. Perfluorocarbons (PFCs), and
6. Sulphur hexafluoride (SF_6).

The Protocol is based on the principle of common but differentiated responsibilities, which acknowledges that individual countries have different capabilities in combating climate change, owing to economic development, and therefore puts the obligation to reduce current emissions on developed countries on the basis that they are historically responsible for the current levels of greenhouse gases in the atmosphere.

Note that, the major distinction between UNFCCC and Kyoto Protocol is that while the Convention encouraged industrialized countries to stabilize GHG emissions, the Protocol commits them to do so.

Doha Amendment

The Protocol's first commitment period started in 2008 and ended in 2012. The 18th Conference of the Parties in Doha (Qatar) in 2012 agreed an amendment to the Kyoto Protocol. The 'Doha Amendment' establishes a second commitment period (2013–20), adds nitrogen trifluoride (NF_3) to the list of greenhouse gases covered, and facilitates the unilateral strengthening of commitments by individual parties. Around 147 countries have accepted the Doha Amendment, while entry into force required the acceptances of 144 states (three fourths of 192, i.e., 0.75 × 192 = 144). Thus, it came into force from 31st Dec 2020.

India ratified the second commitment period (2012-2020) of the Kyoto Protocol in August 2017, that commits countries to contain the emission of greenhouse gases, reaffirming its stand on climate action.

1. Which of the following Green House gases were the target gases whose emission was to be covered under the commitment period of the Kyoto protocol? (UGC NET 24th Nov 2021- Morning Shift)

A. SO_2
B. CO_2
C. N_2O
D. NH_3
E. CH4

- A, B, C and D only
- B, C, D and E only
- B, C and E only
- A, B and C only

Check

Question: 1 of 3 questions

5. United Nations Framework Convention on Climate Change (UNFCCC)

The Cancun Agreements are a set of significant decisions by the international community to address the long-term challenge of climate change collectively and comprehensively over time and to take concrete action now to speed up the global response. The agreements, reached in December in Cancun, Mexico, at the COP-16 (December 2010) represent key steps forward in capturing plans to reduce greenhouse gas emissions and to help developing nations protect themselves from climate impacts and build their own sustainable futures.

Key objectives of the Agreement are given below.

- Set clear objectives to reduce human-generated greenhouse gas emissions to limit global temperature rise under 2 degrees.
- Encourage all countries to reduce emissions according to their abilities.
- Ensure transparent reporting and global progress review.
- Promote the development and transfer of clean technology.
- Provide funding for developing countries to take climate action.
- Help vulnerable populations adapt to climate change.
- Preserve carbon-rich forests.
- Enhance global capacity, especially in developing nations.
- Establish effective institutions to achieve these goals.

5. United Nations Framework Convention on Climate Change (UNFCCC)

The Paris Agreement is a legally binding international treaty agreement within the UNFCCC, dealing with greenhouse-gas-emissions mitigation, adaptation, and finance, starting in the year 2020. It was adopted by 196 Parties at the UN Climate Change Conference (COP21) in Paris, France, on 12th December 2015. The Agreement opened for signature on 22 April 2016 – Earth Day – at UN Headquarters in New York. It entered into force on 4th November 2016, 30 days after "double threshold" (*ratification by 55 countries that account for at least 55% of global emissions*) had been met.

The Paris Agreement's long-term goal is:

- to keep the increase in global average temperature to well below 2 °C above pre-industrial levels; and
- to limit the increase to 1.5 °C, since this would substantially reduce the risks and effects of climate change.

Under the Paris Agreement, each country must determine, plan, and regularly report on the contribution that it undertakes to mitigate global warming. No mechanism forces a country to set a specific target by a specific date, but each target should go beyond previously set targets.

Since 2020, countries have been submitting their national climate action plans, known as *Nationally Determined Contributions (NDCs)*. Article 3 requires them to be "*ambitious*", "*represent a progression over time*" and set "*with the view to achieve the purpose of this Agreement*". The contributions should be reported every 5 years and are to be registered by the UNFCCC Secretariat. Each further ambition should be more ambitious than the previous one, known as the principle of '*progression*'. The countries can cooperate and pool their nationally determined contributions.

The level of NDCs set by each country will set that country's targets. However, the '*contributions*' themselves are not binding as a matter of international law. Furthermore, there will be no mechanism to force a country to set a target in their NDC by a specific date and no enforcement if a set target in an NDC is not met. There will be only a *"name and shame"* system.

To better frame the efforts towards the long-term goal, the Paris Agreement invites countries to formulate and submit Long-Term Low Greenhouse Gas Emission Development Strategies (LT-LEDS). LT-LEDS provide the long-term horizon to the NDCs. Unlike NDCs, they are not mandatory. Nevertheless, they place the NDCs into the context of countries' long-term planning and development priorities, providing a vision and direction for future development.

The Paris Agreement has a '*bottom up*' structure in contrast to most international environmental law treaties, which are '*top down*', characterized by standards and targets set internationally. Unlike its predecessor, the Kyoto Protocol, which sets commitment targets that have legal force, the Paris Agreement, with its emphasis on consensus-building, allows for voluntary and nationally determined targets.

Another key difference between the Paris Agreement and the Kyoto Protocol is their scope. While the Kyoto Protocol differentiated between Annex-1 and non-Annex-1 countries, this bifurcation is blurred in the Paris Agreement, as all parties will be required to submit emissions reductions plans. In other words, the Kyoto Protocol required only developed countries to reduce emissions, while the Paris Agreement recognized that climate change is a shared problem and called on all countries to set emissions targets.

While the Paris Agreement still emphasizes the principle of "*Common but Differentiated Responsibility and Respective Capabilities*"—the acknowledgement that different nations have different capacities and duties to climate action—it does not provide a specific division between developed and developing nations.

India's Nationally Determined Contribution

In August 2022, India submitted its Updated Nationally Determined Contributions (NDCs) to the United Nations Framework Convention on Climate Change (UNFCCC). It represents the framework for India's transition to cleaner energy for the period 2021-2030.

The 2015 NDC comprised 8 goals; 3 of which have quantitative targets upto namely:

1. cumulative Electric Power Installed capacity from non-fossil sources to reach 40%,
2. reduce the Emissions Intensity of GDP by 33 to 35 % compared to 2005 levels, and
3. creation of Additional Carbon Sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover.

The new NDCs have updated 2 of the 3 quantitative targets of 2015 NDCs related to emissions intensity and share of non-fossil fuels in installed electricity capacity. These are – India now stands committed to reduce Emissions Intensity of its GDP by 45 % by 2030, from 2005 level and achieve about 50 % cumulative Electric Power Installed Capacity from non-fossil fuel-based energy resources by 2030.

1. Which of the following are features of Paris Agreement? **(UGC NET 25th June 2020 Evening paper)**

(i) The agreement focuses on mitigation measures for environmental pollution.
(ii) The agreement recognizes the principles of equity and common but differentiated responsibilities.
(iii) Paris agreement pertains to 2020 climate actions.

- ○ (ii) and (iii) only
- ○ (i) and (iii) only
- ○ (i) and (ii) only
- ○ (i), (ii) and (iii)

Check

Question: 1 of 5 questions

6. Convention on Biological Diversity

The Convention on Biological Diversity (CBD), known informally as the Biodiversity Convention, is a multilateral treaty. The Convention has 3 main goals that include:

1. The conservation of biological diversity (*or biodiversity*);
2. The sustainable use of its components;
3. The fair and equitable sharing of benefits arising from genetic resources.

The Convention was opened for signature at the Earth Summit in Rio de Janeiro on 5 June 1992, and entered into force on 29th December 1993.

The organs of CBD have been discussed below.

- *Conference of the Parties:* The Convention's governing body is the Conference of the Parties (COP), consisting of all governments (*and regional economic integration organizations*) that have ratified the treaty. This ultimate authority reviews progress under the Convention, identifies new priorities, and sets work plans for members. The COP can also make amendments to the Convention, create expert advisory bodies, review progress reports by member nations, and collaborate with other international organizations and agreements.
- *Secretariat:* The CBD Secretariat, based in Montreal, operates under the United Nations Environment Programme.
- *Subsidiary body for Scientific, Technical and Technological Advice (SBSTTA):* The SBSTTA is a committee composed of experts from member governments competent in relevant fields. It plays a key role in making recommendations to the COP on scientific and technical issues.

The CBD has 2 supplementary agreements.

1. The **Cartagena Protocol** on Biosafety to the CBD is an international treaty governing the movements of Living Modified Organisms (LMOs) resulting from modern biotechnology from one country to another. It was adopted on 29th January 2000 as a supplementary agreement to the Convention on Biological Diversity and entered into force on 11th September 2003.

2. The **Nagoya Protocol** on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) to the CBD is a supplementary agreement. It provides a transparent legal framework for the effective implementation of one of the 3 objectives of the CBD, i.e., the fair and equitable sharing of benefits arising out of the utilization of genetic resources. The Nagoya Protocol on ABS was adopted on 29th October 2010 in Nagoya, Japan and entered into force on 12th October 2014.

Note that, the United Nations General Assembly (UNGA) proclaimed 2021–2030 as "*the Decade on Ecosystem Restoration*".

International Day for Biological Diversity is observed every year on 22nd May.

1. The Secretariat of Convention on Biodiversity (CBD) is based in **(UGC NET 16th Mar 2023 Morning Shift)**

- ○ Rio de Janeiro, Brazil
- ○ Geneva, Switzerland
- ○ Montreal, Canada
- ○ New York, United States

Check

Question: 1 of 2 questions

6. Convention on Biological Diversity

15th COP of United Nations Convention on Biological diversity was held in Montreal, Canada from 7th to 19th Dec 2022. At the Conference "Kunming-Montreal Global Biodiversity Framework" (GBF) was adopted. The Framework includes 4 goals and 23 targets for achievement by 2030. The Declaration was adopted by over 100 countries. The theme of the COP15 was *"Ecological Civilization: Building a Shared Future for All Life on Earth"*. Note that, KMGBF replaced Aichi Biodiversity Targets (time period 2011-2020).

Major targets for GBP are discussed below.

- 30 \(\times \) 30 Deal: Restore 30% degraded ecosystems globally (on land and sea) by 2030 and conserve and manage 30% areas (terrestrial, inland water, and coastal and marine) by 2030.
- Stop the extinction of known species, and by 2050 reduce tenfold the extinction risk and rate of all species (including unknown).
- Reduce risk from pesticides by at least 50% by 2030.
- Reduce nutrients lost to the environment by at least 50% by 2030.
- Reduce pollution risks and negative impacts of pollution from all sources by 2030 to levels that are not harmful to biodiversity and ecosystem functions.
- Reduce global footprint of consumption by 2030, including through significantly reducing overconsumption and waste generation and halving food waste.
- Tackle climate change through nature-based solutions.
- Reduce the rate of introduction and establishment of invasive alien species by at least 50% by 2030.
- Secure the safe, legal and sustainable use and trade of wild species by 2030.
- Green up urban spaces.

India at COP 15

At COP 15, India called for an urgent need to create a new and dedicated fund to help developing countries successfully implement a post-2020 global framework to halt and reverse biodiversity loss. So far, the Global Environment Facility which caters to multiple conventions, including the UNFCCC and UN Convention to Combat Desertification, remains the only source of funding for biodiversity conservation.

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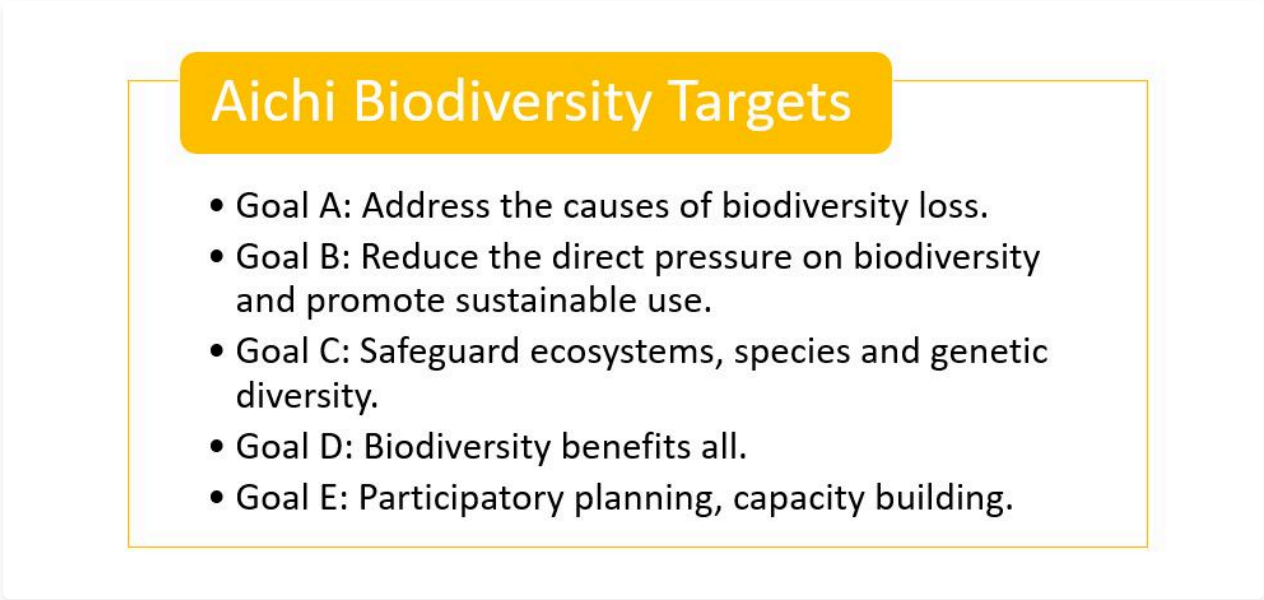
6. Convention on Biological Diversity

2011 to 2020 was declared as United Nations Decade of Biodiversity to highlight the importance of biodiversity conservation and promote actions to safeguard it. The Strategic Plan for Biodiversity 2011-2020 (SPB 2011-2020) was adopted by the parties to the CBD, during the 10th meeting of the Conference of the Parties (CoP10) in 2010 in Nagoya, Japan, with the purpose of inspiring broad-based action in support of biodiversity over the next decade by all countries and stakeholders.



The Strategic Plan is comprised of a shared vision, a mission and 20 targets organized under 5 strategic goals, collectively known as the Aichi Biodiversity Targets (ABTs).

Strategic Goal A: Address the causes of biodiversity loss.

Strategic Goal B: Reduce the direct pressure on biodiversity and promote sustainable use.

Strategic Goal C: Safeguard ecosystems, species and genetic diversity.

Strategic Goal D: Biodiversity benefits all.

Strategic Goal E: Participatory planning, capacity building.

To implement the SPB 2011-2020, Parties to CBD agreed to:

- Update their national biodiversity strategies and action plans (NBSAPs) in line with the SPB 2011-2020.
- Develop national targets (taking into account national priorities and capacities) using the Strategic Plan and ABTs as a flexible framework and integrate these national targets into the updated NBSAPs.
- Adopt the updated NBSAPs as a policy instrument for the integration of biodiversity into national development, accounting and planning processes.
- Report on progress achieved towards implementation of the Strategic Plan and Aichi Biodiversity Targets through National Reports.

Presently, the negotiations to develop the post-2020 global biodiversity framework are ongoing.

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6. Convention on Biological Diversity

Pursuant to ratification of the CBD by India in 1994, India prepared its first National Biodiversity Action Plan (NBAP) entitled "National Policy and Macro Level Action Strategy on Biodiversity" in 1999 which was revised and updated into NBAP, 2008 to bring the biodiversity agenda in alignment with the National Environment Policy (NEP), 2006. The revised NBAP was approved in November 2008.

The NBAP, 2008 was updated with Addendum 2014 in order to integrate it with the SPB 2011-20. Accordingly, India developed 12 National Biodiversity Targets (NBTs) which cover all the 20 ABTs. For overseeing and monitoring the implementation of these targets, agencies were identified on the basis of their mandate, domain areas and geographical coverage in the country. Indicators and monitoring framework were also developed for each NBT. According to India's 6th National Report, India is on track to achieve 9 out of its 12 NBTs.

These 12 Targets are given below:

1. **National Biodiversity Target 1:** By 2020, a significant proportion of the country's population, especially the youth, is aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.
2. **National Biodiversity Target 2:** By 2020, values of biodiversity are integrated in National and State planning processes, development programmes and poverty alleviation strategies.
3. **National Biodiversity Target 3:** Strategies for reducing rate of degradation, fragmentation and loss of all natural habitats are finalized and actions put in place by 2020 for environmental amelioration and human well-being.
4. **National Biodiversity Target 4:** By 2020, invasive alien species and pathways are identified and strategies to manage them developed so that populations of prioritized invasive alien species are managed.
5. **National Biodiversity Target 5:** By 2020, measures are adopted for sustainable management of agriculture, forestry and fisheries.
6. **National Biodiversity Target 6:** By 2020, more than 20% of a country's land, inland waters, coastal and marine zones, emphasizing areas crucial for species, biodiversity, and ecosystem services, should be effectively and fairly preserved. This involves designating and managing protected areas, along with other conservation measures, ensuring their integration into larger landscapes and seascapes.
7. **National Biodiversity Target 7:** By 2020, genetic diversity of cultivated plants, farm livestock and their wild relatives, including other socioeconomically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.
8. **National Biodiversity Target 8:** By 2020, ecosystem services, especially those relating to water, human health, livelihoods and wellbeing, are enumerated and measures to safeguard them are identified, taking into account the needs of women and local communities, particularly the poor and vulnerable sections.
9. **National Biodiversity Target 9:** By 2015, Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization as per the Nagoya Protocol are operational, consistent with national legislation.
10. **National Biodiversity Target 10:** By 2020, an effective, participatory and updated national biodiversity action plan is made operational at different levels of governance.
11. **National Biodiversity Target 11:** By 2020, national initiatives using communities' traditional knowledge relating to biodiversity are strengthened, with a view to protecting this knowledge in accordance with national legislations and international obligations.
12. **National Biodiversity Target 12:** By 2020, opportunities to increase the availability of financial, human and technical resources to facilitate effective implementation of the Strategic Plan for Biodiversity 2011–2020 and the national targets are identified and the Strategy for Resource Mobilization is adopted.

Also, in pursuance to the CBD, India enacted the Biological Diversity Act in 2002. which aims to protect biodiversity, ensure sustainable use of its parts, and fairly share the benefits from using biological resources and knowledge, along with related matters.

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7. United Nations Convention to Combat Desertification

The United Nations Convention to Combat Desertification (UNCCD) is a convention to combat desertification and mitigate the effects of drought through national action programs that incorporate long-term strategies supported by international cooperation and partnership arrangements.

The Convention, the only convention stemming from a direct recommendation of the Rio Conference's Agenda 21, was adopted in Paris, France on 17 June 1994 and entered into force in December 1996. It is the only internationally legally binding framework set up to address the problem of desertification. The Convention is based on the principles of participation, partnership and decentralization—the backbone of Good Governance and Sustainable Development.

The Conference of the Parties (COP) oversees the implementation of the Convention. It is established by the Convention as the supreme decision-making body, and it comprises all ratifying governments. The permanent Secretariat of the UNCCD is in Haus Carstanjen, Germany.

COP15

The 15th session of the Conference of the Parties (COP15) of the United Nations Convention to Combat Desertification (UNCCD) was held in May 2022 in Cote d'Ivoire (Western Africa). It aimed to build on the findings of the second edition of the Global Land Outlook, UNCCD flagship publication, and offer a concrete response to the interconnected challenges of land degradation, climate change and biodiversity loss. Note that, the 16th Session of the Conference is scheduled to be held in Riyadh, Saudi Arabia.

Theme: *"Land. Life. Legacy: From scarcity to prosperity".*

1. Which of the following conventions protocol originated from Rio Earth Summit? **(UGC NET 4th Nov 2020 Morn**

A. UN Framework convention on climate change
B. Ramsar convention on wetlands
C. UN convention to combat desertification
D. Kyoto Protocol
E. Convention on Biological Diversity

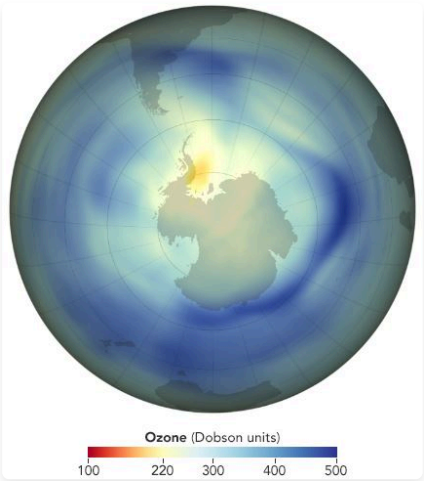
- ○ A, B and E only
- ○ A, C and E only
- ○ B, C, D and E only
- ○ A, C, D and E only

Check

Question: 1 of 1 questions

8. Ozone Layer Protection

The stratospheric ozone layer protects life on Earth by absorbing ultraviolet light, which damages DNA in plants and animals (including humans) and leads to sunburns and skin cancer. Prior to 1979, scientists had not observed atmospheric ozone concentrations below 220 Dobson Units. But in the early 1980s, through a combination of ground-based and satellite measurements, scientists began to realize that Earth's natural sunscreen was thinning dramatically over the South Pole each spring. This thinning of the ozone layer over Antarctica came to be known as the ozone hole.



3 significant conventions were held to safeguard the ozone layer:

(i) the Vienna Convention in 1985, establishing a framework for international cooperation,

(ii) the Montreal Protocol in 1987, which outlined concrete measures to phase out ozone-depleting substances, and

(iii) the Kigali Amendment in 2016, focusing on reducing hydrofluorocarbons to further protect the ozone layer and mitigate climate change.

Let us discuss them one by one.

1. Given below are two statements: **(UGC NET 5th Mar 2023 Morning Shift)**

Statement-I: International Solar Alliance's present post of President is held by India.

Statement-II: The United States of America is not a member of International Solar Alliance.

- ○ Both Statement I and Statement II are true.
- ○ Statement I is false but Statement II is true.
- ○ Both Statement I and Statement II are false.
- ○ Statement I is true but Statement II is false.

Check

Question: 1 of 1 questions

8. Ozone Layer Protection

By 1985, the world had already seen advancements in the scientific understanding of ozone depletion and its impacts on human health and the environment. It was then that the Vienna Convention for the Protection of the Ozone Layer was created in response.

The Vienna Convention for the Protection of the Ozone Layer is a treaty on the framework for international cooperation concerning the protection of the ozone layer, which was adopted in 1985 and entered into force in 1988. This agreement is a framework convention that lays out principles agreed upon by many parties. It does not, however, require countries to take control actions to protect the ozone layer. This would come later in the form of the Montreal Protocol.

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8. Ozone Layer Protection

The Montreal Protocol on Substances that Deplete the Ozone Layer is a treaty on the control of Ozone Depleting Substances (ODSs) that establishes the schedule for the phase-out of production and consumption of ODSs, as well as the scheme for trade restriction, etc. It was adopted om 16th September 1987 and entered into force in 1989 followed by a first meeting in Helsinki, May 1989. Since then, it has undergone 8 revisions, the last one in 2016 (*Kigali, adopted, but not in force*).

Universal Ratification

The Montreal Protocol is the only environmental treaty which enjoys universal ratification by 198 UN member countries.

The substances controlled by the Protocol are listed in Annexes A (CFCs, halons), B (other fully halogenated CFCs, carbon tetrachloride, methyl chloroform), C (HCFCs), E (methyl bromide), and F (HFCs).

The Multilateral Fund for the Implementation of the Montreal Protocol was established in 1991 under Article 10 of the treaty. The Fund's objective is to provide financial and technical assistance to developing country parties to the Montreal Protocol whose annual per capita consumption and production of ODS is less than 0.3 kg to comply with the control measures of the Protocol.

Phase out of HCFCs

Hydrochlorofluorocarbons (HCFCs) are gases used worldwide in refrigeration, air-conditioning and foam applications, but they are being phased out under the Montreal Protocol since deplete the ozone layer. HCFCs are both ODS and powerful greenhouse gases: the most commonly used HCFC is nearly 2,000 times more potent than carbon dioxide in terms of its Global Warming Potential (GWP). Recognizing the potential benefits to the Earth's climate, in September 2007 the Parties decided to accelerate their schedule to phase out HCFCs. Developed countries have been reducing their consumption of HCFCs and needed to completely phase them out by 2020. Developing countries agreed to start their phase-out process in 2013 and are now following a stepwise reduction until the complete phase-out of HCFCs by 2030.

As a result of the international efforts, the ozone hole in Antarctica is slowly recovering. Climate projections indicate that the ozone layer will return to 1980 levels between 2050 and 2070. Due to its widespread adoption and implementation, it has been hailed as an example of exceptional international co-operation.

1. The only UN Treaty related to environmental issues which has been ratified by all 197 UN member states is: **(U 5th Nov 2020 Morning paper)**

- ○ Paris Agreement
- ○ Basel Convention
- ○ Kyoto Protocol
- ○ Montreal Protocol

Check

Question: 1 of 3 questions

8. Ozone Layer Protection

Kigali Agreement is an amendment to Montreal Protocol adopted by the Parties at their 28th Meeting of the Parties on 15th October 2016 in Kigali, Rwanda to phase down Hydrofluorocarbons (HFC) by cutting their production and consumption. Countries agreed to add HFCs to the list of controlled substances and approved a timeline for their gradual reduction by 80-85 % by the late 2040s. It is a legally binding agreement between the signatory parties with non-compliance measures. It came into effect from 1st January 2019, after it was signed by 65 countries.

It has shown a considerable flexibility in approach while setting phase-down targets for different economies accommodating their developmental aspirations, different socio-economic compulsions, and scientific & technological capabilities. It has divided the signatory parties into 3 groups:

- The *first group* consists of rich and developed economies like USA, UK and EU countries who will start to phase down HFCs by 2019 and reduce it to 15% of 2012 levels by 2036.
- The *second group* consists of emerging economies like China, Brazil as well as some African countries who will start phase down by 2024 and reduce it to 20% of 2021 levels by 2045.
- The *third group* consists of developing economies and some of the hottest climatic countries like India, Pakistan, Iran, Saudi Arabia who will start phasing down HFCs by 2028 and reduce it to 15% of 2024-2026 levels till 2047.

It also has a provision for a multilateral fund for developing countries for adaptation and mitigation. The Technology and Energy Assessment Panel (TEAP) will take a periodic review of the alternative technologies and products for their energy efficiency and safety standards.

It was ratified by India in August 2021. India will complete its phase-down of HFCs in 4 steps from *Kigali Amendment* 2032 onwards with a cumulative reduction of 10% in 2032, 20% in 2037, 30% in 2042 and 80% in 2047. India became a Party to the Montreal Protocol on Substances that Deplete the Ozone Layer on 19th June 1992 and since then has ratified the amendments to the Montreal Protocol.

1. Kigali Amendment to the Montreal Protocol envisages reduction in HFCs consumption by late 2040s to the exte
(UGC NET 25th Nov 2021- Morning Shift)

- ○ 65-70%
- ○ 50-55%
- ○ 80-85%
- ○ 90-95%

Check

Question: 1 of 1 questions

9. International Solar Alliance

The International Solar Alliance (ISA) is an alliance of more than 121 countries initiated by India, most of them being sunshine countries, which lie either completely or partly between the Tropic of Cancer and the Tropic of Capricorn.

The primary objective of the alliance is to work for efficient exploitation of solar energy to reduce dependence on fossil fuels. This initiative was first proposed by Indian Prime Minister in a speech in November 2015 at Wembley Stadium, in which he referred to sunshine countries as Suryaputra (Sons of the Sun). The alliance is a treaty-based inter-governmental organization. The countries that do not fall within the Tropics can join the alliance and enjoy all benefits as other members, with the exception of voting rights.

In May 2024, Spain became the 99th member of the International Solar Alliance (ISA). At present, 119 countries are signatories to the ISA Framework Agreement, 119th being Malta, of which 98 countries have submitted the necessary instruments of ratification to become full members of the ISA.

It was launched at the United Nations Climate Change Conference in Paris (COP21) in November 2015 (on the sidelines of COP 21), by the then Prime Minister of India, Narendra Modi, and the then President of France, François Hollande. The framework agreement of International Solar Alliance (ISA) was opened for signature of member countries in Marrakesh, Morocco. It is headquartered in India (Gurgaon). The alliance is also called International Agency for Solar Policy and Application (IASPA).

India has pledged a target of installing 100 GW by 2022 and reduction in emission intensity by 33-35% by 2030 to let solar energy reach to the most unconnected villages and communities and also towards creating a clean planet. Note that, India's pledge to the Paris Summit offered to bring 40% of its electricity generation capacity (not actual production) from non-fossil sources (renewable, large hydro, and nuclear) by 2030.

The alliance has partnered with the World Bank to launch Global Solar Atlas. The Global Solar Atlas is a free online tool that displays annual average solar power potential at any location in the world and thus identifies potential sites for solar power generation.

One Sun One World One Grid (OSOWOG)

The declaration was adopted in Glasgow in November 2021 by the ISA. The vision behind the OSOWOG initiative is the mantra that "the sun never sets". The OSOWOG initiative aims to connect different regional grids through a common grid that will be used to transfer renewable energy power and, thus, realize the potential of renewable energy sources, especially solar energy.

1. Given below are two statements: **(UGC NET 15th Mar 2023 Morning Shift)**

Statement I: International Solar Alliance (ISA) is an alliance of countries most of which lie between tropic of cance

Statement II: Presently, ISA is headed by India.

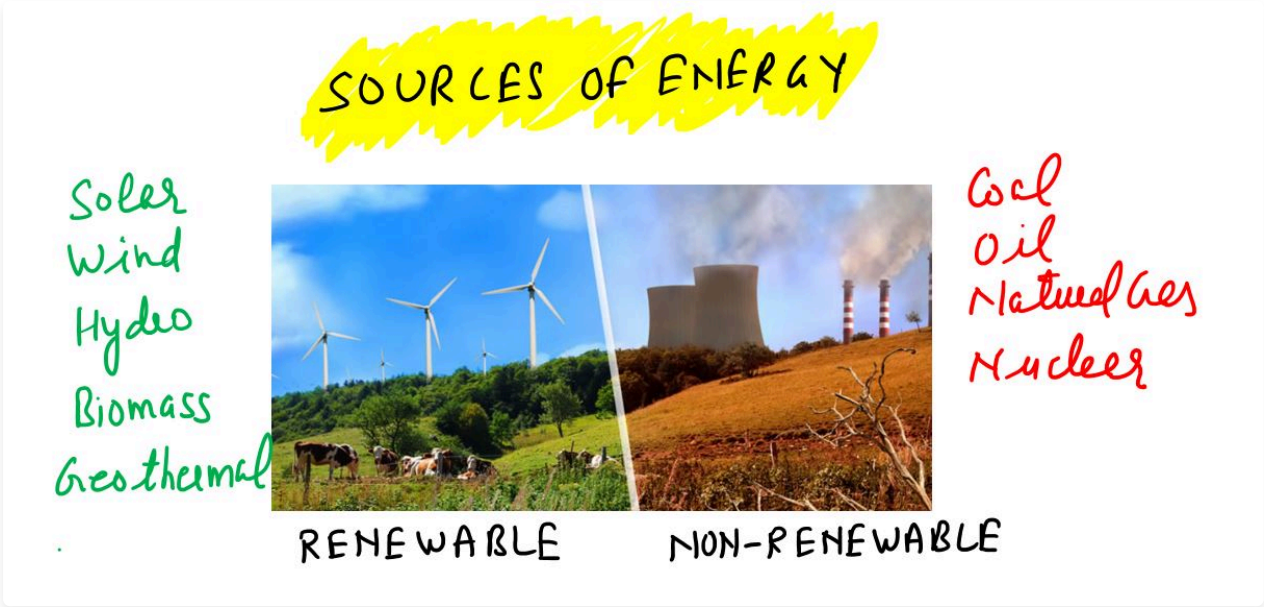
- Both Statement I and Statement II are correct.
- Statement I is correct but Statement II is incorrect.
- Both Statement I and Statement II are incorrect.
- Statement I is incorrect but Statement II is correct.

Check

Question: 1 of 3 questions

1. Renewable and Non-Renewable Sources

Renewable sources of energy are those that are replenished naturally and can be sustained over the long term. They have minimal environmental impact and contribute to a cleaner, more sustainable energy future.



Examples of renewable sources include:

- *Solar Energy:* Harnessing sunlight to generate electricity using solar panels or through Concentrated Solar Power (CSP).
- *Wind Energy:* Utilizing the kinetic energy of the wind to generate electricity through wind turbines.
- *Hydropower:* Generating electricity by harnessing the energy of flowing or falling water in rivers and dams.
- *Biomass:* Using organic materials like wood, crop residues, and animal waste to produce energy through combustion or biofuel production.
- *Geothermal Energy:* Tapping into the Earth's internal heat to generate electricity or provide direct heating.

Non-renewable sources of energy are finite and deplete over time. They are derived from fossil fuels and have significant environmental consequences, including air pollution and greenhouse gas emissions.

Examples of non-renewable sources include:

- *Coal:* A fossil fuel formed from plant remains over millions of years, burned for electricity generation.
- *Oil (Petroleum):* Extracted from underground reservoirs, refined into various products like gasoline, diesel, and jet fuel.
- *Natural Gas:* A hydrocarbon gas extracted from beneath the Earth's surface, often used for heating and electricity generation.
- *Nuclear Energy:* Produced by nuclear reactions, typically in the form of nuclear fission, to generate electricity.

Nuclear energy is usually considered non-renewable energy source. This is because, although nuclear energy itself is a renewable energy source, the material used in nuclear power plants is not.

Note that, the Government of India in its submission to the United Nations Framework Convention on Climate Change on Intended Nationally Determined Contribution (INDC), has stated that India will achieve 40% cumulative Electric power capacity from non-fossil fuel based energy resources by 2030. This will be achieved with the help of transfer of technology and low cost International Finance including from Green Climate Fund.

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2. Sources of Energy

Conventional sources of energy are those that have been widely used for a long time and are the traditional methods of producing power. These sources are generally characterized by being well-established and having a long history of industrial use.

Non-Conventional Sources of energy, also known as renewable or alternative energy sources, are newer and often considered more environmentally friendly. They are characterized by their sustainability and reduced environmental impact.

The list of Conventional and Non-Conventional sources of energy are discussed next.

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2. Sources of Energy

A Thermal Power Plant is a facility that converts thermal energy (heat) into electrical energy. The primary source of thermal energy for these power plants is the combustion of fossil fuels such as coal, oil, or natural gas, coal-based being prominent in India.

The heat generated from the burning of fuel is used to produce high-pressure steam in a boiler. The high-pressure steam is directed onto the blades of a turbine. The steam's high kinetic energy turns the turbine, converting thermal energy into mechanical energy. The rotating turbine is connected to a generator. As the turbine spins, it causes the generator to rotate, converting the mechanical energy into electrical energy.

Although, fossil fuels are the most common energy source for thermal power plants, there are efforts to explore cleaner alternatives becuase of its harmful impacts on environment. The major pollutants from coal-fired power plants are the oxides of nitrogen oxide (NO_x), sulphur oxide (SO_2), and particulate matter.

Carbon Intensity typically measures the amount of CO_2 emitted per unit of energy obtained from burning those fuels. It is an important metric for evaluating the environmental impact of energy production and consumption. Different fuels emit different amounts of carbon dioxide (CO_2) in relation to the energy they produce when burned. Given below are the decreasing order of carbon intensity.

Coal > Petroleum > Natural Gas

1. Arrange the following fossil fuels in increasing order of their carbon intensities (gC/MJ): **(UGC NET 09 July 202 Evening shift)**

A. Natural gas
B. Coal
C. Petroleum

- ○ A<C<B
- ○ C<A<B
- ○ A<B<C
- ○ B<A<C

Check

Question: 1 of 2 questions

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2. Sources of Energy

Hydropower plants generate electricity by utilizing the kinetic energy of flowing water. They are typically located near rivers, streams, or other water bodies. Many hydropower plants use a dam to create a reservoir, which stores water at a higher elevation. The dam controls the flow of water and helps regulate electricity generation. The process includes the conversion of kinetic energy of water into mechanical energy by turbines, which is then transformed into electrical energy by generators. This type of energy generation is renewable, reliable, and environmentally friendly, with minimal greenhouse gas emissions.

Hydro power projects are generally categorized in two segments i.e. small and large hydro. In India, hydro projects up to 25 MW station capacities have been categorized as Small Hydro Power (SHP) projects. While Ministry of Power, Government of India is responsible for large hydro projects, the mandate for the subject small hydro power (up to 25 MW) is given to Ministry of New and Renewable Energy. Small hydro power projects are further classified as:

Class	Station Capacity in kW
Micro Hydro	Up to 100
Mini Hydro	101 to 2,000
Small Hydro	2,001 to 25,000

There are 3 types of hydropower facilities:

1. *Impoundment or Storage Hydropower:* Uses a dam to create a reservoir, allowing for controlled release of water to generate electricity.
2. *Run-of-River Hydropower:* Generates electricity using the natural flow of a river without a significant reservoir. This type often includes a diversion structure to channel water through the plant.
3. *Pumped Storage Hydropower:* Involves two reservoirs at different elevations. During periods of low electricity demand, excess electricity is used to pump water from the lower reservoir to the upper reservoir. During peak demand, water is released from the upper reservoir to generate electricity.

1. According to the classification of Ministry of New and Renewable Energy and Central Electricity Authority of Ind hydro power plants have capacity in the range: **(UGC NET 30th Sept 2020 Evening paper)**

- ○ 1-100 kW
- ○ 1-25 MW
- ○ 1-50 MW
- ○ 100-1000 kW

Check

Question: 1 of 1 questions

2. Sources of Energy

Wind Power Generation means getting the electrical energy by converting wind energy into rotating energy of the blades and converting that rotating energy into electrical energy by the generator. Wind energy increases with the cube of the wind speed, therefore plants should be installed in the higher wind speed area.

Wind farms are large-scale installations consisting of multiple wind turbines strategically positioned across an area with the primary purpose of harnessing wind energy to generate electricity. These turbines, also known as wind generators or windmills, are connected to a power grid to distribute the electricity they produce.

Gujarat has highest wind energy potential followed by Karnataka, Maharashtra, Andhra Pradesh and Tamil Nadu. China is leading producer of wind energy.

1. Wind energy is very sensitive to the wind velocity because wind power is directly proportional to the: **(UGC NET 2020 Evening paper)**

- ○ cube of the wind velocity
- ○ square root of the wind velocity
- ○ wind velocity
- ○ square of the wind velocity

Check

Question: 1 of 2 questions

2. Sources of Energy

Electricity generation from solar energy involves converting sunlight into electrical power through the use of solar panels. These panels consist of interconnected photovoltaic cells made of semiconductor materials such as silicon. When sunlight hits these cells, it excites electrons, creating an electric current which is a direct current (DC). The direct current (DC) is then sent to an inverter, which converts it into alternating current (AC) electricity. AC is the standard form of electricity used in homes and on the power grid.

The solar energy reaching unit area at outer edge of the earth's atmosphere exposed perpendicularly to the rays of the Sun at the average distance between the Sun and earth is known as the *solar constant*. It is estimated to be approximately 1.4 kJ per second per square metre.

India is lucky to receive solar energy for greater part of the year. It is estimated that during a year India receives the energy equivalent to more than 5,000 trillion kWh.

Solar Ponds are specialized solar energy systems that utilize the sun's energy to collect, trap, and store heat within a large, shallow body of water. They are designed to efficiently capture solar radiation and convert it into thermal energy, which can be used for various applications, including space heating, water heating, and electricity generation. The key to the efficiency of solar ponds lies in the salt gradient created within the pond. The gradual increase in salinity from the top layer to the bottom layer creates a stable density gradient. This prevents the warm water from rising to the surface and losing heat through convection, thus allowing the solar pond to effectively trap and store solar energy.

1. Which of the following sources of energy has the maximum potential in India?

- ○ Wind energy
- ○ Tidal energy
- ○ Ocean thermal energy
- ○ Solar energy

Check

Question: 1 of 2 questions

2. Sources of Energy

Tidal energy is a form of power produced by the natural rise and fall of tides caused by the gravitational interaction between Earth, the sun, and the moon. Tidal currents with sufficient energy for harvesting occur when water passes through a constriction, causing the water to move faster. Using specially engineered generators in suitable locations, tidal energy can be converted into useful forms of power, including electricity. Other forms of energy can also be generated from the ocean, including waves, persistent ocean currents, and the differences in temperature and salinity in seawater. Suitable locations for capturing tidal energy include those with large differences in tidal range, which is the difference between high tide and low tides, and where tidal channels and waterways become smaller and tidal currents become stronger. The potential of Tidal Energy in India is 12 GW.

Wave energy is derived from the movement of ocean waves. It involves capturing the kinetic and potential energy present in the up-and-down motion of waves. Various technologies are employed to convert wave energy into electricity, including oscillating water columns, point absorbers, attenuators, and oscillating bodies. These systems use the movement of waves to create air oscillations within a chamber, which then drive a turbine connected to a generator. The potential of Waves Energy in India is 40 GW.

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2. Sources of Energy

Ocean Thermal Energy technology that utilizes the temperature difference between warm surface water and cold deep water in the ocean to generate electricity.

Ocean thermal energy conversion, or OTEC, uses ocean temperature differences from the surface to depths lower than 1,000 meters, to extract energy. A temperature difference of only 20°C can yield usable energy. Research focuses on two types of OTEC technologies to extract thermal energy and convert it to electric power: closed cycle and open cycle. In the closed cycle method, a working fluid, such as ammonia, is pumped through a heat exchanger and vaporized. This vaporized steam runs a turbine. The cold water found at the depths of the ocean condenses the vapor back to a fluid where it returns to the heat exchanger. In the open cycle system, the warm surface water is pressurized in a vacuum chamber and converted to steam to run the turbine. The steam is then condensed using cold ocean water from lower depths. The potential of Ocean Thermal Energy in India is 180 GW.

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2. Sources of Energy

Geothermal energy is heat energy from the earth — Geo (earth) + thermal (heat). Geothermal resources are reservoirs of hot water that exist or are human made at varying temperatures and depths below the Earth's surface. Wells, ranging from a few feet to several miles deep, can be drilled into underground reservoirs to tap steam and very hot water that can be brought to the surface and used to drive turbines connected to generators. This process converts the Earth's thermal energy into electrical power.

Sources of Geothermal Energy

Several elements and geological processes contribute to the existence and harnessing of geothermal energy. Key elements responsible for geothermal energy:

- *Heat from the Earth's Interior:* The Earth's interior contains a vast amount of heat generated by the decay of radioactive isotopes (such as Potassium-40 and Thorium-232) and residual heat from the planet's formation. This heat flows towards the surface through conduction and convection, contributing to the temperature gradient that makes geothermal energy extraction possible.
- *Geothermal Reservoirs:* Geothermal reservoirs are subsurface areas where high temperatures and pressure lead to the accumulation of steam, hot water, or dry rocks with significant thermal energy. These reservoirs are critical for harnessing geothermal energy.
- *Magma and Volcanic Activity:* Regions with active volcanic activity, where magma is relatively close to the Earth's surface, provide excellent opportunities for geothermal energy extraction. The heat from magma can directly heat surrounding rock formations or contribute to the formation of geothermal reservoirs.
- *Hot Springs and Geysers:* Hot springs and geysers are surface manifestations of geothermal activity. They occur when geothermally heated water or steam escapes to the Earth's surface. Geothermal power plants often tap into these hot springs or use geysers to generate electricity.
- *Faults and Fractures:* Faults and fractures in the Earth's crust can create pathways for heated fluids to rise to the surface, forming geothermal reservoirs. These geological features play a role in the development of geothermal resources.
- *Hydrothermal Systems:* Hydrothermal systems involve the circulation of water through the Earth's crust, where it is heated and then rises to the surface. These systems create conditions suitable for geothermal power generation.
- *Groundwater Circulation:* Groundwater circulation through permeable rock formations can absorb heat from the Earth's interior. This heated water can then be extracted for geothermal energy production.
- *Temperature Gradients:* The Earth's interior exhibits a temperature gradient, meaning that temperatures increase with depth. This gradient allows for the extraction of heat from the Earth's interior for various geothermal applications.
- *Tectonic Plate Boundaries:* Geothermal resources are often found near tectonic plate boundaries, where movements of the Earth's plates can lead to the creation of faults, fractures, and volcanic activity. These geological processes contribute to the development of geothermal reservoirs.

The most active geothermal resources are usually found along major tectonic plate boundaries where most volcanoes are located, also known as subduction zone. Most prominent geothermal sites in the world are - circum pacific belt (also called ring of fire), himalayan region (specifically Puga Valley, Ladakh), East Africas Rift Valley among others.

Main environmental concern associated with geothermal energy is the release of hydrogen sulphide gas, a naturally occurring component in geothermal fluids.

1. The main environmental concern associated with geothermal energy is the release of **(UGC NET 24th Dec 202 Evening shift)**

- ○ Methane
- ○ Carbon monoxide
- ○ Carbon dioxide
- ○ Hydrogen sulphide

Check

Question: 1 of 2 questions

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2. Sources of Energy

Waste-to-Energy (WTE) is a process that involves the conversion of non-recyclable solid waste materials into usable forms of energy, typically electricity or heat.

Various technologies are used for WTE, including incineration, anaerobic digestion, and gasification.

1. *Incineration:* Involves the controlled burning of waste materials at high temperatures. The heat produced is used to generate steam, which drives turbines to produce electricity.
2. *Anaerobic Digestion:* Biological process where microorganisms break down organic waste in the absence of oxygen. This produces biogas, mainly methane, which can be used for electricity generation or as a fuel.
3. *Gasification:* Converts solid waste into a synthetic gas (syngas) by heating it in a low-oxygen environment. The syngas can be used for electricity generation or converted into biofuels.

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3. India' Growth Story

As per a Government report, published in 2021, the total potential for renewable power generation in the country is estimated at 1,097 GW. This includes solar power potential of 68.25% (749 GW), wind power potential of 27.54% (302 GW), Small-Hydro Power (SHP) potential of 1.93% (20 GW), and Biomass power of 1.60%.

As reported till March 2025, out of total power generated approximately 52% is from fossil fuels (Thermal power (Coal is major source followed by Gas, lignite and Oil)). Remaining 48% is from non-fossil fuels, which includes:

- Large Hydro 10%
- Nuclear 2%
- Residual (MNRE) 36%, which can be further divided into:

(i) Wind Energy 10%
(ii) Solar 21%
(iii) Small Hydro Project 1%
(iv) Bio Power 2%
(v) Waste to Energy conversion <1%.

These are approximate values and are changing very fast on monthly basis, as contribution of solar and wind energy is increasing.

India has 4^{th} Global position for overall installed renewable energy capacity, 4^{th} position for wind power and 5^{th} position for solar power, as in 2023.

India's Target

- India has set a target to reduce the carbon intensity of the nation's economy by less than 45% by the end of the decade, achieve 50 % cumulative electric power installed by 2030 from renewables, and achieve net-zero carbon emissions by 2070.
- India aims for 500 GW of renewable energy installed capacity by 2030.
- India aims to produce 5 million tonnes of green hydrogen by 2030. This will be supported by 125 GW of renewable energy capacity.

The Government of India had earlier (in year 2015) set a target of 175 GW renewable power installed capacity by the end of 2022. This includes 60 GW from wind power, 100 GW from solar power, 10 GW from biomass power and 5 GW from small hydro power.

Against the target of achieving 175 GW of Renewable Energy (excluding Large Hydro) installed capacity by 2022, a total of 119 GW renewable energy capacity (excluding large hydro) was installed in the country till Nov 2022.

The Government has taken several steps to promote renewable energy in the country. These include :

- Permitting Foreign Direct Investment (FDI) up to 100 percent under the automatic route,
- Waiver of Inter State Transmission System (ISTS) charges for inter-state sale of solar and wind power for projects to be commissioned by 30th June 2025,
- Schemes such as Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM), Solar Rooftop Phase II, 12000 MW CPSU Scheme Phase II, etc,
- Laying of new transmission lines and creating new sub-station capacity under the Green Energy Corridor Scheme for evacuation of renewable power.
- PM-KUSUM (Prime Minister-Kisan Urja Suraksha evam Utthaan Mahabhiyan) was launched in 2019 with the objective of providing financial and water security to farmers.

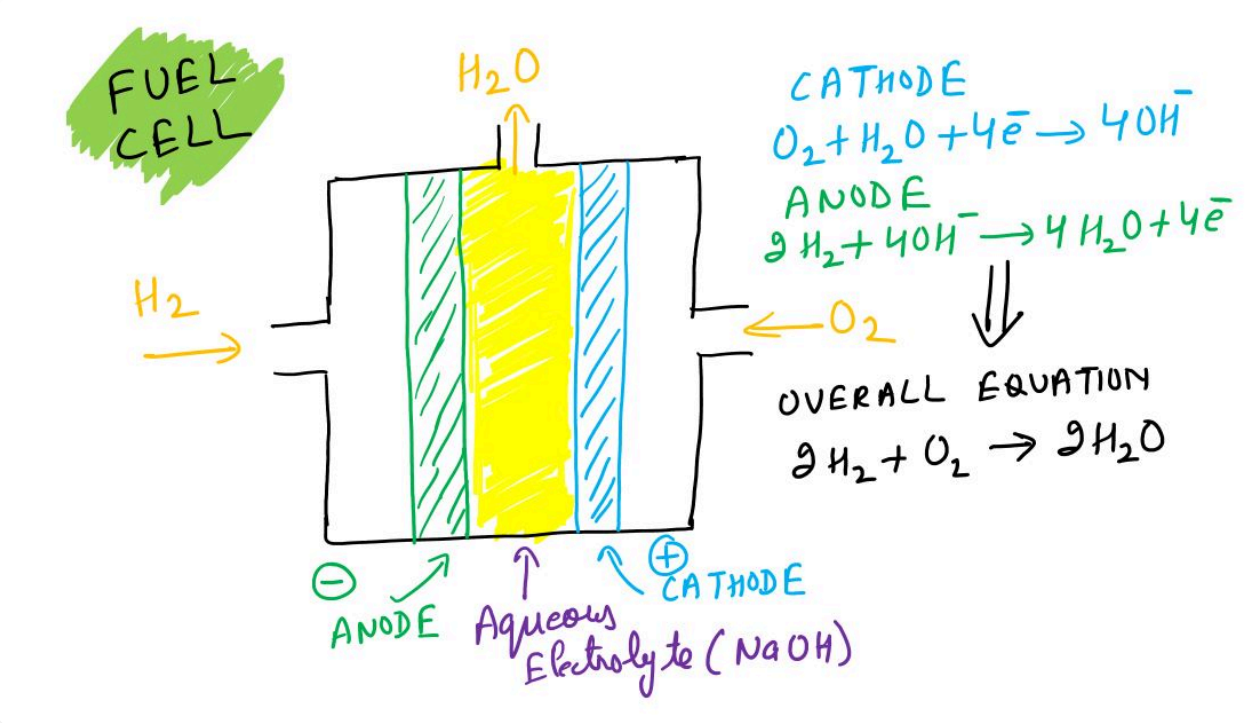
1. Which sector contributes maximum to the India's total electricity production? **(UGC NET 6th Mar 2023 Evening**

- Thermal
- Hydro
- Nuclear
- Renewable

Check

Question: 1 of 3 questions

4. Fuel Cell



A **Fuel Cell** is an electrochemical device that converts the chemical energy stored in a fuel directly into electrical energy through a chemical reaction. Unlike traditional combustion-based power generation, fuel cells operate without combustion, which makes them more efficient and environmentally friendly.

The Fuel Cell requires a supply of hydrogen gas as the fuel. Hydrogen is the most common fuel used in fuel cells due to its high energy content and environmentally friendly nature. Once produced, hydrogen generates electrical power in a fuel cell, emitting only water vapor and warm air.

In the fuel cell, hydrogen and oxygen are bubbled through porous carbon electrodes into concentrated aqueous sodium hydroxide solution. Catalysts like finely divided platinum or palladium metal are incorporated into the electrodes for increasing the rate of electrode reactions.

The cell runs continuously as long as the reactants are supplied. Fuel cells produce electricity with an efficiency of about 70 % compared to thermal plants whose efficiency is about 40%.

Applications of Fuel Cell can be classified into 3 broad sectors:

1. Transport,
2. Portable such as military applications, Auxiliary Power Units, laptops etc., and
3. Stationary such as power to industrial/commercial/residential buildings etc.

1. Concept behind Fuel Cell Vehicles (FCVs) is **(UGC NET 11 July 2022 Morning shift)**

- ○ Using rechargeable batteries to run cars
- ○ Using solar energy to run cars
- ○ Using hydrogen and oxygen to run cars
- ○ Using improvised CNG to run cars

Check

Question: 1 of 2 questions

5. Biomass

Biomass refers to organic materials, often plant-based, used as a renewable energy source. It can include things like wood, agricultural residues, or even dung. When bacteria interact with biomass, they can break it down through various processes like fermentation or decomposition. For instance, certain bacteria, like methanogens, act on biomass in anaerobic conditions, breaking down organic matter such as cellulosic materials, and producing gases like methane, carbon dioxide, and hydrogen. This bacterial action is crucial in processes like biogas production, where organic materials are broken down by bacteria to produce usable gases for energy.

Biomass is used as fodder for both biogas and biofuels.

1. Given below ate two statements: One is labelled as Assertion A and the other is labelled as Reason R **(UGC NI Oct 2022 Morning shift)**

Assertion A: Energy produced from biomass is considered ‘carbon neutral’

Reason R: Biomass does not add CO_2 to the atmosphere

- ○ Both A and R are correct but R is not the correct explanation of A
- ○ A is correct but R is not correct
- ○ A is not correct but R is correct.
- ○ Both A and R are correct and R is the correct explanation of A

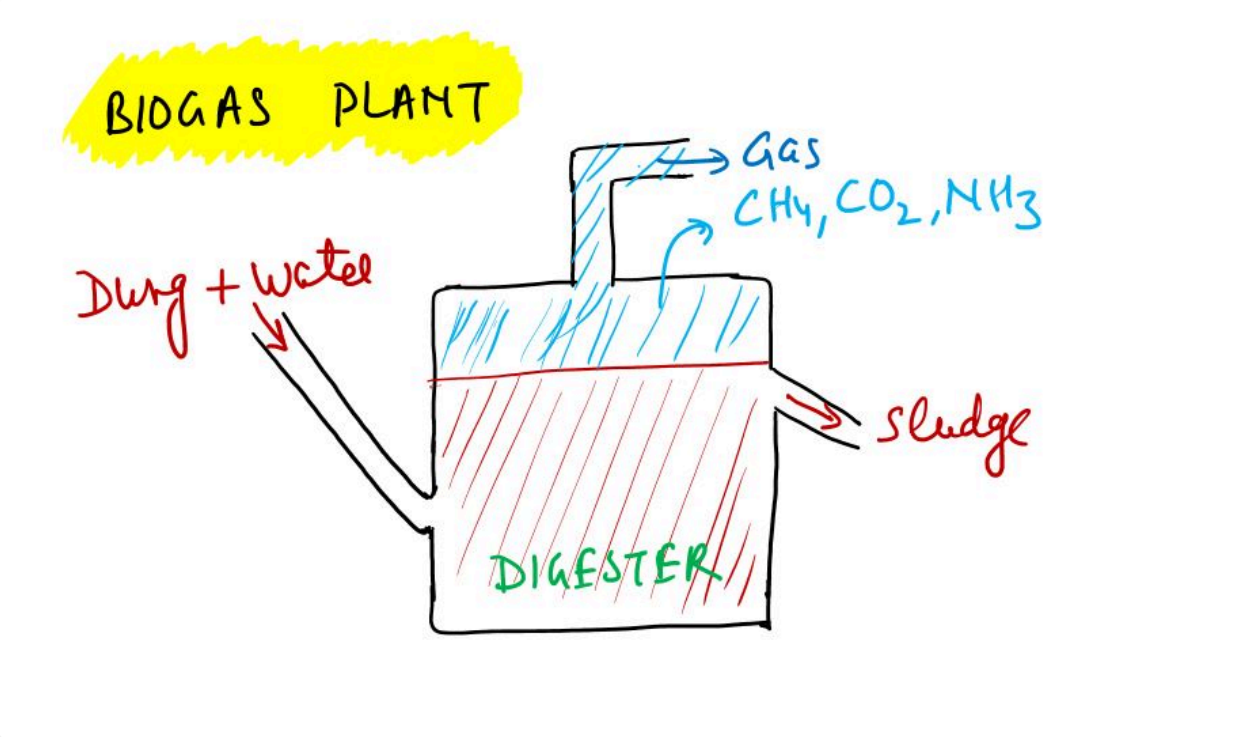
Check

Question: 1 of 1 questions

5. Biomass

Biogas a renewable fuel that's produced when organic matter, such as food or animal waste, is broken down by microorganisms in the absence of oxygen. This process is called anaerobic digestion. For this to take place, the waste material needs to be enclosed in an environment where there is no oxygen. Biogas can occur naturally or as part of an industrial process to intentionally create it as a fuel.

The process occured in a typical biogas plant is described below.



Bio-mass materials are collected from various sources, including wood, agricultural residues, vegetable waste, and cow-dung. For bio-gas production, cow-dung is typically mixed with water in a mixing tank to create a slurry that can be easily processed.

The slurry is then fed into a sealed chamber called the digester, where anaerobic micro-organisms thrive. In this oxygen-free environment, these micro-organisms decompose the complex compounds present in the slurry.

Over a few days, the anaerobic digestion process generates gases such as methane, carbon dioxide, hydrogen, and hydrogen sulphide. The primary component is methane, making bio-gas an excellent fuel. A floating cover is placed over the slurry, which keeps on rising as the gas is produced in the tank due to the microbial activity.

The produced bio-gas is stored in a gas tank located above the digester. From there, the gas is drawn through pipes for various applications, such as cooking, heating, and electricity generation.

As the anaerobic digestion process progresses, the slurry is left behind as a by-product. This nutrient-rich residue is periodically removed and used as high-quality manure, containing valuable nitrogen and phosphorous.

Cattle dung is available in large quantities in rural areas where cattle are used for a variety of purposes. So biogas plants are more often built in rural areas.

In terms of their abundance, the correct sequence of various components of biogas are:

Methane (CH_4) > Carbon dioxide (CO_2) > Hydrogen sulfide (H_2S) >Ammonia (NH_3)

Gobar Gas

Certain bacteria called methanogens grow without oxygen on cellulosic materials and produce methane, CO_2, and H_2. They are found in places like sewage treatment and in the stomachs of cattle, where they aid in breaking down cellulose, which is a big part of their diet. Humans can't digest cellulose like these bacteria can. Because of this, cattle dung, known as gobar, is packed with these bacteria. It can be used to make biogas, commonly called gobar gas.

1. What is the correct sequence of various components of biogas in terms of their abundance? **(UGC NET 14th C Morning shift)**

A. Ammonia (NH_3)
B. Hydrogen Sulfide (H_2 S)
C. Methane (CH_4)
D. Carbon dioxide (CO_2)

- ○ D > C > B > A
- ○ C > D > A > B
- ○ C > D > B > A
- ○ B > D > A > C

Check

Question: 1 of 2 questions

5. Biomass

Biofuels refers to a type of liquid fuel that is derived from biomass—organic materials or living organisms. They can be blended with existing automotive fuels. The production of biofuels involves converting biological materials into fuel sources that can be used for energy, typically as a substitute for or additive to conventional fossil fuels.

The 2 most common types of biofuels in use today are ethanol and biodiesel, both of which represent the first generation of biofuel technology.

1. *Bioethanol:* Produced through the fermentation of sugars in crops such as corn, sugarcane, and wheat.
2. *Biodiesel:* Produced from vegetable oils (such as soybean oil, canola oil) or animal fats through a process called transesterification.

Biofuels can be broadly categorized into 4 main groups:

1. First-Generation (1G) biofuels are derived from food crops or feedstocks that are also used for human consumption.
2. Second-Generation (2G) biofuels are produced from non-food crops, agricultural residues, and other biomass materials. These feedstocks are often referred to as lignocellulosic biomass.
3. Third-Generation (3G) biofuels are derived from algae or other non-food aquatic plants. Algae biofuels can produce lipids that can be converted into biodiesel, and other components can be used for bioethanol or biogas production.
4. Fourth-Generation biofuels (4G) are the amalgamation of genomically prepared microorganisms and genetically engineered feedstock. These feedstocks can be grown in nonarable land.

It is to be noted that Biomass fuels have the potential to from a sustainable carbon-neutral energy source because they produce carbon dioxide (CO_2) on combustion as much as they consume when they grow.

1. Which of the following are biofuels? **(UGC NET 5th Mar 2023 Morning Shift)**

A. Gasoline
B. Methanol
C. Methane
D. Ethanol

- ○ A, B and C only
- ○ A and D only
- ○ B, C and D only
- ○ B and D only

Check

Question: 1 of 1 questions

6. Nuclear Energy

Nuclear energy is made through a process called **nuclear fission**. In this process, the nucleus of a heavy atom, like Uranium or Plutonium, is hit by low-energy neutrons, causing it to split into smaller nuclei. When this happens, a lot of energy is released if the original nucleus is slightly heavier than the sum of the smaller nuclei. For example, the fission of a uranium atom produces 10 million times more energy than burning a carbon atom from coal.

The most common fuel for nuclear power plants is Uranium-235 (U-235). Natural uranium, found in the Earth's crust, is typically composed mostly of Uranium-238 (U-238) with a small percentage of U-235. To use uranium as fuel, it is often necessary to enrich the concentration of U-235 through a process called **uranium enrichment**. Other fissile material include Uranium-233 and Plutonium 239.

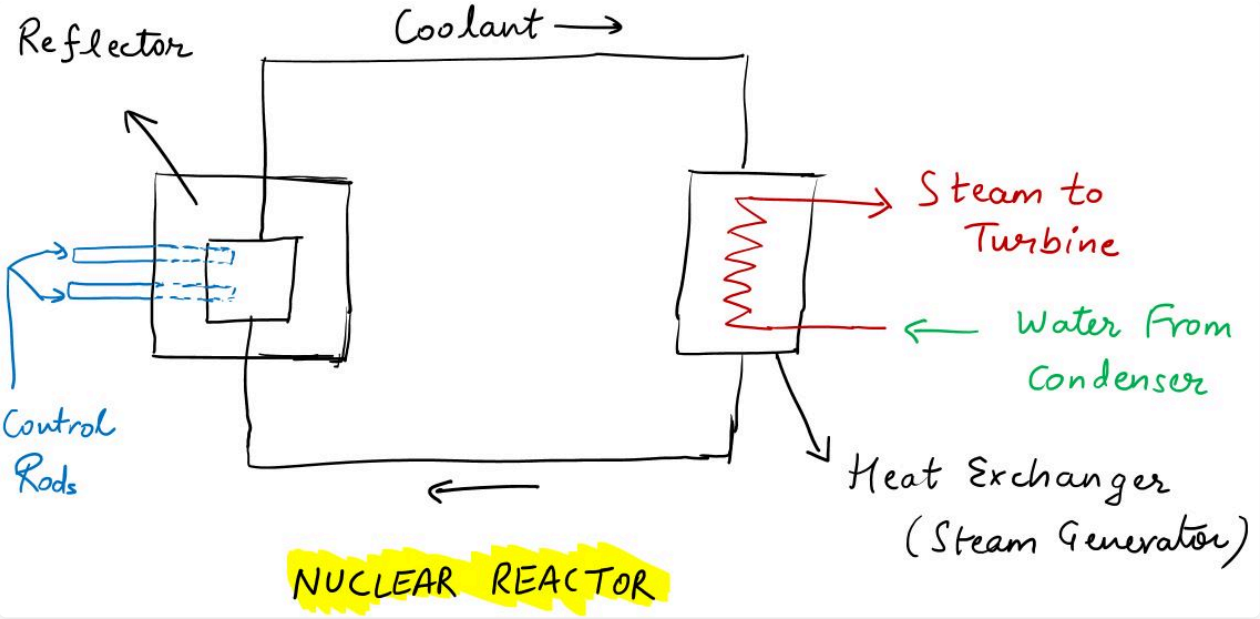
Within a Nuclear Reactor, nuclear fission takes place. In a reactor meant for generating electricity, the nuclear "fuel" allows a sustained fission chain reaction. When a nucleus splits, it emits neutrons capable of triggering nearby nuclei to split as well, setting off a chain reaction. Through careful control of this reaction, a consistent energy output is produced, serving as a source to generate electricity. This controlled process characterizes the functioning of a nuclear reactor. Conversely, an uncontrolled chain reaction results in an explosive release of energy, similar to what occurs in a nuclear bomb.

There is, however, a hurdle in sustaining a chain reaction. It is known experimentally that slow neutrons are much more likely to cause fission in U-235 than fast neutrons. Also if these neutrons are not slowed down, they will escape the reactor without interacting with uranium nuclei. To sustain the chain reaction without using a vast amount of fissionable material, the fast neutrons need to be slowed down. This is done by having them undergo **elastic scattering** with light nuclei.

Experiments (James Chadwick Experiment) showed that in an elastic collision with hydrogen, the neutron almost stops, and the proton carries away the energy. It's similar to when a moving marble hits another marble at rest. Therefore, in reactors, light nuclei called **moderators** are used along with fissionable nuclei to slow down fast neutrons. Commonly used moderators include water, heavy water (D_2O), and graphite. For example, the Apsara reactor at the Bhabha Atomic Research Centre (BARC), Mumbai, uses water as a moderator. Other Indian reactors used for power production use heavy water as a moderator. Note that, light-water nuclear reactors uses ordinary water (H_2O) as moderator.

Because of the use of moderator, it is possible that the ratio, K, of number of fission produced by a given generation of neutrons to the number of fission of the preceeding generation may be greater than 1. This ratio is called the multiplication factor; it is the measure of the growth rate of the neutrons in the reactor. For K = 1, the operation of the reactor is **said to be critical**, which is what we wish it to be for steady power operation. If K becomes greater than one, the reaction rate and the reactor power increases exponentially. Unless the factor K is brought down very close to unity, the reactor will become supercritical and can even explode. The explosion of the Chernobyl reactor in Ukraine in 1986 is one such example of nuclear accident.

The reaction rate is controlled through **control rods** made out of neutron-absorbing material such as cadmium. In addition to control rods, reactors are provided with safety rods which, when required, can be inserted into the reactor and K can be reduced rapidly to less than unity.



The Figure shows the schematic diagram of a nuclear reactor based on thermal neutron fission. The core of the reactor is the site of nuclear fission. It contains the **fuel rods**, which is enriched uranium, formed into ceramic pallets.

The core contains a moderator to slow down the neutrons. The core is surrounded by a reflector to reduce leakage. The energy (heat) released in fission is continuously removed by a suitable **coolant**. A containment vessel prevents the escape of radioactive fission products. The whole assembly is shielded to check harmful radiation from coming out. The reactor can be shut down by means of rods (made of, for example, cadmium) that have high absorption of neutrons. The coolant transfers heat to a working fluid which in turn may produce stream. The steam drives turbines and generates electricity. Common coolants include water, pressurized heavy water, or liquid sodium.

The steam is directed to a turbine, causing it to spin. The spinning turbine is connected to a generator, converting the mechanical energy into electrical energy. After passing through the turbine, the steam is condensed back into water using a cooling system. The condensed water is returned to the reactor to repeat the process.

India Thorium Reserve

India has abundant quantity of thorium resources contained in the mineral monazite occurring in the beach sand placer deposits along the eastern and western coasts of the country as well as the inland placers in parts of Kerala, Tamil Nadu, Odisha, Andhra Pradesh, West Bengal, Jharkhand and Chhattisgarh. The Department of Atomic Energy (DAE) through its Atomic Minerals Directorate for Exploration & Research (AMD) has carried out exploration activities which have resulted in establishing in situ resources of more than 11 million tonnes of monazite. Indian Monazite contains about 9-10% of Thorium oxide (ThO_2). On account of physics characteristics of Thorium, it is however not possible to build a nuclear reactor using Thorium alone. It has to be converted to Uranium-233 in a reactor before it can be used as fuel.

Nuclear power reactors located at Tarapur (Maharashtra), Rana Pratap Sagar (Rajasthan), Kalpakkam (Tamil Nadu), Narora (UP), Kakrapar (Gujarat) and Kaiga (Karnataka) have the installed capacity of less than 2% of the total electricity generation capacity of our country.

1. The substance that slows down the neutrons to have controlled chain reaction during nuclear energy productio as **(UGC NET 10th Oct 2022 Evening Shift)**

- ○ Reducer
- ○ Controlled
- ○ Inhibitor
- ○ Moderator

Check

Question: 1 of 4 questions

1. Introduction

The **biosphere** is the zone of Earth where life exists. It encompasses all living organisms, their habitats, and the interactions between them. This include everything from the deepest root systems of trees, to the dark environment of ocean trenches, to lush rainforests and high mountaintops.

Scientists describe Earth in terms of spheres.

- The solid surface layer of Earth is the *lithosphere*.
- The *atmosphere* is the layer of air that stretches above the lithosphere.
- The Earth's water—on the surface, in the ground, and in the air—makes up the *hydrosphere.*

Since life exists on the ground, in the air, and in the water, the biosphere overlaps all these spheres. Although the biosphere measures about 20 kilometers from top to bottom, almost all life exists between about 500 meters (1,640 feet) below the ocean's surface to about 6 kilometers (3.75 miles) above sea level.

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1. Introduction

Biodiversity is all the different kinds of life one will find in one area — the variety of animals, plants, fungi, and even microorganisms like bacteria that make up our natural world. Each of these species and organisms work together in ecosystems, like an intricate web, to maintain balance and support life. Biodiversity supports everything in nature that we need to survive i.e., food, clean water, medicine, and shelter.

The term 'biodiversity' was popularised by the Sociobiologist Edward Wilson to describe the combined diversity at all the levels of biological organisation.

Levels of Biodiversity

Biodiversity is usually defined at 3 levels. These are explained below.

1. *Genetic diversity:* at this level, species might differ in their tolerance of heat or cold, or resistance to diseases.
2. *Species diversity:* this is the level that most people are familiar with – the variety of species we share our world with – all of the different kinds of plants and animals. This includes wild and domesticated species of plants and animals and wild and laboratory-cultured species of microorganisms.
3. *Ecosystem diversity:* at this level, we describe broad habitat types such as grasslands, woodlands, rivers, and estuaries that are defined by the particular community of species, and the environments in which they co-occur.

---

1. Introduction

Biodiversity is essential for the processes that support all life on Earth, including humans. Without a wide range of animals, plants and microorganisms, we cannot have the healthy ecosystems that we rely on to provide us with the air we breathe and the food we eat.

Some of the key reasons significance of biodiversity are given below:

- *Ecological Stability:* Biodiversity contributes to the resilience and stability of ecosystems. Diverse ecosystems are better able to withstand and recover from environmental changes or disturbances, such as natural disasters or human activities.
- *Ecosystem Services:* Biodiversity provides essential ecosystem services that support human well-being. These services include pollination of crops by bees and other insects, water purification by wetlands, regulation of climate through forests, and the decomposition of organic matter by microorganisms.
- *Genetic Resources:* Biodiversity represents a vast reservoir of genetic resources. This genetic diversity within species is important for the adaptability and resilience of populations to changing environmental conditions, pests, and diseases.
- *Medicine and Pharmaceuticals:* Many species in diverse ecosystems are potential sources of medicinal compounds.
- *Cultural and Aesthetic Value:* Biodiversity is integral to the cultural and aesthetic value of landscapes. It enriches human experiences and provides inspiration for art, literature, and cultural practices. Many indigenous cultures have deep connections to their local biodiversity.
- *Economic Benefits:* Biodiversity supports various industries, including agriculture, forestry, and fisheries. Healthy ecosystems contribute to the economy by providing resources such as timber, fish, and non-timber forest products.
- *Scientific Knowledge:* Biodiversity is a vast source of scientific knowledge. Studying diverse species and ecosystems helps scientists understand ecological processes, evolutionary relationships, and the functioning of life on Earth.
- *Ethical and Intrinsic Value:* Many people believe that all species have intrinsic value and a right to exist. Preserving biodiversity is seen as an ethical responsibility to maintain the richness and diversity of life on Earth.

India Biodiversity

Although India has only 2.4 % of the world's land area, its share of the global species diversity is an impressive 8.1 %. That is what India is one of the 12 mega diversity countries of the world. Nearly 45,000 species of plants and twice as many of animals have been recorded from India.

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1. Introduction

As humans exert growing pressure on the Earth, utilizing and depleting resources at unprecedented rates, there is a potential for disturbing the equilibrium of ecosystems and jeopardizing biodiversity.

Some major factors contributing to the decline of biodiversity include:

- *Habitat Destruction and Fragmentation:* The conversion of natural habitats into agricultural land, urban areas, and infrastructure projects leads to the destruction and fragmentation of ecosystems. This disrupts the living spaces and migration patterns of many species.
- *Pollution:* Air, soil and water pollution can harm species by degrading their habitats, physically harming them, or increasing their vulnerability to diseases or predation. Some pollutants, such as pesticides and heavy metals, can be passed up the food chain, therefore contaminating many levels of the ecosystem.
- *Climate change:* Global warming and the resulting changes in climate patterns have altered habitats, making it challenging for organisms to perform their natural functions or adapt to new conditions. Changes in temperatures or rain patterns, for example, make it different for certain plants to grow or survive, which also affects the species that depend on them.
- *Overexploitation:* Unsustainable harvesting of natural resources, such as overfishing, poaching, logging, and hunting, can deplete populations of species and lead to their decline or extinction.
- *Invasive Species:* The introduction of non-native species to new environments can outcompete or prey upon native species, disrupting the balance of ecosystems and contributing to the decline of indigenous flora and fauna.
- *Co-extinctions:* When a species becomes extinct, the plant and animal species associated with it in an obligatory way also become extinct. For instance, when a host fish species becomes extinct, its unique assemblage of parasites also meets the same fate.
- *Genetic Pollution:* The release of genetically modified organisms or the hybridization of closely related species can lead to the loss of genetic diversity, which is crucial for species' adaptability and resilience.
- *Ocean acidification:* Increases in carbon dioxide levels are responsible for the acidification of oceans, which makes it difficult for marine organisms, like corals, plankton or shellfish, to maintain their protective coating. The result is a decline in these species' populations, as well as those of species that rely on them for food and shelter.
- *Global Trade and Transportation:* The movement of species and goods across borders facilitates the spread of invasive species and diseases, contributing to changes in local ecosystems and threatening native biodiversity.

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2. Biodiversity Conservation

Biodiversity Conservation involves efforts to protect and sustainably manage the variety of life on Earth. It encompasses the conservation of species, ecosystems, and genetic diversity, aiming to maintain the ecological balance and ensure the long-term well-being of both natural systems and human societies.

Biodiversity conservation is of 2 types:

(i) *In-situ Conservation:* In-situ conservation refers to conservation of species within its natural habitat and the natural ecosystem is protected and maintained. This method is convenient and cost effective as a large number of species can be simultaneously conserved. This type of conservation includes national parks, wildlife sanctuaries and biosphere reserves.

(ii) *Ex-situ Conservation*: Ex-situ conservation refers to moving the threatened animals and plants from their natural habitat to special settings where they are protected and cared for. Zoos, botanical parks and wildlife safaris are common examples.

Note

Some interesting aspects about earth's biodiversity are discussed below.

- Animals make up over 70% of all recorded species, while plants (including algae, fungi, bryophytes, gymnosperms, and angiosperms) account for no more than 22%.
- Among animals, insects are the most species-rich taxonomic group.
- Insects constitute more than 70% of the total number of animal species on Earth.
- It means out of every 10 animals on the planet, 7 are insects.

Arguments for Conservation

Reasons for conservationof biodiversity can be grouped into 3 categories: narrowly utilitarian, broadly utilitarian, and ethical.

1. *Narrowly Utilitarian Argument:* Humans benefit directly from nature in various ways, such as food, firewood, and materials for construction and industry. Exploring biodiversity (bioprospecting) can lead to economic gains, especially for countries with rich biodiversity.
2. *Broadly Utilitarian Argument:* Biodiversity contributes to essential ecosystem services, like the Amazon forest producing a significant portion of the Earth's oxygen. The economic value of services like pollination is challenging to measure, and there are also intangible benefits, such as the aesthetic pleasures of nature, that are challenging to put a price on.
3. *Ethical Argument:* There's an ethical responsibility to preserve biodiversity based on the intrinsic value of every species. Regardless of their current economic importance to humans, all species deserve care and preservation for the well-being of the planet and future generations.

To protect our flora and fauna (the plants and animals found in a particular area are termed flora and fauna respectively of that area) and their habitats, protected areas called wildlife sanctuaries, national parks and conservation and community reserves have been earmarked. Plantation, cultivation, grazing, felling trees, hunting and poaching are prohibited in these areas. The Protected Areas are declared under Wildlife (Protection) Act, 1972.

Animals whose numbers are diminishing to a level that they might face extinction are known as the endangered animals. The International Union for Conservation of Nature (IUCN) maintains a record of all the endangered animals and plants in the world and calls it Red Data Book.

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3. Protected Areas in India

The Wildlife (Protection) Act, 1972 provides for the establishment of Protected Areas in India. There are different categories of protected areas which are managed with different objectives for the larger motive of conservation.

There are 4 types of protected areas under the Act which are:

1. Wildlife Sanctuaries,
2. National Parks,
3. Conservation Reserves, and
4. Community Reserves

These are discussed next.

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3. Protected Areas in India

Wildlife Sanctuaries are the areas where animals are protected from any disturbance to them and their habitat. These provide protection and suitable living conditions to wild animals. Some of the threatened wild animals like black buck, white eyed buck, elephant, golden cat, pink headed duck, gharial, marsh crocodile, python, rhinoceros, etc., are protected and preserved in these wildlife sanctuaries.

The State Government has the authority to designate any area, excluding reserve forests or territorial waters, as a sanctuary. This can be done if the area holds ecological, faunal, floral, geomorphological, natural, or zoological significance deemed sufficient by the government. Certain limited human activities are permitted within the sanctuary, and are provided in Chapter IV of the Wildlife Protection Act of 1972.

As per the data provided bt the National Wildlife Database Centre (November 2023), there are 573 existing wildlife sanctuaries in India covering an area of 3.76 % of the geographical area of the country.

The International Union for Conservation of Nature (IUCN) and its World Commission on Protected Areas has defined wildlife sanctuary as its *Category IV* type of protected areas.

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3. Protected Areas in India

National Parks, area notified by the State Government, provide protection to the entire ecosystem, that is, flora, fauna, landscape, etc. of that region. The national parks not only conserve wildlife but also provide a diversion of environmental and landscape heritage in a manner that does not harm it, in order to provide enjoyment to future generations.

National parks are given a greater degree of protection, with human activity greatly restricted. Only certain areas can be visited and only activities permitted by the chief wildlife warden of the state are allowed in the park. The first national park in India was established as Hailey National Park in the year 1936 and later renamed as Corbett National Park.

While wildlife sanctuary focuses on only wildlife, the focus of National Parks is the entire ecosystem e.g. flora, fauna, landscape.

There are 106 existing national parks in India covering an area of 1.35 % of the geographical area of the country (National Wildlife Database Centre, November 2023).

The International Union for Conservation of Nature (IUCN) and its World Commission on Protected Areas has defined national park as its Category II type of protected areas.

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3. Protected Areas in India

Conservation reserves and Community Reserves denotes protected areas of India which typically act as buffer zones or connectors and migration corridors between established national parks, wildlife sanctuaries and reserved and protected forests of India.

Such areas are designated as conservation areas if they are uninhabited and completely owned by the Government of India but used for subsistence by communities. They are designated as community areas if parts of the lands are privately owned. These protected area categories were first introduced in the Wildlife (Protection) Amendment Act of 2002 – the amendment to the Wildlife Protection Act of 1972.

These categories were added because of reduced protection in and around existing or proposed protected areas due to private ownership of land and land use.

There are 220 existing Community Reserves in India covering 0.04% of the geographical area of the country (National Wildlife Database Centre, Nov. 2023).

There are 115 existing Conservation Reserves in India covering 0.17% of the geographical area of the country (National Wildlife Database Centre, Nov. 2023).

The International Union for Conservation of Nature (IUCN), and its World Commission on Protected Areas has defined Conservation Reserves as its *Category V* type of protected areas and Community Reserves as its *Category VI* type of protected areas.

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4. Biosphere Reserve

What are Biosphere Reserves?

Biosphere reserves are 'learning places for sustainable development'. They are sites for testing interdisciplinary approaches to understanding and managing changes and interactions between social and ecological systems, including conflict prevention and management of biodiversity.

Biosphere Reserves are sites established by countries and recognized under UNESCO's Man and the Biosphere (MAB) Programme to promote sustainable development based on local community efforts and sound science. The purpose of formation of the biosphere reserve is to conserve in situ all forms of life, along with its support system, in its totality, so that it could serve as a referral system for monitoring and evaluating changes in natural ecosystems. The first biosphere reserve of the world was established in 1979.

Launched in 1971, UNESCO's Man and the Biosphere Programme (MAB) is an intergovernmental scientific programme that aims to establish a scientific basis for the improvement of relationships between people and their environments. MAB combines natural and social sciences, economics and education to improve human livelihoods and the equitable sharing of benefits, and to safeguard natural and managed ecosystems, thus promoting innovative approaches to economic development that are socially and culturally appropriate, and environmentally sustainable.

The World Network of Biosphere Reserves of the MAB Programme consists of a dynamic and interactive network of sites of excellence. It fosters the harmonious integration of people and nature for sustainable development through participatory dialogue; knowledge sharing; poverty reduction and human well-being improvements; respect for cultural values and society's ability to cope with change - thus contributing to the 2030 Agenda and the Sustainable Development Goals (SDGs).

The International Union for Conservation of Nature (IUCN), and its World Commission on Protected Areas has defined Biosphere Reserves as its Category V type of protected areas.

As reported till November 2023 on UNESCO website, there are currently 738 biosphere reserves in 134 countries, including 22 transboundary sites.

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4. Biosphere Reserve

Biosphere Reserves are nominated by national government which meets a minimal set of criteria under the Man and Biosphere Reserve Program of UNESCO.

Criteria for Designation of Biosphere Reserve:

- A site must contain a protected and minimally disturbed core area of value of nature conservation.
- The core area must be a bio-geographical unit and should be large enough to sustain a viable populations representing all trophic levels.
- The involvement of local communities and use of their knowledge in biodiversity preservation.
- Area's potential for preservation of traditional tribal or rural modes of living for harmonious use of the environment.

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4. Biosphere Reserve

There are 3 main zones of Biosphere Reserve:

1. *Core Areas:* It is the most protected area of a biosphere reserve. It may contain endemic plants and animals. They conserve the wild relatives of economic species and also represent important genetic reservoirs having exceptional scientific interest. A core zone is a protected region, like a National Park or Sanctuary/ protected/ regulated mostly under the Wildlife (Protection) Act, 1972. It is kept free from human interference.
2. *Buffer Zone:* The buffer zone surrounds the core zone, and its activities are managed in this area in ways that help in the protection of the core zone in its natural condition. It includes restoration, limited tourism, fishing, grazing, etc., which are permitted to reduce its effect on the core zone. Research and educational activities are to be encouraged.
3. *Transition Zone:* It is the outermost part of the biosphere reserve. It is the zone of cooperation where human ventures and conservation are done in harmony. It includes settlements, croplands, managed forests and areas for intensive recreation and other economic uses characteristics of the region.

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4. Biosphere Reserve

India has overall 18 biosphere reserves out of which 12 are recognized by UNESCO. These are given below:

1. Nilgiri Biosphere Reserve - Western Ghats and Nilgiri Hills in South India
2. Gulf of Mannar Biosphere Reserve - between India and Sri Lanka
3. Sunderban Biosphere Reserve - Estuaries of River Ganges and River Brahmaputra
4. Nanda Devi Biosphere Reserve - Northeast of Uttarakhand
5. Nokrek Biosphere Reserve - West Garo Hills, Meghalaya
6. Pachmarhi Biosphere Reserve - Satpura Range, Madhya Pradesh
7. Similipal Biosphere Reserve - Northeast Odisha
8. Amarkantak Biosphere Reserve - Chhattisgarh and Madhya Pradesh
9. Great Nicobar Biosphere Reserve - Nicobar Islands
10. Agasthyamala Biosphere Reserve - Kerala and Tamil Nadu
11. Khangchendzonga Biosphere Reserve - Sikkim
12. Panna Biosphere Reserve - Madhya Pradesh (recognized in Nov 2020)

The list of remaining bioshpere reserve is given below:

1. Cold Desert, Himachal Pradesh
2. Dehang-Debang, Arunachal Pradesh
3. Manas, Assam
4. Dibru-Saikhowa, Assam
5. Kachchh, Gujarat
6. Seshachalam, Andhra Pradesh

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5. Biodiversity Hotspots

Biodiversity hotspots are regions that contain a high level of species diversity, many endemic species and a significant number of threatened or endangered species. The concept of biodiversity hotspots was first introduced in the late 1980s and since then, it has been used as a tool for identifying areas of high conservation priority.

In 1988, British Ecologist Norman Myers published a seminal paper identifying 10 tropical forest "hotspots". These regions were characterized both by exceptional levels of plant endemism and serious levels of habitat loss. To qualify as a biodiversity hotspot on Myers 2000 edition of the hotspot-map, a region must meet 2 criterias:

1. Must have at least 1,500 species of vascular plants as endemics (> 0.5% of world's total).
2. Should have lost at least 70% of its primary vegetation habitat.

Note

Endemic species are those species of plants and animals which are found exclusively in a particular area. They are not naturally found anywhere else. A particular type of animal or plant may be endemic to a zone, a state or a country.

India has 4 biodiversity hotspots:

1. Eastern Himalayas,
2. Western Ghats,
3. Indo Myanmar landscape and
4. Andaman and Nicobar Islands.

Biodiversity Heritage Sites (BHSs)

They are well defined areas that are unique, ecologically fragile ecosystems. They are spread over terrestrial, coastal and inland and marine waters having rich biodiversity comprising of any one or more of the following components: richness of wild as well as domesticated species or intra-specific categories, high endemism, presence of rare and threatened species, keystone species, species of evolutionary significance, wild ancestors of domestic/ cultivated species or their varieties, past pre-eminence of biological components represented by fossil beds and having significant cultural, ethical or aesthetic values and are important for the maintenance of cultural diversity, with or without a long history of human association with them.

BHS may be identified and notified by the State Government as per the provisions of the Biological Diversity Act 2002.

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6. Natural World Heritage Sites

UNESCO Natural World Heritage Sites are recognized for their outstanding natural beauty, ecological significance, and unique biodiversity. These sites represent crucial habitats and ecosystems that contribute to the planet's environmental heritage. Recognized for their unique and often irreplaceable features, these sites serve as living laboratories for scientific research, allowing us to understand and appreciate the complexity of Earth's natural systems.

There are 7 UNESCO Natural World Heritage Sites in India:

1. Western Ghats (2012)

2. Kaziranga Wild Life Sanctuary, Assam (1985)

3. Sundarbans National Park, West Bengal (1987)

4. Great Himalayan National Park, Himachal Pradesh (2014)

5. Manas Wild Life Sanctuary, Assam (1985)

6. Keoladeo National Park, Bharatpur, Rajasthan (1985)

7. Nanda Devi and Valley of Flowers National Parks, Uttarakhand (1988)

India has 42 sites in the UNESCO's World Heritage list whuich includes 34 Cultural, 7 Natural and 1 Mixed World Heritage Site. Khangchendzonga National Park, Sikkim has been inscribed as India's first and the only “Mixed World Heritage Site”.
