

**Environment Pollution & Management**

- When unwanted materials are introduced into the environment as a result of human activity, pollution has occurred.
- Pollutants are the substances that damage the environment.
- A physical, chemical, or biological substance that is released into the environment that is either directly or indirectly hazardous to people or other living things is referred to as a pollution.
- Air pollution, noise pollution, water pollution, soil pollution, thermal pollution, and radiation pollution are all examples of different types of pollution.
- The Environment (Protection) Act, 1986 (Bhopal disaster) was passed by the Indian government to reduce environmental pollution and enhance the quality of our air, water, and soil.
- Air pollution may be defined as the presence of any solid, liquid or gaseous substance **including noise and radioactive radiation** in the atmosphere in such concentration that may be directly and/or indirectly injurious to humans or other living organisms, property or **interferes with the normal environmental processes.**
- Air pollution has been caused by an ever-increasing usage of fossil fuels in power plants, industry, transportation, mining, building construction, and stone quarries.
- Nitrogen and sulphur are found in trace levels in fossil fuels.
- When fossil fuels like coal or petroleum are burned, various nitrogen and sulphur oxides are released into the atmosphere (thermal power plants).
- These gases produce sulfuric and nitric acids when they interact with atmospheric water vapour.
- Acidic rain results from the acids being carried away by the rain.
- This is referred to as acid rain.
- Marble structures like the Taj Mahal become corroded by acid rain.
- The term “Marble cancer” refers to this phenomena.

- Other kinds of pollutants are **chlorofluorocarbons (CFCs)** which are used in **refrigerators, air conditioners and as pressurising agents in aerosol sprays.**
- CFCs **damage the ozone layer** of the atmosphere.
- The combustion of fossil fuels also increases the number of suspended particles in the air.
- These suspended particles could be unburnt carbon particles or substances called hydrocarbons.
- Presence of high levels of all these pollutants causes visibility to be lowered, especially in cold weather when water also condenses out of the air.
- This is known as **smog** and is a visible indication of air pollution.

#### Classification of Pollutants:

- **Primary pollutants:** These are persistent in the form in which they are added to the environment, e.g., **DDT, plastic, CO, CO<sub>2</sub>, oxides of nitrogen and sulphur, etc.**
- **Secondary Pollutants:** These are formed by interaction among the primary pollutants. For example, **peroxyacetyl nitrate (PAN)** is formed by the interaction of **nitrogen oxides and hydrocarbons.**
- **Quantitative Pollutants:** These occur in nature and become pollutant when their concentration reaches beyond a threshold level. E.g., carbon dioxide, nitrogen oxide.
- **Qualitative Pollutants:** These do not occur in nature and are human-made. E.g., fungicides, herbicides, DDT etc.

#### Particulate pollutants:

- Particulate pollutants are matter suspended in air such as dust and soot.
- Major source of SPM (suspended particulate matter) are industries, vehicles, power plants, construction activities, oil refinery, railway yard, market place, industries, etc.
- Their size ranges from **0.001 to 500 micrometres (µm)** in diameter.
- Particles less than 10 µm float and move freely with the air current.
- Particles which are more than 10 µm in diameter settle down.

- Particles less than  $0.02 \mu\text{m}$  form **persistent aerosols**.
- According to the Central Pollution Control Board (CPCB), particulate size  **$2.5 \mu\text{m}$  or less in diameter (PM 2.5)** are responsible for causing the **greatest harm to human health**.
- These fine particulates can be inhaled deep into the lungs and can cause breathing and respiratory symptoms, irritation, inflammations and **pneumoconiosis** (disease of the lungs caused due to inhalation of dust. It is characterised by inflammation, coughing, and fibrosis – excess deposition of fibrous tissue).

#### Fly ash:

- Fly ash is ejected mostly by **thermal power plants** as by-products of coal burning operations.
- Fly ash pollutes air and water and may cause **heavy metal pollution** in water bodies.
- Fly ash affects crops and vegetation as a result of its direct deposition on leaf surfaces.

#### Composition:

- Fly ash particles are **oxide rich and consist of silica, alumina, oxides of iron, calcium, and magnesium and toxic heavy metals like lead, arsenic, cobalt, and copper**.
- Major oxides are present are **aluminium silicate** (in large amounts), **silicon dioxide** ( $\text{SiO}_2$ ) and **calcium oxide** ( $\text{CaO}$ ).

#### Uses:

- Cement can be replaced by fly ash up to 35%, thus reducing the cost of construction, making roads, etc.
- Fly ash bricks are light in weight and offer high strength and durability.
- Fly ash is a better fill material for road embankments and in concrete roads.
- Fly ash can be used in the reclamation of wastelands.
- Abandoned mines can be filled up with fly ash.
- Fly ash can increase crop yield when added to the soil. But if it gets deposited on the leaf, it will reduce photosynthesis.

- It also enhances the water holding capacity of the land.

#### Policy measures of MoEF:

- The Ministry of Environment and Forests has made it mandatory to use Fly Ash-based products in all construction projects, road embankment works, and low lying landfilling works within 100 km radius of Thermal Power Station and mine filling activities within 50 km radius of Thermal Power Station.

#### Lead:

- It is present in **petrol, diesel, lead batteries, paints, hair dye** products, etc.
- It can cause nervous system damage and digestive problems and, in some cases, cause cancer.
- Lead affects children in particular.
- **Tetraethyl lead (TEL)** is used as an **anti-knock agent in petrol** for a smooth and easy running of vehicles.
- The lead particles coming out from the exhaust pipes of vehicles is mixed with air.
- It produces injurious effects on kidney and liver and interferes with the development of red blood cells.
- Lead mixed with water and food can create cumulative poisoning.
- It has long term effects on children as it lowers intelligence.

#### Metallic Oxides:

- Oxides of iron, aluminium, manganese, magnesium, zinc and other metals have an adverse effect due to deposition of dust on plants during mining operations and metallurgical processes.
- They create physiological, biochemical and developmental disorders in plants and also contribute towards reproductive failure in plants.

#### Nanoparticles (NPs):

- Nanoparticles are particles with dimensions comparable to  $1/10^9$  of a meter (1 divided by 100 crores).
- Major natural processes that release NPs in the atmosphere are **forest fires, volcanic eruptions, weathering, dust storms from desert** etc.

- Naturally occurring NPs are quite heterogeneous in size and can be transported over thousands of kilometres and remain suspended in the air for several days.
- Nanotechnology has a global socioeconomic value, with applications ranging from electronics to biomedical uses (delivering drugs to target sites).
- Man-made NPs are unknowingly or purposely released in the environment during various industrial and mechanical processes.

#### **Effects of Nanoparticles on the environment:**

- After releasing in the environment, NPs will accumulate in various environmental matrices such as air, water, soil and sediments including wastewater sludge.
- NPs in the environment influences **dust cloud formation, environmental hydroxyl radical concentration, ozone depletion,** or **stratospheric temperature change.**

#### **Effect of NPs on dust cloud formation:**

- NPs in environment coagulate and form dust cloud.
- Dust cloud formation decreases sunlight intensity.

#### **Asian brown clouds impact on Himalayan glaciers:**

- Asian brown clouds carry large amounts of soot and black carbon (NPs) and deposit them on the Himalayan glaciers.
- This could lead to higher absorption of the sun's heat (reduced albedo) and potentially contributing to the increased melting of

#### **NPs and ozone depletion:**

- NPs can result in increased production of reactive oxygen species (ROS), including free radicals like Cl<sup>-</sup>.
- Radicals like Cl<sup>-</sup> destroy ozone. (Explained in Geography > Climatology > Polar Vortex > Ozone Depletion)

#### **Effect of NPs on stratospheric temperature:**

- NPs in the troposphere interact with molecular hydrogen accidentally released from hydrogen fuel cells and other sources.

- Molecular hydrogen along with NPs moves up to the stratosphere, resulting in the abundance of water vapour in the stratosphere.
- This will cause stratospheric cooling due to the formation of Stratospheric clouds (mostly ice crystals).
- Stratospheric clouds destroy ozone. (Geography > Climatology > Polar Vortex > Ozone Depletion)

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- In chemistry, a radical (a free radical) is an atom, molecule, or ion that has unpaired valence electrons.

#### **Environmental Effects:**

#### **Major Gaseous Air Pollutants:**

#### **Carbon monoxide (CO):**

- Carbon monoxide (CO) is a colourless, odourless, tasteless and highly toxic gas that is **slightly less dense than air**. It is **short-lived** (stay only a few months) in the atmosphere.
- Carbon monoxide is produced from the exhaust of **internal combustion engines** and **incomplete combustion** of various other fuels. **Iron smelting** also produces carbon monoxide as a by-product.
- It forms when there is not enough oxygen to produce carbon dioxide (CO<sub>2</sub>).
- In the presence of oxygen, carbon monoxide burns with a **blue flame**, producing carbon dioxide.
- Worldwide, the largest source of carbon monoxide is **natural in origin**, due to photochemical reactions in the troposphere.
- Other natural sources of CO include **volcanoes, forest fires**, and other forms of combustion.

### Health Effects:

- Carbon monoxide poisoning is the most common type of fatal air poisoning (poor ventilation and heat management in laptops and other electronics can cause the release of CO).
- It is toxic to **haemoglobin animals (including humans)** when encountered in concentrations above about 35 ppm.
- **It combines with haemoglobin to produce carboxyhaemoglobin, which usurps the space in haemoglobin that normally carries oxygen.**

### Effects on Environment:

- Carbon dioxide is an important **greenhouse gas**.
- Burning of carbon-based fuels since the industrial revolution has led to **global warming**.
- It is also a major cause of **ocean acidification** because it dissolves in water to form **carbonic acid**.

### Chlorofluorocarbons (CFCs):

- Chlorofluorocarbons (CFCs) are used in refrigerators, air conditioners and aerosol sprays.
- Since the late 1970s, the use of CFCs has been heavily regulated because of their destructive effects on the ozone layer. (Explained in Geography > Climatology > Polar Vortex > Ozone Depletion)
- The Montreal Protocol on Substances that Deplete the Ozone Layer (a protocol to the Vienna Convention for the Protection of the Ozone Layer) is an international treaty designed to protect the ozone layer by phasing out the production of numerous substances including CFCs which are responsible for ozone depletion.

### Ozone (O<sub>3</sub>):

- It occurs naturally in the stratosphere and absorbs harmful ultraviolet rays of the sun.
- However, at the ground level, it is a pollutant (**Greenhouse gas**) with highly toxic effects.
- Vehicles and industries are the major sources of ground-level ozone emissions.

- **Carbon monoxide, Nitrogen dioxide** play a major role in converting  $O_2$  to  $O_3$ .
- Ozone makes our eyes itchy, and watery. It lowers our resistance to cold and pneumonia.

#### **Nitrogen oxide ( $NO_x$ ):**

- $NO_x$  is a generic term for the various nitrogen oxides produced during combustion.
- They are produced mainly in **internal combustion engines** and **coal-burning power plants**.
- They are also produced naturally by **lightning**.
- Oxygen and nitrogen do not react at ambient temperatures. But at high temperatures, they produce various oxides of nitrogen. Such temperatures arise inside an internal combustion engine or a power station boiler.
- **Agricultural fertilisation** and the **use of nitrogen-fixing plants** also contribute to atmospheric  $NO_x$  by promoting nitrogen fixation by microorganisms.
- $NO$  and  $NO_2$  (contribute to global cooling) should not be confused with nitrous oxide ( $N_2O$  – GHG), which is a greenhouse gas and has many uses as an oxidiser.

#### **Effects on Health and Environment:**

- They are believed to aggravate asthmatic conditions and create many respiratory health issues.
- The reduction of  $NO_x$  emissions is one of the most important technical challenges facing biodiesel.
- $NO_x$  gases react to form smog and acid rain as well as being central to the formation of tropospheric ozone. (Explained in Geography > Climatology > Forms of Condensation > Smog)
- When  $NO_x$  and volatile organic compounds (VOCs) react in the presence of sunlight, they form photochemical smog.
- Mono-nitrogen oxides eventually form nitric acid when dissolved in atmospheric moisture, forming a component of acid rain.

- NO and NO<sub>2</sub> emissions cause global cooling through the formation of -OH radicals that destroy methane molecules, countering the effect of greenhouse gases.

### Sulphur dioxide (SO<sub>2</sub>):

- It is a toxic gas with a pungent, irritating smell. It contributes to acid rain.
- It is released naturally by volcanic activity. It is abundantly available in the atmosphere of Venus.
- Sulphur dioxide is primarily produced for sulfuric acid manufacture.
- Inhaling sulphur dioxide is associated with increased respiratory symptoms and premature death.
- It also weakens the functioning of certain nerves
- It is also produced by
  - Burning coal in thermal power plants and diesel fuels.
  - Some industrial processes, such as the production of paper and smelting of metals.
  - Reactions involving Hydrogen Sulphide (H<sub>2</sub>S) and oxygen.
  - The roasting of sulphide ores such as pyrite, sphalerite, and cinnabar (mercury sulphide).

### Volatile organic compounds (VOCs):

- Volatile Organic Compounds (VOCs) are a large group of carbon-based chemicals that easily evaporate at room temperature.
- For example, formaldehyde, which evaporates from paint, has a boiling point of only -19 °C.
- Formaldehyde causes irritation to the eyes and nose and allergies.
- The main indoor sources are perfumes, hair sprays, furniture polish, glues, air fresheners, moth repellents, wood preservatives, and other products.
- **Health effects:** irritation of the eye, nose and throat, headaches, nausea and loss of coordination.
- Long term health effects: suspected to damage the liver and other parts of the body.

**Benzene:**

- Benzene is a natural constituent of crude oil and is one of the elementary petrochemicals.
- Because benzene has a high octane number, it is an important component of gasoline (petrol).
- Benzene increases the risk of cancer and other illnesses.
- Benzene is a notorious cause of **bone marrow failure**.

**Ethylene:**

- Ethylene is widely used in the chemical industry.
- Much of this production goes toward polyethylene, a widely used plastic containing polymer chains of ethylene units in various chain lengths.
- Ethylene is also an important natural plant hormone, used in agriculture to force the ripening of fruits.
- Ethylene is of low toxicity to humans and exposure to excess ethylene cause adverse health effects like headache, drowsiness, dizziness and unconsciousness.
- Ethylene is not but ethylene oxide is a carcinogen (cancer-causing agent).

**Biological pollutants:**

- It includes pollen from plants, mite, and hair from pets, fungi, parasites, and some bacteria.
- Most of them are allergens and can cause asthma, hay fever, and other allergic diseases.

**Asbestos:**

- Asbestos refers to a set of six naturally occurring silicate **fibrous minerals** -- chrysotile, crocidolite, amosite, anthophyllite, tremolite, and actinolite.
- It is now known that prolonged inhalation of asbestos fibres can cause serious and fatal illnesses including **lung cancer, mesothelioma**, and **asbestosis** (a type of pneumoconiosis).

**Radon:**

- It is a gas that is emitted naturally by the **soil**.

- Due to modern houses having poor ventilation, it is confined inside the house and causes lung cancers.
- **System of Air Quality and Weather Forecasting and Research (SAFAR) Portal.**
- **Air Quality Index:** AQI has been developed for eight pollutants viz. PM2.5, PM10, Ammonia, Lead, nitrogen oxides, sulphur dioxide, ozone, and carbon monoxide.
- **Graded Response Action Plan** (for Delhi).
- For Reducing Vehicular Pollution:
  - **BS-VI Vehicles,**
  - **Push for Electric Vehicles (EVs),**
  - **Odd-Even Policy** as an emergency measure (for Delhi).
- **New Commission for Air Quality Management**
- Subsidy to farmers for buying **Turbo Happy Seeder (THS) Machine** for reducing stubble burning.
- **National Air Quality Monitoring Programme (NAMP):** Under NAMP, four air pollutants viz. SO<sub>2</sub>, NO<sub>2</sub>, PM<sub>10</sub>, and PM<sub>2.5</sub> have been identified for regular monitoring at all locations.

#### **The Central Pollution Control Board (CPCB):**

- It is a statutory organisation under the Ministry of Environment, Forest and Climate Change (MoEF).
- It was established in 1974 under the **Water (Prevention and Control of pollution) Act, 1974.**
- It is also **entrusted** with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981.
- It **provides technical services** to the Ministry of Environment and Forests under the provisions of the Environment (Protection) Act, 1986.
- It **Co-ordinates** the activities of the State Pollution Control Boards by providing technical assistance and guidance and also **resolves disputes** among them.
- It is the **apex organisation** in country in the field of pollution control.

**Air (Prevention and Control of Pollution) Act, 1981:**

- The **Air (Prevention & Control of Pollution) Act** was enacted by the Parliament in 1981 with an objective to prevent, control & abatement of air pollution.
- The act provides for the establishment of Central Pollution Control Board (CPCB) at the apex level and State Pollution Control Boards at the state level to advise the government on any matter concerning the improvement of the quality of the air and prevention, control and abatement of air pollution.
- The CPCB also lays down standards for the quality of air and provides technical assistance to and guidance to the State Pollution Control Board.

**Water Pollution:**

- Water pollution is the addition/presence of undesirable substances to/in water such as organic, inorganic, biological, radiological, heat, which degrades the quality of water so that it becomes unfit for use’.
- Natural sources of pollution of water are soil erosion, leaching of minerals from rocks (due to natural solubility and solubility triggered by acid rain) and decaying of organic matter.

**Point and non-point sources of pollution:**

- When pollutants are discharged from a specific location such as a drain pipe carrying industrial effluents discharged directly into a water body it represents point source pollution.
- In contrast, non-point sources include discharge of pollutants from diffused sources or from a larger area such as runoff from agricultural fields, grazing lands, construction sites, abandoned mines and pits, etc.

**Causes of Water Pollution:****Sewage Water:**

- Sewage water includes discharges from houses and other establishments.
- The sewage contains human and animal excreta, food residues, cleaning agents, detergents, etc.
- Domestic and hospital sewage contain many undesirable pathogenic microorganisms.

**Dissolved Oxygen (DO):**

- Presence of organic and inorganic wastes in water decreases the dissolved oxygen content of the water.
- Water having DO content below 8.0 mg/L may be considered as contaminated.
- Water having DO content below 4.0 mg/L is considered to be highly polluted.
- DO content of water is important for the survival of aquatic organisms.
- A number of factors like surface turbulence, photosynthetic activity, O<sub>2</sub> consumption by organisms and decomposition of organic matter are the factors which determine the amount of DO present in water.
- The higher amounts of waste increase the rates of decomposition and O<sub>2</sub> consumption thereby decreases the **DO content of water**.

**Biological Oxygen Demand (BOD):**

- Water pollution by organic wastes is measured in terms of Biochemical Oxygen Demand (BOD).
- BOD is the **amount of dissolved oxygen needed by bacteria in decomposing the organic wastes** present in water. It is expressed in milligrams of oxygen per litre of water.

**Chemical oxygen demand (COD):**

- Chemical oxygen demand (COD) is a slightly better mode used to measure pollution load in the water.
- COD measures the **amount of oxygen in parts per million required to oxidise organic (biodegradable and non-biodegradable) and oxidizable inorganic compounds** in the water sample.

**Industrial Wastes:**

- Discharge of wastewater from industries like petroleum, paper manufacturing, metal extraction and processing, chemical manufacturing, etc., that often contain toxic substances, notably, heavy metals (defined as elements with density > 5 g/cm<sup>3</sup> such as mercury, cadmium, copper, lead, arsenic) and a variety of organic compounds.

**Agricultural sources:**

- Agricultural runoff contains dissolved salts such as nitrates, phosphates, ammonia and other nutrients, and toxic metal ions and organic compounds.
- Fertilizers contain major plant nutrients such as nitrogen, phosphorus and potassium.
- Excess fertilisers may reach the groundwater by leaching or may be mixed with surface water.
- Pesticides include insecticides, fungicides, herbicides, etc.
- They contain a wide range of chemicals such as chlorinated hydrocarbons (CHCs. E.g. DDT, Endosulfan etc.), organophosphates, metallic salts, carbonates, etc.
- Many of the pesticides are non-degradable, and their residues have a long life.
- Wastes from poultry farms, piggeries and slaughterhouses etc. reach the water through runoff.

**Thermal and Radiation Pollution:**

- Power plants – thermal and nuclear, chemical and other industries use a lot of water for cooling purposes, and the used hot water is discharged into rivers, streams or oceans.
- Discharge of hot water may increase the temperature of the receiving water by 10 to 15 °C above the ambient water temperature. This is thermal pollution.
- Increase in water temperature decreases dissolved oxygen in the water.
- Unlike terrestrial organisms, aquatic organisms are adapted to a uniform steady temperature of the environment.
- A sudden rise in temperature kills fishes and other aquatic animals.
- One of the best methods of reducing thermal pollution is to store the hot water in cooling ponds, allow the water to cool before releasing into any receiving water body.
- Nuclear accidents near water bodies or during natural calamities like tsunami and earthquakes pose the risk of radiation leakage (radiation exposure) into water bodies. E.g. Fukushima Daiichi nuclear disaster.
- Radiation exposure causes mutations in the DNA of marine organisms.
- If those mutations are not repaired, the cell may turn cancerous.

**Marine pollution:**

- Oceans are the ultimate sink of all natural and manmade pollutants.
- The sewerage and garbage of coastal cities are also dumped into the sea.
- The other sources of oceanic pollution are navigational discharge of oil, grease, detergents, sewage, garbage and radioactive wastes, offshore oil mining, oil spills.

**Oil Spills:**

- The most common cause of oil spill is leakage during marine transport and leakage from underground storage tanks.
- An oil spill could occur during offshore oil production as well.

**Impact of oil spill on marine life:**

- Oil being lighter than water covers the water surface as a thin film cutting off oxygen to floating plants and other producers.
- Within hours of an oil spill, the fishes, shellfish, plankton die due to suffocation and metabolic disorders.
- Birds and sea mammals that consume dead fishes and plankton die due to poisoning.

**Invasive species:**

- Plants of water hyacinth are the world's most problematic aquatic weed, also called 'Terror of Bengal'.
- They grow abundantly in eutrophic water bodies and lead to an imbalance in the ecosystem.
- They cause havoc by their excessive growth leading to stagnation of polluted water.

**Underground water pollution:**

- In India at many places, the groundwater is threatened with contamination due to seepage from industrial and municipal wastes and effluents, sewage channels and agricultural runoff.
- Pollutants like fluorides, uranium, heavy metals and nutrients like nitrates and phosphates are common in many parts of India.

**Nitrates:**

- Dissolved nitrates commonly contaminate groundwater.
- Excess nitrate in drinking water reacts with haemoglobin to form non-functional methaemoglobin and impairs oxygen transport. This condition is called methemoglobinemia or blue baby syndrome.
- Methaemoglobin is a form of the oxygen-carrying metalloprotein haemoglobin. Methaemoglobin cannot bind oxygen, unlike oxyhaemoglobin.
- High level of nitrates may form carcinogens and can accelerate eutrophication in surface waters.

**Trace metals:**

- Include lead, mercury, cadmium, copper, chromium and nickel.
- These metals can be toxic and carcinogenic.

**Arsenic:**

- Seepage of industrial and mine discharges, fly ash ponds of thermal power plants can lead to arsenic in groundwater.
- In India and Bangladesh (Ganges Delta), millions of people are exposed to groundwater contaminated with high levels of arsenic, a highly toxic and dangerous pollutant.
- Chronic exposure to arsenic causes black foot disease. It also causes diarrhoea and also lung and skin cancer.

**Fluoride:**

- Excess fluoride in drinking water causes neuromuscular disorders, gastrointestinal problems, teeth deformity, hardening of bones and stiff and painful joints (skeletal fluorosis).
- Pain in bones and joint and outward bending of legs from the knees is called Knock-Knee syndrome.
- Fluorosis is a common problem in several states of the country due to the intake of high fluoride content water.

**Effects of Water Pollution:****Effects of Water Pollution on Human Health:**

- Domestic and hospital sewage contain many undesirable pathogenic microorganisms, and its disposal into water without proper treatment may cause an outbreak of serious diseases, such as typhoid, cholera, etc.
- Metals like lead, zinc, arsenic, copper, mercury and cadmium in industrial wastewaters adversely affect humans and other animals.
- Consumption of such arsenic polluted water leads to accumulation of arsenic in the body parts like blood, nails and hairs causing skin lesions, rough skin, dry and thickening of the skin and ultimately skin cancer.
- Mercury compounds in wastewater are converted by bacterial action into extremely toxic methyl mercury, which can cause numbness of limbs, lips and tongue, deafness, blurring of vision and mental derangement.
- Pollution of water bodies by mercury causes Minamata (neurological syndrome) disease in humans.
- Lead causes lead poisoning (Lead interferes with a variety of body processes and is toxic to many organs and tissues).
- The compounds of lead cause anaemia, headache, loss of muscle power and bluish line around the gum.
- Water contaminated with cadmium can cause itai-itai disease also called ouch-ouch disease (a painful disease of bones and joints) and cancer of lungs and liver.

**Effects of Water Pollution on the Environment:**

- Micro-organisms involved in biodegradation of organic matter in sewage waste consume a lot of oxygen and make water oxygen deficient killing fish and other aquatic creatures.
- Presence of large amounts of nutrients in water results in **algal bloom** (excessive growth of planktonic algae. This leads to **ageing of lakes**).
- A few toxic substances, often present in industrial wastewaters, can undergo biological magnification (Biomagnification) in the aquatic food chain.
- This phenomenon is well-known for mercury and DDT.

- High concentrations of DDT disturb calcium metabolism in birds, which causes thinning of eggshell and their premature breaking, eventually causing a decline in bird populations.

#### **Effects of Water Pollution on Aquatic Ecosystem:**

- Polluted water reduces Dissolved Oxygen (DO) content, thereby, eliminates sensitive organisms like plankton, molluscs and fish etc.
- However, a few tolerant species like Tubifex (annelid worm) and some insect larvae may survive in highly polluted water with low DO content. Such species are recognized as indicator species for polluted water.
- Biocides, polychlorinated biphenyls (PCBs) and heavy metals directly eliminate sensitive aquatic organisms.
- Hot waters discharged from industries, when added to water bodies, lowers its DO content

#### **Eutrophication:**

- Lakes receive their water from surface runoff and along with its various chemical substances and minerals.
- Over periods spanning millennia, ageing occurs as the lakes accumulate mineral and organic matter and gradually, get filled up.
- The nutrient-enrichment of the lakes promotes the growth of algae, aquatic plants and various fauna. This process is known as natural eutrophication.
- Similar nutrient enrichment of lakes at an accelerated rate is caused by human activities and the consequent ageing phenomenon is known as cultural eutrophication.
- On the basis of their nutrient content, lakes are categorized as Oligotrophic (very low nutrients), Mesotrophic (moderate nutrients) and Eutrophic (highly nutrient rich).
- A vast majority of lakes in India are either eutrophic or mesotrophic because of the nutrients derived from their surroundings or organic wastes entering them.

**Eutrophication and Algal Bloom:**

- **Eutrophic water body:** it is a body of water rich in nutrients and so supporting a dense plant population, the decomposition of which kills animal life by depriving it of oxygen.
- Eutrophication is the response to the addition of nutrients such as nitrates and phosphates naturally or artificially, fertilising the aquatic ecosystem.
- Phytoplankton (algae and blue-green bacteria) thrive on the excess nutrients and their population explosion covers almost entire surface layer. This condition is known as algal bloom.

**Mechanism:**

- Phytoplankton are photosynthetic during day time adding oxygen to the aquatic ecosystem.
- But during nights, they consume far more oxygen as they respire aggressively.
- i.e. Algal blooms accentuate the rate of oxygen depletion as the population of phytoplankton is very high.
- The primary consumers like small fish are killed due to oxygen deprivation caused by algal blooms.
- Death of primary consumers adversely affects the food chain.
- Further, more oxygen is taken up by microorganisms during the decomposition process of dead algae, plants and fishes.
- The new anaerobic conditions (absence of oxygen) created to promote the growth of bacteria such as Clostridium botulinum which produces toxins deadly to aquatic organisms, birds and mammals.
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**Effects of Eutrophication:**

- **Loss of freshwater lakes:** Eutrophication eventually creates **detritus layer** in lakes and produces successively **shallower** depth of surface water.

- Eventually, the water body is reduced into marsh whose plant community is transformed from an aquatic environment to a recognizable terrestrial environment.
- Algal Blooms restrict the penetration of sunlight resulting in the death of aquatic plants and hence restricts the replenishment of oxygen.
- **New species invasion:** Eutrophication may cause the ecosystem competitive by transforming the normal limiting nutrient to abundant level.
- This cause shifting in species composition of the ecosystem.
- **Loss of coral reefs:** Occurs due to decrease in water transparency (increased turbidity).
- Affects navigation due to increased turbidity; creates colour (yellow, green, red), smell and water treatment problems; increases biomass of inedible toxic phytoplankton, benthic and epiphytic algae and bloom of gelatinous zooplankton.

#### **Harmful Algal Blooms:**

- Most algal blooms are not harmful, but some produce toxins. These are known as Harmful Algal Blooms (HABs).
- Toxicity: Some algal blooms when died or eaten, release neuro & hepatotoxins which can kill aquatic organism & pose a threat to humans. E.g. Shellfish poisoning.
- HAB events adversely affect commercial and recreational fishing, tourism, and valued habitats, creating a significant impact on local economies and the livelihood of coastal residents.

#### **Dead zones:**

- Dead zones (biological deserts) are increasing in the coastal delta and estuarine regions.
- Hypoxic zones (zones deprived of oxygen) can occur naturally (due to upwelling of nutrients).
- They can be created or enhanced by human activity to form dead zones.
- Dead zones are areas in the ocean with very low oxygen concentration (hypoxic conditions).

- Dead zones emerge when influx of chemical nutrients spur algae growth.
- These zones usually occur 200-800 meters (in the saltwater layer) below the surface.
- Dead zones are detrimental to animal life. Most of the animal life either dies or migrates from the zone.
- One of the largest dead zones forms in the Gulf of Mexico every spring (farmers fertilize their crops and rain washes fertilizer off the land and into streams and rivers).

#### **Mitigation of Eutrophication:**

- Treating Industrial effluents domestic sewage to remove nutrient-rich sludge through wastewater processing.
- Riparian buffer: Interfaces between a flowing body of water and land created near the waterways, farms, roads, etc. in an attempt to filter pollution.
- Sediments and nutrients are deposited in the buffer zones instead of deposition in water (Wetlands, estuaries are natural riparian buffers).
- Increase in efficiency of nitrogen & phosphorous fertilisers and using them inadequate levels.
- Nitrogen testing & modelling: N-Testing is a technique to find the optimum amount of fertiliser required for crop plants. It will reduce the amount of nitrogen lost to the surrounding area.
- Encouraging organic farming.
- Reduction in nitrogen emission from vehicles and power plants.
- Algae or phytoplankton are microscopic organisms that can be found naturally in coastal waters.
- They are major producers of oxygen and food for many of the animals that live in these waters.
- When environmental conditions are favorable for their development, these cells may multiply rapidly and form high numbers of cells, and this is called an algal bloom

**Water Body Regulating and Monitoring Agency:**

The water quality of the country's various rivers is regulated by several agencies such as-

- **Central Pollution Control Board (CPCB)**
- **State Pollution Control Boards (SPCBs)**
- **Pollution Control Committees (PCCs)**
- **Central Water Commission (CWC)**

**Measures Taken by the Government to prevent water pollution:**

- Various programmes have been launched by the Government of India for the conservation and protection of rivers and water bodies in the country.
  - **National River Conservation Programme (NRCP)**
  - **National Lake Conservation Programme (NLCP)**
  - **Atal Mission for Rejuvenation and Urban Transformation (AMRUT)**
  - **Smart Cities Mission**
  - **Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS)**
  - **Repair, Renovation and Restoration (RRR) schemes**
- **National River Conservation Programme (NRCP):** The Ministry of Environment and Forests (MoEF) National River Conservation Plan (NRCP) aims to protect rivers from pollution and enhance water quality.
- **National Green Tribunal (NGT):** The concerned States and Union Territories (UTs) are trying to implement Action Plans for the restoration of water quality in the identified polluted stretches of

**Jal Jeevan Mission (JJM):**

- Since August 2019, the Indian government has been working with the states to carry out the Jal Jeevan Mission (JJM), which aims to provide drinkable tap water to every rural home in India by 2024, including those in habitations where the water quality is poor.
- Children are especially sensitive to water-borne diseases and contamination in drinking water.

- A particular effort was started in 2020 to make the provision of potable tap water supply in schools, Anganwadi centres, ashram shalas, etc. on a priority basis.
- As a result, 8.52 lakh (83%) schools and 8.76 lakh (78.4%) Anganwadi centres across the country now have access to tap water.

#### **National Lake Conservation Programme (NLCP):**

- The National Lake Conservation Plan (NLCP) is being implemented by the Ministry of Environment and Forests to manage and conserve contaminated and degraded lakes in urban and semi-urban areas.
- Its objective was to conserve aquatic ecosystems (lakes and wetlands) by putting long-term conservation plans into action that were guided by uniform policies and standards.

#### **Atal Mission for Rejuvenation and Urban Transformation (AMRUT):**

- Atal Mission for Rejuvenation and Urban Transformation (AMRUT) was established with the intention to make sure that every home has access to a water tap with a reliable water supply and a sewer connection.

#### **Soil Pollution:**

- Soil pollution is defined as the 'addition of substances to the soil, which adversely affects physical, chemical and biological properties of soil and reduces its productivity.
- It is a build-up of persistent toxic compounds, chemicals, salts, radioactive materials, or disease-causing agents in the soil which have adverse effects on plant growth, human and animal health.

#### **Causes and Sources of Soil Pollution:**

##### **Plastic bags:**

- They accumulate in soil and prevents germination of seeds.
- They stay in the soil for centuries without decomposing (non-biodegradable).
- Burning of plastic in garbage dumps release highly toxic and poisonous gases like carbon monoxide, carbon dioxide, phosgene, dioxins and other poisonous chlorinated compounds.
- Toxic solid residue left after burning remains in the soil.
- The harmful gases enter soils through chemical cycles.

**Industrial sources:**

- They include fly ash, metallic residues, mercury, lead, copper, zinc, cadmium, cyanides, chromates, acids, alkalies, organic substances, nuclear wastes
- A large number of industrial chemicals, dyes, acids, etc. find their way into the soil.

**Pesticides and fertilisers:**

- **Chlorohydrocarbons (CHCs) like DDT, endosulfan, heptachlor** accumulate in soil and cause biomagnification.
- Some of these pesticides like DDT and endosulfan are banned by most of the countries.
- Excessive use of chemical fertilisers **reduces the population of soil-borne organisms** and the crumb structure of the soil, productivity of the soil and increases salt content of the soil.

**Other pollutants:**

- Many air pollutants (acid rain) and water pollutants ultimately become part of the soil, and the soil also receives some toxic chemicals during weathering of certain rocks.
- Radioactive elements from mining and nuclear power plants, find their way into the water and then into the soil.

**Effects of soil pollution:**

- Reduced soil fertility due to increase in alkalinity, salinity or pH.
- Reduced nitrogen fixation due to the reduced number of nitrogen fixers.
- Increased erosion due to loss of forests and other vegetation.
- Runoff due to deforestation cause loss of soil and nutrients.
- Deposition of silt in tanks and reservoirs due to soil erosion.
- Health effects are similar to the effects of water pollution.
- Ecological imbalance.

**Solid Wastes:**

- Solid wastes or municipal solid wastes generally comprise paper, food wastes, plastics, glass, metals, rubber, leather, textile, etc.

- Open-burning reduces the volume of the wastes, although it is generally not burnt to completion and open dumps often serve as the breeding ground for rats and flies.
- Sanitary landfills were adopted as the substitute for open-burning dumps.
- In a sanitary landfill, wastes are dumped in a depression or trench after compaction and covered with dirt every day.
- Landfills are also not much of a solution since the amount of garbage generation especially in the metros has increased so much that these sites are getting filled too.
- Also, there is a danger of seepage of chemicals, etc. from these landfills polluting the underground water resources.

#### Effects of Plastic Waste:

- Conventional plastics, right from their manufacture to their disposal are a major problem to the environment.
- The land gets littered by plastic bag garbage and becomes ugly and unhygienic.
- Conventional plastics have been associated with reproductive problems in both humans and wildlife.
- Dioxin (highly carcinogenic and toxic) by-product of the manufacturing process is one of the chemicals believed to be passed on through breast milk to the nursing infant.
- Burning of plastics, especially PVC releases dioxin and also furan into the atmosphere.
- Dioxins are environmental pollutants. They belong to the so-called “dirty dozen” – a group of dangerous chemicals known as persistent organic pollutants (POPs).
- The name “dioxins” is often used for the family of structurally and chemically related polychlorinated dibenzo para dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs).
- Plastic bags can also contaminate foodstuffs due to leaching of toxic dyes and transfer of pathogens.

- Careless disposal of plastic bags chokes drains, blocks the porosity of the soil and causes problems for groundwater recharge.
- Plastic disturbs the soil microbe activity.
- The terrestrial and aquatic animals misunderstand plastic garbage as food items, swallow them and die.
- Plastic bags deteriorate soil fertility as it forms part of manure and remains in the soil for years.

#### **Industrial solid waste:**

- Thermal power plants producing coal ash/fly ash;
- The integrated iron and steel mills producing blast furnace slag;
- Non-ferrous industries like aluminium, copper and zinc producing red mud and tailings;
- Sugar industries generating press mud;
- Pulp and paper industries producing lime mud;
- Fertilizer and allied industries producing gypsum;

#### **Plastic waste in road construction:**

- Polyblend is a fine powder of recycled and modified plastic waste.
- This mixture is mixed with the bitumen that is used to lay roads.
- Blends of Polyblend and bitumen, when used to lay roads, enhanced the bitumen's water repellent properties, and helped to increase road life by a factor of three.

#### **Issues with treatment and disposal of solid waste:**

##### **Open dumps:**

- Open dumps refer to uncovered areas that are used to dump solid waste of all kinds.
- The waste is untreated, uncovered, and not segregated. It is the breeding ground for flies, rats, and other insects that spread disease.
- The rainwater runoff from these dumps contaminates nearby land and water thereby spreading disease.

##### **Landfills:**

- It is a pit that is dug in the ground.

- The garbage is dumped, and the pit is covered with soil every day thus preventing the breeding of flies and rats.
- After the landfill is full, the area is covered with a thick layer of mud, and the site can thereafter be developed as a parking lot or a park.
- All types of waste are dumped in landfills, and when water seeps through them it gets contaminated and in turn, pollutes the surrounding area.
- This contamination of groundwater and soil through landfills is known as leaching.

#### Sanitary landfills:

- Sanitary landfill is more hygienic and built methodically to solve the problem of leaching.
- These are lined with materials that are impermeable such as plastics and clay and are also built over impermeable soil.
- Constructing a sanitary landfill is very costly.

#### Incineration plants:

- The process of burning waste in large furnaces at high temperature is known as incineration.
- In these plants, the recyclable material is segregated, and the rest of the material is burnt.
- Burning garbage is not a clean process as it produces tonnes of toxic ash and pollutes the air and water.
- At present, incineration is kept as the last resort and is used mainly for treating infectious waste.

#### Pyrolysis:

- It is a process of combustion in the absence of oxygen or the material burnt under a controlled atmosphere of oxygen.
- It is an alternative to incineration.
- The gas and liquid thus obtained can be used as fuels.
- Pyrolysis of carbonaceous wastes like firewood, coconut, palm waste, corn cobs, cashew shell, rice husk paddy straw and sawdust, yields charcoal along with products like **tar, methyl alcohol, acetic acid, acetone** and **fuel gas**.

**Composting:**

- Composting is a biological process in which micro-organisms, mainly fungi and bacteria, decompose degradable organic waste into humus-like substance in the presence of oxygen.
- This finished product, which looks like soil, is high in carbon and nitrogen and is an excellent medium for growing plants.
- It increases the soil's ability to hold water and makes the soil easier to cultivate. It helps the soil retain more plant nutrients.

**Vermiculture:**

- It is also known as earthworm farming. In this method, Earthworms are added to the compost.
- These worms break the waste, and the added excreta of the worms makes the compost very rich in nutrients.

**Waste Minimization Circles (WMC):**

- WMC helps Small and Medium Industrial Clusters in waste minimisation in their industrial plants.
- This is assisted by the World Bank with the Ministry of Environment and Forests acting as the nodal ministry.
- The project is being implemented with the assistance of the National Productivity Council (NPC), New Delhi.
- The initiative aims to realise the objectives of the Policy Statement for Abatement of Pollution (1992), which states that the government should educate citizens about environmental risks, the economic and health dangers of resource degradation and the real economic cost of natural resources.
- The policy also recognises that citizens and non-governmental organisations play a role in environmental monitoring, therefore, enabling them to supplement the regulatory system and recognizing their expertise where such exists and where their commitments and vigilance would be cost effective.

### Hazardous Waste:

- Any substance that is present in the environment or released into the environment causing substantial damage to public health and welfare of the environment is called hazardous substance.
- Any hazardous substance could exhibit any one or more of the following characteristics: toxicity, ignitability, corrosivity or reactivity (explosive).
- Thus, any waste that contains hazardous or very hazardous substance is called hazardous waste.
- Hazardous wastes can originate from various sources such as household, local areas, urban, industry, agriculture, construction activity, hospitals and laboratories, power plants and other sources.

### Stockholm Convention on Persistent Organic Pollutants:

- Stockholm Convention on Persistent Organic Pollutants is an international environmental treaty.
- Came into effective in 2004.
- Aims to eliminate or restrict the production and use of persistent organic pollutants (POPs).
- POPs are defined as “chemical substances that persist in the environment, bioaccumulate through the food web, and pose a risk of causing adverse effects to human health and the environment”.

### Important Listed substances:

- **Aldrin:** Used as an insecticide
- **Heptachlor:** Uses as a termiticide (including in the structure of houses and underground), for organic treatment and in underground cable boxes
- **Hexachlorobenzene:** Use as a chemical intermediate and a solvent for pesticides
- **Endrin:** Endrin has been used primarily as an agricultural insecticide on tobacco, apple trees, cotton, sugar cane, rice, cereal, and grains.
- **Polychlorinated biphenyl:** PCB’s commercial utility was based largely on their chemical stability, including low flammability, and physical properties, including electrical insulating properties. They are highly toxic.

- **DDT:** DDT is the best-known of several chlorine-containing pesticides used in the 1940s and 1950s.

#### **Basel Convention:**

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal.
- An international treaty that was designed to reduce the movements of hazardous waste between nations.
- Main goal is to prevent the transfer of hazardous waste from developed to less developed countries (LDCs).
- It does not address the movement of radioactive waste.

#### **Rotterdam Convention:**

- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade.
- Multilateral treaty to promote shared responsibilities in relation to the importation of hazardous chemicals.
- The convention promotes an open exchange of information and calls on exporters of hazardous chemicals to use proper labelling, safe handling, and inform purchasers of any known restrictions or bans.
- Signatory nations can decide whether to allow or ban the importation of chemicals listed in the treaty.

#### **Electronic waste (e-waste):**

- The discarded and end-of-life electronic products ranging from computers, equipment, home appliances, audio and video products and all of their peripherals are popularly known as Electronic waste (E-waste).
- E-waste is not hazardous if it is stocked in safe storage or recycled by scientific methods or transported from one place to the other in parts or totality in the formal sector.
- The e-waste can, however, be considered hazardous if recycled by primitive methods.

**e-Waste in India:**

- India generates about 18.5 lakh metric tonnes (MT) of electronic waste every year, with Mumbai and Delhi-NCR accounting for the biggest chunk. The figure is likely to reach up to 30 lakh MT per year by 2018.
- Bangalore, Chennai, Kolkata, Ahmadabad, Hyderabad, Pune, Surat and Nagpur are other important cities generating a substantial amount of e-waste.
- Among the eight largest e-waste generating states, Maharashtra ranks first followed by Tamil Nadu (2nd), Andhra Pradesh (3rd), Uttar Pradesh (4th), Delhi (5th), Gujarat (6th), Karnataka (7th) and West Bengal (8th).

**Heavy Metal Toxicity and Methods of their Prevention:**

- Toxic metals are dispersed in the environment through metal smelting industrial emissions, burning of organic wastes, automobiles and coal-based power generation.
- Heavy metals can be carried to places far away from their source of origin by winds when they are emitted in gaseous form or form of fine particulates.
- Rain ultimately washes the air having metallic pollutants and brings them to the land and to water bodies.
- Heavy metals cannot be destroyed by biological degradation.
- The heavy metals often encountered in the environment include lead, mercury, arsenic, chromium. These are known to cause toxic effects in living organisms.

**Lead:**

- Lead enters the atmosphere from automobile exhaust.
- Tetraethyl lead (TEL) was added to petrol as an anti-knock agent for a smooth running of engines
- Lead enters the atmosphere from automobile exhaust.
- Tetraethyl lead (TEL) was added to petrol as an anti-knock agent for a smooth running of engines.
- Lead in petrol is being phased out by the introduction of lead-free petrol.
- Many industrial processes use lead, and it is often released as a pollutant.
- Battery scrap also contains lead.
- It can get mixed up with water and food and create cumulative poisoning.

- Lead can cause irreversible behavioural disturbances, neurological damage and other developmental problems in young children and babies.
- It is a carcinogen of the lungs and kidneys.

**Mercury:**

- In Japan, mass mercury poisoning (Minamata disease) was observed in the 1960s, caused by eating fish from Minamata Bay which was contaminated with methyl mercury.
- Mercury kills cells in the body and damages organs and thus impairs their functioning.
- Inhalation of mercury vapours is more dangerous than its ingestion.
- Chronic exposure causes lesions in the mouth and skin and neurological problems.
- Mercury thermometers used earlier are getting replaced by mercury-free thermometer.

**Arsenic:**

- Arsenic is associated with copper, iron and silver ores.
- Arsenic is also emitted from fossil fuel burning.
- Liquid effluents from fertilizer plants also contain arsenic.
- Groundwater contamination with arsenic is very common in areas where it is present.
- Chronic arsenic poisoning causes melanosis and keratosis (dark spots on the upper chest, back and arms are known as melanosis).
- The next stage is keratosis in which palms become hard) and leads to loss of appetite, weight, diarrhoea, gastrointestinal

**Cadmium:**

- Mining, especially of zinc and metallurgical operations, electroplating industries, etc., release cadmium in the environment.
- It may enter the human body by inhalation or from aquatic sources including fish, etc.
- It may cause hypertension, liver cirrhosis, brittle bones, kidney damage and lung cancer.

- **Itai-itai disease** first reported from Japan in 1965 was attributed to cadmium contamination in water and rice caused by the discharge of effluents from a zinc smelter into a river.

#### Other Heavy Metals:

- Metals such as zinc, chromium, antimony and tin enter food from cheap cooking utensils.
- Preserved foods stored in tin cans also cause contamination by tin.
- Zinc is a skin irritant and affects the pulmonary system.

#### Related Initiative:

##### Waste Minimization Circles (WMC):

- The term "waste minimization" refers to the process of reducing waste. It is accomplished by implementing techniques to reduce waste generation and emissions on a constant basis.
- WMC assists Small and Medium Industrial Clusters in reducing waste in their industrial facilities.
- The World Bank is helping with this, and the Ministry of Environment and Forests is the nodal ministry.
- The National Productivity Council (NPC), New Delhi, is assisting with the project's implementation.
- The effort intends to achieve the goals of the 1992 Policy Statement for Abatement of Pollution, which specifies that government should inform residents about environmental threats, the financial and health risks of resource degradation, and the actual economic cost of natural resources.
- The policy also acknowledges that non-governmental organizations (NGOs) and citizens play a part in environmental monitoring, allowing them to supplement the regulatory system and be recognized for their expertise in areas where it exists and where their dedication and vigilance would be advantageous.

#### Thermal Pollution:

- The rise or fall in temperature of a natural aquatic environment induced by human intervention is known as thermal pollution.

- This has become increasingly common due to the expanding demand for globalization everywhere.
- Thermal pollution is generated by dumping hot water from factories and power plants, or by removing trees and vegetation that shade streams, allowing sunshine to raise the temperature of these waters, and then releasing cold water to cool them down.
- Thermal pollution, like other types of water pollution, is ubiquitous, impacting numerous lakes and a large number of streams and rivers around the world.

### Sources of Thermal Pollution:

#### Power Plants:

- Thermal pollution is caused by **thermoelectric power stations** that use coal, natural gas, nuclear power, biomass, and other waste products as fuel.
- Typically, power plants are situated next to a river, lake, or ocean, which provides a constant supply of water.
- This is transformed into steam, which is used to power turbines, which generate electricity.
- Water is also utilized to keep machinery cool when it gets too hot.
- The water absorbs heat and is normally released back to its source if it does not evaporate.
- This ultimately results in a rise in the temperature of water bodies and causes thermal pollution.

#### Industrial Wastewater:

- Industrial plants, such as petroleum refineries, pulp, and paper mills, chemical plants, and steel mills, contribute to thermal pollution, in addition to power plants.
- Water is also used to cool machinery and to discharge water at high temperatures.
- Once-through cooling is the process of draining water from a lake, ocean, or river for industrial uses and then releasing hot water back to its source.
- It is one of the most significant contributors to thermal pollution.

- It has long been recognized as having a negative impact on aquatic and marine habitats.
- Fish and larvae stuck against intake screens are killed by once-through cooling, and habitats are altered by the release of warmer, frequently dirty water

#### **Desalination Plants:**

- Once-through cooling is also used in desalination plants.
- More than half of the desalinated seawater is discharged into the ocean as effluent, frequently at a high temperature.
- Desalination plants are crowded together in several parts of the world, discharging huge amounts of hot, saline wastewater into shallow coastal locations.
- This can drastically increase the warmth and salinity of saltwater.

#### **Urban Runoff:**

- Urban runoff can have a considerable thermal impact on minor waterways during hot weather.
- Surface runoff absorbs some of the heat as it travels over hot rooftops, parking lots, roadways, and walkways, creating an urban heat island effect.
- The runoff water management facilities, such as bioretention systems and infiltration basins, which absorb runoff or route it into groundwater, lessen these thermal impacts by giving the water more time to discharge excess heat before entering the aquatic environment.
- These linked runoff management technologies are part of a growing urban design strategy known as green infrastructure.
- Because the water may be heated by the sun before being discharged to a receiving stream, retention basins (stormwater ponds) are less effective at reducing runoff temperature

#### **Effects of Thermal Pollution:**

##### **Decrease in DO (Dissolved Oxygen) Levels:**

- The amount of DO (Dissolved Oxygen) in water decreases as the temperature rises.
- Warm water has a lower oxygen content than cold water.

- Reduced DO can cause suffocation in plants and animals like fish, amphibians, and copepods, resulting in anaerobic conditions.
- Animals that are unable to relocate to another place may begin to die if the oxygen level falls.
- Warm water injections into deeper bodies of water can prevent oxygen from diffusing, which is beneficial to bacteria but harmful to aquatic species.
- Algal blooms can result from a lack of oxygen, posing harm to aquatic plants and animals.
- The most common and well-known negative effect of thermal pollution is algal blooms.

#### **An Increase in Toxins:**

- Toxins in the water are a result of dumping wastewater rather than being a direct result of thermal pollution.
- The toxins include heavy metals such as arsenic, mercury, cadmium, chromium, lead, and more.
- The use of water for cooling almost always results in chemical contamination.
- Solvents, fuel oil, and dissolved heavy metals end up in the lake or river where cooling water is discharged.
- Cooling water from nuclear power plants can be mildly radioactive.
- The compounds could have a wide range of adverse consequences on plants and animals, including death, mutations, and sterilization.

#### **Loss of Biodiversity:**

- The sudden rise in temperature might kill or drive away vulnerable organisms.
- For fragile and endangered animal species, this is just one of many critical challenges.
- Organisms suffering from the hot water, being unable to reproduce as effectively as before, or simply abandoning the area can all contribute to this loss.
- Animals are frequently the victims of water pollution, but multicellular aquatic plants are also at risk when the local aquatic ecology is altered by thermal pollution.

**Ecological Impact:**

- Thermal pollution can harm the local aquatic ecosystem, especially if it is severe, such as when large amounts of warm water are poured into a frigid pond, bay, or river.
- The fast shift in water temperature, either an increase or reduction, known as thermal shock, can kill fish and other creatures that evolved to a specific temperature range when a power plant first opens or shuts down for repair or other reasons.
- This untimely death has exacerbated the ecosystem's problems.
- The availability of key food sources has dwindled.
- A local population that is threatened or endangered may be wiped out or put under even more stress.
- When waste from a power plant or business is thrown into coastal waters, coral reef bleaching can occur. When coral organisms die, coral bleaching occurs.

**Measures to Control Thermal Pollution:****Cooling Ponds:**

- The most basic ways of controlling thermal discharges are cooling ponds or reservoirs.
- Heated effluents on the surface of the water in cooling ponds maximize heat dissipation to the atmosphere while reducing the area and volume of water.
- This is the simplest and most affordable way to chill the water to a very low temperature.
- However, in terms of air-water contact, the method alone is less attractive and inefficient.

**Cooling Towers:**

- The cooling process is defined as the process of taking water from water sources for cooling purposes and then returning it to the water body after passing through the condenser.
- As a result, cooling towers are built to regulate the temperature of water in order to improve the cooling process.

- Cooling towers are primarily used to dissipate recovered waste heat and hence alleviate thermal pollution issues.

#### **Artificial Lakes:**

- Artificial lakes are man-made bodies of water that can be used as an alternative.
- It can be created by damming a valley, digging the land, or enclosing an area of land with dykes and redirecting a portion of the river flow into the reservoir.
- The heated effluents could be dumped into the lake on one end, and the water could be recovered for cooling on the other.
- Through evaporation, the heat is gradually released. However, these lakes must be replenished on a regular basis.

#### **Spray Ponds:**

- A spray pond is a reservoir where overheated water from a power plant is cooled before reuse by spraying it into the cooler air via nozzles.
- Cooling is accomplished through heat exchange with the surrounding air.
- This includes both conductive heat transfer between the water droplets and the surrounding air as well as evaporative cooling which provides by far the greatest portion, typically 85 to 90 percent, of the total cooling.
- This eventually aids in controlling thermal pollution.

#### **Noise pollution:**

- Unwanted sounds are classified as noise.
- When noises are too loud and persist too long, they become noise pollution.
- Noise pollution is generally defined as regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms.
- Decibels (dB) are the units of measure for indicating the intensity or loudness of a sound.
- It is a unit for expressing the relative intensity of sound on a logarithmic scale.
- Since it is a logarithmic scale, even small difference in decibel level indicates orders-of-magnitude difference in intensity of sound e.g., a 60-dB, or 6-bel, sound, such as normal speech, is six powers of 10 (i.e., 10<sup>6</sup>, or 1,000,000) times more intense than a barely detectable sound, such as a faint whisper, of 1 db.

- According to the World Health Organization, sound levels less than 70 dB are not damaging to living organisms, regardless of how long or consistent the exposure for more than 8 hours to constant noise beyond 85 dB may be hazardous.

**The key findings of the UNEP’s Frontiers Report on Noise Pollution:**

- Delhi, Jaipur, Kolkata, Asansol and Moradabad are the five Indian cities mentioned in the UNEP’s list of cities with maximum noise pollution.
- At a maximum value of 114, Moradabad was the second-most-noisiest city in the list.
- The first was Dhaka, Bangladesh at a maximum value of 119 dB.
- Over 72% of Barcelona’s residents are exposed to noise levels of over 55 dB. More than half of the residents of large European cities live in areas where noise levels may adversely affect their health and well-being
- Two in five residents of Hong Kong are exposed to road traffic noise above the permissible limit.
- Residents with lower income and poor housing are more exposed to traffic noise compared to wealthier residents.
- The report bases its findings from already published research papers or studies on noise pollution in cities world over.
- These studies typically involve measurements of levels of noise pollution in different parts of the city: residential areas, industrial areas and commercial places during the day and night.

**The various causes of noise pollution:**

- **Transportation:**
  - A large number of vehicles on roads, airplanes flying over houses, underground trains etc. produce heavy noise.
  - According to the Frontiers Report, across the European Union, at least 20% of citizens are currently exposed to road traffic noise levels that are considered harmful to health.

- **Industrialization:**
  - Many industries use big machines like compressors, generators, exhaust fans, grinding mills etc., which produce a large amount of noise.
  - The 114 dB measurement in Moradabad was an average of measurements reported from a factory in an industrial zone.
- **Social Events:**
  - Noise is at its peak in most of the social events like marriage, parties, pub, disco or place of worship etc.
  - People normally flout rules set by the local administration and create nuisance in the area.

#### Impacts of noise pollution:

- **Hearing Loss:** Experts believe that regular exposure to over 85 dB for an 8-hour day or longer can cause permanent hearing damage.
- **Sleeping Disorders:**
  - Loud noise can hamper sleeping patterns and may lead to irritation and uncomfortable situations.
  - Sleeping disorders can further disturb the body's circadian rhythm.
- **Chronic Health Problems:**
  - Noise pollution is a risk factor for the development of cardiovascular and metabolic disorders such as elevated blood pressure, arterial hypertension, coronary heart disease and diabetes.
  - A conservative estimate indicates that long-term exposure to environmental noise contributes to 48,000 new cases of ischemic heart disease and causes 12,000 premature deaths annually in Europe.
- **Productivity Loss:**
  - High levels of noise causes extreme discomfort to workers that adversely impacts their mind and reduces their productivity.
  - This in turn enhances cost of production.
- **Impact on other species:**
  - Traffic and other urban noises disturb and endanger the survival of other species.

- For instance, Acoustic signals are used in a variety of communication contexts by animals like territory defense, warning of danger, locating or attracting a mate, and caring for offspring.
- However, these functions are severely hindered by noise pollution.
- Many species tend to adapt to the pollution by altering their behaviour e.g., modifying their signals by switching their vocal frequency or altering their vocalization timing. However, these adaptations can have unintended consequences (like altered vocalization patterns may be considered less attractive by potential mating partner, therefore affecting reproductive success).
- These consequences might eliminate them from their habitats, with possible significant ecological implications.
- **Central Pollution Control Board** has listed fines for the violation of noise pollution norms, including the use of loudspeakers or public addresses that can result in a fine of Rs 10,000.
- The noise level at the boundary of the public place, where a loudspeaker or public address system or any other noise source is being used, shall not exceed 10 dB (A) above the ambient noise standards for the area or 75 dB (A), whichever is lower.
- The rules also state that a loudspeaker or a public address system shall not be used except after obtaining written permission from the designated authority.
- **Exemption:** The state government can provide exemption during any cultural or religious festive occasion of a limited duration not exceeding 15 days in all during a calendar year.

#### Noise pollution impact health:

- While noise pollution does not receive as much attention as air and water pollution, it is known to impact the health of people.
- According to the World Health Organisation (WHO), about 1.1 billion young people (aged between 12–35 years) are at the risk of hearing loss due to noise exposure.

- The WHO has stated that there is sufficient evidence that noise exposure at night causes self-reported sleep disturbance and noise-induced sleep disturbance is viewed as a health problem.
- WHO also states there is evidence, albeit limited, that disturbed sleep causes fatigue, accidents and reduced performance.
- Various physical disorders due to higher noise include temporary deafness, headache and an increase in blood pressure.

#### **The Noise Pollution (Regulation and Control) Rules, 2000:**

- **Section 2 (a) of the Air (Prevention and Control of Pollution) Act, 1981 considers noise as ‘air pollutant’.**
- According to reports, “air pollutant” is any solid, liquid, or gaseous substance, including noise, present in the atmosphere in such concentrations as to be or tend to be harmful to humans, other living creatures, plants, property, or the environment.
- Noise pollution and its sources are regulated under the Noise Pollution (Regulation and Control) Rules, 2000 under the Environment (Protection) Act, 1986.
- Under the Act, there is a defined ambient acceptable noise levels, restrictions on the use of loudspeakers, sound-emitting construction equipment, horns, bursting of crackers and so on.
- Lid waste **refers to** all non-liquid wastes that include Solid as well as semi-solid wastes, but excluding Human and Animal excreta.
- Solid waste can create very serious health problems and an unpleasant living environment if not disposed of in a proper and a safe manner, such waste may then also provide breeding sites for insect-vectors, pests, snakes and vermin that increase the risk of disease transmission.
- It may also pollute water sources and the environment.

#### **Different categories of solid waste include:**

- **Organic waste:** Food waste, Market associated wastes etc.
- **Dead animals:** Carcasses of animals (Cows, Buffaloes, Dogs etc.)

- **Combustibles:** Paper, wood, dried leaves etc. (high organic and low moisture content) Non-combustibles: Metal, tin cans, bottles, etc.
- **Ashes:** Residue from fires used for cooking.
- **Bulky waste:** Tree branches, tyres, etc.
- **Hazardous waste:** Battery acid, medical waste etc.
- **Construction waste:** Roofing, broken concrete, etc.

#### Factors behind the generation of Solid Waste:

Solid wastes are generated from Rural as well as Urban areas in India.

#### The main factors affecting these are:

- **Geographical Industrially** and technologically developed regions like Delhi, Bengaluru generate more solid wastes when compared with less industrialized places like Shimla or Kashmir.
- **Socio-cultural** practices such as dumping waste in rivers, performing rituals which generate a lot of solid wastes.
- The packaging of food items use of packaged food items, that too more often, leads to generation of solid waste.
- It is seen that the volume of waste generated is likely to be small and degradable where the population is of rural origin while the urban populations are more likely to generate larger volumes of non-degradable waste, especially where packaged food is consumed more.

#### The Present Scenario:

##### The Extent:

- Most of the dumpsites of megacities have reached way beyond their capacity and permissible height limit of 20 meters.
- It is estimated that more than 10,000 hectares of urban land are locked in these dumpsites in India.
- The per capita waste generation in Indian cities ranges from 200 grams to 600 grams per day.
- Only about 75-80% of the municipal waste gets collected and only 22-28 % of this waste is processed and treated.

**India generates the most waste globally, and by 2050, our waste generation will double:**

- Drains and water bodies, emptying out into Indian rivers, also carry with them an unimaginable amount of waste.
- The Ganga is among the top 10 polluted rivers in the world, together accounting for 90% of the total ocean plastic pollution.
- India faces a seemingly insurmountable challenge of treating and getting rid of the legacy waste, with simultaneous and continuous accumulation of fresh everyday waste.
- Central, state, city and municipal governments, over decades, have not been able to prevent this situation, nor deal with its scale.
- For a country the size of India, there are about 92 large WTE plants. Of these, only a small fraction is operational, and the plants that are operational, run at suboptimal capacity.
- State governments have, so far, invested an estimated Rs 10,000 crore in such plants.
- The task now is to be clear on what needs to be done, on what has not been done, or done incorrectly, and to ensure correct execution of a national mission.

**The Impact:**

- The proliferation of airless open dumps of garbage leads to emissions of methane, which absorbs the sun's heat, warms the atmosphere and contributes to global warming.
- Leachate, which is a black liquid oozing out from the waste as it slowly decomposes over a period of 25 to 30 years, contaminates soil and groundwater.
- Foul odour from the waste rotting in airless heaps, and smoke from the fires that routinely erupt in them, are other consequences of dumping waste in the open.
- The earlier landfills are without bottom liners and sideliners, which allows the Leachate to seep into the ground causing groundwater and land pollution.

- The dumpsites being open and easily accessible, have become a site for further dumping by the public aggravating the situation.

**Some of the major issues concerning solid waste management are:**

- Absence of segregation of waste at source
- Lack of funds for waste management at ULBs
- Lack of technical expertise and appropriate institutional arrangement
- Unwillingness of ULBs to introduce proper collection, segregation, transportation and treatment/disposal systems
- Indifference of citizens towards waste management due to lack of awareness
- Lack of community participation towards waste management and hygienic conditions
- Lack of sewage management plan.

**Associated Risks:**

- **Spread of Diseases:**
  - Decomposing solid waste attracts animals, mosquitoes, vermin and flies.
  - They play a major role in the transmission of faecal-oral diseases and the transmission of diseases such as leptospirosis, typhoid, dengue, yellow fevers, microfilariae, gastro-enteritis, dysentery and other illnesses.

**Water, Soil and Air Pollution:**

- Poor management of the collection and disposal of solid waste may lead to Water Pollution (pollution of surface water/groundwater).
- This may also result in deterioration of Soil (Soil Pollution).
  - Where large quantities of Solid dry waste are stored in hot climates this may create a fire hazard.
  - Related hazards include Air pollution and fire threat to surrounding buildings and people.

**Management of Solid Waste:**

- Solid waste management can be divided into four key components: **Generation Storage and Collection Transportation Disposal**

**Generation:**

- Generation of solid waste is the stage at which materials become of no use to the owner and they wish to get rid of them.

#### **Storage and Collection:**

- Storage takes place after the materials have been discarded.
- Key here is to not discard items directly into family pits and poorly defined heaps close to dwelling areas, but an effective storage system must be at place, like the Government of India has directed municipal corporations to undertake Door to Door collection of Solid wastes under Jawaharlal Nehru National Urban Renewal Mission (JNNURM).
- Whereas under Swacch Bharat Abhiyan, two different dustbins have been provided (Blue and Green Dustbins) which are used to segregate two different kinds of wastes, the green is meant for wet wastes while the blue one is for Solid dry waste.

#### **Transportation:**

- This is the stage when solid waste is transported to the final disposal site.
- There are various modes and methods which may be adopted depending upon availability and the volume of waste to be transported.
- In India, Solid wastes are generally transported first by small municipal vehicles to a dumping site, then big municipal vehicles carry them for final disposal, be it to landfills or to recycling plants.

#### **Disposal:**

- The final stage of solid waste management is safe disposal where associated risks are minimised. **There are six main methods for the disposal of solid waste:**
- **Land application:**
  - Open dumps or landfilling, Open dumps and landfills are uncovered/covered areas that are used to dump solid waste of all kinds.
  - The waste is not treated nor it is segregated and thus it is also a place where a lot of insects and other disease causing organisms breed.
  - They are generally located in urban areas.

- For landfills, a pit is dug where garbage is dumped and the pit is covered with soil everyday thus preventing the breeding of flies and rats.
- Open dumps are more harmful than landfills as landfills after they are full can be used as a park/parking lot after covering it, but open dumps cannot be treated as such.
- **Composting:**
  - Composting is a biological process in which micro-organisms such as fungi or bacteria decompose in the presence of oxygen the degradable organic wastes.
  - The finished product is very rich in carbon and nitrogen thus acting as a great medium for plant cultivation.
- **Burning or incineration:**
  - The process of burning solid wastes in a large furnace at a very high temperature whereby producing ash is called Incineration.
  - It is only used as a last resort because it also produces a lot of toxic gases resulting in Air Pollution.
- **Pyrolysis:**
  - The process of burning solid wastes, but in the absence of oxygen in a large furnace at a very high temperature whereby producing charcoal, tar, methyl alcohol, acetic acid, acetone which can be used as fuels is called Pyrolysis.
- **Vermiculture:**
  - It is also known as Earthworm farming.
  - In this method, Earthworms are added to the compost.
  - These worms break the solid waste and along with the earthworms excreta, the compost becomes rich in nutrients.
- **Recycling:** Solid wastes are also recycled, where the solid wastes **Legislation in India.**

**Solid Waste Management Rules 2016:**

- These rules replace the **Municipal Solid Wastes (Management and Handling) Rules, 2000**, are now applicable beyond municipal areas and have included urban agglomerations, census towns, notified industrial townships etc.
- They **focus 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.
- It has also been advised that the bio-degradable waste should be processed, treated and disposed of through composting or bio-methanation within the premises as far as possible and the residual waste shall be given to the waste collectors or agency as directed by the local authority.
- The rules promote the use of compost, conversion of waste into energy, revision of parameters for landfills location and capacity.
- The government has also constituted a Central Monitoring Committee under the chairmanship of Secretary, MoEF & CC to monitor the overall implementation of the rules.
- The Rules for the Safe Treatment of Legacy Waste prescribe bio-remediation and bio-mining in all open dumpsites and existing operational dumpsites in India.
- Are first taken to compost plants which are either set up by Government or by Private companies (under Corporate Social
- Responsibility), then they are either converted to fertilizers or they are recycled to produce various other items such as Plastics bottles, electronic instruments, building materials etc.

**Waste-to-energy (WtE) plants which rely on the incineration of mixed waste:**

- WtE plants in India burn mixed waste.
- The presence of chlorinated hydrocarbons like PVC results in the release of dioxins and furans when the waste is burnt at less than 850 degree Celsius

- **Harmful emissions:** Dioxins and furans are known to be carcinogenic and can lead to impairment of immune, endocrine, nervous and reproductive systems.
- **Poor compliance:** These WtE are not in compliance with guidelines given by the National Green Tribunal.
- **Environmentally unsustainable:** Even when incineration takes place under optimal conditions, large amounts of flue gases, mercury vapour and lead compounds are released, and there is always about 30 per cent residue from incineration in the form of slag (bottom ash) and fly ash (particulate matter), which are also known to be serious pollutants of air and water.
- Also, WtE plants in India are also inefficient in generating energy.
- Municipal waste in India has a very high biodegradable (wet) waste content ranging anywhere between 60 to 70 % of the total, compared with 30 % in the Western countries.
- This gives our waste high moisture content and low calorific value.

#### Compactors:

- Compactors are expensive machines that squeeze and compress the volume of waste, this enables more waste to be carried per trip and, thus, reduces transportation costs.
- **The antithesis of segregation:** The use of compactors on mixed waste makes it almost impossible to extract the recyclable dry waste such as plastics, metal, paper and cardboard from the mixture.
- **Polluting:** The compression of wet waste in the mixture releases leachate (a black foul-smelling liquid) that is difficult to dispose of. Leachate percolates into the soil and contaminates groundwater. When it drains off into the sewer system, it overloads the sewage treatment plants.
- **Increases global warming:** After the compacted waste is transported and dumped, the lack of aeration at the site results in the decomposing wet waste generating methane, a potent greenhouse gas that causes global warming.

**Waste transport contracts with private parties**

- A payment for waste transportation is made on a tonnage basis.
- This provides an incentive to maximize the weight of waste.
- These private players mix whatever the waste is given to them separately.
- Also, the unmixed transportation and processing of wet and dry waste encourage citizens to keep their waste unmixed too.
- In India, less than 60% of waste is collected from households and only 15% of urban waste is processed.
- Hyper consumption is a curse of our modern times.
- Humans generate monumental amounts of waste, a sizeable portion of which is disposed in landfills and through waste-to-energy incinerators.
- However, billions of tonnes of garbage, including microplastics, never make it to landfills or incinerators and end up in the oceans.
- This garbage chokes marine life and disturbs zooplankton, which are vital to the elimination of carbon dioxide from the atmosphere.
- To understand the existing scenario of waste management, impact of poor waste management solutions, policies that have been framed to address it and the major systemic changes that need to happen to ensure this important public issue does not turn into a national calamity.

**Problems of unscientific MSW disposal:**

- Only about 75- 80% of the municipal waste gets collected and out of this only 22-28 % is processed and treated and remaining is disposed of indiscriminately at dump yards.
- It is projected that by the year 2031 the MSW generation shall increase to 165 million tonnes and to 436 million tons by 2050.
- If cities continue to dump the waste at present rate without treatment, it will need 1240 hectares of land per year and with projected generation of 165 million tons of waste by 2031, the requirement of setting up of land fil for 20 years of 10 meters height will require 66,000 hectares of land.

- Scientific disposal of solid waste through segregation, collection and treatment and disposal in an environmentally sound manner minimises the adverse impact on the environment.
- The local authorities are responsible for the development of infrastructure for collection, storage, segregation, transportation, processing and disposal of MSW.
- If municipal solid waste management is done through proper planning and management, it would lead to a business case of income generation and provide financial support to ULBs by generating revenue.

#### **Waste Treatments Problems:**

- Segregation of waste into organic, recyclable and hazardous categories is not enforced at source.
- As a result, mixed waste lands up in the landfills, where waste-pickers, in hazardous conditions, try to salvage the recyclables, which are of poor quality and quantity by then.
- Ideally, waste management should not be offered free of cost to residents.
- Only if residents pay will they realise the importance of segregation and recycling.
- There is the issue of logistical contractors who are motivated to dump more garbage in landfills as their compensation is proportional to the tonnage of waste.
- They are also prone to illegally dump waste at unauthorised sites to reduce transportation costs.
- Importantly, organic farming and composting are not economically attractive to the Indian farmer, as chemical pesticides are heavily subsidised, and the compost is not efficiently marketed.
- There are solutions to the garbage pandemic through the crucial processes of material recycling and composting.
- Efficient composting is possible through an optimal combination of microbes and temperature to produce a nutrient-dense soil conditioner.

### Way Forward:

- There is a need for a comprehensive waste management policy that stresses the need for decentralised garbage disposal practices as this will incentivise private players to participate.
- It is important that Biomining and Bioremediation are made compulsory for areas wherever they can be applied.
- To overhaul the waste management sector and induce the necessary behavioural change, citizen participation and engagement is the key.
- Waste segregation practice can be inculcated in the masses through an awareness-building programme accompanied by a fine if mixed waste is handed out.
- The Ministry of Housing and Urban Affairs should either stop financing compactors or at least offer municipalities similar levels of support for more sustainable methods of waste management. For example, access to bio-composters in residential localities.
- A much smarter alternative for municipalities under the Smart Cities Mission would be to promote decentralised composting of wet waste, tie-up with local “kabadiwalas” or NGOs for recyclable dry waste, and work on safe disposal of the rest.
- The savings from eliminating costly secondary transport can easily fund the construction and operation of decentralised centres for the processing of wet and dry waste.

### Government’s Initiatives for Solid Waste Management:

#### ▪ Waste to Wealth Portal:

- The Waste to Wealth Mission is one of the nine scientific missions of the **Prime Minister’s Science, Technology, and Innovation Advisory Council (PMSTIAC)**.
- It aims to identify, develop, and deploy technologies to treat waste to generate energy, recycle materials, and extract resources of value.

- **National Water Mission:**

- It was launched with the objective of **conservation of water, minimising wastage and ensuring more equitable distribution** both across and within states through integrated water resources development and management.

- **Waste to Energy:**

- A **waste-to-energy or energy-from-waste plant** converts municipal and industrial solid waste into electricity and/or heat for industrial processing.

- **Plastic Waste Management (PWM) Rules, 2016:**

- It mandates the **generators of plastic waste to take steps to minimize generation of plastic waste, prevent littering of plastic waste, and ensure segregated storage of waste** at source among other measures.

#### **Hazardous Waste:**

- Any substance that is present in the environment or released into the environment causing substantial damage to public health and welfare of the environment is called hazardous substance.
- Any hazardous substance could exhibit any one or more of the following characteristics: toxicity, ignitability, corrosivity or reactivity (explosive).
- Thus, any waste that contains hazardous or very hazardous substance is called hazardous waste.
- Hazardous wastes can originate from various sources such as household, local areas, urban, industry, agriculture, construction activity, hospitals and laboratories, power plants and other sources.

#### **Stockholm Convention on Persistent Organic Pollutants:**

- Stockholm Convention on Persistent Organic Pollutants is an international environmental treaty.
- Came into effective in 2004.
- Aims to eliminate or restrict the production and use of persistent organic pollutants (POPs).

- POPs are defined as “chemical substances that persist in the environment, bioaccumulate through the food web, and pose a risk o
- Causing adverse effects to human health and the environment”.

#### Important Listed substances:

- **Aldrin:** Used as an insecticide
- **Heptachlor:** Uses as a termiticide (including in the structure of houses and underground), for organic treatment and in underground cable boxes
- **Hexachlorobenzene:** Use as a chemical intermediate and a solvent for pesticides
- **Endrin:** Endrin has been used primarily as an agricultural insecticide on tobacco, apple trees, cotton, sugar cane, rice, cereal, and grains.
- **Polychlorinated biphenyl:** PCB’s commercial utility was based largely on their chemical stability, including low flammability, and physical properties, including electrical insulating properties. They are highly toxic.
- **Dichlorodiphenyltrichloroethane:** DDT is the best-known of several chlorine-containing pesticides used in the 1940s and 1950s.

#### Basel Convention:

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal.
- An international treaty that was designed to reduce the movements of hazardous waste between nations.
- Main goal is to prevent the transfer of hazardous waste from developed to less developed countries (LDCs).
- It does not address the movement of radioactive waste.

#### Rotterdam Convention:

- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade.
- Multilateral treaty to promote shared responsibilities in relation to the importation of hazardous chemicals.

- The convention promotes an open exchange of information and calls on exporters of hazardous chemicals to use proper labelling, safe handling, and inform purchasers of any known restrictions or bans.
- Signatory nations can decide whether to allow or ban the importation of chemicals listed in the treaty.

