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Environmental Science

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Environmental Science:

Environmental science is defined as a branch of biology focused on the study of the relationships of the natural world, the relationships of the organisms with their environments.

The integrated study of factors that influence the environment and environmental systems, especially the interaction of the physical, chemical, and biological components of the environment.

Environmental science studies all aspects of the environment in an **interdisciplinary** way. This means that it requires the knowledge of various other subjects including biology, chemistry, physics, statistics, microbiology, biochemistry, geology, economics, law, sociology, etc. It is a relatively new field of study that has evolved from integrated use of many disciplines.

Environmental engineering is one of the fastest growing and most complex disciplines of engineering. Environmental engineers solve problems and design systems using knowledge of environmental concepts and ecology, thereby providing solutions to various environmental problems. **Environmentalism**, in contrast, is a social movement through which citizens are involved in activism to further the protection of environmental landmarks and natural resources. This is not a field of science, but incorporates some aspects of environmental knowledge to advance conservation and sustainability efforts.

Brief History: In 1962, **Rachel Carson** wrote the book *Silent Spring* that alerted the public to the rising use of pesticides and other chemicals and their effect on the ecosystem and to humans. This focus on the environment and human impact began to change the way we viewed our role in both the preservation and destruction of the natural world.

Environmental Systems refer to the system of the biosphere wherein life interacts with the atmosphere, hydrosphere, and lithosphere. An **environmental management system** (EMS) is a

set of procedures that allow an industry to increase its efficiency and reduce its environmental impacts.

Scope of Environment: The environment consists of four segments/components as under:

1. An **atmosphere** is a layer or a set of layers of gases surrounding a planet or other material body, that is held in place by the gravity of that body. The atmosphere of Earth is composed of nitrogen (about 78%), oxygen (about 21%), argon (about 0.9%) with carbon dioxide and other gases in trace amounts.
 - (a) It sustains life on the earth.
 - (b) It saves it from the hostile environment of outer space.
 - (c) It absorbs most of the cosmic rays from outer space and a major portion of the electromagnetic radiation from the sun.
 - (d) It transmits only here ultraviolet, visible, near infrared radiation (300 to 2500 nm) and radio waves. (0.14 to 40 m) while filtering out tissue-damaging ultraviolet waves below about 300 nm.

Components of Atmosphere;

Exosphere: 700 to 10,000 km (440 to 6,200 miles)

Thermosphere: 80 to 700 km (50 to 440 miles)

Mesosphere: 50 to 80 km (31 to 50 miles)

Stratosphere: 12 to 50 km (7 to 31 miles)

Troposphere: 0 to 12 km (0 to 7 miles)

2. **Lithosphere**, earth's lithosphere includes the crust and the uppermost mantle, which constitute the hard and rigid outer layer of the Earth. The uppermost part of the lithosphere that chemically reacts to the atmosphere, hydrosphere and biosphere through the soil forming process is called the **Pedosphere**.

It consists of minerals occurring in the earth's crusts and the soil *e.g.* minerals, organic matter, air and water.

3. The **hydrosphere** is the liquid water component of the Earth. It includes the oceans, seas, lakes, ponds, rivers and streams. The **hydrosphere** covers about 70% of the surface of the Earth and is the home for many plants and animals.
 - (i) Nature 97% of the earth's water supply is in the oceans,
 - (ii) About 2% of the water resources is locked in the polar icecaps and glaciers.

(iii) Only about 1% is available as fresh surface water-rivers, lakes streams, and ground water fit to be used for human consumption and other uses.

4. **Biosphere** is the global ecological system integrating all living beings and their relationships, including their interaction with the elements of the lithosphere, hydrosphere, and atmosphere.

ENVIRONMENTAL POLLUTION:

Introduction, Causes & Types:

What is Environmental Pollution?

- Environment Pollution is the addition of contaminants into the natural environment that causes detrimental effects to nature, natural resources and mankind.
- Any unnatural and negative changes in all the dimensions like chemical, physical and biological characteristics of any component of the ecosystem i.e. air, water or soil which can cause harmful effects on various forms of life and property is called environmental pollution.

What is a Pollutant?

- Any substance which causes harmful effects or uneasiness in the organisms, then that particular substance may be called as the pollutant.

The materials that cause pollution are of two types:

1. **Persistent pollutants:** Those pollutants which remain consistent in the environment for a long period of time without any change in its original form are called persistent pollutants. For example pesticides, nuclear wastes, and plastics etc.

2. **Non-persistent pollutants:** These pollutants are the opposite of persistent pollutant and break down in the simple form. If this process of breaking down is done by living organisms, then such pollutants are referred to as biodegradable pollutants. From another perspective, pollutants can be classified as follows:

1. **Primary Pollutants:** Primary pollutants are those which remain in the form in which they were added to the environment for ex. DDT, Plastic

2. **Secondary Pollutants:** Secondary pollutants are formed due to interaction of primary pollutants amongst themselves viz. PAN by the interaction of NO_x & Hydrocarbons. According to their existence in nature:

1. **Quantitative Pollutants:** These substances are already present in the atmosphere but they become pollutant when their concentration level reaches to a particular level which is above a threshold limit.

2. **Qualitative Pollutants:** These are man-made pollutants eg. Fungicides, herbicides etc.

According to origin:

1. **Man-made Pollutants**

2. **Natural Pollutants**

According to the nature of disposal:

1. Biodegradable Pollutants

2. Non-biodegradable Pollutants

According to the nature of disposal:

1. Biodegradable Pollutants

2. Non-biodegradable Pollutants

Types of pollution:

Air Pollution:

- Air pollution is the presence of one or more disadvantageous content in such quantity and for such duration, as it is catastrophic, or tend to be catastrophic, to human health and welfare, animal or plant life.
- It is the contaminants of air by the discharge of detrimental substances.

Some of the air pollutants, their sources and effects:

Name of the pollutants	Sources	Health effects
Nitrogen oxides	Industries, vehicles and power plants	Problems in the lungs, respiratory systems and causes asthma and bronchitis.
Carbon monoxide	Emission and burning of fossil fuels	Severe headache, irritation to mucous membrane, unconsciousness and death.
Carbon dioxide	Burning of fossil fuels	Vision problem, severe headache and heart strain.
Suspended particulate matter	Vehicular emission and burning of fossil fuels.	Lung irritation reduces development of RBC and pulmonary malfunctioning.
Sulphur oxide	Industries and power plant	Irritation in eyes and throat, allergies, cough etc.
Smog	Industries and vehicular pollution	Respiratory and eye problems
Hydrocarbons	Burning of fossil fuels	Kidney problems, irritation

		in eyes, nose and throat, asthma, hypertension and carcinogenic effects on lungs.
Chlorofluorocarbons	Refrigerators, emission from jets	Depletion of ozone layer, global warming

- Other pollutants are cadmium, lead, mercury, silica, coal dust and particles and radioactive pollutants.

Control measures

- Policy measures
- Modification of industrial process and selection of suitable fuels and its utilization.
- Collection of pollutants and convert it into less toxic forms by different methods.

Government initiatives

- National air quality monitoring programme (NAMP)
- National ambient air quality standards (NAAQS).

Water Pollution:

- Addition of certain substances such as organic, inorganic, biological and radiological to the water, which degrades the water quality and makes it unhealthy for use.
- Water pollution is not only confined to surface water but also spread to groundwater, sea and ocean.

Sources:

Point sources: These are directly pointed towards the water bodies from the source of origin of pollution and are thus easy to regulate.

Non-point sources: These sources are related to many diffuse sources and are thus difficult to regulate.

Some of the sources are:

1. Industrial and community wastewater: Industries like mining, iron and steel, pharmaceuticals, food processing, soap and detergent and paper and pulp.
2. Agricultural sources, thermal pollution (discharge of hot water by thermal power plants cause deficiency of dissolved oxygen in water) and underground water pollution.
3. Marine pollution: river discharge, manmade pollution and oil spills etc.

Effects

- An excessive amount of mercury in water can cause Minamata disease in humans and dropsy in fishes; Lead in large amount can cause dyslexia, Cadmium poisoning causes Itai or Itai disease etc.
- Polluted water has less amount of Dissolved oxygen (DO) content which is important for sensitive organisms, thereby eliminates sensitive organisms.
- Excess of nitrate in drinking water is dangerous for infants and human health, excess fluoride cause neuromuscular disorder and teeth deformity, hardening of bones and painful joints.
- Biological magnification and eutrophication.

Control measures

- Usage of water should be minimized by changing the techniques involved.
- Recycling and treatment of water should be used to the maximum extent possible.
- The quantity of discharge of wastewater can be minimized.
- Excessive use of pesticides and fertilizers should be avoided.
- Organic farming and efficient use of animal residues as fertilizers.

Soil Pollution:

- Addition of unwanted substances to the soil which negatively affects physical, chemical and biological properties of soil and reduces its productivity is called soil pollution.
- The factors which disturb the biological balance of the soil and deteriorate the quality, texture and mineral content are called soil pollutants.
- Use of fertilizers, pesticides, insecticides, dumping of solid waste, deforestation and pollution due to urbanization and other anthropogenic substances causes soil pollution.

Sources

- Industrial waste: lead, cadmium, mercury, alkalies, organic substances and chemicals.
- Agricultural waste: fertilizers, pesticides, insecticides and manures.
- Discarded materials and radioactive elements and plastic bags.

Effects

- Agriculture: It reduces soil fertility and thus crop yields; increase soil erosion and salinity.
- Ecological imbalance and imbalance in flora and fauna further increases.
- Problems in urban areas like clogging in drains, release of gases, foul smells and problems in

wastewater management.

- Release of radioactive rays, bio-magnification and pollutant gases cause health problems.

Control measures

- Afforestation, reforestation and use of organic farming.
- Solid waste management and reduction of waste from the construction area.
- Stop the use of plastic bags and use bags of degradable materials like paper and cloth.
- Biomedical waste should be collected and incinerated in incinerators.

Sources of Environmental Pollution:

Fossil Fuel Sources of Environmental Pollution (oil, gas and coal etc.)

Fossil fuels are among the **most** serious sources of environmental pollution. Power-generating plants and transport are probably the biggest sources of fossil fuel pollution. Common **sources** of fossil fuel pollution are:

Industry:

- Power-generating plants
- Petroleum refineries
- Petrochemical plants
- Production and distribution of fossil fuels
- Other manufacturing facilities

Transport:

- Road transport (motor vehicles)
- Shipping industry
- Aircraft

Fossil fuel combustion is also a major source of **carbon dioxide** (CO₂) emissions and perhaps the most important cause of global warming.

Other (Non-Fossil Fuel) Sources of Environmental Pollution

Among other pollution sources, **agriculture** (livestock farming) is the largest generator of ammonia emissions resulting in *air pollution*. Chemicals such as pesticides and fertilizers are also widely used in agriculture, which may lead water pollution and soil contamination as well.

Trading activities may be another source of environmental pollution. For example, it's been recently noted that packaging of products sold in supermarkets and other retail outlets is far too

excessive and generates large quantities of solid waste that ends up in landfills leading to *soil contamination* and *air pollution*.

Residential sector is another significant source of pollution generating solid municipal waste that may end up in landfills or incinerators leading to soil contamination and air pollution.

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Environmental Deterioration/Degradation

Environmental degradation/deterioration is the disintegration of the earth or environment through consumption/destruction of assets, for example, air, water and soil; the destruction of environments and the eradication of wildlife. It occurs when earth's natural resources are depleted and environment is compromised in the form of extinction of species, pollution in air, water and soil, and rapid growth in population.

Causes of Environmental Deterioration/Degradation:

- 1. Land Disturbance:** A more basic cause of environmental degradation is land damage. Numerous weedy plant species, for example, garlic mustard, are both foreign and indigenous. A rupture in the environmental surroundings provides for them a chance to start growing and spreading which destroy the natural vegetation.
- 2. Pollution:** Pollution, in whatever form, whether it is air, water, land or noise is harmful for the environment. Air pollution pollutes the air that we breathe which causes health issues. Water pollution degrades the quality of water that we use for drinking purposes. Land pollution results in degradation of earth's surface as a result of human activities. Noise pollution can cause irreparable damage to our ears when exposed to continuous large sounds like honking of vehicles on a busy road or machines producing large noise in a factory or a mill.
- 3. Overpopulation:** Rapid population growth puts strain on natural resources which results in degradation of our environment. Mortality rate has gone down due to better medical facility which has resulted in increased lifespan. More population simply means more demand for food, clothes and shelter. You need more space to grow food and provide homes to millions of people. This results in deforestation which is another factor of environmental degradation.
- 4. Landfills:** Landfills pollute the environment and destroy the beauty of the city. Landfills come within the city due to the large amount of waste that gets generated by households, industries, factories and hospitals. Landfills pose a great risk to the health of the environment and the people who live there. Landfills produce foul smell when burned and cause huge environmental degradation.
- 5. Deforestation:** Deforestation is the cutting down of trees to make way for more homes and industries. Rapid growth in population and urban sprawl are two of the major causes of deforestation. Apart from that, use of forest land for agriculture, animal grazing, harvest for fuel

wood and logging are some of the other causes of deforestation. Deforestation contributes to global warming as decreased forest size puts carbon back into the environment.

- 6. Natural Causes:** Things like avalanches, quakes, tidal waves, storms, and wildfires can totally crush nearby animal and plant groups to the point where they can no longer survive in those areas. This can either come to fruition through physical demolition as the result of a specific disaster, or by the long term degradation of assets by the presentation of an obtrusive foreign species to the environment. The latter frequently happens after tidal waves, when reptiles and bugs are washed ashore.

Effects of Environmental Degradation:

- 1. Impact on Human Health:** Human health might be at the receiving end as a result of the environmental degradation. Areas exposed to toxic air pollutants can, cause respiratory problems like pneumonia and asthma. Millions of people are known to have died of due to indirect effects of air pollution.
- 2. Loss of Biodiversity:** Biodiversity is important for maintaining balance of the ecosystem in the form of combating pollution, restoring nutrients, protecting water sources and stabilizing climate. Deforestation, global warming, overpopulation and pollution are few of the major causes for loss of biodiversity.
- 3. Ozone Layer Depletion:** Ozone layer is responsible for protecting earth from harmful ultraviolet rays. The presence of chlorofluorocarbons, hydro chlorofluorocarbons in the atmosphere is causing the ozone layer to deplete. As it will deplete, it will emit harmful radiations back to the earth.
- 4. Loss for Tourism Industry:** The deterioration of environment can be a huge setback for tourism industry that rely on tourists for their daily livelihood. Environmental damage in the form of loss of green cover, loss of biodiversity, huge landfills, increased air and water pollution can be a big turn off for most of the tourists.
- 5. Economic Impact:** The huge cost that a country may have to borne due to environmental degradation can have big economic impact in terms of restoration of green cover, cleaning up of landfills and protection of endangered species. The economic impact can also be in terms of loss of tourism industry.

Persistent Organic Pollutants (POPs):

POPs are organic chemical substances which are carbon based. They have unique physical and chemical properties that when once released into environment, they travel very long distance through air and water. POPs bio-accumulate in animals and humans.

These pollutants are primarily the products and by-products of human industrial processes.

The initial lists of twelve POPs include;

- Industrial chemicals like polychlorinated biphenyls (PCBs) used in transformer oils;
- pesticides like DDT, endrin, dieldrin, aldrin, chlordane, toxaphene, heptachlor, mirex, hexachlorobenzene (HCB); and
- Unwanted wastes like dioxins ($C_{12}H_4Cl_4O_2$) and furans (C_4H_4O).

They are not soluble in water and are absorbed in fatty tissues where their concentration become magnified by up to 70,000 times the background level. Fish, predatory birds, mammals and humans absorb their greatest concentration and become just like a food chain. When they travel, the POPs travel through them as a result these can be found in people and animals living in regions such as arctic, thousands of kilometer from any major POPs source.

Common Characteristics POPs;

As a general rule, POPs have a number of common properties:

- POPs are persistent in the environment. They resist degradation or breakdown through physical, chemical, or biological processes;
- POPs generally are semi-volatile. They evaporate relatively slowly but when they enter the air, they travel long distances on air currents. They return to earth in rain and snow in the colder areas of the globe, resulting in their accumulation in regions such as the Arctic, thousands of kilometers away from their original sources;
- POPs generally have low water solubility (they do not dissolve readily in water) and high lipid (fat) solubility (they do dissolve easily in fats and oils). Persistent substances with these properties bio-accumulate in fatty tissues of living organisms. In the environment, concentrations of these substances can increase by factors of many thousands or millions as they move up the food chain; and
- POPs have the potential to injure humans and other organisms even at the very low concentrations at which they are now found in the environment, wildlife and humans. Some POPs in extraordinarily small amounts can disrupt normal biological functions, including the

activity of natural hormones and other chemical messengers, triggering a cascade of potentially harmful effects.

Specific Effects of POPs;

Cancer, allergies and hypersensitivity, damage to the central nervous system and peripheral nervous system, reproductive disorders and disruption of the immune system, disruption of endocrine system and hormones which can damage the reproductive and immune systems of exposed individuals as well as their offspring and they can also have developmental and carcinogenic effects.

Green House Effect:

The **greenhouse effect** is the process by which radiation from earth atmosphere warms the earth surface to a temperature above what it would be without its atmosphere. Greenhouse gases in the atmosphere radiate energy, some of which is directed to the surface and lower atmosphere. The mechanism that produces this difference between the actual surface temperature and the effective temperature is due to the atmosphere and is known as the greenhouse effect.

History: The existence of the greenhouse effect was observed first time by **Joseph Fourier** in 1824. The argument and the evidence was further strengthened by **Claude Pouillet** in 1827 and 1838, and reasoned from experimental observations by **John Tyndall** in 1859. The effect was more fully quantified by **Svante Arrhenius** in 1896. However, the term "greenhouse" was not used to refer to this effect by any of these scientists; the term was first used in this way by **Nils Gustaf Ekholm** in 1901. In 1917 **Alexander Graham Bell** wrote "[The unchecked burning of fossil fuels] would have a sort of greenhouse effect", and "The net result is the greenhouse becomes a sort of hot-house. Bell went on to also advocate the use of alternate energy sources, such as solar energy.

Mechanism: Earth receives energy from the Sun in the form of **ultraviolet, visible, and near-infrared** radiation. Of the total amount of solar energy available at the top of the atmosphere, about 26% is reflected to space by the atmosphere and clouds and 19% is absorbed by the atmosphere and clouds. Most of the remaining energy is absorbed at the surface of Earth. Because the Earth's surface is colder than the photosphere of the Sun, it radiates at wavelengths that are much longer than the wavelengths that were absorbed. Most of this thermal radiation is absorbed by the atmosphere, thereby warming it. In addition to the absorption of solar and thermal radiation, the atmosphere further gains heat by sensible and latent heat fluxes from the surface. The atmosphere radiates energy both upwards and downwards; the part radiated downwards is absorbed by the surface of Earth. This leads to a higher equilibrium temperature than if the atmosphere were absent.

Within the region where radiative effects are important, the description given by the idealized greenhouse model becomes realistic. Earth's surface, warmed to a temperature around 255 K, radiates long-wavelength, infrared heat in the range of **4–100 μm** . At these wavelengths, greenhouse gases that were largely transparent to incoming solar radiation are more absorbent. Each layer of atmosphere with greenhouses gases absorbs some of the heat being radiated

upwards from lower layers. It reradiates in all directions, both upwards and downwards; in equilibrium (by definition) the same amount as it has absorbed. This results in more warmth below. Increasing the concentration of the gases increases the amount of absorption and reradiation, and thereby further warms the layers and ultimately the surface below.

Greenhouse gases, including most diatomic gases with two different atoms (such as carbon monoxide, CO) and all gases with three or more atoms are able to absorb and emit infrared radiation. Though more than 99% of the dry atmosphere is IR transparent (because the main constituents, N₂, O₂, and Ar are not able to directly absorb or emit infrared radiation), intermolecular collisions cause the energy absorbed and emitted by the greenhouse gases to be shared with the other, non-IR-active, gases.

Green House Gases: By their percentage contribution to the greenhouse effect on Earth the four major gases are;

- water vapor, 36–70%
- carbon dioxide, 9–26%
- methane, 4–9%
- ozone, 3–7%

It is not physically realistic to assign a specific percentage to each gas because the absorption and emission bands of the gases overlap (hence the ranges given above). The major non-gas contributor to Earth's greenhouse effect, clouds, also absorb and emit infrared radiation and thus have an effect on the radiative properties of the atmosphere.

Role of Green House Gases in Climate Change: Strengthening of the greenhouse effect through human activities is known as the enhanced (or **anthropogenic**) greenhouse effect. This increase in radiative forcing from human activity is attributable mainly to increased atmospheric carbon dioxide levels. According to the latest Assessment Report from the **Inter-governmental Panel on Climate Change**, "atmospheric concentrations of carbon dioxide, methane and nitrous oxide are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming since the mid-20th century".

CO₂ is produced by fossil fuel burning and other activities such as cement production and **tropical deforestation**. Measurements of CO₂ from the Mauna Loa observatory show that concentrations have increased from about 313 parts per million (ppm) in 1960 to about 389 ppm

in 2010. It reached the 400 ppm milestone on May 9, 2013. The current observed amount of CO₂ exceeds the geological record maxima (~300 ppm) from ice core data. The effect of combustion-produced carbon dioxide on the global climate, a special case of the greenhouse effect first described in 1896 by **Svante Arrhenius**, has also been called the **Callendar effect**.

Over the past 800,000 years, ice core data shows that carbon dioxide has varied from values as low as 180 ppm to the pre-industrial level of 270 ppm. **Paleoclimatologists** consider variations in carbon dioxide concentration to be a fundamental factor influencing climate variations over this time scale.

Deforestation:

It is the removal of a forest or stand of trees where the land thereafter converted to a non-forest use. Examples of deforestation include conversion of forestland to farms, or urban use. The most concentrated deforestation occurs in tropical rainforests (**Tropical rainforests** are rainforests that occur in areas of tropical rainforest climate in which there is no dry season. All months have an average precipitation of at least 60 mm. About 31 percent of Earth's land surface is covered by forests. The removal of trees without sufficient **reforestation** has resulted in **habitat damage, biodiversity loss** and **aridity**. About 31 percent of Earth's land surface is covered by forests.

It is estimated that the world is currently losing over **9 million hectares** per year which is an area the size of **Portugal**.

Causes: According to the United Nations Framework Convention on Climate Change (UNFCCC) secretariat, the direct cause of deforestation is agriculture. Subsistence farming is responsible for 48% of deforestation; commercial agriculture is responsible for 32%; logging is responsible for 14%, and fuel wood removals make up 5%.

Other causes of deforestation may include corruption of government institutions population growth and overpopulation, and urbanization. Globalization is often viewed as another root cause of deforestation.

Environmental Effects:

Atmospheric. Deforestation is a contributor to global warming and is often cited as one of the major causes of the enhanced greenhouse effect. Tropical deforestation is responsible for approximately 20% of world greenhouse gas emissions. Deforestation causes carbon dioxide to emit/spread in the atmosphere. As a result, it produces a layer in the atmosphere that traps radiation from the sun. This radiation converts to heat which causes global warming, which is better known as the greenhouse effect.

Hydrological. The water cycle is also affected by deforestation. Trees extract groundwater through their roots and release it into the atmosphere. When part of a forest is removed, the trees no longer transpire this water, resulting in a much drier climate. Deforestation reduces the content of water in the soil and groundwater as well as atmospheric moisture. The dry soil leads to lower water intake for the trees to extract. Deforestation changes the soil structure which results in flooding and landslides ensue.

Trees and plants in general, affect the water cycle significantly:

- their canopies intercept a proportion of precipitation, which is then evaporated back to the atmosphere (canopy interception)
- their litter, stems and trunks slow down surface runoff
- their roots create macropores, large conduits in the soil that increase infiltration of water
- they contribute to terrestrial evaporation and reduce soil moisture via transpiration
- their litter and other organic residue change soil properties that affect the capacity of soil to store water.
- their leaves control the humidity of the atmosphere by transpiring. 99% of the water absorbed by the roots moves up to the leaves and is transpired.

Soil. Deforestation causes soil erosion (In earth science, **erosion** is the action of surface processes that removes soil, rock, or dissolved material from one location on the Earth's crust, and then transports it to another location). Soils are usually by the presence of trees, which secure the soil by binding their roots to soil bedrock. Due to deforestation, the removal of trees causes sloped lands to be more susceptible to landslides.

Biodiversity. Deforestation on a human scale results in decline in biodiversity and on a natural global scale is known to cause the extinction of many species. Since the tropical rainforests are the most diverse ecosystems on earth and about 80% of the world's known biodiversity could be found in tropical rainforests removal or destruction of significant areas of forest cover has resulted in a degraded environment with reduced biodiversity. It has been estimated that we are losing 137 plants, animals and insect species every single day due to rainforest deforestation, which equates to 50,000 species a year.

Salinity or Soil Salinity:

Soil salinity is the salt content in the soil and the process of increasing the salt content is known as **salinization**. **Salinity** is the measure of all the salts dissolved in water. **Salinity** is usually measured in parts per thousand (ppt). The average ocean **salinity** is 35 ppt and the average river water **salinity** is 0.5 ppt or less. This means that in every kilogram (1000 grams) of seawater, 35 grams are salt. Salinity is either expressed in grams of salt per kilogram of water, or in parts per thousand (ppt). For example, if you have 1 gram of salt and 1,000 grams of water, your salinity is 1 g/kg, or 1 ppt.

Freshwater has very little salt, usually less than 0.5 ppt. Water with salinity of 0.5-17 ppt is called **brackish** water (it is **salt water** and fresh **water** mixed together. It is saltier than fresh **water**, but not as salty as seawater), which is found in **estuaries** and coastal salt marshes. Depending on their location and source of fresh water, some estuaries can have salinities as high as 30 ppt. Seawater is on average 35 ppt, but it can range between 30 - 40 ppt. This variation occurs because of differences in evaporation, precipitation, freezing, and freshwater runoff from land at different latitudes and locations. Seawater salinity also varies by water depth because water density and pressure increase with depth. Water with salinity above 50 ppt is **brine** water (**Brine** is a high-concentration solution of salt (usually sodium chloride) in water), though not many organisms can survive in such a high salt concentration. The Dead Sea has a salinity of more than 200 g/kg. Rainwater before touching the ground typically has a TDS (total dissolved solids) of 20 mg/L or less. **Total dissolved solids (TDS)** comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates) and some small amounts of organic matter that are dissolved in **water**.

Water can be classified by the level of total dissolved solids (TDS) in the water:

- **Fresh water:** TDS = 500 ppm
- **Brackish water:** TDS = 500 - 30,000 ppm
- **Saline water:** TDS = 30,000 - 40,000 ppm
- **Hyper saline:** TDS greater than 40,000 ppm

Influences of salinity on Environment: It influences different types of organisms that live in a body of water. Salinity also influences the kinds of plants that will grow either in a water body, or on land fed by water. A plant adapted to saline conditions is called a halophyte

(A **halophyte** is a salt-tolerant plant that grows in waters of high salinity e.g. *Spartina alterniflora*). A halophyte which is tolerant to residual sodium carbonate salinity are called glasswort (The **glassworts** are various succulent, annual halophytes plants that thrive in saline environments, such as seacoasts) barilla plants (*Barilla* refers to several species of salt-tolerant (halophyte) plants. Organisms (mostly bacteria) that can live in very salty conditions are classified as extremophiles, halophiles specifically. An organism that can withstand a wide range of salinities is euryhaline (**Euryhaline** organisms are able to adapt to a wide range of salinities). An example of a euryhaline fish is the molly which can live in fresh water, brackish water, or salt water. Organisms (mostly bacteria) that can live in very salty conditions are classified as extremophiles, or halophiles (Halophiles are organisms that survive in high salt concentrations. They are a type of extremophile organisms "salt-loving").

Common Effects:

- Detrimental effects on plant growth and yield
- Damage to infrastructure (roads, bricks, corrosion of pipes and cables)
- Reduction of water quality for users, sedimentation problems, increased leaching of metals, especially copper, cadmium, manganese and zinc.
- soil erosion ultimately, when crops are too strongly affected by the amounts of salts.
- More energy required to desalinate.

Environmental Issues

Our environment is constantly changing. There is no denying that. However, as our environment changes, so does the need to become increasingly aware of the problems that surround it. With a massive influx of natural disasters, warming and cooling periods, different types of weather patterns and much more, people need to be aware of what types of environmental problems our planet is facing. Our planet is poised at the brink of a severe environmental crisis. Current environmental problems make us vulnerable to disasters and tragedies, now and in the future. We are in a state of planetary emergency, with environmental problems piling up high around us. Unless we address the various issues prudently and seriously we are surely doomed for disaster. Current environmental problems require urgent attention.

Top Environmental Issues:

- 1. Pollution:** Pollution of air, water and soil require millions of years to recoup. Industry and motor vehicle exhaust are the number one pollutants. Heavy metals, nitrates and plastic are toxins responsible for pollution. While water pollution is caused by oil spill, acid rain, urban runoff; air pollution is caused by various gases and toxins released by industries and factories and combustion of fossil fuels; soil pollution is majorly caused by industrial waste that deprives soil from essential nutrients.
- 2. Global Warming:** Climate changes like global warming is the result of human practices like emission of Greenhouse gases. Global warming leads to rising temperatures of the oceans and the earth's surface causing melting of polar ice caps, rise in sea levels and also unnatural patterns of precipitation such as flash floods, excessive snow or desertification.
- 3. Overpopulation:** The population of the planet is reaching unsustainable levels as it faces shortage of resources like water, fuel and food. Population explosion in less developed and developing countries is straining the already scarce resources. Intensive agriculture practiced to produce food damages the environment through use of chemical fertilizer, pesticides and insecticides. Overpopulation is one of the crucial current environmental problem.
- 4. Natural Resource Depletion:** Natural resource depletion is another crucial current environmental problems. Fossil fuel consumption results in emission of Greenhouse gases, which is responsible for global warming and climate change. Globally, people are taking efforts to shift to renewable sources of energy like solar, wind, biogas and geothermal

energy. The cost of installing the infrastructure and maintaining these sources has plummeted in the recent years.

5. **Waste Disposal:** The over consumption of resources and creation of plastics are creating a global crisis of waste disposal. Developed countries are notorious for producing an excessive amount of waste or garbage and dumping their waste in the oceans and, less developed countries. Nuclear waste disposal has tremendous health hazards associated with it. Plastic, fast food, packaging and cheap electronic wastes threaten the well being of humans. Waste disposal is one of urgent current environmental problem.
6. **Climate Change:** Climate change is yet another environmental problem that has surfaced in last couple of decades. It occurs due to rise in global warming which occurs due to increase in temperature of atmosphere by burning of fossil fuels and release of harmful gases by industries. Climate change has various harmful effects but not limited to melting of polar ice, change in seasons, occurrence of new diseases, frequent occurrence of floods and change in overall weather scenario.
7. **Loss of Biodiversity:** Human activity is leading to the extinction of species and habitats and loss of bio-diversity. Eco systems, which took millions of years to perfect, are in danger when any species population is decimating. Balance of natural processes like pollination is crucial to the survival of the eco-system and human activity threatens the same. Another example is the destruction of coral reefs in the various oceans, which support the rich marine life.
8. **Deforestation:** Our forests are natural sinks of carbon dioxide and produce fresh oxygen as well as helps in regulating temperature and rainfall. At present forests cover 30% of the land but every year tree cover is lost amounting to the country of Panama due to growing population demand for more food, shelter and cloth. Deforestation simply means clearing of green cover and make that land available for residential, industrial or commercial purpose.
9. **Ocean Acidification:** It is a direct impact of excessive production of CO₂. 25% of CO₂ produced by humans. The ocean acidity has increased by the last 250 years but by 2100, it may shoot up by 150%. The main impact is on shellfish and plankton in the same way as human osteoporosis.
10. **Ozone Layer Depletion:** The ozone layer is an invisible layer of protection around the planet that protects us from the sun's harmful rays. Depletion of the crucial Ozone layer of the

atmosphere is attributed to pollution caused by Chlorine and Bromide found in Chloro-fluorocarbons (CFC's). Once these toxic gases reach the upper atmosphere, they cause a hole in the ozone layer, the biggest of which is above the Antarctic. The CFC's are banned in many industries and consumer products. Ozone layer is valuable because it prevents harmful UV radiation from reaching the earth. This is one of the most important current environmental problem.

- 11. Acid Rain:** Acid rain occurs due to the presence of certain pollutants in the atmosphere. Acid rain can be caused due to combustion of fossil fuels or erupting volcanoes or rotting vegetation which release sulfur dioxide and nitrogen oxides into the atmosphere. Acid rain is a known environmental problem that can have serious effect on human health, wildlife and aquatic species.
- 12. Water Pollution:** Clean drinking water is becoming a rare commodity. Water is becoming an economic and political issue as the human population fights for this resource. One of the options suggested is using the process of desalinization. Industrial development is filling our rivers seas and oceans with toxic pollutants which are a major threat to human health.
- 13. Urban Sprawl:** Urban sprawl refers to migration of population from high density urban areas to low density rural areas which results in spreading of city over more and more rural land. Urban sprawl results in land degradation, increased traffic, environmental issues and health issues. The ever growing demand of land displaces natural environment consisting of flora and fauna instead of being replaced.
- 14. Public Health Issues:** The current environmental problems pose a lot of risk to health of humans, and animals. Dirty water is the biggest health risk of the world and poses threat to the quality of life and public health. Run-off to rivers carries along toxins, chemicals and disease carrying organisms. Pollutants cause respiratory disease like Asthma and cardiac-vascular problems. High temperatures encourage the spread of infectious diseases like Dengue.
- 15. Genetic Engineering:** Genetic modification of food using biotechnology is called genetic engineering. Genetic modification of food results in increased toxins and diseases as genes from an allergic plant can transfer to target plant. Genetically modified crops can cause serious environmental problems as an engineered gene may prove toxic to wildlife. Another

drawback is that increased use of toxins to make insect resistant plant can cause resultant organisms to become resistant to antibiotics.

Sustainable Development of the Environment:

Environmental governance advocates **sustainability** as the supreme consideration in managing all human activities. According to them “*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*”

Sustainable development is based on the three pillars of sustainability: (i) economic, (ii) environmental and (iii) social sustainability.

At the United Nations Sustainable Development Summit in 2015, world leaders adopted the 2030 Agenda for Sustainable Development, which includes a set of 17 Sustainable Development Goals (SDGs) aimed at ending poverty, fighting inequality and injustice and tackling climate change by 2030.

Sustainable Development Goals

1. End poverty in all its forms everywhere.
2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
3. Ensure healthy lives and promote well-being for all at all ages.
4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
5. Achieve gender equality and empower all women and girls.
6. Ensure availability and sustainable management of water and sanitation for all.
7. Ensure access to affordable, reliable, sustainable and modern energy for all.
8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
10. Reduce inequality within and among countries.
11. Make cities and human settlements inclusive, safe, resilient and sustainable.
12. Ensure sustainable consumption and production patterns.
13. Take urgent action to combat climate change and its impacts.

14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
17. Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Desertification:

Desertification is defined as a process of land degradation in arid, semi-arid and sub-humid areas due to various factors including climatic variations and human activities. Desertification, in short, is when land that was originally of another type of biome turns into a desert biome because of changes of all sorts.

Overgrazing is the major cause of desertification worldwide. Other factors that cause desertification include urbanization, climate change, over-drafting of groundwater, deforestation, natural disasters and tillage practices in agriculture that place soils more vulnerable to wind. Desertification affects topsoil, groundwater reserves, surface runoff, human, animals and plant populations. Water scarcity in dry lands limits the production of wood, crops, forage and other services that ecosystems provide to our community.

Major Causes of Desertification:

Overgrazing: Animal grazing is a huge problem for many areas that are starting to become desert biomes. If there are too many animals that are overgrazing in certain spots, it makes it difficult for the plants to grow back, which hurts the biome and makes it lose its former green glory.

Deforestation: When people are looking to move into an area, or they need trees in order to make houses and do other tasks, then they are contributing to the problems related to desertification. Without the plants (especially the trees) around, the rest of the biome cannot thrive.

Farming Practices: Some farmers do not know how to use the land effectively. They may essentially strip the land of everything that it has before moving on to another plot of land. By stripping the soil of its nutrients, desertification becomes more and more of a reality for the area that is being used for farming.

Urbanization and other types of land development: As mentioned above, development can cause people to go through and kill the plant life. It can also cause issues with the soil due to chemicals and other things that may harm the ground. As areas become more urbanized, there are less places for plants to grow, thus causing desertification.

Climate Change: Climate change plays a huge role in desertification. As the days get warmer and periods of drought become more frequent, desertification becomes more and more eminent. Unless climate change is slowed down, huge areas of land will become desert; some of those areas may even become uninhabitable as time goes on.

Stripping the land of resources: If an area of land has natural resources like natural gas, oil, or minerals, people will come in and mine it or take it out. This usually strips the soil of nutrients, which in turn kills the plant life, which in turn starts the process toward becoming a desert biome as time goes on.

Natural Disasters: There are some cases where the land gets damaged because of natural disasters, including drought. In those cases, there isn't a lot that people can do except work to try and help rehabilitate the land after it has already been damaged by nature.

Effects of Desertification:

Farming becomes next to impossible: If an area becomes a desert, then it's almost impossible to grow substantial crops there without special technologies. This can cost a lot of money to try and do, so many farmers will have to sell their land and leave the desert areas.

Hunger: Without farms in these areas, the food that those farms produce will become much scarcer, and the people who live in those local areas will be a lot more likely to try and deal with hunger problems. Animals will also go hungry, which will cause even more of a food shortage.

Flooding: Without the plant life in an area, flooding is a lot more eminent. Not all deserts are dry; those that are wet could experience a lot of flooding because there is nothing to stop the water from gathering and going all over the place. Flooding can also negatively affect the water supply, which we will discuss next.

Poor Water Quality: If an area becomes a desert, the water quality is going to become a lot worse than it would have been otherwise. This is because the plant life plays a significant role in keeping the water clean and clear; without its presence, it becomes a lot more difficult for you to be able to do that.

Overpopulation: When areas start to become desert, animals and people will go to other areas where they can actually thrive. This causes crowding and overpopulation, which will, in the long run, end up continuing the cycle of desertification that started this whole thing anyway.

Poverty: All of the issues that we've talked about above (related to the problem of desertification) can lead to poverty if it is not kept in check. Without food and water, it becomes harder for people to thrive, and they take a lot of time to try and get the things that they need.

Solutions for Desertification:

Policy Changes Related to How People can Farm: In countries where policy change will actually be enforced on those in the country, policy change related to how often people can farm and how

much they can farm on certain areas could be put into place to help reduce the problems that are often associated with farming and desertification.

Policy Changes to Other Types of Land Use: If people are using land to get natural resources or they are developing it for people to live on, then the policies that govern them should be ones that will help the land to thrive instead of allowing them to harm the land further. The policy changes could be sweeping or they could be depending on the type of land use at hand.

Education: In developing countries, education is an incredibly important tool that needs to be utilized in order to help people to understand the best way to use the land that they are farming on. By educating them on sustainable practices, more land will be saved from becoming desert.

Technology Advances: In some cases, it's difficult to try and prevent desertification from happening. In those cases, there needs to be research and advancements in technology that push the limits of what we currently know. Advancements could help us find more ways to prevent the issue from becoming epidemic.

Putting Together Rehabilitation Efforts: There are some ways that we can go back and rehabilitate the land that we've already pushed into desertification; it just takes some investment of time and money. By putting these together, we can prevent the issue from becoming even more widespread in the areas that have already been affected.

Sustainable practices to prevent desertification from happening: There are plenty of sustainable practices that can be applied to those acts that may be causing desertification. By adding these to what we should be doing with land, we can ensure that we don't turn the entire world into a desert.

Environmental Migration/Migrants:

Environmental migrants are people who are forced to leave their home region due to sudden or long-term changes to their local environment. These are changes which compromise their well-being or secure livelihood. Such changes are held to include increased droughts, desertification, sea level rise, and disruption of seasonal weather patterns. Or “**Environmental migrants are persons or groups of persons who, predominantly for reasons of sudden or progressive change in the environment that adversely affects their lives or living conditions, are obliged to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their country or abroad**”.

Types:

The International Organisation for Migration (IOM) proposes three types of environmental migrants:

- **Environmental emergency migrants:** people who flee temporarily due to an environmental disaster or sudden environmental event. (Examples: someone forced to leave due to a hurricane, tsunami, earthquake, etc.)
- **Environmental forced migrants:** people who have to leave due to deteriorating environmental conditions. (Example: someone forced to leave due to a slow deterioration of their environment such as deforestation, coastal deterioration, etc.)
- **Environmental motivated migrants also known as environmentally induced economic migrants:** people who choose to leave to avoid possible future problems. (Example: someone who leaves due to declining crop productivity caused by desertification)

“those displaced temporarily due to local disruption such as an avalanche or earthquake; those who migrate because environmental degradation has undermined their livelihood or poses unacceptable risks to health; and those who resettle because land degradation has resulted in desertification or because of other permanent and untenable changes in their habitat.”

Other categorizations include:

Pressured environmental migrants.

This type of migrant is displaced from their environment when an event is predicted prior to when it would be imperative for the inhabitants to leave. Such events could be desertification or prolonged drought, where the people of the region are no longer able to maintain farming or hunting to provide a hospitable living environment.

Imperative environmental migrants.

These are migrants that have been or will be "permanently displaced" from their homes due to environmental factors beyond their control.

Temporary environmental migrants.

This includes migrants suffering from a single event (i.e. Hurricane Katrina). This does not go to say that their status of being temporary is any less severe than that of the other, it simply means that they are able to go back to the place they fled from (though it may be undesirable to do so) granted that they are able to rebuild what was broken, and go on to maintain a similar quality of life to the one prior to the natural disaster. This type of migrant is displaced from their home state when their environment rapidly changes. They are displaced when disastrous events occur, such as tsunamis, hurricanes, tornadoes, and other natural disasters occur.

Global statistics:

Odi Jacobson (1988) is cited as the first researcher to enumerate the issue, stating that there were already up to 10 million 'Environmental Refugees'. Drawing on 'worst-case scenarios' about sea-level rise, she argued that all forms of 'Environmental Refugees' would be six times as numerous as political refugees. By 1989, Executive Director of UNEP, was claiming that 'as many as 50 million people could become environmental refugees' if the world did not act to support sustainable development. In 1990, the Intergovernmental Panel on Climate Change (IPCC 1990) declared that the greatest single consequence of climate change could be migration, 'with millions of people displaced by shoreline erosion, coastal flooding and severe drought'.

In the mid-1990s, British environmentalist, **Norman Myers**, became the most prominent by noting, that "environmental refugees will soon become the largest group of involuntary refugees". Myers argued that the causes of environmental displacement would include desertification, lack of water, salination of irrigated lands and the depletion of biodiversity. He also hypothesised that displacement would amount to 30m in China, 30m in India, 15m in Bangladesh, 14m in Egypt, 10m in other delta areas and coastal zones, 1m in island states, and with otherwise agriculturally displaced people totalling 50m by 2050. More recently, Myers has suggested that the figure by 2050 might be as high as 250 million. These claims have gained significant currency, with the most common projection being that the world will have 150–200 million climate change refugees by 2050.

Asia and the Pacific: According to the Internal Displacement Monitoring Centre, more than 42 million people were displaced in Asia and the Pacific during 2010 and 2011, more than twice the population of Sri Lanka. This figure includes those displaced by storms, floods, and heat and cold waves. Still others were displaced by drought and sea-level rise. Most of those compelled to leave their homes eventually returned when conditions improved, but an undetermined number became migrants, usually within their country, but also across national borders.

A 2012 Asian Development Bank study argues that climate-induced migration should be addressed as part of a country's development agenda, given the major implications of migration on economic and social development. The report recommends interventions both to address the situation of those who have migrated, as well as those who remain in areas subject to environmental risk.