

MCN-201 :

SUSTAINABLE ENGINEERING

MODULE 2

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MODULE 2

- ❑ Environmental Pollution: Air Pollution and its effects
- ❑ Water pollution and its sources,
- ❑ Zero waste concept and 3 R concepts in solid waste management
- ❑ Greenhouse effect
- ❑ Global warming
- ❑ Climate change
- ❑ Ozone layer depletion
- ❑ Carbon credits
- ❑ carbon trading and carbon footprint
- ❑ legal provisions for environmental protection.

POLLUTION

- "Pollution is the introduction of substances (or energy) that harm the environment and living things."
- The word pollution is derived from the Latin word "Polluere" which means to defile or make dirty.
- Undesirable changes in the environment/surroundings which not only adversely affect humans and other living things, but also our developmental activities and socio-cultural life.
- Materials in any form that causes pollution are called pollutants.

1. Air Pollution and its effects

Air pollution refers to the release of harmful contaminants (chemicals, toxic gases, particulates, biological molecules, etc.) into the earth's atmosphere. These contaminants are quite detrimental and in some cases, pose serious health issues. Some causes that contribute to air pollution are:

- Burning fossil fuels
- Mining operations
- Exhaust gases from industries and factories

SOURCES OF AIR POLLUTION

The sources of air pollution may be broadly classified as **natural & anthropogenic**

- **Natural sources of air pollution include:**

Volcanoes: Volcanic activity produces smoke, ash, CO_2 , SO_2 etc

Dust: Wind blown dust from areas with little or no vegetation such as desert.

Forest fires: Forest fires created by natural causes , result in the formation and release of smoke, ash, dust, CO_2

- **Anthropogenic (Man-made) sources of air pollution:**

Stationary point sources: It is a source of air pollutant emission can be controlled at the origin. (factories & power plants)

Mobile sources: It includes the exhaust emissions from vehicles

Evaporative sources: Volatile liquids that, when not completely enclosed in a tank or other container, evaporate and release vapour over time. (paints, solvents, pesticides , perfumes etc.)

EFFECTS OF AIR POLLUTION

- **Effects of air pollution on human health :**

- Generally occur as a result of contact between pollutants and the body.
- Eye irritation , Nose and throat irritation , Increase in mortality rate , Chronic pulmonary diseases , Carbon monoxide readily combines with haemoglobin in blood replacing oxygen from blood , Causes cancer.

- **Effects of air pollution on plants :**

- Suppressed growth and premature ageing in plants
- Causes leaf bleaching which results in Chlorosis (photosynthesis is affected due to loss of Chlorophyll) , Premature falling of leaves(abscission) , Causes necrosis (dead spots on leaves) .

- **Effects of air pollution on animals & birds**

- Affects the mucous lining of respiratory tract , Causes bronchitis and asthma
- Lack of appetite in pet animals , Acid deposition cause aquatic life damage
- Migration of seasonal birds are hampered due to severe air pollution

- **Effects of air pollution on material and property**

- Acid deposition can corrode metals, eat away stone on statues and monuments
- Discolour buildings, cloth fabrics

- **Effects of air pollution on environment**

- Reduce visibility , Pollutants can travel long distance – results in global (transboundary) pollution
- Climate change , acid rain, global warming etc

2. Water pollution and its sources

- ❖ Water pollution can be defined as the contamination of water bodies.
- ❖ Water pollution is caused when water bodies such as rivers, lakes, oceans, groundwater and aquifers get contaminated with industrial and agricultural effluents.
- ❖ Water contained in water bodies like lakes, rivers and oceans are called surface water.
- ❖ Water stored in aquifers (underground rock structures) is called underground water (subsurface water). Both these sources are prone to pollution.

SOURCES OF WATER POLLUTION

Water pollution occurs mainly due to presence of domestic as well as industrial wastes in fresh water.

1. Point Source: Sources which can be readily identified at a single location. This type of discharges can be controlled easily.

Examples: Waste water discharge from industries, domestic sector etc..

2 Non-point sources: Source of origin cannot be traced to a single discharge point. Examples: runoff from agricultural land, mining areas etc...

3. Natural sources of water pollution

Rain water, atmosphere, Underground rocks and volcanoes

4. Anthropogenic (man made) sources of water pollution

These sources include oil spills, industrial waste water discharges runoff from agricultural fields, waste water from automobile garages etc.

Generally water gets polluted from the following sources.

a) Domestic Waste water:

- Waste water generated from residential areas, commercial places, institution and other public places. Generally domestic sewage consists of 99.9% water and 0.1% solids.

b) Agricultural waste water:

- This is the runoff from the agricultural fields and animal farms and this waste water is rich in Nitrogen, Phosphate, Organic matter and Pesticides.

- This induces rapid growth of microscopic plants in surface waters thereby reducing oxygen content in aquatic environment, known as Eutrophication.

c) Industrial waste water:

- They are the one which results from industrial operations.
- It may have pollutants of almost all kinds ranging from simple nutrients and organic matter to complex toxic substances.

d) Groundwater pollution:

- Various kinds of harmful materials like fertilizers, pesticides, metals etc present in the solid waste gets dissolved into water.
- During rain these pollutants drain down into the soil & contaminate the groundwater.

Control Measures of Water Pollution

- ❖ Water pollution, to a larger extent, can be controlled by a variety of methods.
- ❖ Rather than releasing sewage waste into water bodies, it is better to treat them before discharge.
- ❖ Practising this can reduce the initial toxicity and the remaining substances can be degraded and rendered harmless by the water body itself.
- ❖ If the secondary treatment of water has been carried out, then this can be reused in sanitary systems and agricultural fields.

3. ZERO WASTE CONCEPT AND 3 R CONCEPTS IN SOLID WASTE MANAGEMENT

- **Zero waste** is a set of principles focused on waste prevention that encourages redesigning resource life cycles so that all products are reused.
- The goal of this movement is to avoid sending trash to landfills, incinerators or the ocean.
- In a zero waste system, the material will be reused until the optimum level of consumption is reached

- The definition of zero waste according to the Zero Waste International Alliance (ZWIA) is as follows:

“Zero waste: The conservation of all resources by means of responsible production, consumption, reuse, and recovery of products, packaging, and materials without burning and with no discharges to land, water, or air that threaten the environment or human health.”

IMPORTANCE OF ZERO WASTE

- It is important to promote zero waste in order to ensure that our planet will be able to sustain itself in the future.
- It is no secret we are running out of resources and pollution are at its peak.

"The importance of zero-waste living is becoming more and more obvious. It creates awareness and conversations surrounding environmental degradation, climate change, social justice, and stems wider than simply throwing fewer things away."

BENEFITS OF ZERO WASTE

- Living organism consume resources and produce waste ,which is food for other organism.As a result all the waste are continuously recycled and thereby making the environment clean and more sustainable
- Reducing, reusing and recycling can be a key part of a climate change strategy to reduce our greenhouse gas emissions.
- A zero waste approach can build community capacity, support marginalized communities and protect community health.

“Zero waste can have huge positive impact on society,community,climate and business”

THE “3 R’s” IN SOLID WASTE MANAGEMENT

- The 3 R’s of waste management
 - Reduce
 - Reuse
 - Recycle.

REDUCE

- The first goal of source reduction is simply to reduce the overall amount of waste that is produced.
- The second goal is to conserve resources by not using raw, virgin materials.
- In other words, by following source reduction, fewer raw materials will have to be used to produce products.

REUSE

- There are two main ways that the concept of reusing can be applied to reduce waste.
 - First, when purchasing a new item, you can look for a product that can be used repeatedly instead of a version that is only used once and thrown away.
 - The second way to reuse is to buy an item secondhand, borrow, or rent an item, instead of buying the product new.

RECYCLE

- Recycling is the last and most commonly used of the 3 Rs. Recycling is changing discarded materials into new products in order to avoid using more virgin resources.
- You can opt to recycle as much as you can for various items such as papers, plastic, stained fabrics, waste electronics, metals, etc.
- It decreases pollutants while saving money, energy, raw materials, and land space.
- Recycling means treating the materials as valuable resources rather than as waste.

4. Greenhouse effect

"The greenhouse effect is the process by which solar radiation is absorbed by greenhouse gases rather than reflected back into space. This insulates the earth's surface and keeps it from freezing."

- It is a natural phenomenon which refers to the rise in temperature of the earth due to the presence of certain greenhouse gases (GHG) in the atmosphere.
- GHG are water vapours, carbon dioxide, methane, nitrous oxide etc
- These gases are transparent to the incoming ultraviolet solar radiations but trap the outgoing infrared radiations, reflected back from the earth's surface.
- If these gases were not present, the annual average temperature of the earth would be much lower (-18°C) than they are now (15°C).
- Excess amount of greenhouse gases will create excess hot conditions all over the earth.

The Greenhouse Effect

Some solar radiation is reflected by the Earth and the atmosphere.

Some of the infrared radiation passes through the atmosphere. Some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.

Most radiation is absorbed by the Earth's surface and warms it.

Infrared radiation is emitted by the Earth's surface.

Atmosphere
Earth's surface



- Although the greenhouse effect is a naturally occurring phenomenon, it is possible that the effect could be intensified by the emission of greenhouse gases into the atmosphere as the result of human activity.
- From the beginning of the Industrial Revolution through the end of the 20th century, the amount of carbon dioxide in the atmosphere increased by roughly 30 percent and the amount of methane more than doubled.
- A number of scientists have predicted that human-related increases in atmospheric carbon dioxide and other greenhouse gases could lead by the end of the 21st century to an increase in the global average temperature of 3–4 °C (5.4–7.2 °F) relative to the 1986–2005 average.
- This **global warming** could alter Earth's climates and thereby produce new patterns and extremes of drought and rainfall and possibly disrupt food production in certain regions.

5. GLOBAL WARMING

- It is the increase of earth's average surface temperature due to the presence of too much greenhouse gases such as carbon dioxide, methane etc.
- The atmosphere holds on to too much heat, instead of letting it escape into space. This results in Global Warming.

Causes of Global Warming

- Burning of fossil fuels
- Refrigerants and air conditioners release CFC
- Deforestation - carbon dioxide intake is reduced when forests are cut down.
- Methane emission occurs due to anaerobic decomposition at huge landfills.
- Methane emission from livestock (animal farm)

Effects of Global Warming

- Rising Seas
- Changes in rainfall patterns
- Increased global temperature
- Melting of the ice
- Melting glaciers
- Widespread vanishing of animal populations
- Spread of disease
- Acidification of oceans

Measures to control Global Warming

- Promote renewable energy usage (solar energy, wind energy etc.)
- Depend more on public transport system to reduce the use of fossil fuels.
- Afforestation and reforestation
- Adopt 3R concept whenever possible.
- Reduce energy consumption at home, office etc.

6.Climate change

Climate change refers to changes caused by global warming in weather (temperature, untimely rain etc) and exists for an extended period of time.

Causes of climate change

1. Natural causes of climate change are :
 - a. Continental Drift
 - b. Variations in solar output
 - c. Volcanoes
 - d. Earth's tilt
 - e. Ocean Currents

2. Anthropogenic causes of climate change are :

- a. Increase in usage of fossil fuels
- b. Deforestation
- c. Population growth
- d. Urbanization
- e. Industrial revolution

Effects of climate change

- ❖ Rising Seas
- ❖ Changes in rainfall patterns
- ❖ Increased global temperature
- ❖ Melting of the ice
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- ❖ Widespread vanishing of animal populations
- ❖ Spread of disease
- ❖ Acidification of oceans

7. OZONE LAYER DEPLETION

- Ozone layer is a deep layer in earth's atmosphere
- Ozone is a naturally occurring molecule containing three oxygen atoms
- These ozone molecules form a gaseous layer in the Earth's upper atmosphere called stratosphere.
- This lower region of stratosphere containing relatively higher concentration of ozone is called Ozonosphere.
- The ozonosphere is found 15-35 km (9 to 22 miles) above the surface of the earth and it protects our planet from the harmful UV radiations.
- The ozone layer has the capability to absorb almost 97-99% of the harmful ultraviolet radiations that sun emits.
- UV rays produce long term devastating effects on human beings as well as plants and animals.
- Ozone depletion refers to the phenomenon of reductions in the amount of ozone in the stratosphere.

Man-made causes for Ozone layer depletion

- Main reason for the depletion of ozone layer is the excessive release of chlorine and bromine from man-made compounds like CFCS (chlorofluorocarbons), halons, methylbromide etc
- These -made compounds are classified as Ozone-Depleting Substances (ODS). Ozone- Depleting Substances (ODS) are not washed back in the form of rain on the earth and remains in the atmosphere for quite a long time. With so much stability, they are transported into the stratosphere. These gases are carried to the stratosphere layer of atmosphere.
- Ultraviolet radiations from the sun break them to release chlorine (from CFCs) and bromine (from methylbromide and halons).

Effects of Ozone layer depletion

- ★ Skin cancer
- ★ Eye damage such as cataracts
- ★ Immune system damage
- ★ Reduction in phytoplankton (microscopic marine organisms that are food small fish, as well as whales)
- ★ Damage to the DNA in various life-forms

8. Carbon credits, carbon trading and carbon footprint

CARBON CREDITS

Carbon credits, also known as carbon offsets, are permits that allow the owner to emit a certain amount of carbon dioxide or other greenhouse gases. One credit permits the emission of one ton of carbon dioxide or the equivalent in other greenhouse gases.

KEY TAKEAWAYS

- Carbon credits were devised as a mechanism to reduce greenhouse gas emissions.
- Companies get a set number of credits, which decline over time, and they can sell any excess to another company.
- Carbon credits create a monetary incentive for companies to reduce their carbon emissions. Those that cannot easily reduce emissions can still operate, at a higher financial cost.

How Do Carbon Credits Work?

- ❖ The ultimate goal of carbon credits is to reduce the emission of greenhouse gases into the atmosphere.
- ❖ As noted, a carbon credit represents the right to emit greenhouse gases equivalent to one ton of carbon dioxide.
- ❖ According to the Environmental Defense Fund, that is the equivalent of a 2,400-mile drive in terms of carbon dioxide emissions.
- ❖ Companies or nations are allotted a certain number of credits and may trade them to help balance total worldwide emissions.
- ❖ “Since carbon dioxide is the principal greenhouse gas,” the United Nations notes, “people speak simply of trading in carbon.”

CARBON TRADING

Carbon trade is the buying and selling of credits that permit a company or other entity to emit a certain amount of carbon dioxide or other greenhouse gases. The carbon credits and the carbon trade are authorized by governments with the goal of gradually reducing overall carbon emissions and mitigating their contribution to climate change.

KEY TAKEAWAYS

- Carbon trade agreements allow for the sale of carbon credits in order to reduce total emissions.
- Several countries and territories have started carbon trading programs.
- Carbon trading is adapted from cap and trade, a regulatory approach that successfully reduced sulfur pollution in the 1990s.
- These measures are aimed at reducing the effects of global warming but their effectiveness remains a matter of debate.

Where - Trade Carbon Emissions?

- There are many regional exchanges that can be used for carbon trading. Some of the largest include Xpansiv CBL, based in New York, and Air Carbon Exchange, based in Singapore. The largest is the Shanghai Environment and Energy Exchange, which opened in 2021.

Current Price of Carbon?

- There is no fixed price of carbon worldwide—prices fluctuate by jurisdiction and by market supply and demand—but the benchmark EUA Futures price ranged between €80 and €100 euros for the first four months of 2022.

carbon footprint

- ❖ carbon footprint, amount of carbon dioxide (CO₂) emissions associated with all the activities of a person or other entity (e.g., building, corporation, country, etc.).
- ❖ It includes direct emissions, such as those that result from fossil-fuel combustion in manufacturing, heating, and transportation, as well as emissions required to produce the electricity associated with goods and services consumed.
- ❖ In addition, the carbon footprint concept also often includes the emissions of other greenhouse gases, such as methane, nitrous oxide, or chlorofluorocarbons (CFCs).

Carbon footprint reduction

- ❖ Individuals and corporations can take a number of steps to reduce their carbon footprints and thus contribute to global climate mitigation.
- ❖ They can purchase carbon offsets (broadly stated, an investment in a carbon-reducing activity or technology) to compensate for part or all of their carbon footprint.
- ❖ Carbon footprints can be reduced through **improving energy efficiency and changing lifestyles** and purchasing habits.
- ❖ Switching **one's energy and transportation use can have an impact on primary carbon footprints.**
- ❖ For example, using public transportation, such as buses and trains, reduces an individual's carbon footprint when compared with driving.
- ❖ Individuals and corporations can reduce their respective carbon footprints **by installing energy-efficient lighting, adding insulation in buildings, or using renewable energy sources to generate the electricity** they require.
- ❖ For example, electricity generation from wind power produces no direct carbon emissions.

9. legal provisions for environmental protection

PROVISION IN INDIAN CONSTITUTION

❖ ARTICLE 21

Protection of life and personal Liberty.

❖ ARTICLE 48A

Protection and Improvement of environment and safeguarding of forest and wildlife.

❖ ARTICLE 51A

Fundamental duties of every citizen of India
To Protect and improve natural environment
including forest, rivers, lakes and wildlife.

MAJOR ENVIRONMENTAL LEGISLATIONS OF INDIA

- Water (Prevention & Control of Pollution) - **Act 1974**
- Air (Prevention & Control of Pollution) - **Act 1981**
- Environmental Protection - **Act 1986** (May 1986)