Chhattisgarh Institute of Technology, Jashpur

Department of Science & Humanities

Subject- Environmental Engg. & Sustainable Development

Subject Code-2000B05CT020 (NEP)

Semester- Second

Session- 2025-26

Prepared By-

Dr. Sanjay Kumar Sao

Lecturer,Physics

Environmental Studies Class Notes for Diploma Students

How to use these notes

These notes are written for diploma students in simple language and cover the major topics of environment, pollution, sustainable development, clean technologies, renewable energy, EIA, conservation, and environmental law in India. Key definitions, examples, short diagrams, tables, and exam-ready points are included throughout.

1. Introduction to Environment and Environmental Pollution

1.1 Meaning of environment

Environment means everything that surrounds living organisms and affects their life. It includes air, water, land, plants, animals, microorganisms, sunlight, climate, and human-made surroundings such as buildings, roads, industries, and machines.

The environment has two broad parts:

- **Biotic components:** living things such as plants, animals, and microorganisms.
- **Abiotic components:** non-living things such as air, water, soil, sunlight, temperature, and minerals.

1.2 Components of environment

The environment is commonly studied in four major spheres:

- **Atmosphere:** the layer of gases around Earth.
- **Hydrosphere:** all water bodies such as rivers, lakes, oceans, groundwater, and ice.
- **Lithosphere:** the solid outer crust of Earth, including rocks and soil.
- **Biosphere:** the zone where life exists.

1.3 What is pollution?

Pollution is the undesirable change in the physical, chemical, or biological characteristics of air, water, or land that harms living beings and property. When harmful substances or energy are added to the environment beyond safe limits, pollution occurs.

1.4 Pollutant

A pollutant is any solid, liquid, gas, microorganism, heat, noise, or radiation that causes harm to the environment.

Examples:

- Smoke from factories
- Sewage in rivers
- Plastic waste on land
- Loud sound from traffic
- Hot water discharged from power plants
- Radioactive waste from nuclear activities

1.5 Types of pollution

Main types of pollution are:

- Water pollution
- Air pollution
- Soil pollution
- Noise pollution
- Thermal pollution
- Radioactive pollution

1.6 Simple environmental relationship

```
Sunlight
   ↓
Plants → Animals → Human beings
   ↓         ↓
 Soil      Waste
   ↓         ↓
 Water ← Decomposition
```

This diagram shows that all parts of the environment are linked. Damage to one part affects others.

1.7 Example

If untreated factory effluent enters a river, the river water becomes polluted, fish die, crops irrigated with that water get affected, and humans may suffer disease after using the water.

2. Water Pollution

2.1 Introduction

Water pollution is the contamination of surface water or groundwater by harmful substances. Water becomes polluted when physical, chemical, or biological changes make it unsafe for drinking, domestic use, agriculture, industry, or aquatic life.

2.2 Sources of water pollution

Important sources are:

- Domestic sewage from houses, hostels, hospitals, and hotels
- Industrial effluents from textile, paper, tannery, fertilizer, chemical, and food industries
- Agricultural runoff containing fertilizers, pesticides, and insecticides
- Oil spills from ships and petroleum activities
- Religious and social activities near rivers and lakes
- Dumping of solid waste in water bodies
- Mining and quarrying operations
- Thermal discharge from industries and power plants

2.3 Classification of water pollutants

Water pollutants can be classified as follows:

A. Physical pollutants

- Suspended solids
- Turbidity
- Color
- Odor
- Taste
- Heat

B. Chemical pollutants

- Acids and alkalis
- Salts
- Heavy metals such as lead, mercury, cadmium, chromium, arsenic
- Nitrates and phosphates
- Detergents
- Pesticides

- Oil and grease

C. Biological pollutants

- Bacteria
- Viruses
- Protozoa
- Fungi
- Algae
- Worms and parasites

D. Oxygen-demanding wastes

These are organic materials that consume dissolved oxygen during decomposition. Examples: sewage, food waste, animal waste.

2.4 Indicators of water pollution

- High turbidity
- Bad smell or bad taste
- Change in pH
- Low dissolved oxygen
- High BOD and COD
- Presence of coliform bacteria
- Excessive nitrate, fluoride, iron, arsenic, etc.

2.5 Adverse effects of water pollution

Water pollution causes:

- Water-borne diseases such as cholera, typhoid, dysentery, diarrhea, and hepatitis
- Death of fish and other aquatic organisms
- Eutrophication due to excess nutrients
- Foul smell and bad appearance of water bodies
- Bioaccumulation of toxic substances in the food chain
- Reduced usability of water for drinking and irrigation
- Soil damage when polluted water is used for agriculture

2.6 Eutrophication

Eutrophication is the excessive growth of algae in water bodies due to nutrient enrichment, mainly nitrates and phosphates.

```
Fertilizers/Sewage
      ↓
More nitrates and phosphates
      ↓
Rapid algal growth
      ↓
Algae die and decompose
      ↓
Dissolved oxygen decreases
      ↓
Fish die
```

2.7 Control of water pollution

Main control measures are:

- Treatment of sewage before discharge
- Effluent treatment in industries
- Reuse and recycling of wastewater
- Control on use of fertilizers and pesticides
- Sanitary landfill instead of open dumping
- Prevent direct disposal of waste into rivers and lakes
- Public awareness and strict law enforcement
- Rainwater harvesting and groundwater recharge
- Separation of storm water and sewage drains

2.8 Common treatment steps for wastewater

```
Screening → Sedimentation → Biological treatment → Filtration → Disinfection → Safe
```

2.9 Domestic water standards in India

The Indian Standard IS 10500:2012 gives drinking water specifications. It prescribes acceptable limits and, for some parameters, permissible limits when no alternate source is available.

Important physical and chemical standards for drinking water (domestic water)

Parameter	Acceptable limit	Permissible limit in absence of alternate source
Colour	5 Hazen units	15 Hazen units
pH	6.5 to 8.5	No relaxation
Turbidity	1 NTU	5 NTU
Total dissolved solids	500 mg/L	2000 mg/L
Chloride	250 mg/L	1000 mg/L
Fluoride	1.0 mg/L	1.5 mg/L
Iron	0.3 mg/L	No relaxation
Nitrate	45 mg/L	No relaxation
Sulphate	200 mg/L	400 mg/L
Total hardness as CaCO3	200 mg/L	600 mg/L
Calcium	75 mg/L	200 mg/L
Magnesium	30 mg/L	100 mg/L
Total alkalinity as CaCO3	200 mg/L	600 mg/L
Lead	0.01 mg/L	No relaxation
Arsenic	0.01 mg/L	0.05 mg/L
Residual chlorine	0.2 mg/L minimum	1 mg/L

Bacteriological requirement: E. coli or thermotolerant coliform bacteria should not be detectable in any 100 mL sample of drinking water.

2.10 Example

If a village pond receives sewage and detergent-rich wastewater, algae grow rapidly, dissolved oxygen falls, mosquitoes breed, and the water becomes unsafe for humans and cattle.

3. Air Pollution

3.1 Introduction

Air pollution is the presence of unwanted solid, liquid, or gaseous substances in air in concentrations harmful to humans, animals, plants, materials, and the climate. Clean air is essential for respiration and healthy life.

3.2 Sources of air pollutants

Main sources are:

- Motor vehicles
- Thermal power plants
- Factories and industries
- Burning of coal, diesel, petrol, wood, crop residue, and waste
- Construction and mining activities
- Domestic cooking with biomass fuels
- Natural sources such as dust storms, forest fires, and volcanic eruptions

3.3 Classification of air pollutants

Air pollutants may be classified as follows:

A. On the basis of origin

- **Primary pollutants**: emitted directly into the air, such as CO, SO2, NO, particulate matter.
- **Secondary pollutants**: formed in the atmosphere by chemical reactions, such as ozone, PAN, and photochemical smog.

B. On the basis of physical form

- Gaseous pollutants: CO, CO2, SO2, NOx, hydrocarbons
- Particulate pollutants: dust, smoke, soot, mist, fumes, aerosols

3.4 Major air pollutants

- Particulate matter (PM10 and PM2.5)
- Sulphur dioxide (SO2)
- Nitrogen oxides (NO and NO2)
- Carbon monoxide (CO)
- Ozone (O3)
- Hydrocarbons
- Lead and other toxic metals

3.5 Effects of air pollution on humans

- Eye, nose, and throat irritation
- Asthma and bronchitis
- Lung disease and reduced breathing capacity
- Headache and fatigue due to carbon monoxide

- Heart problems
- Cancer risk from toxic pollutants

3.6 Effects on plants

- Reduction in photosynthesis
- Yellowing and drying of leaves
- Stunted growth
- Reduced crop yield
- Damage due to acid rain and ozone

3.7 Effects on animals

- Respiratory stress
- Reduced productivity in cattle and poultry
- Accumulation of toxic chemicals through food and water
- Harm to wildlife habitats

3.8 Air monitoring system

Air quality monitoring means measurement of pollutants in ambient air to know pollution level and health risk.

In India, air quality is monitored through national and continuous monitoring systems. Pollutants commonly monitored include PM2.5, PM10, SO2, NO2, CO, O3, NH3, Pb, and others depending on the station.

Basic air monitoring setup

```
Air sample → Sampler/Sensor → Analyzer → Data logger → AQI calculation → Public info
```

Purpose of air monitoring

- To know present air quality
- To compare with standards
- To identify pollution trends
- To support pollution control planning
- To issue health advisories

3.9 Air Quality Index (AQI)

AQI is a simple number used to represent overall air quality for the public. It converts pollutant concentrations into categories like good, satisfactory, moderate, poor, very poor, and severe.

3.10 Air pollution control methods

- Use cleaner fuels such as LPG, CNG, electricity, and low-sulphur fuels
- Proper maintenance of vehicles
- Installation of filters, cyclones, scrubbers, and electrostatic precipitators in industries
- Green belt development
- Control of dust at construction sites
- Public transport and traffic management
- Energy efficiency and process improvement

3.11 Devices used in air pollution control

Device	Main use
Settling chamber	Removal of large dust particles
Cyclone separator	Removal of coarse particulate matter
Bag filter	Fine dust removal
Electrostatic precipitator	Removal of very fine particles from flue gas
Wet scrubber	Removal of gases and fine particles
Catalytic converter	Vehicle emission control

3.12 Example

Smoke emitted from a brick kiln contains particulate matter and gases. Nearby residents may suffer coughing, while crops may show dust deposition and reduced growth.

4. Soil Pollution

4.1 Introduction

Soil pollution is the degradation or contamination of soil by chemicals, waste materials, and harmful biological agents. Polluted soil loses fertility and may become unsafe for agriculture and human contact.

4.2 Sources of soil pollution

- Excessive use of fertilizers and pesticides
- Industrial solid waste and hazardous waste
- Municipal garbage and plastics
- Biomedical waste
- Mining waste
- Oil spills
- E-waste and batteries
- Sewage sludge and untreated wastewater irrigation

4.3 Adverse effects of soil pollution

- Loss of soil fertility
- Poor crop quality and low yield
- Entry of toxic metals into food chain
- Groundwater contamination
- Harm to soil microorganisms and earthworms
- Land becoming unfit for agriculture or habitation

4.4 Control measures of soil pollution

- Use biofertilizers and organic manure
- Controlled use of chemical fertilizers and pesticides
- Proper segregation and disposal of solid waste
- Composting of biodegradable waste
- Safe landfill for hazardous waste
- Recycling of plastics, metals, and e-waste
- Soil testing and remediation
- Afforestation and vegetation cover

4.5 Example

Improper disposal of used batteries in open land can release lead and other metals into soil, affecting plant growth and human health.

5. Noise Pollution

5.1 Introduction

Noise pollution is unwanted or excessive sound that disturbs comfort, health, and normal activities. Unlike many other pollutants, noise is a form of energy.

5.2 Measurement of noise

Noise is measured in **decibel (dB)** using a sound level meter.

5.3 Acceptable noise level

Acceptable limits depend on the area such as industrial, commercial, residential, and silence zones. Lower levels are preferred in schools, hospitals, and residential areas.

A simple idea:

- 20–30 dB: whisper, quiet room
- 40–60 dB: normal conversation
- 70–90 dB: busy traffic, loud machinery
- Above 100 dB: harmful for long exposure

5.4 Sources of noise pollution

- Road traffic and horns
- Trains and aircraft
- Generators and compressors
- Industrial machines
- Loudspeakers and music systems
- Construction activities
- Household appliances

5.5 Effects of noise pollution

- Irritation and stress
- Lack of concentration
- Sleep disturbance
- Increased blood pressure
- Hearing loss on long exposure
- Reduced work efficiency

5.6 Control of noise pollution

- Silencers and acoustic enclosures
- Green belts around roads and industries
- Proper maintenance of machines
- Use of sound-absorbing materials
- Restriction on loudspeakers and honking
- Zoning of industrial and residential areas
- Ear plugs and ear muffs for workers

5.7 Example

A generator placed near a classroom may disturb teaching and reduce student concentration.

6. Thermal Pollution

6.1 Introduction

Thermal pollution is the rise or fall of temperature of a natural water body due to human activity, mainly the discharge of hot water from industries and power plants.

6.2 Causes of thermal pollution

- Hot cooling water from thermal and nuclear power plants
- Industrial discharge from steel, chemical, and refinery units
- Removal of shade along river banks
- Soil erosion causing warming in shallow water

6.3 Effects of thermal pollution

- Decrease in dissolved oxygen in water
- Thermal shock to aquatic organisms
- Disturbance of breeding and migration of fish
- Rapid growth of algae and harmful microorganisms
- Change in aquatic ecosystem balance

6.4 Control of thermal pollution

- Cooling towers
- Cooling ponds
- Heat exchangers
- Recycling of cooling water

- Use of waste heat recovery systems
- Controlled discharge temperature

6.5 Example

A power plant releasing hot water into a lake can reduce dissolved oxygen and cause fish mortality.

7. Radioactive Pollution

7.1 Introduction

Radioactive pollution is the contamination of air, water, soil, or living organisms by radioactive substances. These substances emit harmful radiation.

7.2 Sources of radioactive pollution

- Nuclear power plants
- Nuclear weapon testing
- Mining and processing of radioactive ores
- Medical use of radioisotopes
- Research laboratories
- Improper disposal of radioactive waste

7.3 Adverse effects of radioactive pollution

- Genetic mutation
- Cancer and leukemia
- Skin burns and radiation sickness
- Damage to reproductive organs
- Long-term contamination of land and water

7.4 Control of radioactive pollution

- Proper shielding and containment
- Safe transport and storage of radioactive material
- Controlled disposal of radioactive waste
- Monitoring with radiation detectors
- Strict safety rules in nuclear installations
- Emergency preparedness and trained personnel

7.5 Example

Leakage from a medical radioactive source due to careless handling can expose workers and the surrounding area to radiation.

8. Sustainable Development

8.1 Concept of sustainable development

Sustainable development means development that meets present needs without reducing the ability of future generations to meet their own needs. It balances economic growth, social welfare, and environmental protection.

8.2 Main pillars

- Economic sustainability
- Social sustainability
- Environmental sustainability

```
Economic
   /\
  /  \
 /____\
Social  Environment
```

This triangle shows that true development should balance all three pillars.

8.3 Natural resources

Natural resources are materials and services obtained from nature.

Abiotic resources

Non-living resources such as:

- Air
- Water
- Minerals
- Sunlight
- Soil

Biotic resources

Living resources such as:

- Forests
- Crops
- Animals
- Fisheries
- Microorganisms

8.4 Principles of conservation of energy and management

- Avoid energy wastage
- Improve efficiency of machines and systems
- Use energy audits
- Recover waste heat
- Adopt renewable sources
- Use insulation and proper maintenance
- Switch off idle equipment

8.5 Need of renewable energy

Renewable energy is needed because:

- Conventional fuels are limited
- Fossil fuels cause pollution and greenhouse gases
- Renewable sources are cleaner
- They improve energy security
- They support sustainable development

8.6 Growth of renewable energy in India and the world

Renewable energy has grown rapidly due to climate concerns, technological improvement, and policy support. Solar and wind sectors have expanded strongly in India and many other countries.

8.7 Waste management and recycling

Waste management means collection, transportation, treatment, recovery, and safe disposal of waste. Recycling converts waste materials into useful products.

8.8 Importance of recycling

- Saves raw materials
- Saves energy
- Reduces pollution
- Reduces landfill load
- Creates jobs

8.9 Example

Using recycled aluminum saves much more energy than producing aluminum from fresh ore.

9. Clean Technologies

9.1 Introduction

Clean technology means techniques, products, and processes that reduce pollution, save resources, and improve efficiency. It aims at preventing pollution at the source rather than treating it after formation.

9.2 Types of energy

Energy can be broadly grouped into:

- Conventional energy
- Non-conventional energy
- Commercial energy
- Non-commercial energy
- Renewable energy
- Non-renewable energy

9.3 Conventional energy sources

- Coal
- Petroleum
- Natural gas
- Large hydropower (often placed in conventional use category in traditional syllabi)

9.4 Non-conventional energy sources

- Solar energy
- Wind energy
- Biomass energy
- Biogas
- Small hydropower
- Geothermal energy
- Tidal energy
- Ocean thermal energy

9.5 Recycling and pollution control

Clean technologies promote:

- Reuse of process water
- Recycling of scrap and by-products
- Cleaner production
- Low-waste manufacturing
- Energy-efficient equipment
- Emission and effluent reduction

9.6 Example

Replacing old diesel pumps with solar pumps reduces fuel use, air pollution, and operating cost.

10. Solar Power

10.1 Features of solar thermal systems

Solar thermal systems convert solar energy into heat. They are used for water heating, cooking, drying, and steam generation.

Main features:

- Use solar collectors
- Good for thermal applications
- Lower operating cost after installation
- Best in sunny regions

10.2 Features of PV systems

Photovoltaic systems convert sunlight directly into electricity.

Main features:

- Use solar cells/modules
- No moving parts in basic system
- Low maintenance
- Suitable for rooftops and remote areas
- Output depends on sunlight

10.3 Solar PV working diagram

```
Sunlight → Solar panel → Charge controller → Battery/Inverter → Load
```

10.4 Types of solar cookers

- Box type solar cooker
- Parabolic dish solar cooker
- Panel solar cooker

10.5 Types of solar water heaters

- Flat plate collector system
- Evacuated tube collector system

10.6 Advantages of solar energy

- Renewable and clean
- No fuel cost
- Useful in remote areas
- Low maintenance
- Reduces electricity bill

10.7 Limitations of solar energy

- High initial cost
- Depends on sunshine
- Storage is needed for night use
- Large area may be required

10.8 Biofuels and electricity in sectors

Biofuels and electricity are increasingly used in transport, agriculture, irrigation, lighting, and small industries as cleaner alternatives to diesel and petrol.

10.9 Example

A rooftop solar water heater in a hostel can reduce electricity consumption for bathing water.

11. Hydel Energy

11.1 Introduction

Hydel or hydroelectric energy is produced by using the energy of falling or flowing water to rotate turbines and generate electricity.

11.2 Basic working

```
Dam/Reservoir → Penstock → Turbine → Generator → Electricity
```

11.3 Advantages of hydel energy

- Renewable source
- Low operating cost after installation
- No direct air pollution during operation
- Helps irrigation and flood control in many projects
- Long life of plants

11.4 Limitations

- High initial cost
- Large land submergence in some projects
- Ecological and social impacts
- Depends on water availability and rainfall

11.5 Example

A dam-based hydropower station can generate electricity and also provide irrigation water, but it may also require rehabilitation of displaced people.

12. Wind Energy

12.1 Introduction

Wind energy uses moving air to rotate turbine blades and produce electricity.

12.2 Advantages

- Clean and renewable
- No fuel cost
- Useful for coastal and windy regions
- Quick installation compared to large thermal plants

12.3 Limitations

- Variable power output
- Needs windy sites
- Noise and visual impact in some cases
- Bird collision risk if poorly planned
- Large area for wind farms

12.4 Working diagram

```
Wind → Rotor blades → Shaft → Generator → Electricity
```

12.5 Example

Wind turbines installed in coastal or open plateau areas can supply grid electricity with no fuel burning.

13. Biomass Energy

13.1 Introduction

Biomass energy is energy obtained from organic matter such as crop residue, wood, dung, bagasse, and other biological materials.

13.2 Types of biomass energy sources

- Firewood
- Agricultural residue
- Animal dung
- Bagasse

- Energy crops
- Municipal organic waste
- Forest residue

13.3 Energy content of biomass

Different biomass materials have different calorific values depending on moisture content and composition. Dry biomass has higher usable energy than wet biomass.

13.4 Types of biomass conversion processes

- Direct combustion
- Gasification
- Pyrolysis
- Anaerobic digestion
- Fermentation

13.5 Biogas production

Biogas is produced by anaerobic digestion of organic matter like cattle dung, kitchen waste, and sewage in the absence of oxygen.

Simple biogas plant diagram

```
Dung + Water → Inlet tank → Digester → Gas holder → Gas to stove
                                  ↓
                             Slurry outlet
```

13.6 Composition of biogas

Biogas mainly contains:

- Methane
- Carbon dioxide
- Small amounts of hydrogen sulphide and water vapor

13.7 Advantages of biogas

- Clean cooking fuel
- Uses waste material
- Reduces smoke indoors
- Produces slurry useful as manure
- Suitable for rural areas

13.8 Example

A dairy farm can use cattle dung to produce biogas for cooking and electricity in a small generator.

14. Environmental Impact Assessment (EIA)

14.1 Meaning of EIA

Environmental Impact Assessment is a systematic process used to identify, predict, evaluate, and reduce the environmental impacts of a proposed project before decision-making.

14.2 Need for EIA

- To avoid environmental damage before it occurs
- To improve project planning
- To consider alternatives
- To protect ecology and public health
- To ensure legal compliance

14.3 Scope of EIA

EIA may cover:

- Air quality impact
- Water quality impact
- Noise impact
- Soil and land use impact
- Ecological impact
- Social and health impact
- Risk and disaster aspects

14.4 Steps in EIA

1. Screening
2. Scoping
3. Baseline data collection
4. Impact prediction
5. Mitigation measures
6. Public consultation
7. EIA report preparation

8. Review and decision
9. Monitoring and follow-up

14.5 EIA process diagram

```
Project idea
   ↓
Screening
   ↓
Scoping
   ↓
Baseline study
   ↓
Impact assessment
   ↓
Mitigation plan
   ↓
Public hearing
   ↓
EIA report
   ↓
Approval / Rejection
   ↓
Implementation and monitoring
```

14.6 Public participation in EIA

Public participation allows affected people to know project details, raise objections, suggest improvements, and express local concerns. It increases transparency and accountability.

14.7 EIA documentation

Typical EIA documents include:

- Project description
- Baseline environmental status
- Impact analysis
- Alternatives considered
- Environmental management plan
- Risk assessment
- Monitoring plan

14.8 EIA report

An EIA report is the formal document submitted for environmental appraisal. It should be clear, factual, and based on field data and technical analysis.

14.9 EIA Gazette notification

The EIA Notification issued on 14 September 2006 forms the legal basis for environmental clearance of many categories of development projects in India.

14.10 EIA action plan and implementation

After approval, the project must implement mitigation measures, pollution control systems, green belts, waste management systems, and monitoring programs as committed in the EIA/EMP.

14.11 Follow-up in EIA

Follow-up includes:

- Compliance monitoring
- Environmental auditing
- Corrective action
- Reporting to regulatory authorities

14.12 Simple case study idea

A highway expansion project may improve transport but can also cause tree cutting, dust, noise, habitat fragmentation, and displacement. Through EIA, alignment changes, compensatory plantation, drainage planning, and noise barriers can be proposed.

15. Water Conservation

15.1 Meaning

Water conservation means careful use, protection, and efficient management of water resources to avoid wastage and ensure future availability.

15.2 Methods of water conservation

- Repair leakage in pipelines and taps
- Use low-flow fixtures
- Reuse grey water where suitable
- Adopt drip and sprinkler irrigation
- Rainwater harvesting

- Recharge wells and ponds
- Watershed development
- Awareness and water budgeting

15.3 Example

Fixing a leaking tap in a hostel can save a large amount of water over time.

16. Rainwater Harvesting

16.1 Introduction

Rainwater harvesting is the collection and storage of rainwater from rooftops or land surfaces for later use or groundwater recharge.

16.2 Need

- Reduces water scarcity
- Recharges groundwater
- Reduces storm water runoff
- Lowers flooding risk in urban areas
- Improves water availability in dry season

16.3 Rooftop rainwater harvesting diagram

```
Roof → Gutter → Filter → Storage tank / Recharge pit
```

16.4 Components

- Catchment surface
- Gutters and downpipes
- Filter unit
- Storage tank or recharge pit
- First flush arrangement

16.5 Example

A school building roof can collect monsoon rainfall and store it for toilet flushing and gardening.

17. Watershed Management

17.1 Meaning

A watershed is an area of land from which all runoff water drains to a common outlet such as a stream, pond, or river. Watershed management means scientific management of land and water in that area.

17.2 Objectives

- Soil conservation
- Water conservation
- Groundwater recharge
- Increased agricultural productivity
- Reduced floods and erosion
- Improved rural livelihood

17.3 Measures

- Contour bunding
- Check dams
- Gully plugging
- Afforestation
- Farm ponds
- Percolation tanks
- Controlled grazing

17.4 Example

A check dam built in a small watershed slows runoff, increases infiltration, and helps nearby wells retain water longer.

18. Acid Rain

18.1 Introduction

Acid rain is rain or other precipitation with higher acidity due to the presence of sulphuric and nitric acids formed from sulphur dioxide and nitrogen oxides in the atmosphere.

18.2 Formation

```
SO2 + NOx from industries/vehicles
            ↓
Reaction with water vapor and oxygen
            ↓
Acids form in atmosphere
            ↓
Acid rain
```

18.3 Effects of acid rain

- Damage to crops and forests
- Corrosion of buildings and monuments
- Acidification of lakes and soil
- Harm to aquatic life
- Damage to historic structures

18.4 Control measures

- Reduce SO2 and NOx emissions
- Use low sulphur fuel
- Install scrubbers in industries
- Use cleaner transport systems

18.5 Example

Historic stone buildings can slowly erode due to long-term acid deposition.

19. Climate Change, Greenhouse Effect, Ozone Depletion, Global Warming

19.1 Climate change

Climate change means long-term changes in temperature, rainfall, wind, and other climate conditions. Human activities such as burning fossil fuels and deforestation increase greenhouse gases and influence climate.

19.2 Greenhouse effect

The greenhouse effect is the warming of Earth because gases like carbon dioxide, methane, nitrous oxide, and water vapor trap outgoing heat.

```
Sunlight enters atmosphere
       ↓
Earth surface warms
```

```
        ↓
Earth emits heat
        ↓
Greenhouse gases trap part of heat
        ↓
Atmosphere warms
```

19.3 Global warming

Global warming is the rise in average temperature of Earth due to the enhanced greenhouse effect.

19.4 Effects of climate change and global warming

- Rise in temperature
- Irregular rainfall
- Floods and droughts
- Glacier melting and sea-level rise
- Heat waves
- Crop and water stress
- Biodiversity loss

19.5 Measures against global warming

- Energy efficiency
- Renewable energy adoption
- Afforestation and forest protection
- Public transport and electric mobility
- Reduced fossil fuel use
- Waste reduction and methane control

19.6 Ozone layer depletion

The ozone layer in the stratosphere protects life from harmful ultraviolet radiation. Ozone depletion means thinning of this layer due to chemicals such as CFCs, halons, and related substances.

19.7 Effects of ozone layer depletion

- Skin cancer risk increases
- Eye damage such as cataract
- Harm to crops and plankton
- Damage to ecosystems

19.8 Example

Excess use of old refrigeration chemicals contributes to ozone depletion if those gases escape into the atmosphere.

20. Solid Waste Management

20.1 Introduction

Solid waste management means systematic handling of waste from generation to final disposal in order to protect health and the environment.

20.2 Types of solid waste

- Municipal waste
- Industrial waste
- Biomedical waste
- Construction and demolition waste
- E-waste
- Hazardous waste

20.3 Causes of urban and industrial waste problems

- Population growth
- Consumerism and packaging waste
- Industrial expansion
- Lack of segregation
- Poor collection systems
- Limited recycling practices

20.4 Effects of improper waste management

- Bad smell and dirty surroundings
- Fly and mosquito breeding
- Water and soil contamination
- Air pollution from open burning
- Disease spread
- Methane emission from dumps

20.5 Control measures of solid waste

- Segregation at source
- Door-to-door collection
- Composting of wet waste
- Recycling of paper, plastic, glass, and metal
- Scientific landfill
- Incineration where appropriate
- Producer responsibility for e-waste and plastics

20.6 Importance of 3R's

- **Reduce**: use less material and avoid waste generation
- **Reuse**: use items again instead of discarding them
- **Recycle**: process waste into new products

20.7 Example

Separate bins for wet and dry waste in a college campus improve recycling efficiency and reduce landfill burden.

21. Environment Protection Act, 1986

21.1 Importance

The Environment (Protection) Act, 1986 is an umbrella law in India for the protection and improvement of the environment.

21.2 Objectives

- Protect and improve environmental quality
- Prevent hazards to humans, plants, and animals
- Coordinate actions of different authorities
- Lay down standards for emissions and discharges
- Regulate handling of hazardous substances

21.3 Significance for students

This Act supports environmental rules on pollution control, hazardous waste, EIA, and industrial compliance.

22. Short Notes for Revision

22.1 BOD and COD

- BOD: Biochemical Oxygen Demand, oxygen required by microorganisms to decompose organic matter.
- COD: Chemical Oxygen Demand, oxygen required to oxidize organic and inorganic matter chemically.
  Higher values usually indicate stronger pollution.

22.2 Difference between biodegradable and non-biodegradable waste

Biodegradable waste	Non-biodegradable waste
Decomposes naturally	Does not decompose easily
Food waste, leaves, paper	Plastic, glass, metals
Can be composted	Needs recycling or safe disposal

22.3 Difference between renewable and non-renewable energy

Renewable energy	Non-renewable energy
Replenished naturally	Limited and exhaustible
Solar, wind, biomass	Coal, petroleum, natural gas
Cleaner in general	More pollution in general

22.4 Point source and non-point source pollution

Point source	Non-point source
Pollution from identifiable outlet	Pollution from scattered sources
Factory discharge pipe	Agricultural runoff

23. Frequently Asked Exam Questions

1. Define environment and explain its components.
2. What is environmental pollution? Explain major types.
3. Define water pollution and describe its sources.
4. Classify water pollutants with examples.
5. Explain adverse effects and control of water pollution.
6. Write drinking water standards as per Indian Standard.
7. Define air pollution and classify air pollutants.
8. Explain sources and effects of air pollution on humans, plants, and animals.

9. What is AQI? Explain air monitoring system.
10. Explain methods of air pollution control.
11. Define soil pollution and discuss its control measures.
12. What is noise pollution? Explain its effects and control.
13. Write short notes on thermal pollution and radioactive pollution.
14. Explain sustainable development and natural resources.
15. Discuss renewable energy and its need.
16. Explain solar, hydel, wind, and biomass energy.
17. What is EIA? Explain its scope and steps.
18. Explain rainwater harvesting and watershed management.
19. What are acid rain, greenhouse effect, and global warming?
20. Explain solid waste management and the importance of 3R's.

24. Model Answers in Brief

24.1 What is water pollution?

Water pollution is the contamination of water by harmful substances so that it becomes unsuitable for drinking, domestic use, industry, agriculture, and aquatic life. Main causes include sewage, industrial effluent, agricultural runoff, and waste dumping.

24.2 What is sustainable development?

Sustainable development is development that satisfies present needs while preserving resources and environmental quality for future generations. It aims to balance economy, society, and ecology.

24.3 What is rainwater harvesting?

Rainwater harvesting is the collection of rainwater from rooftops or surface runoff and storing it for use or groundwater recharge. It helps reduce water scarcity and improves groundwater levels.

25. Practical Examples from Daily Life

- Wastewater from kitchens should not be discharged directly into open drains without proper management.
- Plantation along roads reduces dust, noise, and heat.
- Carrying cloth bags instead of plastic bags helps reduce land and water pollution.
- Switching off fans, lights, and machines when not in use saves energy and reduces emissions indirectly.

- Composting hostel or household food waste creates manure and cuts waste disposal problems.

26. Important One-Line Definitions

- **Environment:** Total surroundings affecting life.
- **Pollution:** Undesirable change in the environment causing harm.
- **Pollutant:** Substance or energy causing pollution.
- **Eutrophication:** Excessive nutrient enrichment in water leading to algal growth.
- **AQI:** Air Quality Index.
- **Biogas:** Fuel gas produced by anaerobic digestion of organic matter.
- **EIA:** Environmental Impact Assessment.
- **Acid rain:** Rain made acidic by atmospheric pollutants.
- **Global warming:** Rise in Earth's average temperature.
- **3R's:** Reduce, Reuse, Recycle.

27. Mnemonics and Memory Tips

- **Types of pollution:** WASNTR = Water, Air, Soil, Noise, Thermal, Radioactive.
- **EIA steps:** SSCBIMPR = Screening, Scoping, Collection of baseline data, Baseline analysis, Impact prediction, Mitigation, Public hearing, Report.
- **3R's of waste:** Reduce first, Reuse next, Recycle last.

28. Important Tables for Quick Study

28.1 Pollution and main control method

Pollution type	Main control method
Water pollution	Sewage and effluent treatment
Air pollution	Cleaner fuel and pollution control devices
Soil pollution	Safe disposal and reduced chemical use
Noise pollution	Silencing, zoning, green belts
Thermal pollution	Cooling towers and cooling ponds
Radioactive pollution	Shielding, safe storage, strict monitoring

28.2 Renewable energy overview

Source	Main advantage	Main limitation
Solar	Clean and abundant	Intermittent
Wind	No fuel cost	Variable wind
Hydel	Mature technology	Ecological/social impact
Biomass	Uses waste	Emissions if poorly controlled

29. Mini Assignments

Assignment 1

Explain with diagram the causes, effects, and control of water pollution in 300 words.

Assignment 2

Prepare a table comparing solar, wind, hydel, and biomass energy.

Assignment 3

Visit your locality and list five examples of environmental pollution and possible solutions.

Assignment 4

Draw a neat labeled diagram of rooftop rainwater harvesting.

30. Quiz Questions

1. Which pollutant is mainly responsible for eutrophication?
2. What is the unit of noise measurement?
3. Name any two primary air pollutants.
4. What are the three pillars of sustainable development?
5. Which gas is the main useful fuel in biogas?
6. What does EIA stand for?
7. Give one advantage of wind energy.
8. What is the safe pH range for drinking water?
9. What do the 3R's stand for?
10. Name one source of radioactive pollution.

31. Conclusion for Study Purpose

Environment protection is essential for health, development, and quality of life. Diploma students should understand pollution sources, effects, standards, control methods, renewable energy, EIA, and conservation techniques because these topics are closely related to engineering practice and responsible citizenship.

Source-based factual notes used in this document

- IS 10500:2012 specifies drinking water requirements and lists acceptable and permissible limits for organoleptic, physical, chemical, toxic, and radioactive parameters, along with bacteriological requirements.[cite:1]
- The EIA Notification dated 14 September 2006 forms the basis of India's EIA clearance framework for listed projects.[cite:2]
- India's air quality monitoring and AQI dissemination are carried out through CPCB and associated monitoring systems; AQI uses multiple pollutants and is disseminated through official channels.[cite:3]